Freistaat Bayern

RegioneEmilia-Romagna

Catalunya

7th EUREGEO

Bologna | Italy | june 12th - 15th 2012

EUropean Congress on REgional GEOscientific Cartography and Information Systems

Sustainable Geo-Management

Proceedings Volume II

The Congress Proceedings are published in two volumes.

Volume I : Opening Papers
Abstracts of Sessions 1 – 2 – 3 – 4 - 5 – 6

Volume II: Abstracts Sessions 7 – 8 – 9 – 10 – 11
Programme of Special Sessions
Programme of Hosted Meeting

The proceedings were prepared by
Simonetta Scappini and Silvio Zapparoli

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- ✓ Luca Delfini of Allestimenti e Scenografie srl.
- ✓ Istituto Istruzione Superiore "Bartolomeo Scappi", Castel S.Pietro Terme
- ✓ Eni spa.

Organizing Committee

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EuroGeoSurveys
European Geoscience for Society
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European Commission

Patronage

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

CONSIGLIO NAZIONALE DEI GEOLOGI
VIA VITTORIA COLONNA, 40 00193 ROMA
Tel 06 68807735 - 68807737 - Fax 06 68807742
email: info@cngeologi.it

GEOITALIA,
Federazione Italiana di Scienze della Terra, Onlus

Società Geologica Italiana
Mente et Malleo

G&T

Sponsor

ELIOFOTOTECNICABARBIERI Srl,
via Reggio 45/a, 43100 Parma
www.eft.it info@eft.it +390521944911

Fondata all'inizio degli anni settanta, la ditta opera in due settori "contigui"; quello della "**elaborazione e stampa di cartografia tecnica e tematica"** e della "**riproduzione disegni, documenti, cartografia e servizi connessi"**.

I servizi sono erogati alla Pubblica Amministrazione, alle Università, alle Aziende, ai Professionisti; da oltre 25 anni è operativo ed in costante aggiornamento e sviluppo il comparto che **progetta, elabora e riproduce** cartografia con **tecnologie digitali** negli ambienti GIS, CAD e Grafico.

Recentemente sono stati aperti nuovi reparti che erogano servizi accessori dedicati alla grafica pubblicitaria e alla comunicazione.

La **struttura operativa** è distribuita su una superficie di oltre 1.000 mq ed è composta da due soci amministratori e 21 addetti alla produzione.

Fra gli oltre 900 clienti, dei quali circa 600 sono abituali, i nostri committenti operano nei settori, urbanistico pianificazione e governo del territorio, ambiente, topografico, geologico, progettazione e costruzione di infrastrutture viarie e civili.

MAP SERVICE Srl
Sede legale: Via Bologna 12/1, 43122 Parma
Sede operativa di Parma: Via Reggio 45/a
Sede operativa di Bologna: via dello Scalo 3/2
presso l'Archivio cartografico della Regione Emilia-Romagna,
archiviocart@regione.emilia-romagna.it
+390516493230

Il desiderio e l'opportunità di valorizzare l'esperienza di un gruppo di cartografi acquisita in numerosi anni di attività nel settore che produce, elabora e divulga la cartografia nei suoi vari aspetti e contenuti, e' il motivo che ha portato alla "nascita" di MAP SERVICE nel 1996.

Il periodo in cui si e' costituita, e' coinciso con l'inizio della fase evolutiva dell'Archivio Cartografico della Regione Emilia-Romagna che, attraverso l'esternalizzazione della sua gestione operativa, ha iniziato un percorso finalizzato ad incrementare la disponibilità di prodotti e servizi da erogare agli utenti, interni ed esterni ad essa, imponendo come obiettivo al gestore incaricato il perseguimento del costante miglioramento del livello qualitativo degli stessi.

Attualmente MAP SERVICE è aggiudicataria di un incarico triennale per la gestione dei servizi di consultazione e cessione dei prodotti che l'Archivio cartografico regionale riceve dai vari Servizi regionali. Nella sua sede di Bologna operano 5 addetti alla gestione ed al rapporto con gli utenti. nella sede di Parma operano 3 addetti alla riproduzione e all'amministrazione.

I principali ambiti di attività di Arpa, attribuiti dalla L.R. 44/1995 e ss.mm. sono: monitoraggio dell´ambiente; vigilanza e controllo del territorio e delle attività dell´uomo; attività di supporto e consulenza agli enti pubblici nella valutazione degli effetti sull´ambiente di piani e progetti e per la previsione di rischi per il territorio e per la gestione delle emergenze ambientali; effettuazione di attività analitica di laboratorio; informazione ambientale; realizzazione e gestione del Sistema informativo regionale sull´ambiente.

Consistent e è l'attività relativa a progetti di supporto della Regione e degli Enti Locali: piani di risanamento, indirizzo e gestione su tematiche ambientali; analisi territoriali e valutazioni complesse; studio di sistemi ambientali; ricerche per la prevenzione ambientale nei cicli produttivi; studi e ricerche in tema di ambiente e salute; attività osservative e previsionali operative e di ricerca e sviluppo, in meteorologia, climatologia, idrologia.

Sponsor and exhibitor

S.E L.C A. - Firenze
società elaborazioni cartografiche

S.EL.CA. dal 1978 ai vertici della produzione cartografica nazionale, cura la rappresentazione del “mondo” in cui viviamo: la geografia, le scienze della terra, la botanica, la pedologia, le scienze forestali, la fotogrammetria, il telerilevamento e tutto il settore della pianificazione territoriale e urbanistica.

S.EL.CA. nel corso degli anni ha sempre seguito ed assecondato l’evoluzione tecnologica e culturale del mondo della cartografia. Oggi tutta l’organizzazione tecnico-produttiva aziendale è regolata dall’uso degli strumenti informatici più avanzati. Grande attenzione ed impegno viene dedicato ai Sistemi Informativi Geografici (GIS): la S.EL.CA. si adopera, con unanime riconoscimento, nel coniugare il rigore dei numeri (Banche Dati) con l’altrettanto rigorosa produzione cartografica.

S.EL.CA. nel mondo della cartografia oltre ad una organizzazione che è in grado di fornire tutti i servizi ad essa connessi, onora l’arte della stampa litografica, producendo Carte che comunicano scienza, evocano paesaggio e trasmettono cultura.

semenda
INFORMATICA PER IL TERRITORIO

SEMENDA opera in modo esclusivo nella progettazione e realizzazione di Sistemi Informativi Territoriali.

La società si rivolge in particolare alla Pubblica Amministrazione: Regioni, Province, Comuni, Aziende Municipalizzate, Consorzi di Bonifica, Università proponendosi soprattutto come partner qualificato in grado di affiancare l’utenza in tutte le fasi del progetto dall’analisi dei requisiti fino all’inserimento del sistema nei processi amministrativi ed organizzativi dell’Ente.

SEMENDA è impegnata fin dalla sua costituzione a perseguire un’intensa specializzazione tecnologica ed applicativa e ad impiegare tutte le sue risorse nella ricerca di soluzioni innovative per meglio rispondere alle esigenze degli utenti.

La società progetta e sviluppa il proprio software applicativo avvalendosi delle più avanzate tecnologie hardware e software disponibili sul mercato.

SEMENDA e’ Partner Silver Premium di esri Italia Business Network.

SYSTEMCART
Servizi di Cartografia Computerizzata
Computerized Cartographic Services

SystemCart S.r.l. is a Company created in 1991 by the fusion of experts in traditional cartography and printing, who have perceived how wide was the potential of the new available geospatial technologies, for the future development of maps production.

The Company aims at offering a wide range of services mainly referring to land description and management, carried out by means of methodologies developed in GIS environment (e.g. ESRI, Intergraph).

The professional skills and experience acquired by the Company in the traditional preparation of any kind of scientific mapping (geology, seismology, volcanology, hydrogeology, land use, pedology etc.), together with the extensive knowledge of the new available platforms, allows the SystemCart S.r.l. to be an ideal interface between the stakeholders and a series of innovative products, resulting from the application of highly-qualified information systems.

Exhibitor

TRE measures ground deformation to millimeter accuracy by analyzing SAR (Synthetic Aperture radar) satellite images with our latest algorithm: SqueeSAR™ - a unique tool for detecting, measuring and monitoring geophysical phenomena such as: subsidence, uplift, landslides, seismic faults, etc., and verifying the stability of individual structures. Maps of surface deformation provide a quantitative understanding of ground response to both natural and anthropogenic activities.

TRE, the first spin-off company from the Politecnico di Milano, was founded in 2000 with the patenting of its first proprietary algorithm: PSInSAR™. Continuous investment in research and development lead to the unveiling of the new algorithm SqueeSAR™ in 2010, providing a significantly more powerful deformation mapping tool - firmly identifying TRE as leader in ground monitoring with SAR satellite data.

TRE's has two offices: TRE (Milan) and TRE Canada (Vancouver).

Esri Italia S.p.A.
Via Tiburtina, 755 - 00159 Roma (Italy)
Tel. +39 06 40696.1 Fax +39 06 40696.333
www.esriitalia.it
info@esriitalia.it

Esri Italia è l'azienda di riferimento in Italia nelle soluzioni GIS per la Pubblica Amministrazione e per le Imprese.

La Mission aziendale,"essere centro di eccellenza nelle soluzioni e servizi di intelligenza del territorio, facendo leva sulle tecnologie GIS di Esri", riflette la volontà di proporsi come partner di riferimento per i propri clienti, per tutte le attività legate all'uso dell'informazione geospaziale a supporto dei processi operativi e decisionali. Esri Italia è parte integrante della Esri One Company, un sistema di oltre 80 aziende a livello internazionale che opera in network in circa 200 paesi e fa riferimento a Esri Inc., leader mondiale nelle tecnologie software GIS. Esri Italia è Esri Official Distributor per il mercato italiano, dove opera in network con importanti Partner per rispondere in modo sempre più efficace alle esigenze del mercato. Grazie all'Offerta integrata di Software GIS, Dati Geospaziali, Corsi di Formazione e Professional Services qualificati, Esri Italia ha sviluppato, in oltre 20 anni di attività, una forte presenza nel mercato italiano delle soluzioni GIS. I Clienti di riferimento sono prevalentemente nei settori Pubblica Amministrazione Centrale e Locale, Difesa e Intelligence, Telecom & Utilities, Aziende industriali e di servizi, Università e Enti di Ricerca.

FSRER

The Speleological Federation of the Emilia-Romagna Region (FSRER) co-ordinates the caving activities of the regional speleological Clubs: most of them are performed in areas of high natural value, like the Triassic Gypsum outcrop in the Upper Secchia Valley, and the Messinian Gypsum in the Reggio Emilia, Bologna and Romagna Apennines. FSRER co-operated with the University of Bologna in the development of speleological research since long time: presently it is involved in a LIFE project to study the karst water quality and preserve the bat habitats. The main task of FSRER is to implement the regional register of natural cavities, which is available on line thanks to the Geological Service of the Emilia-Romagna Region. The co-operation with the Regional Government includes also the study of karst geosites and their safeguard. Finally FSRER periodically organizes Symposia and Workshops on selected karst areas or speleological themes, the proceedings of which have been printed in its official journal (Speleologia Emiliana).

Exhibitor

LITOGRAFIA artistica CARTOGRAFICA

Litografia Artistica Cartografica S.r.l.
Via del Romito, 11-13R, 50134 FIRENZE
Tel +39 055 483 557 – Fax 055 483 690
www.lac-cartografia.it info@lac-cartografia.it

La Litografia Artistica Cartografica, in breve LAC, viene fondata a Firenze nel 1949 come prima Azienda di produzione cartografica specializzata nelle lavorazioni conto terzi, in particolare per enti pubblici. Dall'inizio degli anni '60 è stato realizzato un Catalogo aziendale che oggi, dopo oltre mezzo secolo di continua attività, si presenta come uno dei più prestigiosi e completi nello scenario cartografico internazionale ed è interamente in vendita nel proprio store on-line. LAC è l'unica Azienda privata italiana e fra le poche in ambito europeo che produce cartografia a rilievo. Da molti anni LAC realizza carte tematiche complete, chiare, leggibili ed insieme di altissima qualità di stampa, per tutti i principali Enti pubblici italiani ed internazionali. Dal 2003 la LAC pubblica un magazine trimestrale referato, inviato a oltre 2.000 utenti e appassionati. Da alcuni anni l'utilizzo delle migliori tecnologie presenti sul mercato e le risorse dedicate alla ricerca e sviluppo hanno consentito di aprire ad alcuni progetti innovativi fra i quali portali cartografici e applicazioni. Dal Febbraio 2012 è disponibile on-line e scaricabile gratuitamente dall'Apple Store, la App "Mappe d'Italia". La applicazione gratuita Mappe d'Italia permette di utilizzare sul proprio iPhone e iPad carte geografiche ad alta qualità, consultabili in modalità off-line, "navigabili" e con la possibilità di inserire punti di interesse personali geo-localizzati.

EXELIS
Visual Information Solutions

Exelis Visual Information Solutions fornisce soluzioni avanzate per l'elaborazione di immagini e l'estrazione di informazioni da immagini geospaziali. ENVI ed il nuovo E3De, dedicato alla visualizzazione ed analisi di dati Lidar alla produzione di DSM, DEM , profili , offrono strumenti per analizzare ed elaborare immagini e dati geospaziali in modo semplice e rapido, integrato nel mondo ESRI, permettendo a utenti GIS di compiere operazioni sulle immagini facilmente e con estremo rigore.

Leica Geosystems

LEICA GEOSYSTEMS S.p.A.
Via Codognino, 12 – 26854 Cornegliano Laudense (LO)
Tel. 0371 6973.1 Fax 0371 6973.33
E-mail surveying@leica-geosystems.it
Sito Internet: www.leica-geosystems.it

Leica Geosystems S.p.A. è la filiale italiana della multinazionale Leica Geosystems AG leader mondiale nel mondo della misura. Nel 2005 è entrata a far parte del Gruppo Hexagon AB, mantenendo il proprio marchio.

La Società ha quale attività principale, la distribuzione di strumenti di misura, strumenti topografici, strumenti GPS per il rilievo satellitare, strumenti per il monitoraggio di eventi sul territorio e/o di infrastrutture, sistemi laser scanner per il rilievo 3D, sistemi e software in ambito GIS Mobile con strumentazione GPS/GIS di accuratezza metrica, sub metrica e centimetrica offrendo integrazione su piattaforma GIS di strumentazione topografica. Leica Geosystems, offre inoltre una serie di servizi come: Servizi di correzione differenziale (ItalPoS), Servizi aggiuntivi per applicazioni GPS/GNSS (Polar) basati sulla infrastruttura di stazioni di riferimento, Formazione all'utente per qualsiasi applicazione di misura, Contratti personalizzati di manutenzione.

Exhibitor

Intergraph è leader mondiale nella fornitura di software per il settore ingegneristico e geospaziale per la gestione ed analisi di dati complessi. Opera attraverso due divisioni: Process, Power & Marine (PP&M) e Security, Government & Infrastructure (SG&I). La divisione SG&I fornisce soluzioni geospaziali, includendo le tecnologie ERDAS, ai settori della difesa e dell'intelligence, della sicurezza, della pubblica amministrazione, dei trasporti, della fotogrammetria, delle telecomunicazioni e dei servizi pubblici. Intergraph Government Solution (IGS) è una conosciata autonoma della divisione SG&I che opera per il Governo Federale degli Stati Uniti e le forniture classificate. Planetek Italia S.r.l., partner Intergraph-ERDAS in Italia, è una società leader nella consulenza multi-disciplinare per lo sviluppo di Sistemi di Informazione Geografica (GIS) e di Osservazione della Terra (E.O.), orientati alla gestione del territorio. La sua mission è creare valore sviluppando soluzioni di archiviazione, gestione, analisi e condivisione di dati geospaziali, coniugando la sostenibilità tecnologica ed economica e l'attenzione all'evoluzione dei desiderata degli utenti.

CODEVINTEC – Tecnologie per le Scienze della Terra
Via Labus, 13 20147 MILANO
Tel +39 02 4830 2175 – Fax 02 4830 2169
www.codevintec.it info@codevintec.it

Dal 1973 la passione e la preparazione di Codevintec hanno portato sui mercati italiani sitemi innovativi ed efficaci, spesso diventati standard per gli studiosi dei diversi settori.: Vulcanologia e Monitoraggio sismico, Geologia, Protezione Civile, Archeologia, Rilievo Urbanistico, Geofisica terrestre, Controlli non distruttivi, Monitoraggio del Territorio, Geofisica marina, Oceanografia, Rilievi costieri integrati sopra e sott'acqua, Laser Scanner e LIDAR, 3D Imaging.

Per i Sistemi ad alta tecnologia per le Scienze della Terra e del Mare: Studio del sottosuolo - georadar, sismografi, geoelettrica, logger da foro, inclinometri; Vulcanologia e Monitoraggio sismico – sismometri, magnetometri, gravimetri, inclinometri, reti con trasmissione VSAT; Rappresentazione dei fondali e delle coste - Multibeam Beamformer e Interferometrici, SideScanSonar e SubBottom Profiler; Navigazione e posizionamento di precisione ad alta dinamica – DGPS, IMU (Inertial Measurement Unit), sistemi subacquei; Rilievi laser statici, dinamici, da barca, auto, aereo e per applicazioni speciali; Laser Scanner 3D a lunga portata, LIDAR, software, sistemi complessi; Sistemi per la rappresentazione della realtà in 3D – terrestre, sott'acqua, sottocosta, anche in dinamico. Per i servizi specializzati: Qualificato laboratorio di assistenza tecnica, stimato e riconosciuto dai Fornitori; Centro assistenza Europeo per i laser scanner terrestri Optech; Sistemi disponibili a noleggio.

EuroGeoSurveys

EuroGeosurvesy is the organisation of the Geological Surveys of Europe, the national institutions responsible for geological inventory, monitoring, knowledge and research. Our principal purpose is to provide public Earth science knowledge to support the EU's competitiveness, social well-being, environmental management and international commitments. In our day-to-day activities, we promote the contribution of geosciences to European Union affairs and action programmes underpinning European policies and regulations for the security, health and prosperity of society, and providing technical advice for the European Union Institutions.

Exhibitor

European Commission - DG JRC
Via E. Fermi, 2749
I-21027 Ispra (VA)
ITALY
http://ec.europa.eu/dgs/jrc/

Joint Reserach Centre
The European Commission in-house science service

The mission of the Joint Research Centre (JRC) is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of European Union policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

The JRC's vision is to be a trusted provider of science-based policy options to EU policy makers to address key challenges facing our society, underpinned by internationally-recognised research. The seven JRC institutes are located on five separate sites in Belgium, Germany, Italy, the Netherlands and Spain. The Ispra Site, the third biggest Commission site after Brussels and Luxembourg, covers an area of 167 hectares with ca 138 heated buildings hosting ca 1 850 staff, and hosts five of the seven JRC Institutes.

Freistaat Bayern

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Bayerisches Landesamt für Umwelt

For more than 150 years the Bavarian Geological Survey has been the authoritative source of geodata-based knowledge. Up to 140 experts in the various geoscientific fields work to improve everyday life. They explore geothermal potential, mitigate geo-hazards, protect soil and groundwater and search for raw materials. The Survey strives to produce reliable Geo-information, which is useful, easily understood, web-based and self-explanatory.

Servizio Geologico Sismico e dei Suoli Regione Emilia-Romagna

The Survey was created in 1976 as a technical entity to support the regional government policies dealing with the environment and land planning. The mission of the Survey is to provide the Administration and society with basic, up-to-date geological, pedological and geothematic information. The remit of the Survey at present encompasses activities related to the monitoring of natural risks which affect the territory of Emilia-Romagna, the reduction of seismic risk and the study of natural resources. This work is made largely available to the public through the Survey's website.

Institut Geologìc de Catalunya

The Institute was created in 2005 through a law passed by the Catalan Parliament and is intended to provide the Administration and society with basic, up-to-date geological, pedological and geothematic information. The Institute takes over from the pre-existing Geological Survey created in 1979, which in turn inherited more than 100 years of works carried out by previous geological institutions. From this legacy, the Institute has accumulated a large amount of data and information, which is added to that currently obtained, managed and supplied through the work of more than 60 experts.

Short programme

TUESDAY 12th JUNE

14.00 Opening Ceremony

15.00 Special session Natural resources and hazards in the Mediterranean
Chairperson: Luca Demicheli Secretary General of EuroGeoSurveys

18.30 Opening of the exhibit

19.00 Welcome party

WEDNESDAY 13th JUNE

9.00-13.00 Special session Soil: sealing and consumption
Chairpersons:Thomas Strassburger European Commission Directorate General Environment, Luca Montanarella European Commission Directorate General Joint Research Centre.

14.00-18.00 Session 2 Soil and land planning
Convenors: Emilio Ascaso, Nicola Filippi, Robert Traidl.
Chairperson: Luca Montanarella European Commission Directorate General Joint Research Centre.

9.00-18.00 Hosted meeting EuroGeoSurveys National Delegates Forum

Hosted meeting Geology and Information Technology-GIT
Annual Meeting of Geological Society of Italy - open to the EUREGEo participants

Session 3 Subsurface geology
Convenors: Carmen Puig, Luca Martelli, Gerold Diepolder.
Chairperson: Francois Robida Bureau de Recherches Géologiques et Minières

THURSDAY 14th JUNE

9.00-13.00 Special session Geological cartography in Italy and in Europe: perspectives and opportunities
Chairperson: Silvio Seno Federazione Italiana Scienze della Terra

Session 4 Popularisation of geoscience and geoheritage
Convenors: Mariona Losantos, Maria Carla Centineo, Johann Rohrmüeller.
Chairperson: Wim de Gans TNo Geological Survey of the Nederlands

14.00-18.00 Session 7 Urban geology
Convenor: Giuseppe Nardi. Chairperson: Andreas Hoppe Technische Universität Darmstadt

Session 9 Seismic risk
Convenor: Xavíer Goula. Chairperson: Gian Vito Graziano Consiglio Nazionale dei Geologi

9.00-18.00 Special session INSPIRE/Spatial Data Infrastructures
Chairpersons: Robert Tomas European Commission Directorate General Joint Research Centre, Kristine Asch Federal Institute for Geosciences and Natural Resources, Francois Robida Bureau de Recherches Géologiques et Minières, Carlo Cipolloni Ist. Superiore per la Protezione e la Ricerca Ambientale

Session 1 Slope instability
Convenors: Marta Gonzales, Giovanni Bertolini, Karl Mayer.
Chairperson: Nicola Casagli Università degli Studi di Firenze - Dip. Scienze della Terra

Session 10 Regional geochemical mapping and its environmental application
Convenors: Marina Guermandi, Alessandro Amorosi.
Chairperson: Benedetto De Vivo Università degli Studi di Napoli Federico II - Dip. Scienze della Terra

Hosted meeting Local forum of the European project Geo.Power - open to the EUREGEo participants

FRIDAY 15th JUNE

9.00-13.00 Session 5 Coastal system management
Convenor: Luisa Perini. Chairperson: Yann Balouin Bureau de Recherches Géologiques et Minières

Session 6 Water resources
Convenor: Bernhard Wagner. Chairperson: Thomas Walter Geological Survey of Saarland

Session 8 Mining and natural aggregate resources
Convenor: Slavko V. Solar. Chairperson: Jouni Vuollo Geological Survey of Finland

Session 11 Mapping data and Information systems
Convenor: Kristine Asch. Chairperson: Silvio Seno Federazione Italiana Scienze della Terra

13.30 Closing Ceremony

SATURDAY 16th JUNE

8.00-18.00 Field trips Secchia Valley

SCIENTIFIC PROGRAMME
VOLUME II

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Session 2 - Soil and land planning

Session 3 - Subsurface geology

Session 4 - Popularisation of geoscience and geoheritage

Session 5 - Coastal system management

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SUBSURFACE STRATIGRAPHY AND URBAN ARCHAEOLOGY IN THE BOLOGNA AREA

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KEY WORDS: Alluvial deposits, Paleosols, Urban Geology; Archaeology, Po Plain, Quaternary.

ABSTRACT

Reconstructing subsurface stratigraphic architecture of Late Quaternary deposits is of paramount importance in the context of resource management and hazard reduction in alluvial and coastal plains. Urban areas, in particular, represent peculiar regions where high density of subsurface stratigraphic data may enable the construction of predictive sequence-stratigraphic models with high temporal resolution. As a part of a project involving University of Bologna, Regione Emilia-Romagna and Superintendence to Archaeological Properties of Emilia-Romagna, this study shows how an integrated sedimentological and archaeological approach to high-resolution subsurface stratigraphy in the Bologna urban area may provide the basis for refined reconstruction of the palaeoenvironmental evolution during the late Holocene.

The subsurface of Bologna hosts an abundance of stratigraphic data stored in the Emilia-Romagna Geological Survey database. Over the last two decades, the realization of the Geological Map of Italy imposed the organization of stratigraphic information into georeferenced datasets. At present, more than 3000 stratigraphic data are available for the Bologna urban area, with average density of about 30 data/km^2. For this study we also used 34 continuously cored boreholes and 9 outcrops (quarries and excavations) as reference points for facies characterization. Stratigraphic correlations were ensured by 35 radiocarbon dates, whereas archaeological data were used to characterize the late Holocene portion of the study succession.

The subsurface stratigraphy of the Bologna area, which forms the southern portion of the Po Basin, displays a peculiar facies architecture that was strongly influenced by the evolution of two major river systems (Reno, west of the old town, and Savena to the east). These river courses form two distally coalescing alluvial fan gravel systems

that radiate out from their outlets into the alluvial plain. During the Last Glacial Maximum, up to the early Holocene, the north-western and eastern parts of the town were periodically affected by lateral migration of Reno and Savena rivers, as documented by the presence of thick sheet-like, fluvial gravel bodies at various depths. The more ancient part of the town, instead, acted invariably as a triangle-shaped interchannel sector comprised between the Reno and Savena outlets. For this reason, subsurface stratigraphy beneath the centre of the old town consists almost entirely of fine-grained (silt-clay) material, with subordinate lens-shaped sand intercalations supplied by the minor drainage network.

Within this monotonous alluvial succession, this study led for the first time to identification of five vertically stacked palaeosols that can be tracked continuously across the study area. These palaeosols represent the only significant stratigraphic marker within the alluvial succession. The older, Pleistocene palaeosols exhibit complex, overprinted profiles, whereas the Holocene palaeosols are characterized by single profiles. In sequence-stratigraphic terms, these paleosol are correlative with the erosional surfaces at the base of the most laterally extensive fluvial bodies and are interpreted to represent interfluvial sequence boundaries of millennial-scale depositional cycles.

The uppermost two palaeosols, assigned to the Eneolitic Age and the Etruscan/Roman culture, respectively, were additionally investigated on an archaeological basis, since they contain ample indications of human activity. The Roman presence, in particular, was pervasive and had direct influence on the geology of the area by digging discharge areas and ditches, filling topographic depressions and modifying and controlling the river network.

The Eneolitic and Roman palaeosols are closely spaced in the urban area, whereas they are separated by an increasing thickness of alluvial deposits, up to 5 meters, in the metropolitan area. Through integration of core analysis, stratigraphic correlations, archaeological excavation results, and historical sources we reconstructed a map that depicts the distribution of Roman settlement in the Bologna area and its relationship with the surrounding fluvial palaeoenvironment. The Roman

palaeosol, which is identified to a maximum depth of 6 m, is buried beneath a variable thickness of either alluvial or anthropogenic deposits. These impart to the subsoil peculiar geotechnical and petrophysical characteristics.

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MORPHOSTRUCTURAL ANALYSIS OF TIRANA CITY CENTER (ALBANIA) UNDER GIS AND CAD TECHNOLOGY

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KEY WORDS: Tirana, urban geology, morfostructural reconstruction, CAD-GIS

Recognizing landscape forms and related geological processes in an urban area is a very difficult target because there is a very intense "coverage" caused by buildings, infrastructure and underground utilities.

The city of Tirana is situated in a plain area surrounded by hills to the north, est and south and is crossed by two main rivers: the "Tirana" in the north peripheral area and the "Lana" in the south area.

This study has been carried out on a limited database under GIS and CAD environment allowing to reconstruct the main recent and relict morphostructures despite the intense urban coverage of Tirana.

The dataset provided by the Polytechnic University of Tirana consists of:

- 27 stratigraphy from continuous core surveys furnished with geotechnical parameters
- Digital Terrain Model acquired by laser scanner and filtered by infrastructure and buildings heights (year 2007)
- Orthophotos (year 2007)
- Historical topographic maps (1927-1937)

The study phases that occurred are mainly two:

1. Reconstruction of the geological subsurface model
2. Identification of surface forms in connection with the geological model proposed

In the first phase stratigraphic data from boreholes allowed the production of geological sections that have been used to reconstruct the geometric relationships between the lithotypes and more important to analyze these ones as depositional facies.

Were thus identified 5 depositional facies (from the substrate up to the more recent stratigraphic terms):

Depositional system	Depositional facies	Lithotype
Marine system	Ramp	Silty shale
River system	Flooding	Calcareous gravel
	Channel	Slightly clayey silty sand
	Lateral accretion	Sand
	Overbank	Silty clayey sand

In the second phase some ESRI ArcGIS 10 3d tools have been used to analyze the DTM (used both as a raster and as a TIN).

Particularly using:

- *3D Analyst Tools -> Terrain and TIN Surface -> **Surface contour***: an accurate contouring (contour lines with a metric gradient) was done with this tool in order to highlight the typical forms of fluvial depositional systems. The contour lines along with several height profiles (obtained using *3D Analyst Toolbar -> Interpolate Line*) allowed the identification of plain areas and banks related to river terraces of the main waterways (*fig.1*).

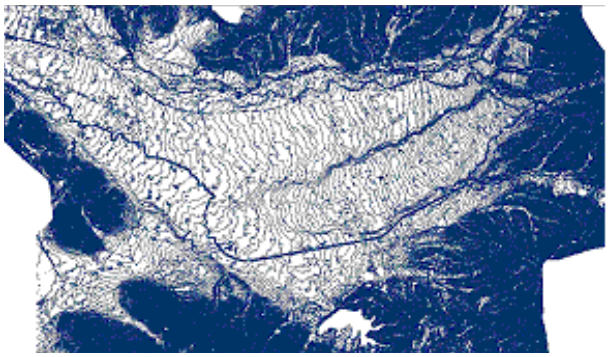

Figure 1 – Contour lines with metric gradient obtained for Tirana center under ArcGIS 10

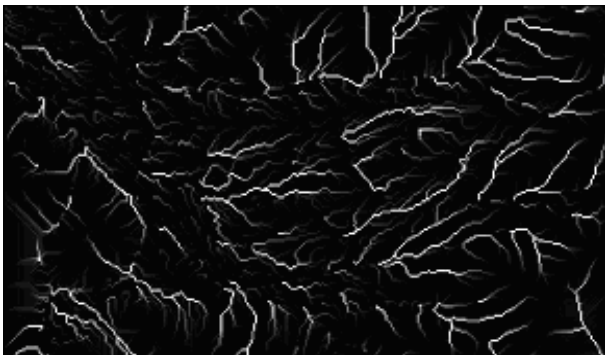

Figure 2 – Surface runoff in Tirana as seen applying the "flow accumulation" tool under ArcGIS 10

- *3D Analyst Tools -> Terrain and TIN Surface ->* **Surface slope**: the steepness map obtained with this tool together with the contour lines allowed the identification of the hills limits distinguishing them from the flood plain. This process also helped to identify some new tectonic evidences at the hill basis (triangular faces, hills line-up, etc**.**
- *Spatial Analyst Tools -> Hydrology ->* **Flow direction and Flow accumulation**: these two tools have been applied to highlight the trend of surface water runoff *(fig.2)*. The current orthophotos were compared with the water network obtained allowing to outline the secondary water flow (including anthropogenic deviations). The trend of the outflow was also compared with the historical topographic maps (properly georeferenced) in order to identify older forms of the wandering rivers. It was thus possible to map the meandering loops of the older Lana river course.

Surface morphostructures (recent and relict) were compared with buried morphostructures identified with geological sections (properly georeferenced and imported into a GIS environment) founding a good correspondence.

This allowed us to recognize depositional, erosive and tectonic landscape forms *(fig.3)* and their related processes that represent the geological background of Tirana urban area.

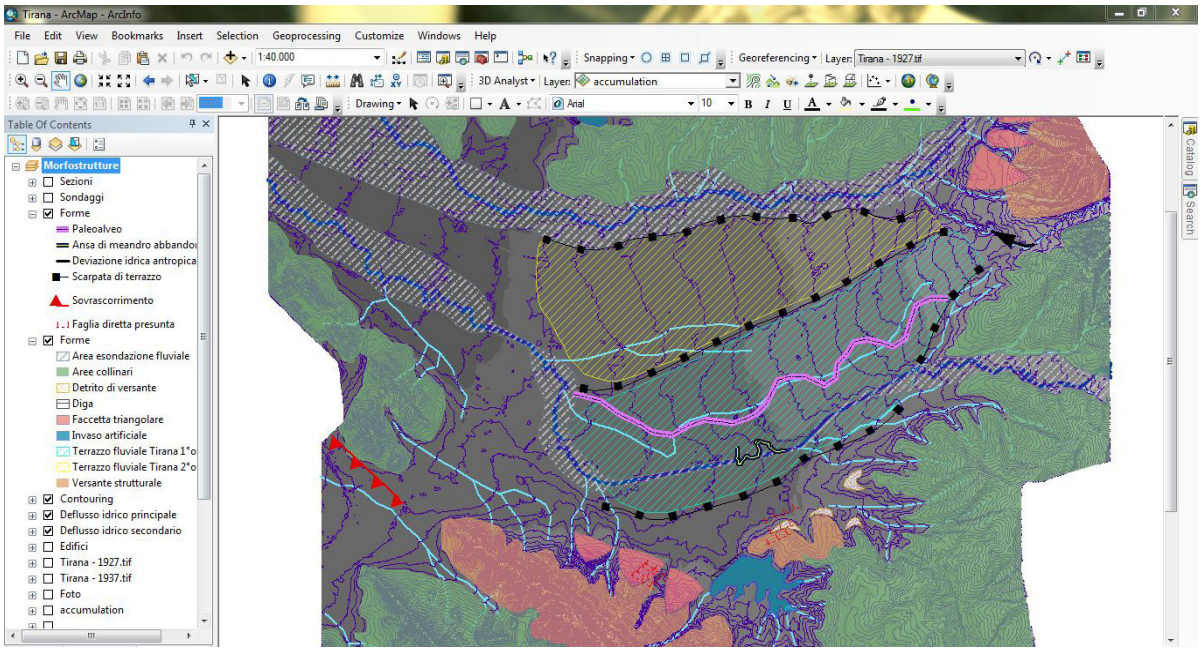

Figure 3 – Morphostructures map of Tirana center in ArcGIS 10

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SUSCEPTIBILITY MAPS OF COLLAPSE SINKHOLES IN URBAN AREAS BY USING GEOSPATIAL ANALYSIS

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KEY WORDS: collapse sinkholes, geospatial analysis, susceptibility maps.

INTRODUCTION

Risk assessment related to collapse sinkholes in urban areas requires quantitative data on the susceptibility of the area associated with the phenomenon and the vulnerability of the human environment affected by it (Smith, 2009). At this scope the following steps should be integrated: 1. the collection of different informative layers (i.e., geology, hydrology, geotechnical characteristics, inventories of cases, geomorphology, etc.); 2. the hierarchization ("weighting") of these layers according to their influence on the phenomenon; 3. the organization in levels of analysis; 4. the creation of an appropriate model according to the available data.

Collapses in the urban area of Rome are mainly linked to the presence of a dense network of underground cavities, such as tunnels produced by historical mining activities, as well as drainage tunnels and catacombs linked to a history of more than a thousand years. The presence of these cavities may easily trigger the collapse of the shallow or deeper layers from ground level. Subordinate causes are associated to the loose of soil below the road surface linked to run-off phenomena concurrently with intense rainfall.

Over the last decades an increase in the occurrence of these collapses in the urban center determines risk conditions to citizenship and disruption of roads and underground networks (sewers, water systems, electricity, telephone, etc.). Furthermore, the aspects related to the preservation of cultural heritage and of underground sites of historical and archaeological importance should be considered.

In this scenario the applicability of the concept of collapse risk is extremely difficult due to the lack of data about return times, and thus it is not possible to calculate probabilities of the event in a given time horizon. Then the concept of risk has been replaced with the most generic concept of susceptibility, which eliminates the probability term related to time, and defines the "risk" in spatial terms only: a collapse could occur in a certain area in an infinite time interval and a certain area has characteristics that facilitate a collapse. In this way collapse susceptibility maps can be produced identifying the areas with characteristics prone to the phenomenon. This could be obtained through three different levels of modeling: i) the first-level provides the potential of an area to the collapse occurrence at large scale; ii) the second-level creates a probabilistic model that can be extrapolated to similar areas; iii) the third-level tries to evaluate the space-time evolution of the phenomenon at site specific.

In this work three methodologies have been proposed and compared to provide the susceptibility model associated to collapse sinkholes in urban areas. First-level modeling can produce susceptibility zonations by using the distance of each point to the nearest collapse (i.e., the Collapse Near Distance, CND, Galve et al., 2011). The CND can be used to test whether new collapses tend to occur in the vicinity of the previously existing ones or not and then have favorable conditions for the development of new collapses. (Galve et al., 2009, 2011). Another approach is the production of collapse density maps, assuming that the zones with a larger number of collapses are more prone to collapse formation (Galve, 2009). Density maps can be calculated by using the Kernel Density Estimation (KDE) (de Smith et al., 2007).

The third predictive strategy belongs to the second-level modeling. It includes the construction of a probabilistic model based on the evaluation of the statistical relationships between the known collapses and a group of conditioning factors (i.e., presence of unfilled cavities, adequate hydrological conditions, sediments prone to subsidence) by using Logistic Regression (LR) and/or Geographically Weighted Regression (GWR) (Doctor et al., 2008).

RESULTS

Sinkhole Susceptibility Models (SSM) have been generated and compared for the urban area of Rome by using CND, KDE and LR at the global scale.

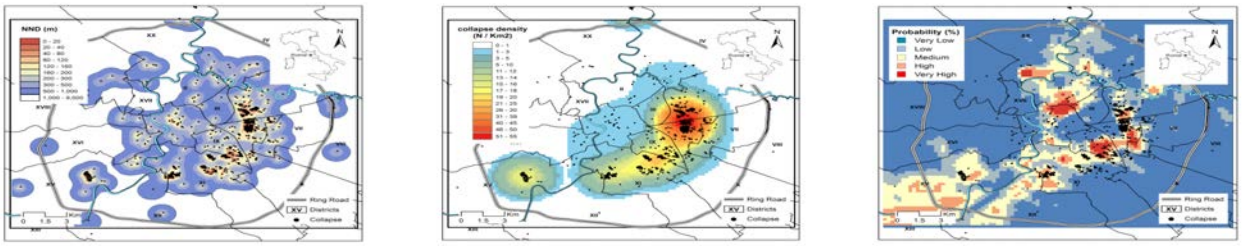

Figure 1. Susceptibility models generated for collapse sinkholes in the Rome urban area by using different methods: Collapse Near Distance (left), Density model (center), Logistic Regression model (right)

The used spatial geo-database includes the sinkhole inventories and a number of layers related to potential conditioning factors for the Rome area (about 350 km^2). The conditioning factors are: geology (i.e., lithologies of the outcropping formations and backfill thickness), hydrogeology (i.e., water table), human activity (i.e., presence of catacombs, caves and galleries, sewer network). All these layers were transformed in raster with a pixel size of 250×250 m and are analyzed by using a GIS (ESRI ®ArcMap ™ 10). The collapse inventories consists of 1507 (about 4 collapse/km^2) cases of which 1160 occur in the eastern side of the Tiber river (about 6 collapse/km^2). The collapse inventory has been constructed by the Institute for Environmental Protection and Research, ISPRA, Dept. Soil Defense of Geological Survey of Italy and includes data provided by the Department of Civil Protection. CND model shows the susceptibility map as an indirect function of the distance to the nearest collapse. The highest susceptibility corresponds to the minimum distance (pixels surrounding the sinkholes) and the lowest to the maximum distance (pixels located farthest away from the nearest sinkhole) (Fig. 1a). KDE model highlights the number of collapses per unit area and assigns the highest susceptibility to the maximum density (Fig. 1b). LR model was calculated to express the significance of the conditioning factors in relation to collapse occurrence. The LR results provide a map of the spatial probability of collapse occurrence (Fig. 1c). The ROC curves give how well the three models predict collapses (Fig. 2).

Further refinements of the models will be realized through the collection of data about the lithological characteristics and thickness of the cover and of the formations in which underground cavities were dug, as well as geometry of the cavities.

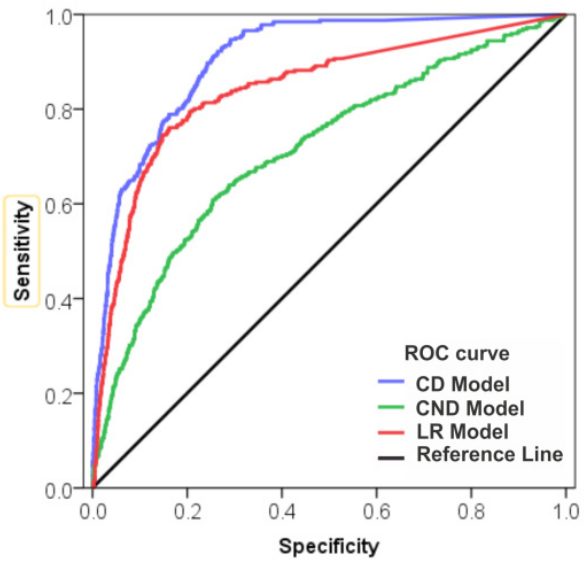

Figure 2. ROC curves representing true positive rates (sensitivity) and false positive rates (specificity) for the three models: Collapse Near Distance (CND), Collapse Density (CD), Logistic Regression (LR)

ACKNOWLEDGEMENTS

Results presented in this paper are part of the Sinkhole project by ISPRA (project manager: S. Nisio). We are grateful to Dr. Claudio Succhiarelli of Roma Capitale municipality for providing data of the cavity locations.

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FIRENZE: FROM THE FIELD SURVEYS TO A 3D FULL KNOWLEDGE OF ITS GEOLOGICAL SETTING

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KEY WORDS: urban geology, Firenze, reconstruction GIS, alluvial plain.

SUMMARY

Since 2001 the, Department of Earth Sciences of the University of Firenze, in cooperation with the Municipality of Firenze, has embarked on a research regarding the improvement of the geological knowledge on the Firenze area (Brigatnti et alii, 2003; Coli et alii, 2003, 2004, 2006, 2007)

The Firenze area is a tectonic depression, NW-SE oriented and at about 45 m to 60 m above the sea level. filled by “Villafranchian” fluvio-lacustrine and Ancient and Recent Deposits of the Arno rivers and its tributaries.

The research project involves:
- collection and the mutual sharing of geological, geomorphological, hydrogeological, geotechnical, seismic data,
- their organization in a relational GIS,
- realisation of thematic maps,
- Internet sgareing of the final products.

In detail the project has expected:
- Implementation of about 2,000 log data in a GIS in terms of UBSU and USCS and geotechnical lab data.
- Implementation of all the available seismic in situ determinations in the GIS.
- Reconstruction of the morpho-anthropic evolution (about 500 BC - 2000 AD) of the Firenze area.
- Development of the: Geoengineering, Seismic Amplification Factor at the surface and Hydrogeological Maps.
- Reconstruction of the 3D setting of the Bedrock and of the main UBSU surfaces.

MODEL CONSTRUCTION AND RESULTS

The model construction is based on a geodatabase (GDB) constructed step by step in several years, that collects all data, geological and not, of the entire municipality.

The geodatabase, or spatial database, is a particular relational database designed to store, query and use geographical data.

The main advantage is that the data are not scattered in the file system but are assembled in a relational database (RDBMS).

This has several advantages including:
- to store a rich collection of spatial data in a centralized location,
- to apply sophisticated rules and relationships to the data,
- to define advanced geospatial relational models (e.g., topologies, networks),
- to maintain integrity of spatial data with a consistent, accurate database,
- to work within a multiuser access and editing environment,
- to integrate spatial data with other databases,
- to easily scale your storage solution,
- to support custom features and behaviour,
- to leverage your spatial data to its full potential.

For practical reasons the project was implemented in the format of a personal geodatabase, in which the data are stored by means of Microsoft Access® (*.mbd). This type of database can have a maximum size of 2Gb, even if the upper limit of the real size of the file before the performance suffer a drastic degradation is 250-500Mb. The personal geodatabase is not so fast, efficient and scalable as other types of geodatabase, but it makes possible to edit and display the attributes directly by using Microsoft Access®.

The geodatabase developed contains the tables that relate to various types of data:
- coding classifications,
- permeability of the various lithologies,
- seismic responses,
- stratigraphy of surveys,
- data drilling,
- results of laboratory tests,
- shares a.s.l.of synthems.

Through the implementation in a GDB of all the available data it has been possible to reconstruct, for the entire Firenze area, the 3D surfaces of the main USBU: Bedrock (Fig.1); fluvial-lacustrine deposit/ancient fluvial deposits (Fig.2a); ancient/ recent fluvial deposits (Fig.2b).

The litho-technical interpretation in USCS terms was associated with laboratory tests in order to have referable geotechnical parameters for each unit.

Seismic in situ data were used to obtain the average Vp and Vs for the main lithostratigraphic units in order to calculate the amplification factor theoretical expected at the surface (Coli et alii, 2008).

The seismic rebound appears to have a strict relationship with the presence of the Ancient Deposits filling the course of the paleo-Arno river, they consists of well sorted calcareous pebbles.

The storage data also allowed to create a map of the degree of knowledge of the underground of the Firenze area at different depths of interest.

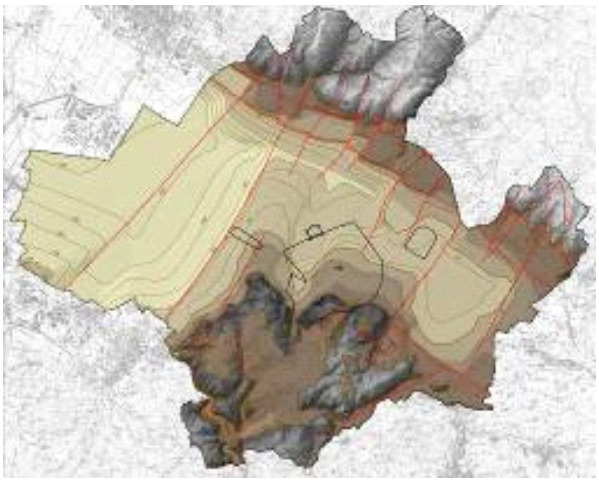

Figure 1 – Reconstruction of the Bedrock surface.

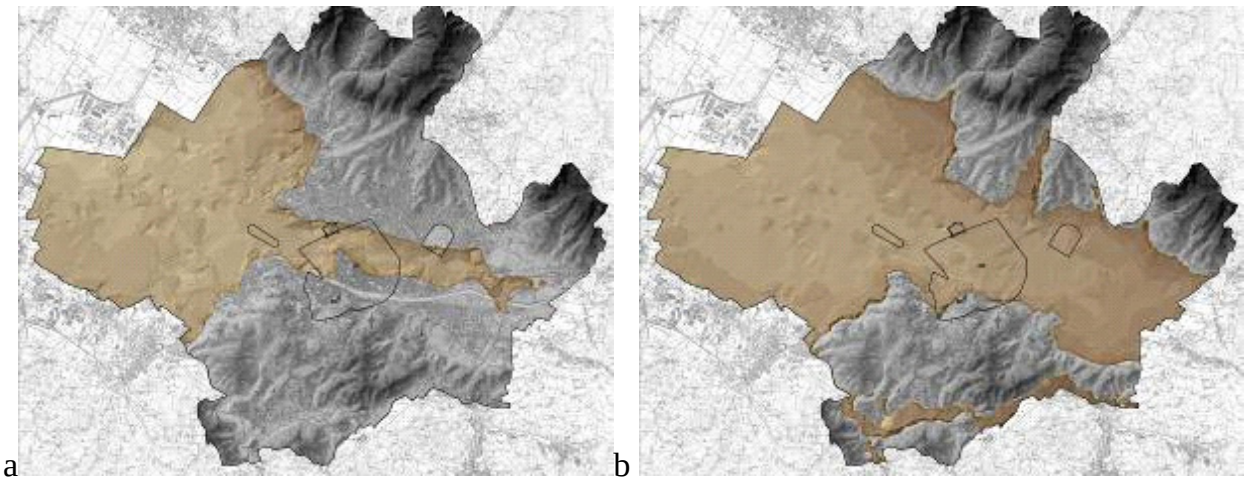

Figure 2 – Reconstruction of the bottom surface of the Ancient (a) and Recent (b) fluvial Deposits.

CONCLUSIONS

The researches undertaken have had the purpose of the development and dissemination of geological knowledge of the Firenze area.

These studies resulted into a body of knowledge that can be considered an essential basis for subsequent actions of both safety planning, design and execution of underground infrastructure both for the management of the cultural heritage monument, and for the due and proper planning of actions for prevention, mitigation and intervention.

An adequate level of geological knowledge leads to minimize the cognitive liability and therefore the potential occurrence of “geological uncertainties”.

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BRUSSELS: 20 YEARS OF UPLIFTING MONITORED BY RADAR INTERFEROMETRY (PSI)

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KEY WORDS: Brussels, Belgium, geology, InSAR, interferometry, PSInSAR.

INTRODUCTION

In the 19th and the beginning of the 20th century the city centre of Brussels was benefiting of the industrialisation process. Many industries and breweries settled along the axis of the Senne river using the water supply of the area. The population extent of Brussels and its economic development into services finally lead to the installation of the large industries at the borders of the city. These changes locally affect the underground exploitation of the aquifer under the city resulting in measurable ground motions. The Persistent Scatterer Interferometry (PSI) technique (Ferretti, Prati & Rocca 2000 & 2001) has been applied on an area covering the city and its suburbs. The PSI technique makes it possible to measure specific displacements of radar reflecting objects present on the ground called persistent scatterer (PS) from a stack of Synthetic Aperture Radar (SAR) image.

PROCESSING AND OBSERVATION

The first processing was carried out over ERS1/2 images covering the years 1992-2003. An update covering the time span 1992-2010, including ERS1/2 and Envisat SAR images, is being processed at the time of writing. The discussion will be based on the first processing results where 173,000 PS were identified on a large area around Brussels. Working on these data in the GIS made it possible to highlight and relate movements of the ground with geological data. The density in the centre of Brussels varies from 800 PS/Km² to a maximum of 1632 PS/Km² for a coherence (quality) higher than 0.65. Such high densities of PS data give the opportunity to precisely look at a high resolution scale, from districts to single house. The city of Brussels contain 92,777 PS for a surface of 161 km². The figure 1 gives the location and a colour classification based on the annual average velocity of all the PS. The red colour represents negative velocities while on the opposite blue colour corresponds to positive values. It appears that Brussels is facing a global vertical positive movement (uplift) of the area centred along the Senne river with velocities ranging from 1 to 6.61 mm/year.

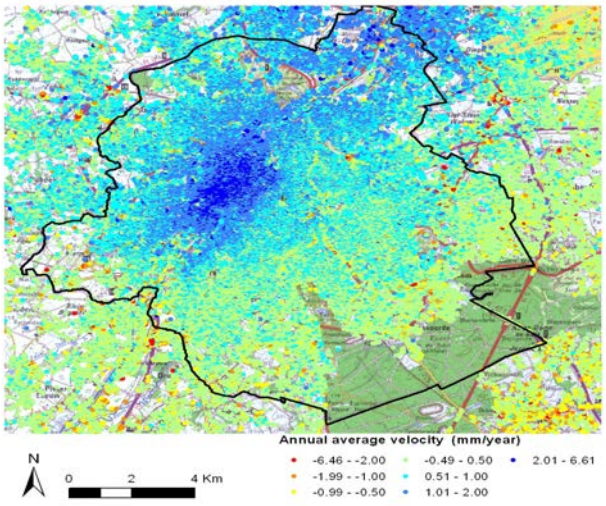

Figure 1 – Colour classification based on the annual average velocity (mm/year) of the PS around Brussels

Several red-yellowish lineaments with negative velocities value (< -0.5 mm/year) pop out of the blue colour in the southeastern part of the region.

GEOLOGY-HYDROGEOLOGY

To understand the movements, a brief description of the aquifers present in the region is given here. The hydrogeological structure of the area of Brussels is composed by a set of superposed aquifers separated by layers mainly formed by clay deposits (Gulinck 1966). An alluvial aquifer lies within the Quaternary deposits of the Senne river flowing through the city in NE-SW direction. The underground of the eastern part of the region hold a significant aquifer in the sands of the Lede and Bruxelles Formations. The glauconitic sands of the

Hannut Formation (Late Paleocene) contain also an aquifer. The Cretaceous is absent in the southern and south western parts of Brussels. The thickness of the Cretaceous thickens from a few metres to around 20 m to the north and to more than 40 m in the most eastern parts of Brussels. Finally, the artesian aquifer of the Cambro-Silurian basement is the major aquifer of the southern part of Brussels.

INTERPRETATION

The area affected by the strongest positive ground deformations corresponds to the zone of water catchments and groundwater pumpings from the Cretaceous aquifer since the industrialisation of Brussels (1880-1950). During the initial years, the data in the archives indicate that artesian wells were used for industrial purposes (breweries, dyeing, distilleries, refineries, etc). The old artesian wells has been superimposed on the PS annual average velocities values. It indicates that the uplift and the location of these wells match perfectly. In details, the artesian wells are specifically located along the Senne river axis. More than 50 wells are present in the uplifting zones. In northern part of the city (Vilvoorde), the Cretaceous aquifer level raises by 30 m since1992 (50 m since the 1970s when records began). It appears that a combined effect of the recharge of the Cretaceous aquifer and the phreatic aquifer of the Senne river explain the observed ground motion.

With the help of old geological and topographical map of Brussels, the interpretation of the lineaments with negative annual velocities value has been realised. It appears that these area corresponds to former alluvial plain deposits where the waterways are now canalized or into pipes. The strong compaction capability and the competence of the Quaternary deposits are responsible for the subsidence recorded by the radar interferometry.

CONCLUSION

The PSInSAR technique combined with geological, hydrogeological and topographical data has permitted to highlight and interpret the ground movements observed in the centre of Brussels. The former industrial activities and its groundwater needs were correlated with the uplifting zones and the recharge of the aquifer. The recent alluvial sediments are subject to compaction as shown by slight subsidence evidences in the interferometry data

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MAPPING OF LOW ENTHALPY GEOTHERMAL RESOURCES THE EXAMPLE OF PARMA

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KEY WORDS: Po Plain stratigraphy, aquifers, geothermal energy, low enthalpy, flow and heat models

PURPOSE OF THE STUDY

The purpose of the study is the creation of thematic maps for zoning based on the sustainability in an urban area of geothermal heat exchange.

To achieve this objective a 3D mathematical flow and heat transport model in steady state will be developed in the urban area of Parma.

The work will be operational tools for the industry, both public and private.

The mathematical model simulates the conduct of the transport of heat and then the heat “plume” due to the use of geothermal heat pump systems both “open” and “closed loop”.

The software that will be used for the mathematical model is the code FEFLOW 6 at finite element.

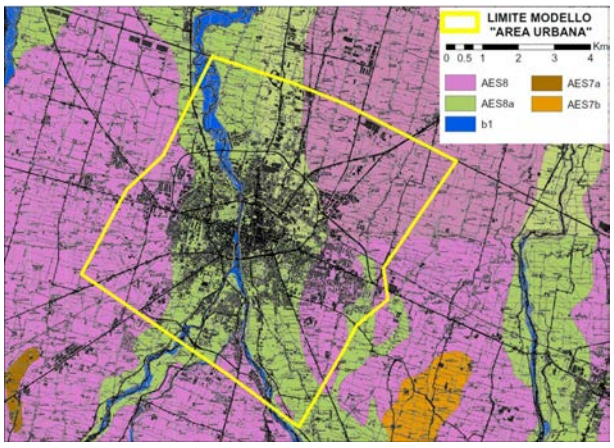

Figure 1 – Limit of the model and geological map

The physic domain of the model will include the aquifer complexes A0, A1 and A2 belonging to aquifer group A. The base of the model coincides with the base of aquifer complex A2. The choice of the physical domain is due to the fact that in the urban sector the major aquifers exploited especially for aqueduct purpose are the aquifer systems A1 and A2. In the study area the base of the aquifer complex A2 reaches the maximum depth of about 140 meters from surface. This means that most of existing geothermal plants and those future hardly exceed the depth of 150 meters.

The study area includes the high and medium alluvial Po plain. The quote is reaching higher in the south with about 75 m s.l.m. while toward north the surface declines up to about 40 meters s.l.m.. The entire area is drained by the rivers Parma and Baganza.

GEOLOGICAL SECTION FOR 3D MODEL

For the purpose of reconstruction of 3D subsurface geological model, geological sections interpreted in a hydrostratigraphical view will be used; the process of this kind of sections allow the creation of physical surface and “layer” for the 3D model.

The geological units of the interesting Parma subsoil belong to higher synthem of Emilia-Romagna region (AES). The outcropping stratigraphic units are the Ravenna synthem (AES8) and the Modena unit (AES8a). These units are made by alluvial deposits, mainly coarse (gravel and sand) of river channel filling.

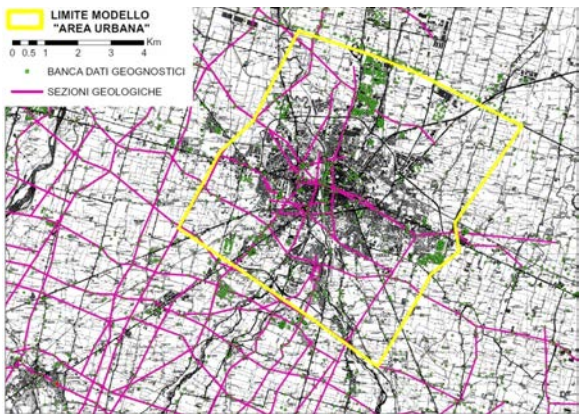

Figure 2 – Limit of the model and network of geological section.

The sections also allow us to identify recharge areas of aquifer complexes, mono-aquifer and multy-aquifer systems and thus the relationship between the different “layers” of the model.

THE HEAT PUMP SYSTEMS IN PARMA

In the last years, in the Parma urban area, 10 geothermal heat pump systems, both closed and open loop, have been approved and installed.

The “open loop” are 4 and reached the total power of about 750 Kwt; the wells have an average depth of about 30-35 meters.

The “closed loop” are 6 and have reached a total installed capacity of about 3500 KWt. The average depth of geothermal probe are about of 120-130 meters.

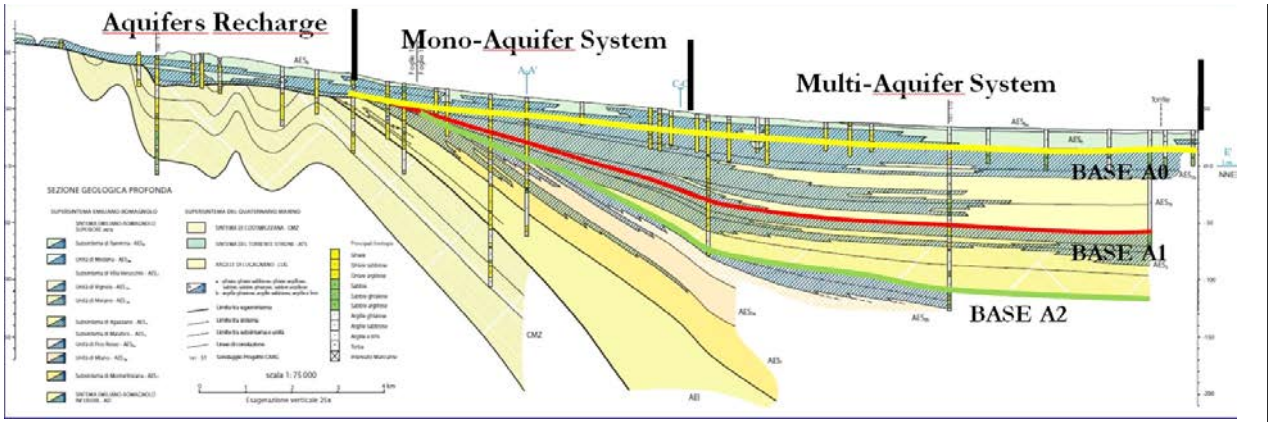

Figure 3 – Geological section and bases of aquifer complex that belong to the domain of the model

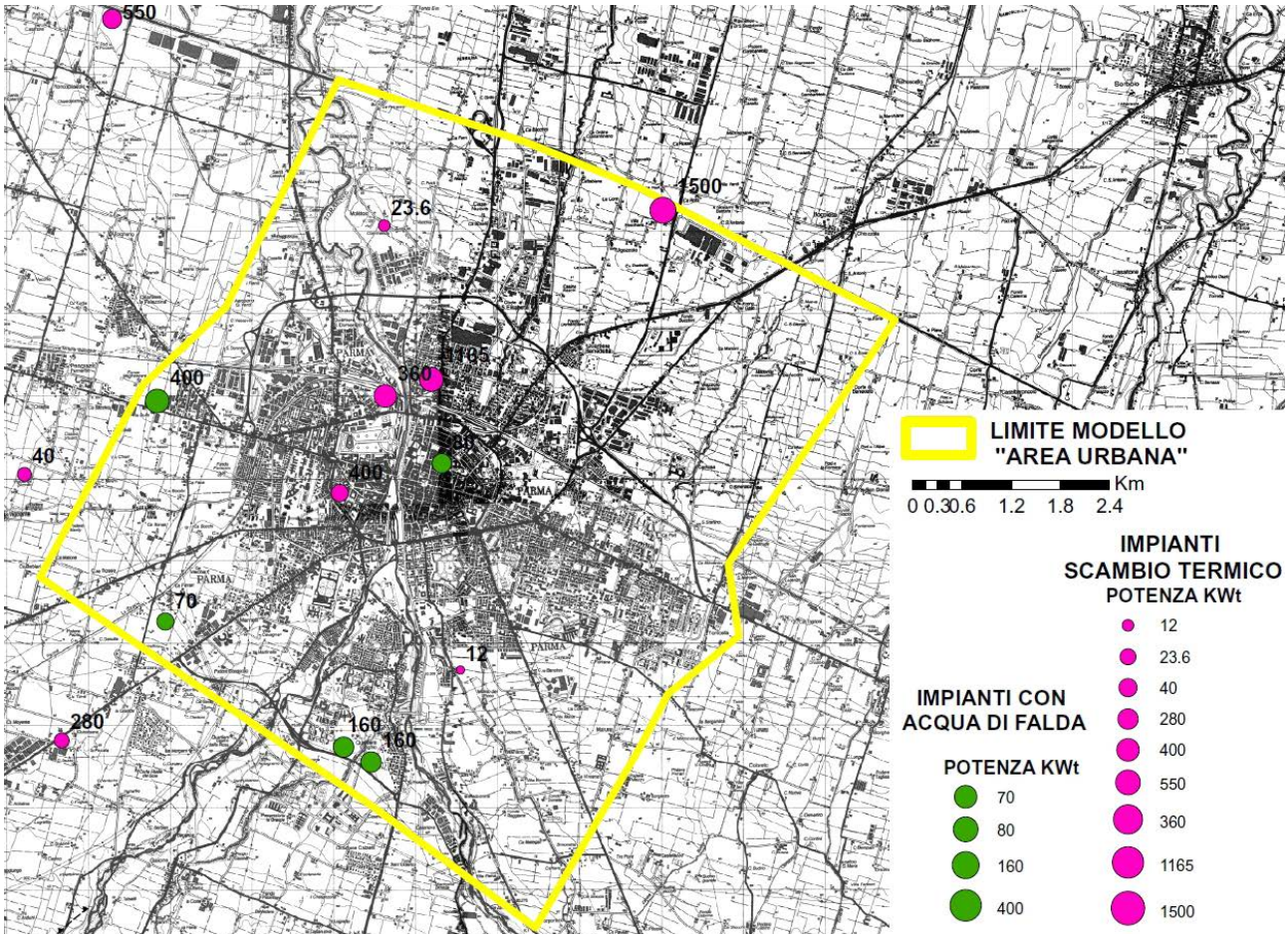

Figure 4 – Geothermal heat pump systems present in the urban area

INTEGRATED GEOSPATIAL SOFTWARE PLATFORM FOR URBAN GROUNDWATER

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KEY WORDS: geospatial data, urban groundwater, urban infrastructure, Bucharest, mark-up languages.

INTRODUCTION

Urban population growth (for 2050 is foreseen that the urban population will be around 68.7% of total population - UN,DESA, 2011) implies a grater consumption of resources (natural or processed) like: electricity, gas and oil products, food and water. As consequence, the urban water management become an important aspect of urban sustainable development planning (Sanchez-Villa, 2002). A large number of urban areas are located in the flood plains of the rivers therefore the geological structure is porous - permeable (sedimentary). Sedimentary media are normally significant aquifers due to their high permeability, storage capacity, interaction with surface water, etc. (Gogu et al, 2011).

Due to the large amount of civil work projects and investigation studies, large quantities of geo-data are produced for the urban areas. These data are usually redundant and spread between different institutions or private companies. Time consuming operations like data processing and information harmonisation represents the main reason to systematically avoid the re-use of data. The urban groundwater data shows the same complex situation due to the fact that the urban elements like underground structures (subway lines, deep foundations, underground parkings, and others), urban infrastructure networks (sewer systems, water supply networks, heating conduits, etc), drainage systems, surface water works and others shows a continuous modification. Due to the rapid evolution of technology in the past few years, transferring large amounts of information through internet has now become a feasible solution for sharing geoscience data. Furthermore, standard data transfer instruments have been developed. They allow easily updating and sharing through internet large geospatial databases between different institutions that do not necessarily use the same database structure. For Bucharest City (Romania) an integrated platform for groundwater geospatial data management is developed under the framework of a national research project.

PLATFORM ARCHITECTURE

The software platform architecture is based on three components (*Figure 1*).

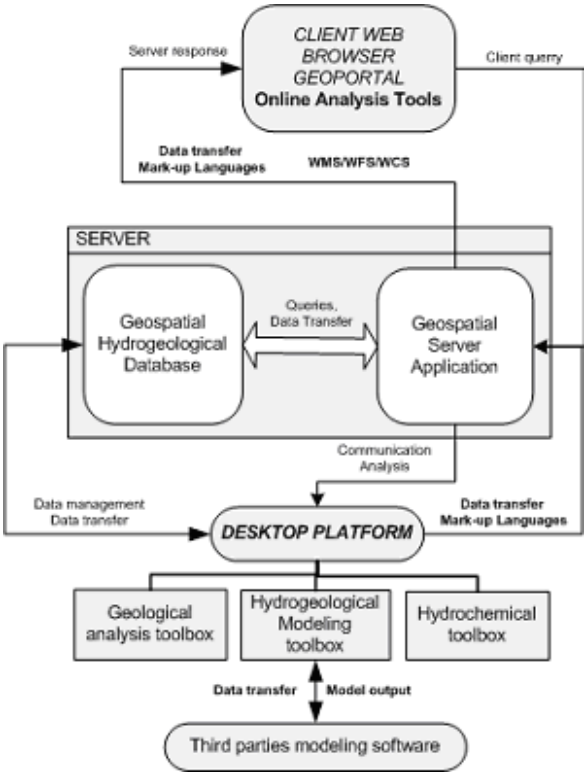

Figure 1 – Software platform architecture

The first component and the core of the platform is the hydrogeological geospatial database and the geospatial server application. The design of the database follows an object-orientated paradigm and is easily extensible. A large spectrum of data is stored in the database (geology, hydrogeology, topography, urban infrastructure, etc). The geospatial database is connected to the desktop platform application and to the geospatial server, so data management and data publishing it is easily made. The geospatial server application allows the communication between the client side application (geoportal), the geospatial database and the desktop platform component. Communication is standardized through a series of services (WMS-Web Map Service, WFS-Web Feature Service,

WCS-Web Coverage Service) and mark-up languages (*GML*-Geographic Mark-Up Language, *GWML*-GroundWater ML, *GeoSciML*-GeoScience ML, CityML-City ML).

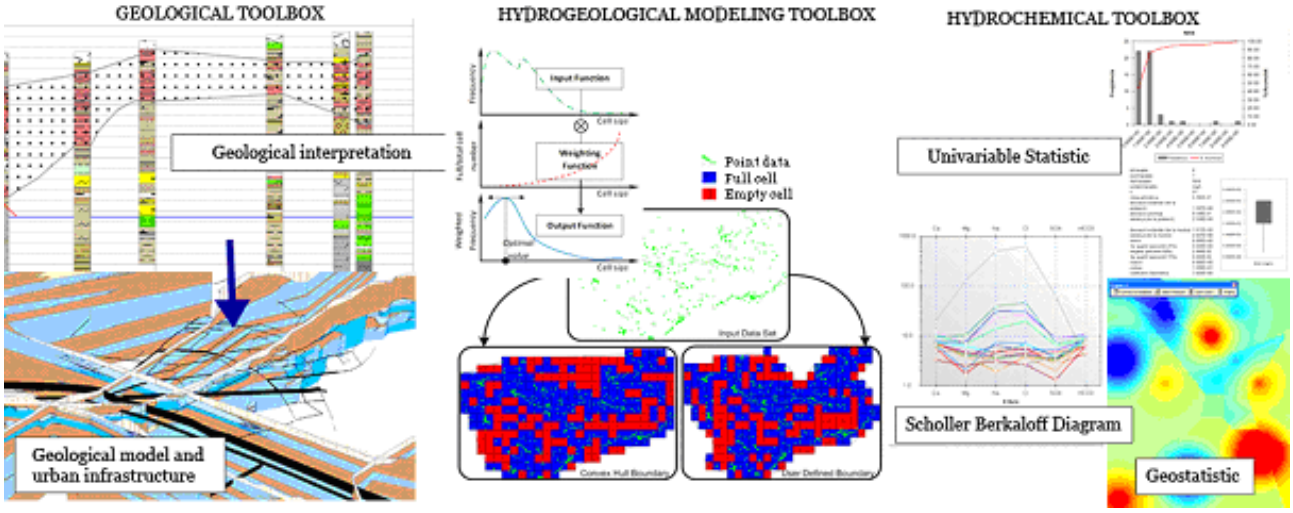

Figure 2 – Software platform toolboxes

The second component is the client side, a geoportal application capable to publish hydrogeological data and to make preliminary analysis (statistic, buffer, intersections) and geospatial queries. The geoportal service offers the possibility of querying a dataset from the spatial database. The query is coded in a standard mark-up language and send to the server to be processed by the local application. After the validation of the query the results are send back to the user to be displayed by the geoportal.

The last and the most developed component is the desktop platform. The desktop platform is designed to be used by specialists and researchers. The platform is developed under a GIS framework (ArcGIS). The main tasks are: (1) geospatial data management and (2) modelling and analysis of different urban groundwater scenarios. Therefore under the ArcGIS framework a series of toolboxes are developed (geological analysis, hydrogeological modelling toolbox, hydrochemical toolbox). Because of the plug-in GIS framework new toolboxes can be added, depending on specific needs.

The geological toolbox allows the specialist to manage litology, geophysical, and petrological data. Analysis such as: borehole diagram, geological cross-sections, defining hydrogeological units, can be easily made and exported in 2D and in 3D environment (geological fence diagram). The toolbox also allows the user to have a preliminary interpretation of the hydraulic conductivity based on geological settings (lithology, sorting, grain size, matrix).

The hydrochemical toolbox performs a series of hydrochemical analysis for groundwater quality data: hydrochemical parameter statistics (univariable, bivariable,analysis), geostatistics (using GSLib library), general chemical diagrams, charts and maps (Stiff Map, Wilcox diagram, Ionic Balance, Piper Diagram) and a series of parameter orientated maps.

The third toolbox is an interface between the platform and other third parties software (such as GMS - Groundwater Modelling System). Data from the geospatial database are exported to the modelling software and the outputs of model can be imported back to the platform. Beside the communication capabilities, the toolbox can generate an optimal cell-size modelling grid on the basis of the hydrogeological data spatial distribution. Starting from the discontinued point data (distributed randomly, uniformly, or clustery over a spatial domain), the algorithm is developed to find the optimal cell size by increasing the number of cells containing at least one data point.

ACKNOWLEDGEMENTS

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EVALUATION OF GEOPOTENTIALS FOR THE URBAN RHINE-MAIN AREA (GERMANY) BY GEOLOGICAL 3D MODELING

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KEY WORDS: Upper Rhine Graben, GIS, 3D-modeling, geopotentials, Quaternary, Rhine-Main area

BACKGROUND

The Rhine-Main area belongs to the economically most dynamic regions in Europe. It is located in a Cenozoic sediment basin which can be subdivided in the Upper Rhine Graben, the Mainz Basin, the Lower Main Plain as well as the Hanau Seligenstädt Basin.

The development of the metropolitan region, in the past and in the future, is strongly dependent on the availability and usability of geo-resources which are provided by or hosted in Tertiary and Quaternary sediments.

Here the near surface area beside its function as provider of geo-resources (water, soil, raw materials) gets increasingly important in context of modern energy production methods (e.g. shallow and deep geothermal energy). This way various interests of use are addressing the same, limited space and lead to an increasing number of utilization conflicts.

Possible usage scenarios of the near surface area in the Rhine-Main region depend, aside from geology itself, on the potential of the natural landscape unit as well as socioeconomic surrounding conditions.

To support successful and sustainable use of the near surface area this project, a co-operation between Darmstadt University of Technology and the Hessian Agency for Environment and Geology (HLUG), intends to model the Quaternary geo-architecture of the northern Upper Rhine Graben and derive an attributed 3D geological model for manifold purposes.

The project area covers almost 1,500 km² and is bounded by the cities Frankfurt in the north as well as Mannheim in the south (Fig. 1).

GEOLOGY

The geological setting is dominated by tectonic stresses which are related to the Alpine orogenesis and lead to the development of the Upper Rhine Graben from the Eocene on. Subsidence caused the accumulation of vast Tertiary deposits with thicknesses of up to 3,000 m as well as Quaternary sediments whose thicknesses in the project area range between 0 m in the fringe-areas of the Graben and up to 400 m in the Heidelberg Basin (Hoselmann 2008).

The varying depth level of the Base Quaternary is assumed to be caused by both tectonics and climate changes. Aside from the major faults of the Upper Rhine Graben the study area shows a high number of minor faults of which several structures are considered as recent/subrecent active (e.g. Haimberger et al. 2005, Peters & Van Balen 2007). Numerous shifts of the riverbeds of the rivers Rhine, Main and Neckar lead to (1) a complex interlocking of strata, especially in the northern part of the project area and (2) a heterogeneous composition of deposited layers.

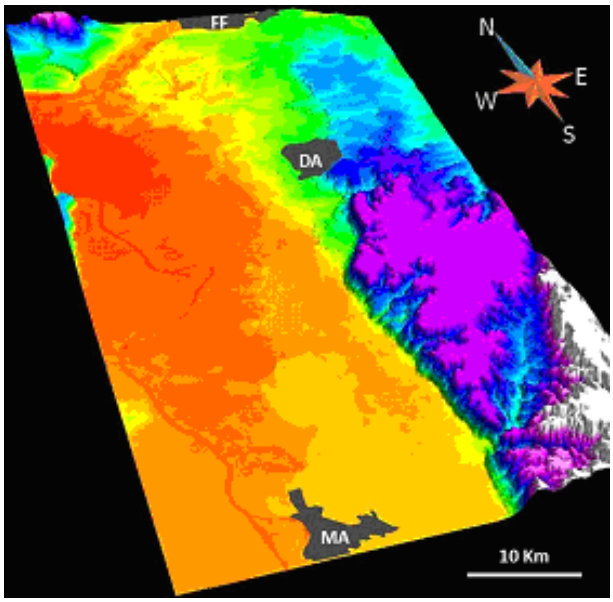

Figure 1 – Topographic overview of the project area (5 times exaggerated). White = high, orange = low. Surface modified after SRTM data (USGS 2004). Cities: MA = Mannheim, DA = Darmstadt; FF = Frankfurt

Sand and gravel layers are alternating with clay and silt layers. Since the Quaternary sediments

built up the Upper Rhine aquifer, which is one of the biggest aquifers in Europe and supplies fresh water to millions of people, the deposits are subdivided into hydrogeological units (HGK 1999). However, clay and silt layers are not present throughout the whole depotcentre. Therefore the project aims to model these horizons, i.e. the base Quaternary, a Deep Interlayer (TZH), an Upper Interlayer (OZH) as well as a minor interlayer called ZH1. Modelling these interlayers will (1) help to analyze connectivities between aquifers, (2) help to deepen knowledge in depositional processes, (3) enable a more detailed evaluation of geopotentials in the study area and (4) support sustainable and efficient decision making by local authorities.

INPUT DATA / WORKFLOW

Basis for the intended model are 15,421 wells, provided by the Hessian Agency for Environment and Geology. Altogether the wells comprise 513,301 drilling metres and a total of 79,609 lithological layers. In a first step these wells have been checked in detail for quality in order to ensure highest standards. According to target horizon specific characteristics, such as grain size, color, carbonate content, heavy minerals, etc., GIS based queries have been carried out in order to separate relevant from non-relevant layers. By the use of both ESRI´s 3D-Analyst and gOcad relevant layers currently are being used for semi-automatic mapping of the target horizons. Once mapping is finished surfaces will be interpolated by the use of gOcad (Fig. 2a), converted into 3D-geological bodies (Fig. 2b) and complemented by so called SGrids which allow to assigning numerous attributes (Fig. 2b). Based on the model geological cross sections as well as qualitative and quantitative information, such as layer thickness, porosity, grain size distribution etc. can be derived.

ACKNOWLEDGEMENTS

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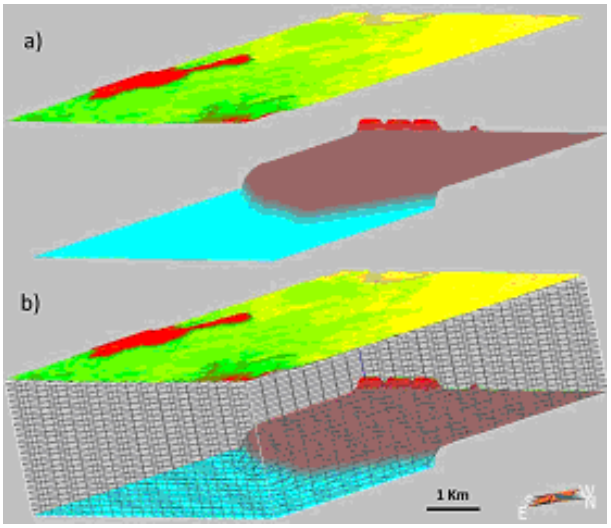

Figure 2 – Workflow of developing an attributed geological 3D-model by the example of a small portion of the study area; a) Interpolation of stratigraphic horizons, here topography and base of Quaternary (modified after Hoselmann 2008). Red = high, blue = low; b) Conversion of surfaces into 3D-geological bodies (here Quaternary) and creation of a SGrid which allows storage of numerous attributes per cell.

INDEX OF SUSCEPTIBILITY TO SETTLEMENT OF THE TIBER RIVER ALLUVIAL VALLEY IN ROME, ITALY

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KEY WORDS: index of susceptibility, settlement, alluvial deposits, plurigaussian simulation, Tiber, Rome

INTRODUCTION

Subsoil modeling plays a key role for the evaluation and managing of geohazard in urban areas. In this respect, the Institute of Environmental Geology and Geoengineering (IGAG) of CNR is coordinating the UrbiSIT project. Within the project, Rome has been chosen as one of the prototype areas for the construction of a GIS aimed at evaluation of geohazards in the Italian urban areas. In Rome, a substantial part of the research activity is aimed at characterizing the upper Pleistocene-Holocene alluvial deposits of the Tiber River. In this contribution, in particular, an index of susceptibility to settlement of the Tiber alluvial deposits is presented. This index was created by integrating geostatistics with more traditional geological and geotechnical methods, in a test area ranging from the *Olimpica* ring road northward to the *Isola Tiberina* southward (Fig. 1).

THREEDIMENSIONAL GEOLOGICAL MODEL

In order to produce a map of susceptibility to settlement of the study area, a 3D geological model was preliminarily built. About 250 vertical boreholes (total depth, TD, up to 60 meters) crossing the alluvial deposits were selected, in order to model the three main lithotypes: 1) gravels to medium clean sand from channel axes and bars; 2) fine to very fine silty sand from bars, levees, and crevasse splays; 3) silt, clay, and organic rich clay from flood plain.

The alluvial lithosomes were modeled using plurigaussian simulation (Armstrong et al. 2011), that allows reproducing complex geometries by means of simulating lithotypes with different spatial structures and considering their proportions. Lithotypes were simulated on a 3D grid with cells of 40x40x0.5 meters (Fig. 2).

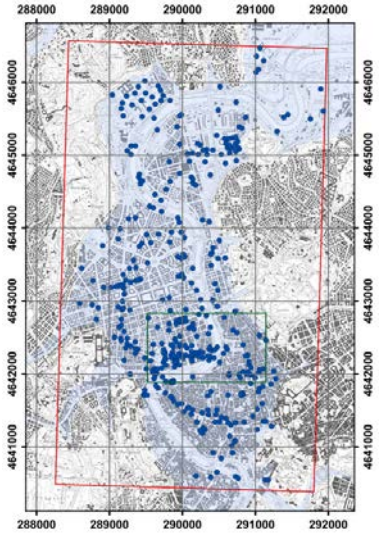

Figure 1 – Map of the study area (red rectangle) with location of the boreholes (blue circles). The green box indicates the detail of figure 3.

GEOTECHNICAL CHARACTERIZATION

Results of laboratory tests on more than 260 undisturbed samples from over 70 boreholes were analyzed to compute the physical and mechanical properties of soils relevant for the susceptibility to settlement. Average values of soil properties are listed in Table 1.

Lithotype	*n*	*γ (kN/m³)*	*e_0*	*OCR*	*C_c*	*C_r*
1	*-*	*20.0*	*-*	*-*	*-*	*-*
2	*51*	*19.0*	*-*	*-*	*-*	*-*
3 - NC	*149*	*18.7*	*0.838*	*1*	*0.295*	*0.071*
3 - OC	*30*	*19.2*	*0.771*	*3.5*	*0.272*	*0.052*

Table 1. Soil properties relevant for the susceptibility to settlement for each lithotype. Legend: n=number of samples; γ=unit weight; e_0=in situ (initial) void ratio; OCR=over consolidation ratio; C_c=compression index; C_r=unloading/reloading (or swelling) index.

Lithotypes 1 and 2 are considered as infinitely rigid and take part in the index calculation just with their own unit weight in the geostatic stress state definition. Lithotype 3 is constituted by an upper portion (approximately above 4 m a.s.l.) of overconsolidated clay (OC) while at greater depth normally consolidated (NC) clays are found.

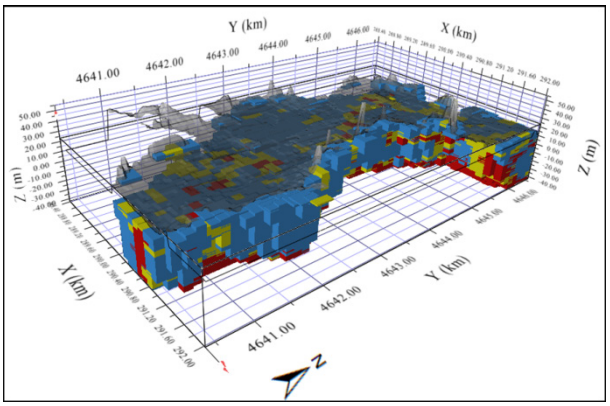

Figure 2 – 3D geological model of the Tiber alluvial deposits in the study area. Red color for lithotype 1, yellow for lithotype 2, blue for lithotype 3.

INDEX OF SUSCEPTIBILITY TO SETTLEMENT

The index is expressed by:

$$I_\delta = \sum_{i=1}^{n} \frac{\frac{H_{o,i}}{1+e_{0i}} * C_i * \log\left(\sigma'_{v0,i} + \Delta\sigma'_{v,i}\right)}{\sigma'_{v0,i}}$$

generally employed to estimate the one-dimensional consolidation settlement of a shallow foundation. In the above expression, $H_{o,i}$ is the thickness of the sub-layer i; $e_{o,i}$ is the initial void ratio of soil in sub-layer i; C_i is a compressibility index for soil in sub-layer i equal to C_c or C_r for clays that behave as normally consolidated and overconsolidated soils respectively; $\sigma'_{vo,i}$ is the initial vertical effective stress in the sub-layer i computed taking into account the pore pressure distribution derived by a global groundwater model of Tiber alluvial deposits; $D\sigma'_{vo,i}$ is the vertical stress increment in the sub-layer i variable with depth according to linear elastic theory. A uniform pressure q=100 kPa over a square flexible area of width B=25 m is assumed at the ground surface. This stress can be considered as representative of the load imposed by a 10-storey building. The summation in the index is extended over a thickness of the soil deposit equal to 2B in which $D\sigma'_{vo,i} \geq \sigma'_{vo,i}$.

The index was computed for each 40x40 m soil column and for each simulation of the geologic 3D model by employing physical and mechanical properties listed in Table 1.

RESULTS AND FUTURE WORK

The map of I_δ is shown in Figure 3 for a single simulation in a sample area, together with the corresponding interferometric velocity maps. A satisfactory agreement is observed even if the index is time-independent, i.e., does not take into account the time in which the urbanization load (buildings, backfill) has actually been imposed.

The next research steps will include integration of the time variable in the calculation of the index.

Finally, index computation for each simulation allows to generate as many maps as the geological model outputs. Results from such a computation give a good indication of the map reliability in terms of prediction uncertainty. As a matter of fact, assessing this uncertainty is crucial for a proper geohazard evaluation, especially when handling scattered not uniformly distributed data (i.e., boreholes), as in this case.

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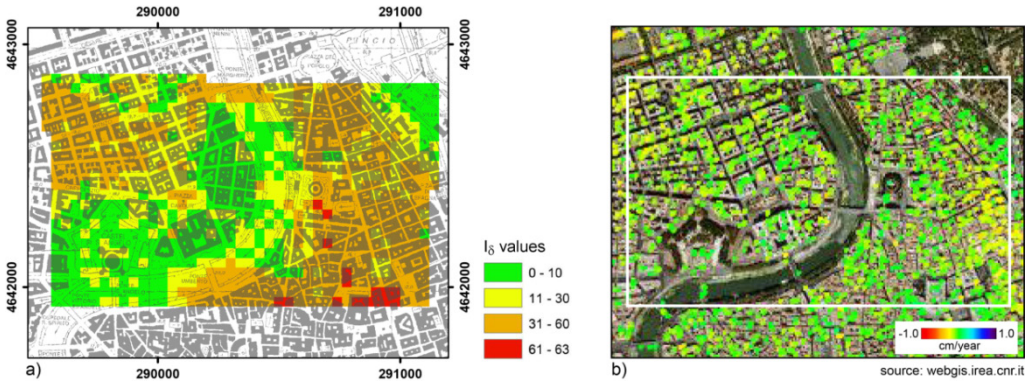

Figure 3 – Map of the index of susceptibility to settlement carried out for a single simulation in the area between Castel Sant'Angelo *and* Piazza di Spagna *(a), compared with the interferometric velocity map (b).*

A REGIONAL GEOLOGICAL AND GROUNDWATER FLOW MODEL AS MANAGING TOOL FOR THE ADMINISTRATION

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KEY WORDS: geothermal, groundwater, salinisation, 3D-model, gOcad, flow model, glazigene deposits, PMWIN.

STRUCTURAL 3D-MODEL

A 3D combined structural-hydrogeological subsurface model for the uppermost groundwater reservoir in the field of the federal city state of Bremen (325 km²) is built using the GOCAD (Geological Object Computer Aided Design) 3D-modelling software.

So far not digital available borehole data has been implemented in a database and are now available for database queries for the interpretation of petrological information.

For the construction of the hydrostratigraphic boundary layers about 70.000 wells within a depth-range between 1 to 2500 m are considered and completed by stratigraphic borehole markers and geophysical parameter logs. For the construction of a verified 3D- model a consistent dataset was compiled and a mesh of 42 cross sections has been developed. Based on the hydrostratigraphic boundary layers hydrogeological bodies will be constructed as tetrahedral voxels or with a regular grid.

Parameters as heat conductivity, permeability, remedation potential were derived from borehole data. They are implemented into the model as borehole logs and interpolated within the hydrogeological bodies.

It is our object to separate layers with different conditions for a transfer to the hydrogeological flow model.

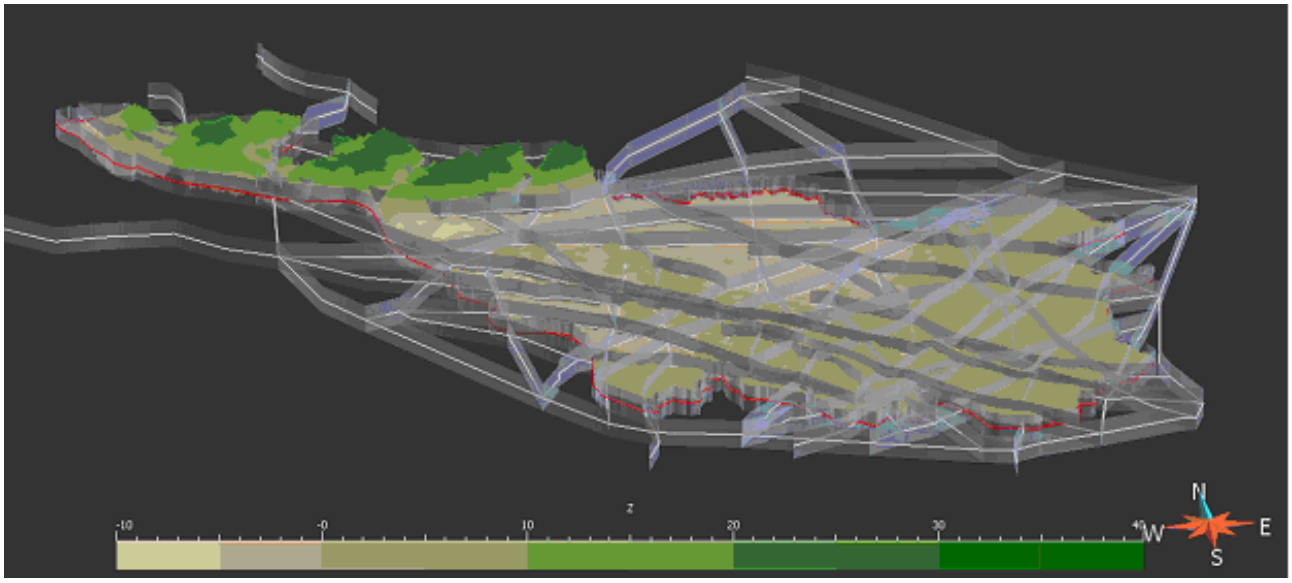

Figure 1 – Holozene-basis layer of 3D-structural model with cross-sections.

FLOW MODEL

Structural and hydraulic data were combined in a flow model using PMWIN. The groundwater reservoir is built up by heterogeneous glacial deposits with a k_f ranging from clay with $1*10^{-9}$ to gravel with $1*10^{-1}$. The base of this aquifer system, composed of tertiary marine clays, is structured by subglacial erosion channels. Using a gateway developed by McDiarmid (2011) the parametrised grid from gOcad can be transferred to PMWIN. Cell size of the 6 layer model is 100x100 m. Modeled groundwater levels were verified by about 450 observation wells. In general, groundwater level is controlled by drainage in the low lying agricultural areas and the water level in the Weser river. The river Weser is partly damed up by a power plant and beyond oscillating with the tidal wave. Extractions of

groundwater are made by local and industrial water works and sum up to about 8,2 Mio m³/a in 2010.

Present groundwater regenerations of about 59,2 Mio m³/a, scenarios of future variations due to climate change are calculated and their impacts on quality mentioned. A special issue of groundwater quality is salinisation due to infiltration of the Weser river respective upconing from underlying salt domes (DROLL M. & ISENBECK-SCHRÖTER M., 1994).

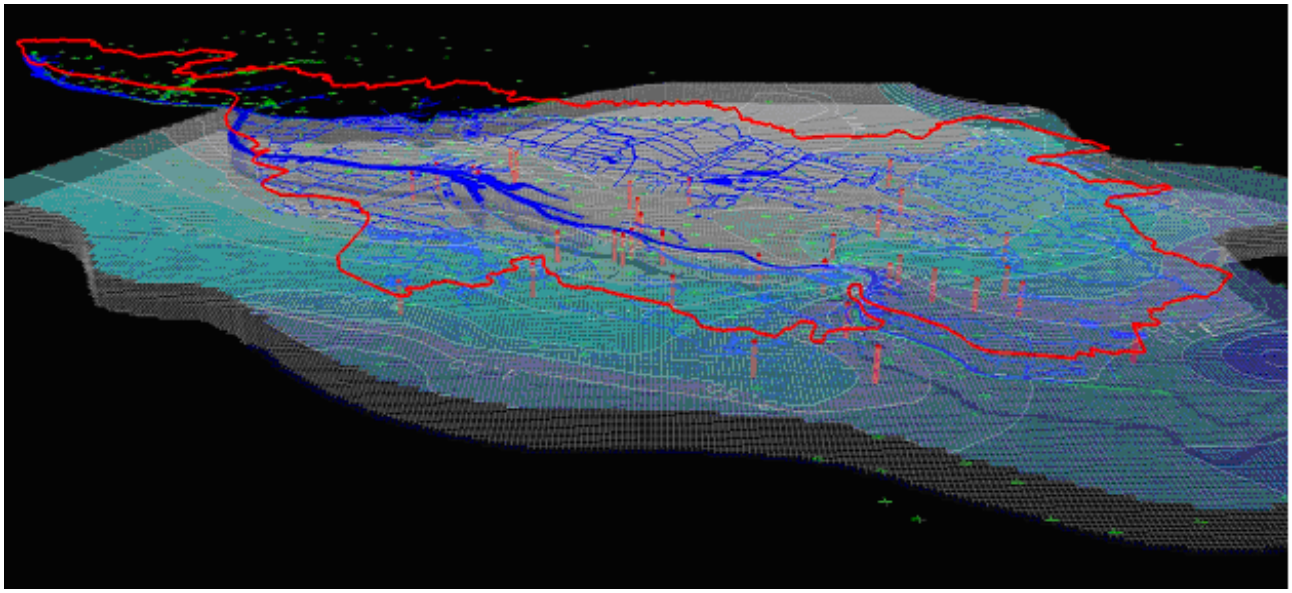

Figure 2 – Flow model of the quarternary aquifer system with groundwater table, surface waters and extraction wells (red) and observations wells (green crosses).

APPLICATIONS

For the population data will be provided via the World Wide Web, allowing quick information for construction parameters as:

- Geothermal potential (depth depending heat conductivity and groundwater flow).
- Building ground quality (setting and depression areas) and corrosive groundwater.
- Flooding risk and the possibility of artificial rain water infiltration.

Enterprises can benefit from detailed subsurface information and framework for more detailed models for:

- Groundwater level and permeability of the sediments for improvement of the Leakage inspection of waste water canals.
- The installation of production wells.
- The dimensioning of geothermal heat exchangers and the identification of their environmental impact

The administration has a managing tool for a professional evaluation of:

- Groundwater or geothermal production well requests.
- Adaption of groundwater protection areas to the remediation potential of the ground to avoid restrictions for the industry higher than necessary in the concurrent areas.
- Securing the supply of raw materials as clay, sand and gravel.
- The impact of climate change on groundwater availbility and flooding risk due to sealevel rising.

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REVEALING THE GEOLOGY OF URBAN AREAS: THE 1:5000 URBAN GEOLOGICAL MAP OF CATALONIA APPROACH

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KEY WORDS: Urban geology, geological mapping, applied geology, Catalunya.

NTRODUCTION

Although urban areas cover less than 1% of the world's surface, such built environments currently host more than 50% of the population and represent the places with highest economic activity.

The ground configuration of urban areas is in permanent change as a result of human activities. This, together with land stability, flooding or environmental pollution are, among others, fundamental topics that affect urban areas. On the other hand, geological knowledge can provide critical information about these issues, and facilitate the planning and management of such dynamic areas. Therefore, the development of systematic urban geological mapping projects provides valuable resources to citizens.

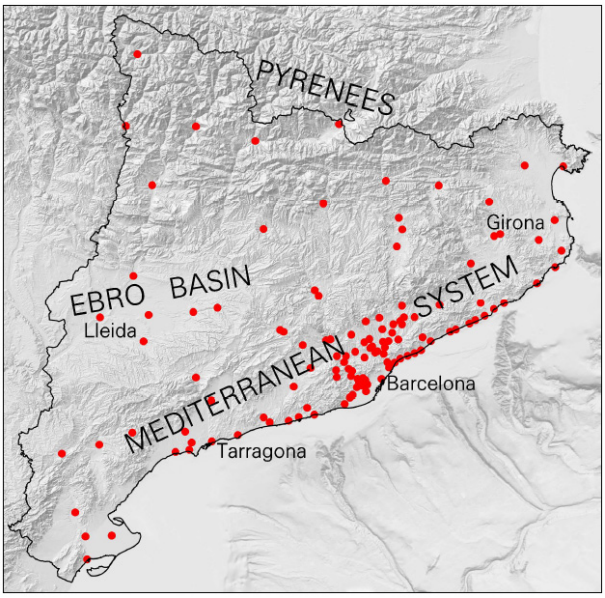

Figure 1 – Dot map showing the towns to be mapped by the MGZUC5m project.

Since 2007, the Institut Geologic de Catalunya (IGC) runs an urban geological mapping project to provide accurate geologic information of county capitals and towns with population larger than 10000 in Catalonia (NE Spain). The urban areas of 131 towns will be surveyed for this project (see Figure 1), totalling an area of about 2200 km^2. Around 60% of the area of interest belongs to Barcelona metropolitan area, which hosts about 3.5 million people and represents one of the main economic centres of SW Europe. The rest of the urban areas are scattered, although it is important to emphasise the existence of cities with more than 100000 people, such as Tarragona, Lleida and Girona.

After 4 years of development of the project, we present the production process of the 1:5000 urban geological map of Catalonia (MGZUC5m).

METHODOLOGY

From a methodological point of view the geological characterization is divided into two stages. The first stage involves the collection and homogenization of geological data frompreexisting documents, as well as the characterization of outcrops existing inside the urban area. The second stage consists on the analysis of all available data, the performance of geological maps and other geological schemes representative of urban areas and their surroundings. Moreover, in areas with few data or ambiguous information the characterization is complemented, as far as possible, with specific geophysical surveying.

Finally, for each targeted urban area we generate, in a GIS environment, the following datasets:

- Outcrop inventory
- Standardized borehole database
- Petrographic, chemical and physical data of representative rocks, sediments and soils
- Geological mapping of artificial deposits, quaternary sediments and the bedrock
- Contouring of the main geological surfaces (e.g. base of the quaternary deposits)
- Cross sections
- Complementary schemes such as stratigraphic columns or thematic maps addressing key issues for the geological understanding
- A catalogue of useful recent and historical documents for geological characterization

The analysis of the database allows composing and printing the MGZUC5m.

THE 1:5000 URBAN GEOLOGICAL MAP

The MGZUC5m map sheets represent a synthesis of the geology of urban areas focused on providing assistance to professionals and general public, who need ground and shallow subsurface information.

Each map sheet covers an area of 8km^2, and is composed of a main 1:5000 scale map with several supplementary elements giving complementary information (see Figure 2).

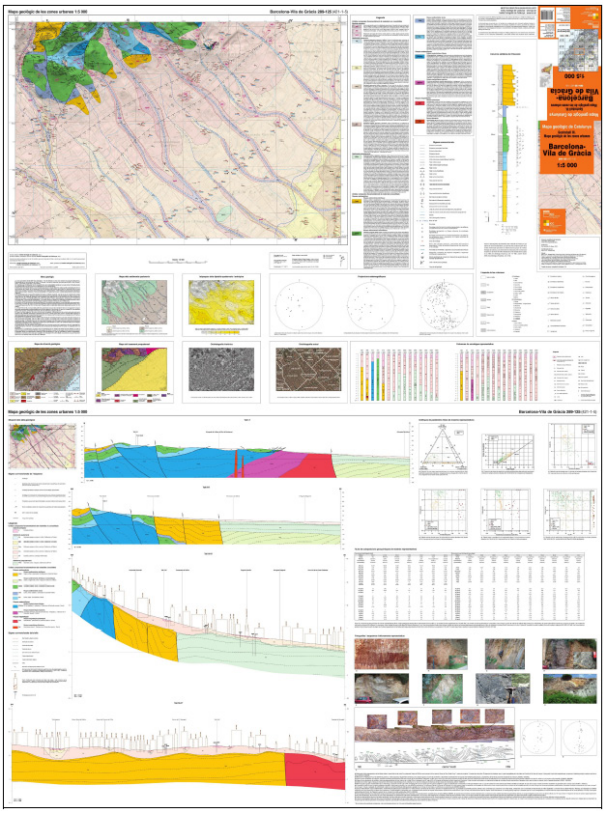

Figure 2 – Example of a printed sheet of the 1:5000 urban geological map from Catalonia series. 'Vila de Gràcia' neighbourhood (Barcelona).

As a whole, it is an applied geological map that integrates a wide spectrum of data, providing from very objective information to elaborated interpretations.

The 1:5000 scale main map, aside of geological units (quaternary and prequaternary) that compose the ground of urban areas, locates the outcrops, includes borehole data (e.g. depth to groundwater level) and shows the distribution of the main anthropogenic deposits.

Regarding the supplementary elements, it is worthy to highlight:

- The bedrock map
- The 5 meter grid size model of thickness of the artificial and quaternary deposits
- A list of borehole logs revealing the lithology of the first 20-40 meters of the representative sites Geological cross sections showing the deep structure
- Detailed cross sections focused on the distribution of the quaternary, anthropogenic and weathered deposits
- Charts of physical parameters of the geological units (e.g. rock compressive strength versus depth) Geochemical analysis of topsoil and representative samples of geological units
- Stereographic projections of major discontinuities Photo gallery of outcrops, samples and other features related to the geology of the urban areas.

Noteworthy that the content of the main map and the supplementary components may change depending not only on the geological features of the area, but also on the gathered data at the time each map sheet was finished.

DISCUSION AND CONCLUSIONS

On the whole the 1:5000 urban geological map of Catalonia represents a systematic urban mapping survey that provides a robust database to be used in targeted studies related to urban planning, geoengineering works, pollution and other important environmental issues that society will deal within next years in Catalonia. This kind of geological characterization can be easily implemented to other regions of the world.

At the time of writing (January 2012), we have been working in an area covering 60 map sheets (480km^2). 8 of them have already been published,

4 are in publication process and we are finalizing the content and format of 17 sheets (ten of these will be completed in the late 2012).

For further information on the project or consulting published sheets, see the following address: *http://www.igc.cat/web/en/mapageol_ geotreballs_ gt3.html*

THE USE OF 3D MODELLING AND GIS TECHNOLOGIES IN UNDERSTANDING AND PREDICTING ANOMALOUS GROUND CONDITIONS IN LONDON

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KEY WORDS: 3D Geological models, London Basin, Faulting, Lambeth Group, Drift Hollows,

ABSTRACT

The population of London is around 7 million. The infrastructure to support this makes London one of the most intensively investigated areas of upper crust. However construction work in London continues to reveal the presence of unexpected ground conditions. These have been discovered in isolation and often recorded with no further work to explain them. There is a scientific, industrial and commercial need to refine the geological framework for London and its surrounding area.

GEOLOGICAL CONTEXT

Geologically, London sits within the London Basin which is a broad, gentle syncline, whose axis can be traced from Chertsey through to Chelmsford (Fig.1). The London Basin is traditionally considered to have formed in the Oligocene to mid-Miocene times during the main Alpine compressional event (Ellison et al., 2004). Formations in London range from Cretaceous (144 to 65 Ma) to Quaternary (2.6 Ma to present day) in age. The Cretaceous Chalk is present at subcrop throughout the London basin and comes to the surface along the southern margin (the North Downs) and along the northwest margin (Chiltern Hills) and is locally at or close to the surface e.g. along the Greenwich and Purfleet anticlines in East London.

The Cretaceous Chalk is typically a fine grained white limestone. It has a total thickness of between 175 and 200 m and generally thins from west to east. Overlying the Chalk is the Palaeogene that comprises the Thanet Sand Formation, the Lambeth Group, consisting the Upnor Formation overlain by an interplay of various facies attributed to the Reading and Woolwich formations, and the Thames Group, which consists of the Harwich and London Clay Formations. Quaternary deposits are encountered throughout the London Basin. These include evidence of ancient river systems and the development of the present-day River Thames valley.

PROJECT OUTLINE

Current failure to share ground investigation geodata and knowledge about anomalous ground conditions in London has prevented the geological model for the Basin from evolving and therefore failed to reduce the risk to engineering projects of unforeseen ground conditions. The current model oversimplifies the geological structure of the region (Royse, 2010). If nothing is done to improve this model, it will continue to result in unrealistic ground models and unreliable predictions (Wycisk et al., 2009). This is a situation that has already proved costly in terms of project overruns and is a continuing health and safety risk. An additional

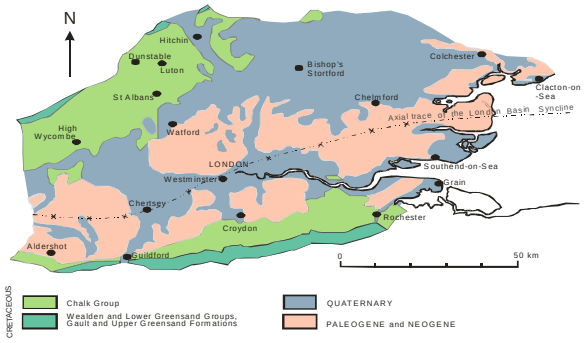

Figure 1 – Geological sketch map of the London Basin based on Sumbler (1996, Fig 1)

issue resulting in a failure to share geodata is that, currently, every major engineering project has to recreate a significant proportion of geodata, adding to the cost of each project (Hack, 2009). It is important to realise that the value in having geoscientific information is not in the possession of it, but in its amalgamation and interpretation.

RESULTS AND DISCUSSION

The variability of the Lambeth Group, especially the presence of lensoid bodies of permeable non-cohesive sediment, can give rise to difficult ground conditions for civil engineering works. The detailed distribution of the component lithofacies is poorly understood, leading to the observation that these sediments are amongst the most difficult to engineer in the United Kingdom (Page & Skipper 2000). The Lambeth Group appears to be most complex under central London, where it occurs widely at shallow depth, so that understanding these deposits has been crucial in recent major civil engineering, such as the Jubilee Line Extension (Bailey et al. 1999), and the Channel Tunnel Rail Link (Dyke & Glover 2007). 3D geological modelling is aiding our understanding of the distribution of these sediments in London and suggests that the marine transgressions and regressions which, are known to have occurred during the deposition of the Lambeth Group, were in part controlled by movement along faults.

3D modelling has also aided in the recognition and identification of 'drift-filled' hollows beneath some of the River Terrace deposits associated with the River Thames. These can vary on average between 5 to 15 m in amplitude, but exceptionally as much as 60 m for example Blackwall Tunnel, and can cause considerable complications in construction projects. Using GIS techniques BGS has mapped the location of these drift filled hollows throughout London and produced a susceptibility layer having identified a number of common features associated with the distribution of these hollows. The value of this lies firstly in the opportunity for planners to have a broader awareness of the potential location of difficult ground conditions associated with these features; secondly in presenting information that can be used to reduce the potential for unforeseen ground conditions through effective site investigation design, and thirdly in the opportunity to further interrogate the GIS hosted information to further process understanding.

CONCLUSIONS

With current advances in the ability of Geographical Information Systems (GIS) and 3D modelling technology to handle large datasets on nothing more than a regular desktop PC, a revolution has occurred in the way geo-environmental information can be viewed, manipulated and interpreted. This is enabling the construction of the 'next generation' of geological models for London that will provide a platform for integrating and visualising data from many different sub-disciplines, so allowing a model to portray some of the natural heterogeneity of real geological systems.

Re-evaluation of geological data from ground investigations (both new and old) is proving that faults are not only more numerous than previously thought, but have had a significant impact on the development and deposition of sediments within the Basin. With the amount and complexity of future engineering work planned in the London Basin, such as the tunnels for Crossrail, scheduled for 2010–2017, Thames Tideway, scheduled for 2012–2020 and the cable tunnels for National Grid, scheduled for 2009 – 2016, the presence or absence of faulting is becoming an ever more significant issue for which a new geological model is urgently required.

ACKNOWLEDGEMENTS

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THE ROLE OF THE URBAN GEOLOGY IN THE HISTORIC DEVELOPMENT OF FERRARA AND IN ITS PRESENT-DAY MANAGEMENT.

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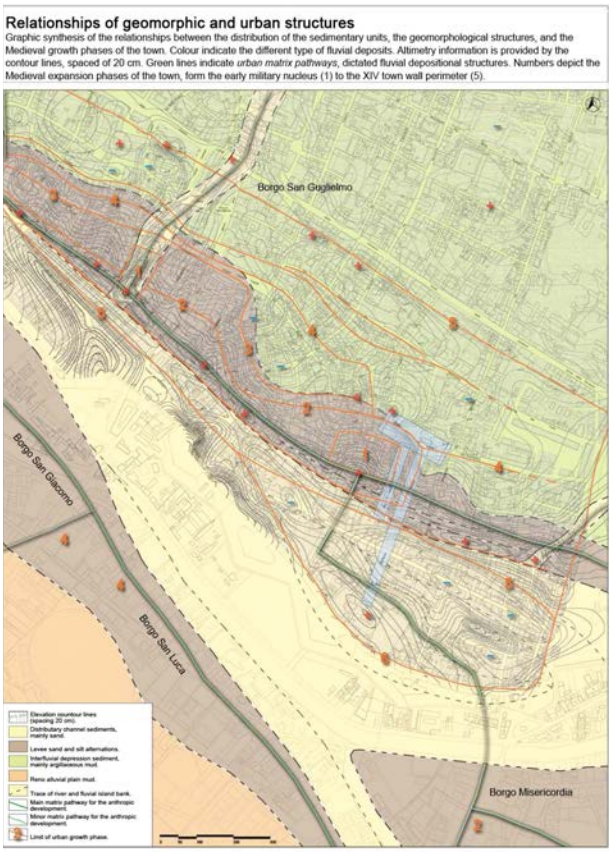
KEY WORDS: Stratigraphy, Geomorphology, Hydrogeology, Town History, Architecture.

The urban area of Ferrara is developed in a low-lying region, subject to significant pollution, flooding and seismic risks. The town has grew at the junction of the Po delta area, the alluvial meander plain of the Po river, and the alluvial systems fed by Apennines-derived streams. The sedimentary evolution of the river systems strongly influenced the urban shape, but human intervention in turn changed the fluvial dynamics, to generate the present-day artificial state. Near the divergence point of these channels, Ferrara was founded during the early Middle Ages (7th century), as a fortified structure (# 1 in Figure), built on a crevasse splay, part of the natural levee body of the Po, near the border between Byzantine and Lonbardic influence area. The southern side of the fortified village, was about 240 m long. The proto-urban structure then grew in a linear way, on the sandy levee crest, since the topographically elevated structure offered protection against flooding waters and provided comparatively firm and well drained ground. During the first half of the 11th century, the urbanised area on the northern levee of the Po stretched over a distance of about 2300 m, with an average width of 50-100 m (# 2). During Medieval times, also the southern levee of the Po was overbuilt. At the beginning of the 12th century, the modern Po channel, flowing at the north of the town, was generated, during a river reorganisation phase. During the following centuries, the early pattern of urban tissue growth through individual building cell implantation gave way to discrete episodes of town planning and urban expansion (numbers 3-4-5), associated with land reclamation works and water canalization. These extensive works made the urban expansion into interfluvial depressions possible. At the ending of the 15th century, a large renaissance expansion (*Addizione Erculea*) into argillaceous depression took place. During the following century, the water flow in the southern Po channels was terminated by an ill-fated attempt to force the Reno River into reaching the sea through the former Po di Primaro delta mouth. The very low topographic gradients and the elevated sediment load transported by this Apennines-derived river rapidly silted up the ancient Po di Ferrara channel, just at the west of the town. Large marsh therefore developed in the areas surrounding the town, engulfing large southern suburbs. After a long period of stagnation, the urban growth took a significant pace only after WWII, in ways totally unaware of the historical, geological and environmental constrains and thus producing significant hazard levels. The Po, Panaro and Reno river water levels are mach higher than the topographic elevation of the town, generating a major flooding risk. The subsurface waters also largely affect the building degradation state. In a anti-intuitive way, impregnation levels are much higher above permeable fluvial sand bodies, showing lower phreatic water levels, than on organic rich argillaceous interfluvial deposits, characterized by higher phreatic levels. The stratigraphic substratum also influence the geotechnical and seismic response, both in the historic edifices and in the modern buildings.



GIS TECHNOLOGY IN MANAGEMENT AND DEVELOPMENT OF THE CITIES AND THEIR UNDERGROUND SPACE: THE EXAMPLE OF GEOHERITAGE, A WEB-GIS CONCERNING PALERMO URBAN AREA

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KEY WORDS: urban areas, underground geology, GIS, monumental heritage, geological hazard assesment.

As urban areas are characterized by high geological variability, the outlining of geological and underground urban setting requires a highly detailed resolution. This difficult task is made feasible when a great deal of stratigraphic, geotechnical, seismic, macroseismic, heritage and infrastructures data are available. Every city collects lots of data about its subsoil deriving by restoration's work, extension and updating interventions of service networks. These data are affected by inhomogeneity due to the different sources and acquisition procedures. However, after a careful data processing, reliable databases can be elaborated by encoding, digitizing and implementing them in a GIS framework. The possibility of displaying data in their mutual spatial relationships makes easier data consistency control and allows to work out reliable dataset, starting point for a realistic 3D subsoil model, essential for hazard assessments, urban planning and underground space utilization.

For these reasons a dedicated GIS can represent a powerful tool to provide sustainable solutions for the development of a city.

A dedicated urban GIS, called GeoHeritage-GIS, has been developed at the Department of Earth and Sea Sciences of the Palermo University. Many reliable and high spatial density dataset have been stored in it for Palermo urban area. The system has a modular, open architecture. Each module handles a particular topic and, belonging to oriented GIS class, GeoHeritage-GIS has an archive structured to receive oriented data models and tools properly developed to easily carry out specific elaborations, useful for hazard assessment in urban areas. GeoHeritage-GIS has been originally developed to support natural and in particular seismic hazard assessment inside urban areas and to correlate the historical-monumental heritage, treasure of many Italian cities, with the local geological succession and physical-mechanical properties of the foundation soils.

In order to share the results of a ten years investigation carried out on Palermo urban geology at the Department of Earth and Sea Sciences, GeoHeritage-GIS is today free on the web (www.ghgis.unipa.it).

In this work GeoHeritage-GIS features and effectiveness are illustrated.

A really meaningful dataset implemented in GeoHeritage-GIS is the Stratigraphic one, collecting 3000 boreholes spread on an area 70 km^2 large. Although Palermo is characterized by a quite complex geology, a detailed reconstruction of the surface geology (within 50 m in depth) is well constrained by the stratigraphic dataset.

The Geotechnical dataset implemented in GeoHeritage-GIS collects the results of tens of thousands tests carried out on all types of soils.

Tools on service with stratigraphic and geotechnical dataset have been developed in order to automatically outline the local litho-technical succession and the variability range of the geotechnical parameters for each lithotype, inside a selected portion of a geo-referred map (Contino et al., 2006).

The Cultural heritage dataset managed by GeoHeritage-GIS includes historical-artistic information, structural data (building typology, damages) and photographic documentation of 700 monuments within Palermo historical centre (Giammarinaro et al., 2003; Giammarinaro & Maiorana, 2007). The outlining of the near-surface geology performed by GeoHeritage–GIS allows defining for each heritage element the corresponding stratigraphic-geotechnical model (Canzoneri et al., 2004), obtaining a classification of Palermo Historical Centre heritage based on the induced vulnerability. Geological sections, crossing 200 most famous monuments, have been carried out and geo-referred for GeoHeritage-GIS handling.

In GeoHeritage-GIS also Instrumental and macroseismic dataset are stored. The first collects records of temporary digital seismic stations installed in Palermo urban area by INGV and Department of Earth and Sea Sciences to survey the seismic sequence occurred in Palermo in 2002 (mainshock on 6th September 2002, Mw 5.9). The variability of ground shaking in Palermo has been evaluated by applying different spectral ratio techniques to seismograms of about 30 aftershocks, with magnitude ≥ 2.8 (Di Giulio et al., 2005). Relevant

spectral variations have been estimated among the different stratigraphic-geotechnical models, in frequency bands varying from 1 to 3.5 Hz.

Seismic noise measurements acquired on 100 sites have been implemented too (Cara et al., 2008).

The Macroseismic dataset has been carried out storing in GeoHeritage-GIS the "AeDES" census damage cards, performed by the Civil Protection Department of Sicily, which codifies the damage suffered by buildings structural elements during the September 2002 seismic sequence. The "AeDES" dataset has been easily related to the other datasets concerning Palermo obtaining a good agreement between the values of the damage indicators and the local stratigraphic-geotechnical model, according to the instrumental data.

The integrated analysis of the illustrated datasets, performed in a devoted GIS environment, represents a powerful approach for planning and management of cities and for the definition of the areas exposed to higher risk. The multidisciplinary investigation on urban areas and their subsoil is also essential for the underground development of the cities. Actually GeoHeritage-GIS is currently used by Public Urban Institutions working on the town administration. Several underground works in Palermo have already got benefits using this system since it gives a great contribution to test different project solutions, plan new local investigations, optimize cost/benefit ratio, reduce work duration and select the optimal intervention methods.

It is worth underlining that GeoHeritage-GIS is today available on line for Palermo urban area but, implementing other geo-referred maps and datasets, it is exportable to any urban area.

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AN OUTLINE OF URBAN GEOLOGY AND FLOOD RISK: THE CASE OF GENOVA

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KEY WORDS: Genova, urban geology and geomorphology, flood risk.

SESSION 7 - URBAN GEOLOGY

Several complicated geological and geomorphological features, directly connected to the particular tectonic history of the area, have influenced over the centuries the development and expansion of the Genoese urban area. The city of Genova lies on a transitional zone between the Alps and the Apennines, whose extremely complicated tectonic history has left evident morphological traces. After the Tethys oceanic crust subduction, during the Paleogene, mountain building occurred due to several compressional phases that superimposed very different formations from the lithological, metamorphic and deformational point of view: cretaceous torbidites, jurassic maphic and ultramaphic rocks from almost non-metamorphic to eclogites facies, dolomites, cherts, basalts, limestones etc. Some chain scale tectonic lines such as the Sestri-Voltaggio cross Genova and influence the morphology of one of the two important valleys that characterize the shape of the city.

The north-east migration of the compressional front after the Oligocene left an extensional regime that caused the formation of the characteristic steep mountain slopes that face the sea along almost all of central and eastern Liguria as well as several graben structures that form the relatively less steep area occupied by the city of Genova. The Messinian–Pliocene sea level oscillations left evidences such as the submarine canyons that continue underwater the course of the two main waterways that cross the city, the Bisagno and Polcevera streams, and, on the other side, the thick marine deposits of overconsolidated shales along the graben structures (Ortovero shales) as well as several marine terraces structures.

Despite the complicated morphological features, Genova has been populated since pre Roman times because of its position on the Mediterranean sea. The development of the town since its origins has been influenced by the peculiar morphology characterized by a few flat areas squeezed between the sea and the mountains (which can be as high as 800 m like mt Fasce) along an almost E-W direction, with the exception of the two larger valleys Bisagno and Polcevera that run northwards, giving the modern city the approximate aspect of a big upside down π. The morphology of the city has somehow influenced the human activities too, driving the ancient Genoese to sail the seas and develop commerce.

The great subsoil lithological variety has allowed the development of several quarries in the urban area. They go from the small Antola marly limestone quarries which used to meet the need of local building material to those of the green ophicalcites (Verde Polcevera), still very appreciated as decorative stones and the more recently opened quarries of basalts and dolomites used for the making of concrete, asphalts and steel making processes.

Several geomorphological and hydrogeological problems affect the city of Genova. The fast growth phase that followed World War II, characterized by a lack of proper planning, led to a quite indiscriminate urban sprawl towards the hills and the mountains. Since the 1960ies landslides and floods have periodically affected the city, leaving behind destruction and death.

On November the 4th 2011, a very heavy flood event affected some quarters of the City of Genova. The area interested by the exceptional precipitation can be roughly subdivided into two parts: an upper, wooded hilly area, little inhabitated, more or less abandoned and left to its natural state and a lower, larger, deeply urbanized area, also characterized by brooks and streams covered during the recent urbanisation.

The huge quantity of rain fallen in a single morning (up to 400mm), caused extensive damage and, far worse, several casualties.

These meteorological events are cyclical and they affect Genova urban area, a very complex and fragile area under a geological, a geomorphological and an urbanistic point of view.

It is possible to see how the return period of these floods is getting shorter, beginnig from the catastrophic event occurred in 1970, followed by a

second one in 1992 and a last one in 2011. It's easy to see that a roughly twenty year period is to be considered.

Climate changes, together with wild urbanisation, have led to the present complex scenario where natural phenomena, which are increasing their rate, can turn out to be destructive or even deadly events. Floods can't perhaps be avoided, but their worst consequences are too often caused by human irresponsibility.

TRANSFORMING THE EXCHANGE OF URBAN SUBSURFACE DATA AND KNOWLEDGE BETWEEN THE PUBLIC AND PRIVATE SECTORS: A PILOT IN GLASGOW, UK

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KEY WORDS: urban subsurface data; knowledge exchange.

THE NEED FOR BETTER KNOWLEDGE AND DATA EXCHANGE IN URBAN AREAS

Insufficient understanding of ground conditions is widely recognised by the construction industry across Europe as the largest single cause of project overspending, project delays (half of projects by more than a month), and overly conservative construction design. It also contributes to a lack of understanding of natural resource sustainability, particularly in urban areas.

Radically improved access to existing subsurface data is the key to potentially major efficiency gains, reduction in the uncertainties in ground conditions, and improved risk management in planning and development, and improved production of 3D digital subsurface models. It is also the key to greatly enhancing the monitoring and regulation of urban resources – such as groundwater. Examples of a changing culture in knowledge exchange from ongoing work by the British Geological Survey (BGS), Glasgow City Council (GCC) and others in Glasgow, Scotland, demonstrate how better data exchange can achieved in urban areas, in tandem with INSPIRE, so that the benefits of past investment in data can be maximised for wide and mutual benefit.

3D URBAN SUBSURFACE MODELS

To improve understanding of subsurface conditions, and make much more effective use of ground investigation data from urban areas, there has been a strong move in recent years to analyse and interpret subsurface data through 3D models. Geological Surveys in Europe are at the forefront in developing such models on citywide scales to underpin urban planning and sustainable development. However, the data on which these models are based are mostly acquired by consultants and contractors during ground investigations on behalf of private and public sector clients. Poor connections in the flow of these data to Geological Survey organisations result in the models, and the decisions which they influence, being based on a fraction of the data and knowledge that is actually available from urban areas.

For example, the 3D geological model of Glasgow recently developed by BGS researchers in partnership with Glasgow City Council is based on over 50 000 borehole records and mine plans, and is the most detailed model developed in the UK to date – yet, many thousands more borehole records had to be excluded from the model as a result of data being inaccessible or unusable.

DEVELOPING A MAJOR CHANGE IN KNOWLEDGE EXCHANGE, GLASGOW

Recent collaboration between BGS and GCC has demonstrated the potential for creating the conditions necessary for a major change in knowledge exchange culture between the public and private sectors in urban areas, to aggregate, store and communicate subsurface data far more efficiently and effectively for the wider good. Work is now in hand to develop a data and knowledge exchange network – **ASK** (**A**ccessing **S**ubsurface **K**nowledge) – between public and private sectors in urban Glasgow, so that high quality systematic subsurface datasets and 3D subsurface models can be effectively developed, exchanged, and revised on a regular basis to support decision making and monitoring of urban resources such as groundwater. Integral to this will be the development of an improved data transfer mechanism between the public and private sectors. GCC will take a lead, by ensuring data it acquires complies with current industry standards for data reporting developed by the Association of Geotechnical and Geoenvironmental Specialists (AGS). A web portal will be developed to check for data compliance before data can be accepted by GCC.

The work in Glasgow could set a standard for effective transfer of usable data between public and private sector users nationally – e.g. for other local authorities and national bodies in the UK, such as Transport Scotland and the Highways Agency, who have long advocated the need for more coherent reporting and exchange of subsurface data – and more widely across Europe. Development of a culture of data and knowledge exchange for mutual benefit will have significant advantages over legislation that aims to ensure such transfer, but that is hard to implement.

RISK MANAGEMENT OF LANDSLIDE IN URBANIZED AREAS. THE CASE STUDY OF THE TOWN OF FOGLIANISE (CAMPANIA)

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KEY WORDS: landslide risk, rock fall, operating procedure plan

On the southern and western slope of San Michele Mount, that is the eastern sector of the Camposauro Mount, the Leschito, Palazzo and Barassano villages are located; they fall within Foglianise municipality, in Benevento province (figure 1 and 2).

In these places the frequent occurrence rock fall forced the City Council to promote geological studies in order to evaluate the possibility to mitigate risk conditions.

San Michele Mount is made up of neritic limestone Jurassic in age; the succession is layered with dipping toward NE and average inclination ranging between 30° and 45°. In some cases on the Middle Jurassic carbonatic succession, siliciclastic deposits, Miocene in age, in angular unconformity lie (BOSCAINO, 2000).

This study is focused on the southern slope of San Michele Mount where a normal fault, dipping at South, is present.

A field geological survey allowed to realize:

- the geological map at 1:5.000 scale with some areas at 1:2.500 scale;
- the geomorphological map at 1:5.000 scale with some areas at 1:2.500 scale;
- the geomechanical classification of outcropping rock masses.

Figure 1 –.

The geomorphological analysis allowed to hypothesize in the upper slope some paths of rock fall related to detachments that can occur in the area. The upper slope, shown in the figure 3, is about 30.000 m2 wide.

Figure 2 – Southern and south-western side of San Michele Mount with the town of Foglianise.

All the acquired data have allowed even a behavior analysis, using numerical simulations, of the rock blocks in phase of the post-breaking relatively to the phenomena of rock fall, for frequency, size of the blocks, speed and therefore energy involved.

The results pointed out areas with higher landslide susceptibility (relative hazard) and consequently, classified as priority areas for safeguard actions. In particular, five distinct areas were identified in which 4, in the last 11 years, have been hit by landslides that strongly damaged the villages and the old church of “San Michele Arcangelo”.

The complexity of the rock falls and their unpredictability, needs the realization of an “Operating Procedure Plan” (OPP) in which are outlined the procedures to apply to the landslide risk of San Michele Mount, that have to be implemented by the staff of Foglianise municipality.

The OPP:

- provides monitoring and “early warning” actions, needed to define the levels of attention and warning to transfer at the Municipal Civil Protection Plan;

- describes the procedures of information (through the installation of signage and information boards) and of mitigation. The latter consisting of routine maintenance works and of special works after severe event with respect to areas of interest.

Ultimately the OPP aims to manage over time the reduction of risk conditions and its effectiveness is closely linked to the quality of basic geological data (structurals, stratigraphics and geomorphologicals). The ability to adequately represent the basic geological data and their validity make the OPP a very useful tool.

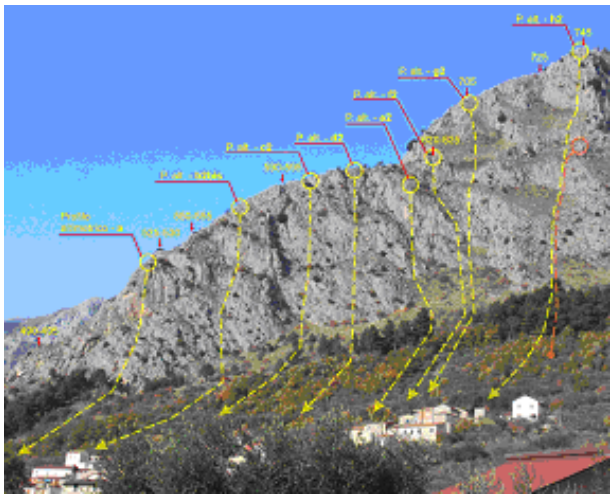

Figure 3 - In yellow the paths on upper slope indicative of rock falls related to hypothesized detachments.

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THE NATURAL ENVIRONMENT AND THE DEVELOPMENT OF CITIES - A GIS-BASED COMPARISON OF MAINZ AND WIESBADEN (GERMANY)

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KEY WORDS: Eigenlogik, cities, natural resources, GIS.

Since 2004, an interdisciplinary urban research cluster at Technische Universität Darmstadt and the Darmstadt University of Applied Sciences has been investigating the specific characteristics of cities. The "intrinsic logic" ("Eigenlogik") of cities is a working concept which aims to identify the basic structures of cities that influence their development (cf. http://www.stadtforschung.tu-darmstadt.de/).

Here, we use interurban comparison as a method to decipher similarities and differences between the cities of Mainz and Wiesbaden focussing on its natural environments. These neighbouring cities, separated by the river Rhine, are located in the Rhein-Main region. In this area the southern margin of the Rhenish Mountains shares a border with the Upper Rhine Graben. Both are state capitals, have more than 200,000 inhabitants each, have its distinct histories and have been governed by different political parties.

The history of Wiesbaden has been greatly influenced by thermal and mineral waters with deep seated origins that ascend along the southern master fault of the Rhenish Massif. Romans already used the springs of "Aquis Mattiacis" (later "Wisibada") for relaxation and healing. The long tradition as a world spa city is still living with popular thermal baths (e.g. Kaiser-Friedrich-Therme) and internationally known healthcare centres (Kopp 1986; Landeshauptstadt Wiesbaden n.d.).

The rise of Mainz is closely connected to its location near the river Rhine. The Romans built their military base on the Kästrich, a high altitude area at the confluence of Main and Rhine. This strategic location made Mainz favourable for the building of a fortress and its development into an important port (Stadt Mainz, Stadtplanungsamt 1997).

Until now, the setting of the natural environment has influenced the urban metabolism. For instance, all cities need a constant supply of water and mass resources (cf. Hoppe et al. 2006; Lamelas et al. 2009; Hoppe 2011). However, the cities also aim for a high quality of life which includes a comfortable climate or an exclusive waterfront location.

Today Mainz and Wiesbaden get its water from the Rhine and groundwater from northern Upper Rhine Graben. In addition, Wiesbaden´s public water supply is supplemented by a series of tunnels that run into Devonian quartzite of the Taunus Mountains (cf. Fig. 1) excavated in the last third of the 19th century when the growing city could not fulfil its needs for water (cf. Kopp 1986). Until the mid-nineteenth-century the water supply in Mainz was divided into small sections. About 110 wells were scattered across the city. However, the increasing water demand also caused the water supply to broaden (Stadt Mainz, Umweltamt 1994).

Over the centuries, mass resources were extracted from both cities. For instance, the global players Dyckerhoff AG and Heidelberg Cement AG mined Tertiary limestone to produce cement, and both stopped it recently. Over the past years, the reclamation of the affected areas has been a major concern (Pilgerstorfer n.d.; Harders 2010), and it will be interesting to see how the two cities will use the new urban capabilities of nature conservation and recreation.

Furthermore, the floods of the river Rhine affect both cities. In addition Wiesbaden is at risk of floods by gently flowing brooks which can escalate to rapid streams. The cities are trying to improve their flood prevention (Stadt Mainz 1993; Landeshauptstadt Wiesbaden, Pressereferat 2011). However, they have also begun to plan houses by the riverside, like the projects of Mainzer Zollhafen and the Linde-Quartier in Wiesbaden. But although, the new apartments at the waterfront in Mainzer Zollhafen are well adapted to "200 year floods" (Landeshauptstadt Wiesbaden, Stadtplanungsamt 2008; Geiß et al. 2010) climate change may change that recent statistical approach.

A geo-information system (GIS) is used as a tool to integrate spatial data from different subjects. It simplifies the detection of correlations between various specific issues. In addition, it stimulates the exploration of new questions, e.g. relations between geomorphological setting and local climatic conditions with demographic and housing data: Is it possible to detect areas where people have high quality of life by mapping rental prices?

Each city has its own natural environment and a particular management of nature which makes it unique. Therefore, research on urban use of natural resources and risks help to get a better understanding of the "intrinsic logic" ("Eigenlogik") of cities.

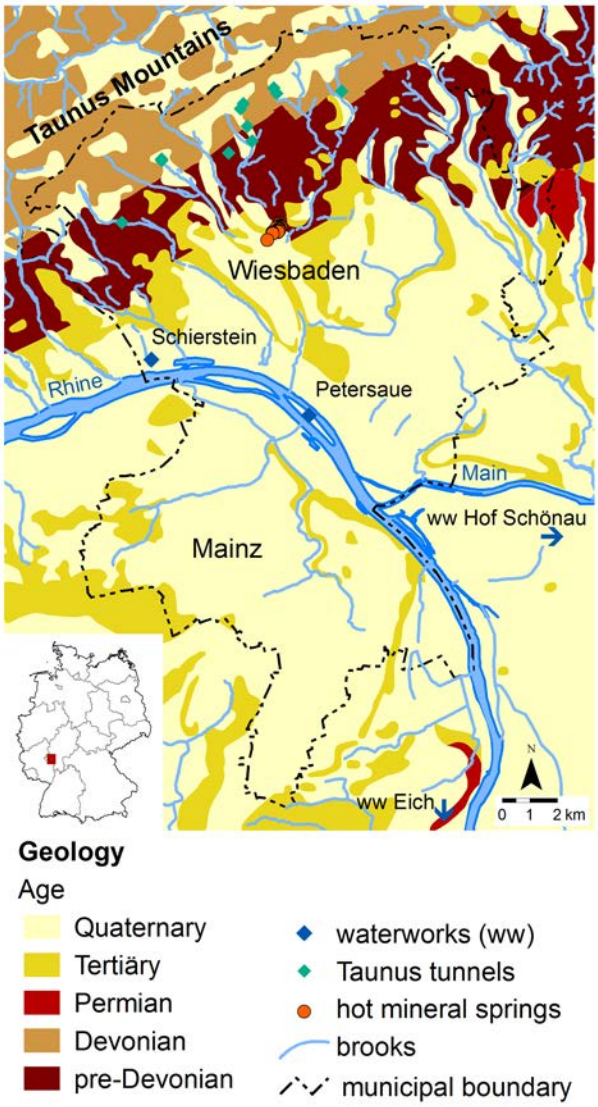

Figure 1 – Geology and water supply in Mainz and Wiesbaden (data source: Geologische Übersichtskarte von Hessen 1:300.000, Ed. Hessisches Landesamt für Umwelt und Geologie (HLUG), agreement 22 2008 0133; Gewässerkundliches Flächenverzeichnis Ed. HLUG, Landesamt für Umwelt, Wasserwirtschaft und Gewerbeaufsicht Rheinland-Pfalz; Fachinformationssystem Grund- und Trinkwasserschutz Hessen, Ed. HLUG; Stadt Mainz 1994; Stadt Mainz, Bauamt; Stadt Wiesbaden, Vermessungsamt; Bundesamt für Kartographie und Geodäsie, Frankfurt am Main, 2012).

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URBAN GROWTH AND ENVIRONMENTAL GEOCHEMICAL PROBLEMS

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KEY WORDS: Urban Soils, Land Contamination, Indicators, Risk Management

INTRODUCTION

Urban growth and the concentration of people in urban areas are creating societal problems world-wide. Cities have changed from small, isolated population centers to large, interconnected economic, physical, and environmental features. In Albania, since 1990, the amount of agricultural land has declined, as urban and forested land has increased. Human activities are increasing the inventory of toxins and heavy metals in the air, water, and land, and are driving changes in quality of people's life. An increasing portion of the population is at risk from them, becoming more serious in densely busy areas, as in the metropolitan areas.

Evaluation of local or regional pollution in a district or an urban area, will be possible only when compared to less polluted areas. Such studies have targeted making a differentiated picture of the complex geochemistry of land in urban areas versus their composition of their natural and anthropogenic pollution.

METHODS

The field work is based in the geochemical mapping of the surface soils and the attic dust of the city. Surface soil was selected and is known to accumulate airborne pollutants. From gardens, parks, fields and industrial sites within the populated parts of city samples were collected. The samples were collected from areas consisting of clay, fluvial sediments or reworked urban soil. From each site, grass was removed before 200-300 gram of material was collected at 0-5 cm depth. The samples were packed in paper bags and air dried. Attic dust samples were collected in the roofs of different private houses, in preserved and possible untouched places. For each sample point was gathered information about construction buildings age. All samples are processed for the fine grain-size fractions and soil samples are analyzed by AAS.

RESULTS AND CONCLUSIONS

In general, the pollution level and the anthropogenic impact in the urban soils is low and moderate. The results of the study generates important data about changes of the different compartments of the environment. Such results obtained by this approach suggest there is a need for a further monitoring plan and improvement interventions in the area. As the conclusions, some remedial actions are given to be carried out.

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THE IMPORTANCE OF SUBSOIL'S EVOLUTIVE DYNAMICS KNOWLEDGE IN THE URBANISTIC PLANNING AND IN THE BUILDING DESIGN: THE EXPERIENCE OF THE "OSSERVANZA" AREA IN IMOLA (ITALY)

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KEY WORDS: geology, geomorphology, history, cartography, stratigraphy, subsoil, urbanistic.

PREMESSA

This study has been realized to underline the importance of the geological and stratigraphical arrangement's reconstruction in urbanistic planning and, in particular, in building new structures or re-qualifing the existents.

The treated case concern on a research campaign led by the writing geologists in the "Osservanza" ex-hospital area, with the aim of valorization and recovery operations of this great historical and architectural interest's area, in the interior of Imola's urban tissue.

The characterization of the area has been articulated in some subsequent, but at the same time complementary, phases:

- A detailed study on the available historical cartography, finalized to reconstruct the anthropization's history of the interested area.
- Looking up the datas (geological, geomorfological and stratigraphical) made available by the Geological, Seismic and Soil Survey of Emilia Romagna's project about territorial database.
- A geognostic researches' campaign, whose the results allow to rebuild the geological and stratigraphical arrangement of the subsoil in the interested area.
- The fusion of the different phases' results has produced a research's area zoning, from geological and geothecnical point of view, meant to give useful indications supporting futures building operations planning.

GEOLOGICAL, STRATIGRAPHICAL AND GEOTHECNICAL CHARACTERIZATION OF THE "OSSERVANZA" AREA

The first study's phase has been led by the looking up of the rich historical cartography concerning the city of Imola, dating from Renaissance to seventeenth-eighteenth century: from the famous Leonardo da Vinci's depicted chart to more rencent maps, bringing to evidence the progressive Osservanza area engulfment into the urban tissue, to the actual configuration.

Arranging the results of historical research with data from present day territorial database, allow to rebuild the palaeogeographic and geomorphologic evolution of the interesting area, in particular reffered to Santerno river's digressions, which are the main transformation factor of the site.

On the other side, the geognostic research's campaign results allowed us to rebuild the site's subsoil geological and stratigraphical arrangement, with great detail. In this phase also, we explicitly referred to stratigraphical datas made available by the Geological, Seismic and Soil Survey of Emilia Romagna, which permitted us to set the locally acquired knowledge in a wider framework.

Particularly, we discovered the presence of a Imola's Sabbie Gialle Formation bedrock, as preconized over 100 years ago by the notorius Imola's naturalist Giuseppe Scarabelli, and of the overhanging alluvial deposits named "Gonze", previously poorly known because of narrowness of existing emergences.

Figure 1 – Superposition of the famous "Carta di Leonardo" on the actual configuration of the city of Imola

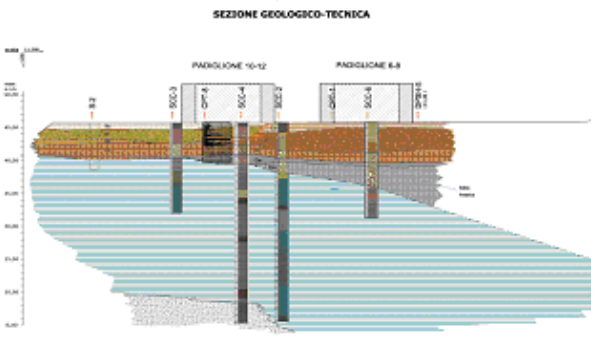

Figure 2 – Geological section of the interested area

Above the ancient soils, has been reconstructed the Santerno's alluvial succession in great detail, backed by an archaeological survey, allowing us to divide the single terraces each other and to assess their orientation.

A detailed picture of sedimentary, geological and geomorphological evolution of the Osservanza area was issued from the depicted study's results crossed exam

The subsoil arrangement coming from this evolution has been sinthesized in a zoning of the area, based on the geotechnical characteristics of the soils and the related surfaces involved in the re-qualifing planning, and on their potential influence in future building project's standards.

From this zoning, it has been possible bringing back the structural demises on existent structures to some specific combination of geological and geomorphological circumstances

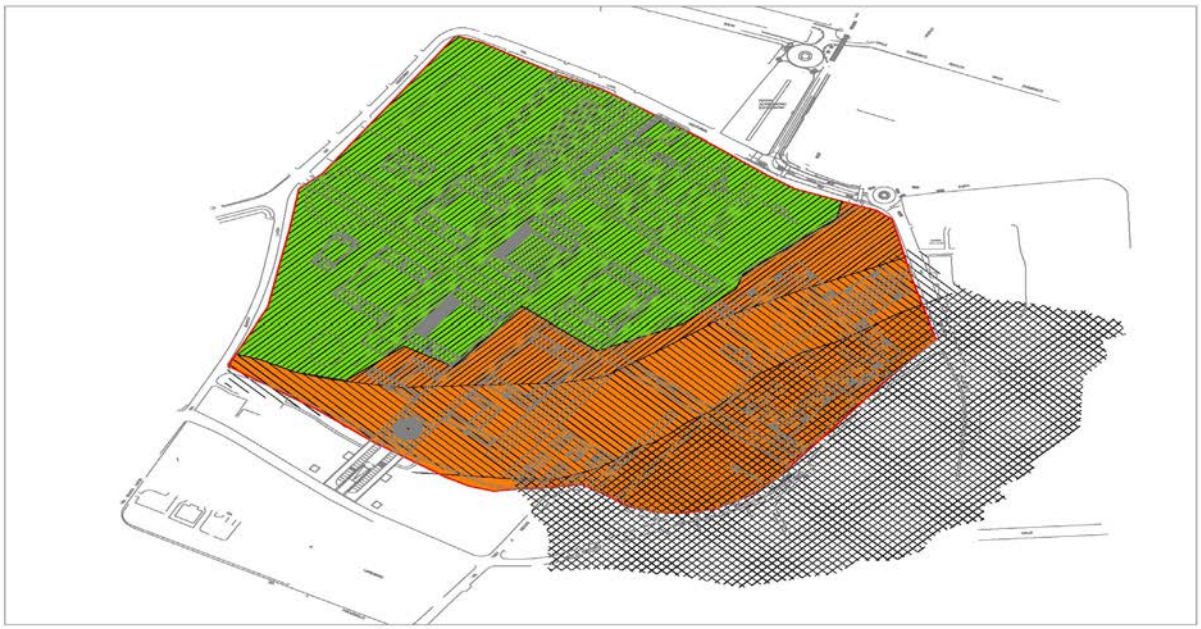

Figure 3 – Geological and geotechnical zoning of the "Osservanza" area, Imola

CONCLUSIONS

This survey has brought to evidence the importance of the integration of data coming from different sources, to reach the most detailed reconstruction of geological and geomorphological peculiarities involved in urbanistic planning. On this item, particular importance have been recognized to looking up the data record provided by the Geological, Seismic and Soil Service of Emilia Romagna, which made us possible fitting the directly-locally-acquired knowledge in dynamic and evolutive framework

Regarding this study's case, the emerged picture will allow to suggest urbanistic and ingegneristic solutions setting store by the subsoil variability, with the consciusness of the influence which this changeableness, from anthropical or natural origins, exercise on coeherent and sustainable development of urban tissue

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STRUCTURAL AND GEODYMAMIC RESEARCHES OF THE URBAN TERRITORIES ON THE EXAMPLE OF THE MOSCOW MEGAPOLIS (RUSSIA)

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KEY WORDS: strucrutural and geodynamic conditions, geodynamic active zones (GDAZ), newest structures, geodynamic safety.

INTRODUCTION

Large-scale (detailed) geological researches of the urban territories become more and more urgent. The cause is an active developing of the underground area, the compaction building, high-rise building including the territories which were considered unfit formerly.

Within the scope of geological researches and mapping of the cities the structural and geomorphological (geodynamic) researches play an important role, because they assure geodynamic safety and geoecological stability. These researches are based on the study of the evolution of newest and modern tectonic movements and deformations.

But the study of the structural and geodynamic conditions of urban territories is connected with great difficulties of the methodological character. They are: lessening of the study territories as compared with usual regional structural and geodynamic researches; more detail of mapping; increasing role of exogenous processes; decay of the generalization effect of the newest structures. Besides the megapolises relief is very changed and planned during building, which greatly complicates the reconstruction of its historical and genesis's development.

At the same time the requirements to the geodynamic safety and geoecological stability on the territories of engineering constructions building are increased. This fact necessitates the exposure of the small (local) newest structures and their derivation, the prognostication of its modern activity and geoecological stability. The latter is considered as potential of geological environment security from technosphere, which includes, for example, the migration and localization of pollutants in the broken zones and others.

The geodynamic active zones (GDAZ) represent the most interest among the not fracture structures at the platform conditions. They are the spatially localized linear ore isometric volumes of the Earth crust of different scales, where there are the conditions for additional concentrations ore relaxation of the tectonic tensions and for higher gradients of rock movements and deformations.

The development of the newest and modern deformations can be accompanied by the secondary exogenous processes, including dangerous, such as impoundment, erosion, abrasion, accumulation, karsts and landslips. Also seismic occurrences, fluid permeability and higher thermic flow can be connected with GDAZ. The latter can be the "channels" of the migrations and localizations of pollutants accompanied by the formation of so-called geopathogenic zones, can be attended by geophysical, hydrogeological and geochemical anomalies, for example, by the radon anomalies in the subsoil air.

STRUCTURAL AND GEODYNAMIC MAP OF MOSCOW MEGAPOLIS

In the Institute of Environmental Geosciences (IEG RAS) the complete set of large-scale geological maps of Moscow of different purpose was created in 2007-2009 years in scales 1:10 000 – 1:50 000. The Moscow area was 1048 km^2. This complete set consisted of the geological maps of quaternary, pre-quarternary and anthropogenic rocks, hydrogeological map, the map of seismic microzoning, engineering-geological map and the map of natural dangers.

These maps have been created on the base of the structural and geodynamic map of Moscow in the scale 1:25 000 (Fig. 1). The different ranges structures, such as elevations and depressions, local geodynamic active zones and tectonic lineaments were allocated on this map. Besides the relief levels were showed by the different colors inside elevations and depressions. The ancient tectonic structures were allocated on the map by the top of basement of the East-European Platform, which situated on the depth of the 1,5-2.5 here. The ancient tectonic structures were allocated also by the structural datums of Carboniferous and Jurassic deposits. The analysis of the ancient structures was made for the purpose of the detection of their correlation with newest structures. In the case of its discordance we assume the appearance of the additional rocks tensions with formation of specific geodynamic

active zones. We suppose such zone at the south part of Moscow, where newest Teplostan elevation formed above Moscow Precambrian graben.

Lineaments, as a rule, are the reflection of all over accepted planetary fracturing, which formed under the impact of rotary forces.

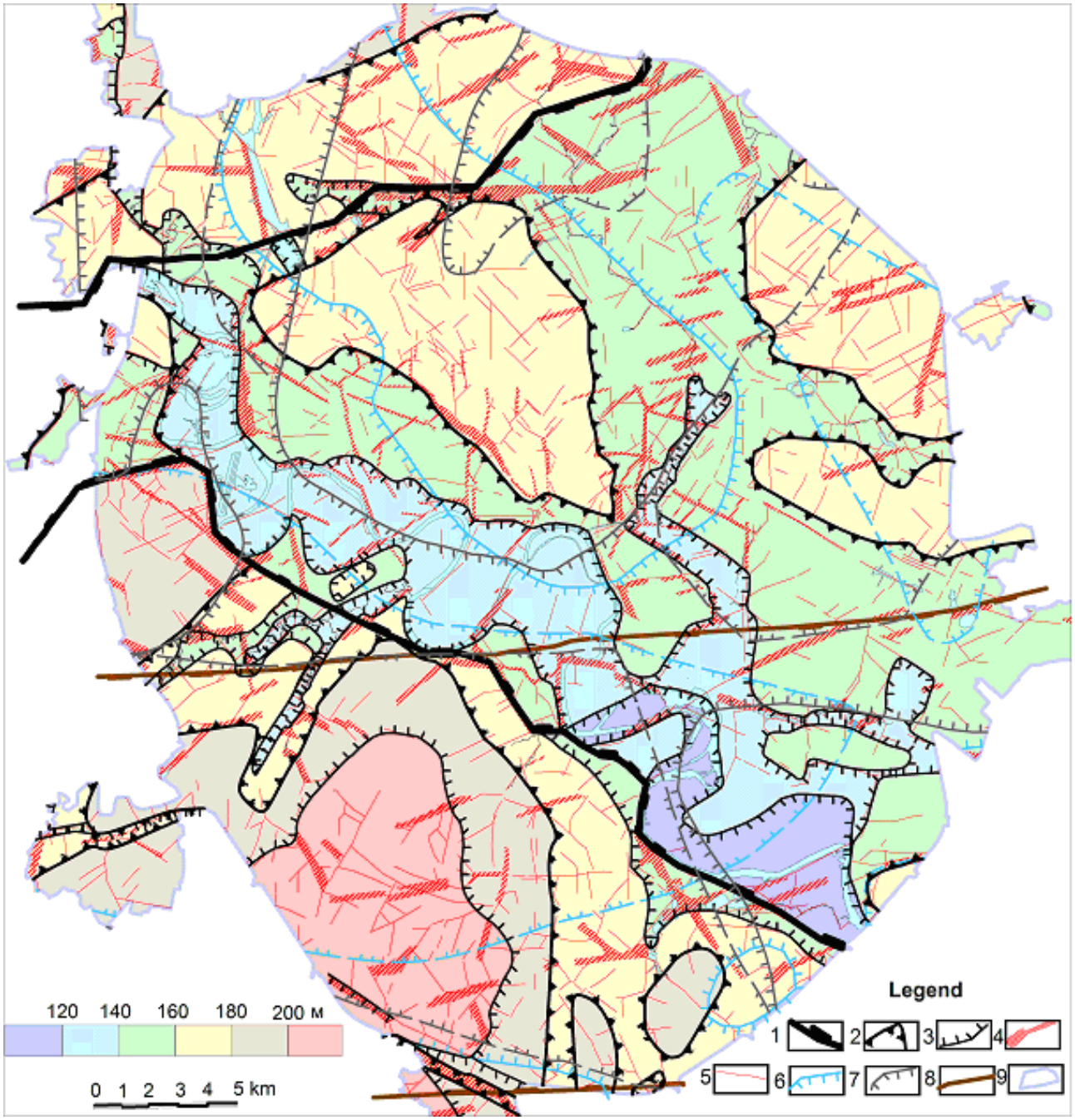

Figure 1 – Structural and geodynamic map of Moscow (with reductions) (by V.I. Makarov, V.M. Makeev, S.V. Grigorieva). Neotectonic structures: 1 – of the 1st range, 2 – of the 2nd range, 3 – of the 3d range; 4 - local geodynamic active zones, 5 – lineaments, 6 – contours of the Jurassic tectonic structures, 7 – contours of the Carboniferous tectonic structures, 8 - faults of basement of the East-European Platform, 9 – Moscow boundary

CONCLUSION

The neotectonic analysis of the modern structural and geodynamic conditions of urban territories is necessary for the exposure, assessment and prognosis of geodynamic, natural and anthropogenic dangers. Particularly, at the Moscow territory the newest structures of the inversion and inherited types were allocated, which not constituted a danger for engineer constructions. The ancient structures of the platform basement and cover are not active now. The higher natural radon density and geopathogenesis can be connected with some mapped geodynamic active zones.

KARST FISSURES ENHANCING THE WEATHERING OF TUSCANY TRAVERTINE. EXAMPLES FROM THE NATIONAL MONUMENT, AMSTERDAM, THE NETHERLANDS

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ABSTRACT

The National Monument in Amsterdam, a World War II memorial, has been erected in 1956. In the 1990s a restoration took place during which the travertine was inspected carefully. Coverstone, cladding and sculptures of the National Monument in Amsterdam are made of Pleistocene travertine, excavated in Serre di Rapolano, Tuscany.

The layering of Tuscany travertine is characterized by two distinct lithofacies types. Firstly, a dense layering of micrite aggregates with small, poorly connected pores and secondly, porous laminae showing tube shaped pores with remnants of plant stalks and root marks. Large cracks in the travertine are tectonically induced fissures, hat have been widened by karstic processes followed by cementation with calcite during diagenesis.

Although hardly visible with the naked eye,most of the large fissures are not completely filled up with sparite calcite, thus allowing water movement through these cracks. The former pathways of meteoric water in the travertine plates became distinctly visible during the more than fifty years of exposure in a temperate humid environment (Fig. 1). Frost and thaw cycli during winter periods are thought to be responsible for the build up of thermal stresses, leading to expansion of the former karst induced fissures.

Figure 1 – Large crack in travertine plate. National Monument Amsterdam.

BEDROCK DEPTH MAPPING IN BOUMERDES CITY (ALGERIA) USING AMBIENT VIBRATION RECORDINGS

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KEY WORDS: Ambient vibration, HVSR method, Array method, soil frequency.

INTRODUCTION

Investigation of geological structures is an important task for geologists and engineers. Data from traditional investigation methods (boreholes, trenches, seismic and electric surveys…) are usually unavailable or incomplete, especially in highly urbanized areas. In these cases, the single station H/V spectral ratio (HVSR) method (Nakamura 1989) and/or dense array technique, based on ambient vibration recordings can provide information about geology.

This technique, first used for seismic microzonation (e.g. Fäh et al. 1997; Guéguen et al. 2000; Alfaro et al. 2001), has been extended for basin structure studies, where 1D soil fundamental frequency variations are used to estimate the first-order geometry of the interface between a sediment layer and the underlying bedrock (e.g., Ibs-von Seth and Wohlenberg 1999; Delgado et al. 2000; Parolai et al. 2002).

The shear-wave velocity (Vs), mostly unavailable, is needed for sediment thickness mapping, using the 1D relationship:

with f_0 the fundamental soil frequency and H the depth of the bedrock.

The aim of this study is to investigate the geological structure under Boumerdes city, by mapping the bedrock top surface over the entire city. To achieve this purpose, 330 single station recordings are used (see location in figure 1).

The single station HVSR recordings are complemented by data from two ambient vibration arrays (R1 and R2, see location in Figure 1).

HSVR RESULTS

Soil frequency increase from 0.5 to 10 Hz in the west-east direction (Figure 1). H/V peaks are found in four different frequency ranges (zones 2 to 5), while H/V curves in zone 1, composed of non-contiguous parts, are flat (Figure 1 and 2). A rapid frequency jump from 0.5-2.0 Hz in the west to 4.1 5 Hz and 5.1-10 Hz in the south-east part of the city can been noted (Figure 1), which indicates an important uprising of the bedrock, may be due to faults.

ARRAY RESULTS

From array R1, the best fitting Vs models (Figure 3) show two interfaces, at 24 and 112 meters depth. From array R2, the best fitting Vs models (Figure 3) show two interfaces at 20- and 110-meter depths, very close to the R1 array results. The two layers may correspond, from top to bottom, to a quaternary sand layer and a plaisancian marls layer overlying a metamorphic bedrock (Hellel, 2010). The shear-wave velocity attributed to the quaternary layer, the plaisancian layer, and the metamorphic bedrock are, respectively, 315, 600, and 860 m/s, from array 1, and 230, 630 and 950 m/s, from array 2 (Figure 3).

BEDROCK DEPTH VARIATION

The bedrock depth variation is obtained from equation (1) using single station HVSR frequency peaks. To use this equation, a 500 m/s average Vs value for the whole sediment column, all over the city, has been taken from R1 and R2 arrays results (Figure 3)

The 3D representation of the metamorphic bedrock depth (Figure 4) shows a shallow bedrock (3 to 15 meters depth) in the eastern part of the city which deeps brutally towards the west with a 120 to 180 meters depth.

The important steep slope affecting the bedrock top surface may correspond to faults.

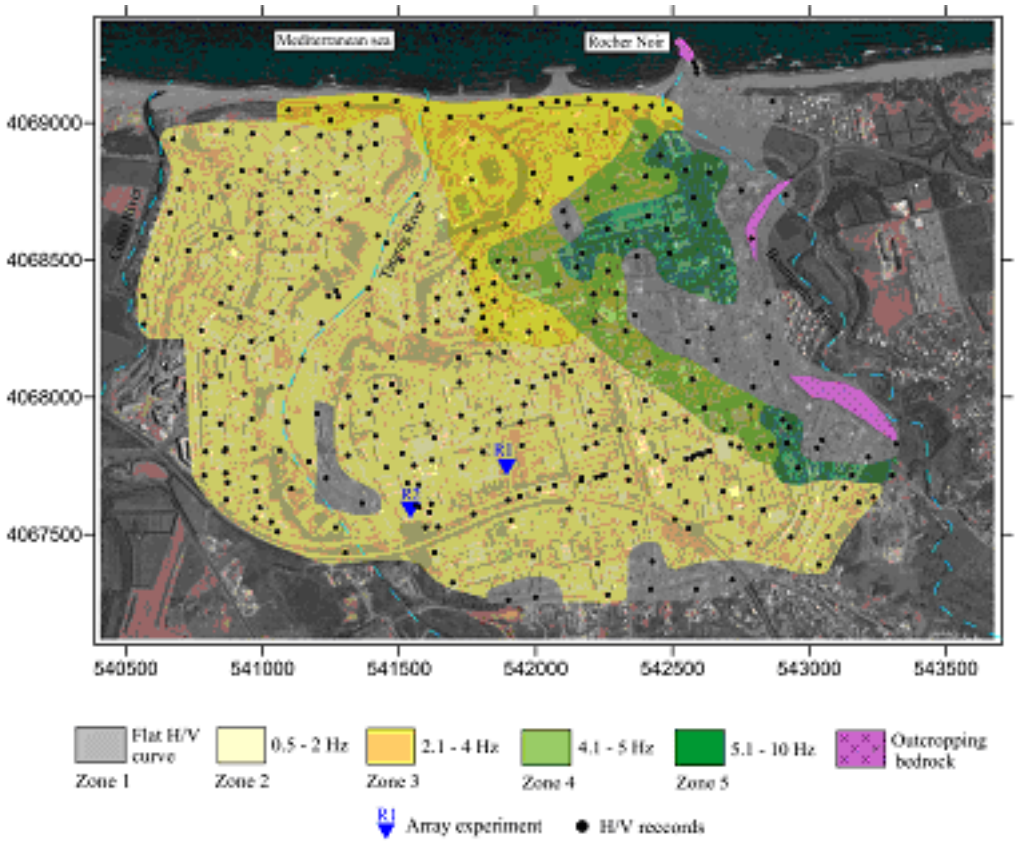

Figure1. Fundamental soil frequency distribution for the city of Boumerdes, Algeria

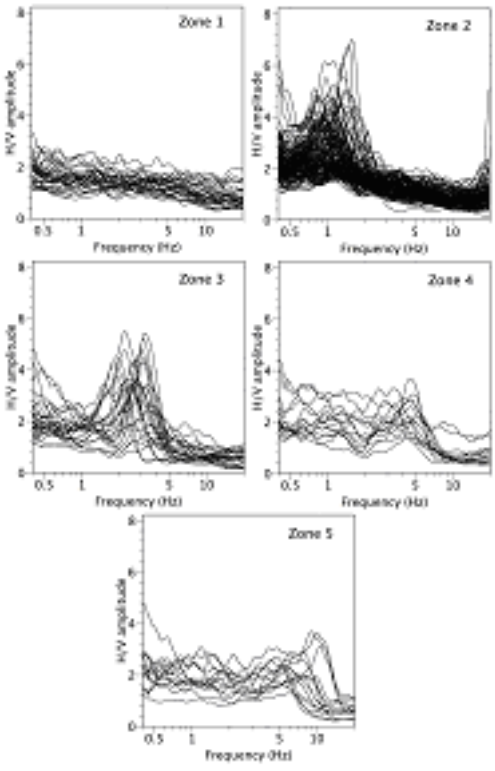

Figure 2. H/V curves grouped by frequency range (frequency value of each zone is given in figure 1).

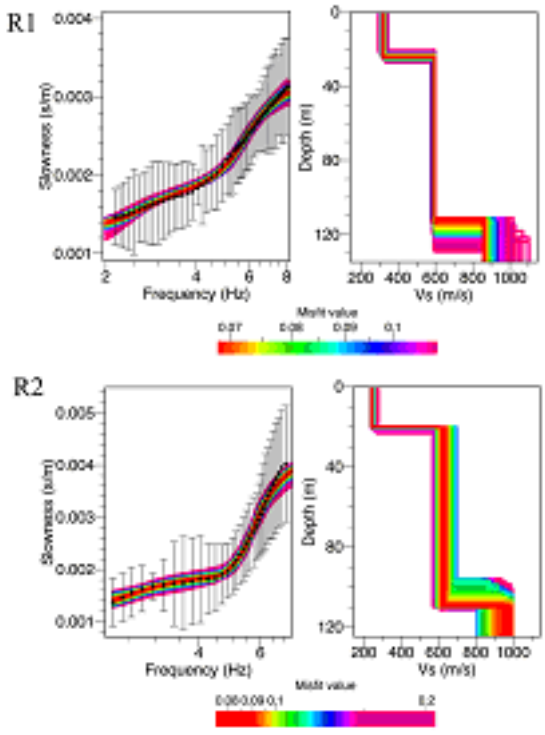

Figure 3. In the left, dispertion curves of the arrays (colored line represent the modeled curves and black dots the experimentale curve. Vertical bars represent the standard deviation). In the right, inverted Vs profilles

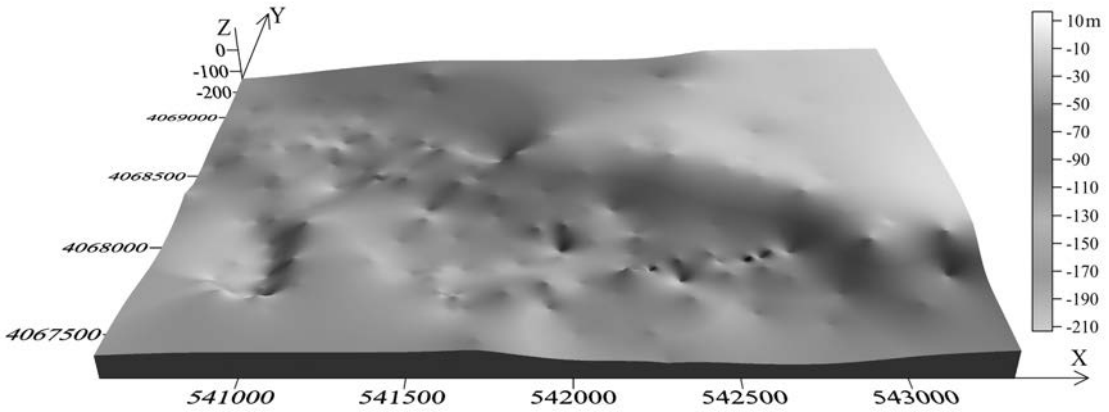

Figure 4. 3D representation of the bedrock (metamorphic baseme, depth under the city of Boumerdes, from ambient vibration H/V and array data

CONCLUSION

The fundamental soil frequency distribution from single station ambient vibration HVSR provides very valuable information on the basement top morphology and its relative depth variation, from which tectonic structures, such as faults, can be deduced and then studied using others methods.

When combined with ambient vibration array results, from which an estimation of the shear-wave velocity is obtained, the absolute depth of the basement can be determined and mapped.

However, geological data, such as boreholes and/or direct observations, are necessary to (1) better choose the area where to perform array recordings, (2) make sure that array results are correct, and (3) help explaining the evidenced tectonic structures.

ACKNOWLEDGEMENTS

This study is part of a cooperative project between the Centre National de la Recherche Appliquée en Génie Parasismique (CGS) of Algiers (Algeria) and the French Institut de Recherche pour le Développement (IRD). We thank all the CGS and LGIT (now ISTerre) people for their participation in the data acquisition..

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LANDFILL SITE SELECTION USING GEOGRAPHIC INFORMATION SYSTEM IN MALAYER REGION, IRAN

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KEY WORDS: Landfill, Site selection, Geographic Information System, Suitability map, Malayer.

INTRODUCTION

Landfill is an important component of any waste management system. Sustainable management of urban solid wastes may involve an integrated system of: (1) waste minimization in the production process; (2) reuse of products to extend their usefulness before entering to the waste stream; (3) recovery of materials and energy from the waste; and (4) depositing the remaining material in landfills. Landfill siting is an extremely difficult task to accomplish because the site selection process depends on different factors and regulations (Sener, 2004). To ensure that an appropriate site is chosen, a systematic process should be developed and followed. Unsuccessful landfill siting is typically the result of strong public opposition (Nas B et al.,2010). The major goal of the landfill site selection process is to ensure that the disposal facility is located at the best location possible with little negative impact to the environment or to the population.

Geographic Information Systems (GIS) are ideal for preliminary site selection studies because it can manage large volumes of spatially distributed data from a variety of sources and efficiently store, retrieve, analyze and display information (Siddiqui, 1996). The purpose of this research is to analyzing and finding suitable sites using Geographic information system for constructing landfill in Malayer region which is located in the west of the Iran.

THE STUDY AREA CHARACTERISTICS

The study area (Malayer city) with an estimate population of 150,000 inhabitants and 1400 km^2 of area is the second largest city in Hamedan province and located at the 48°51′ East longitude and 34°26′ North latitude in west of Iran. Figure 1 shows the considered location in proportion with Iran and Hamedan province. In the study area, the Jurasic metamorphic rocks most have extension. This rocks mostly is consist Schist, Phyllite and Slate. Other faces in the region are Cretaceous and Quaternary units consist of grey limestone's and recent sediments.

The results showed that average daily generation rate was 138 Tons and 0.88 Kg per person per day. The average percent of recyclable materials was about 11% of total daily generated wastes. The common disposal method for solid wastes in Malayer city is disposal in open dumps that can be source of worry to everyone who cares about healthy living (Figure 2). The samples of solid waste were taken in July, 2008. The physical composition of solid waste used for the study is depicted in Figure 3. The dominant part of the degraded fraction is organic material.

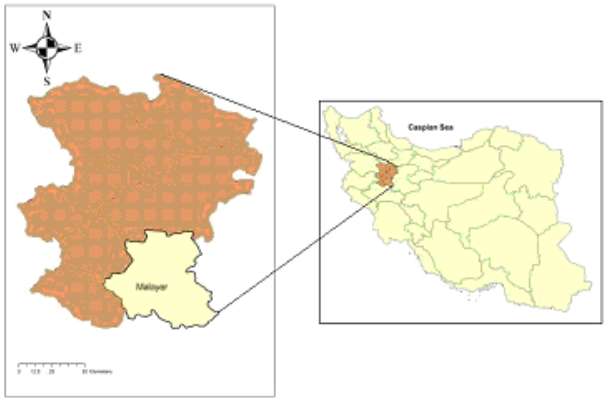

Figure 1 – Location map of the study area

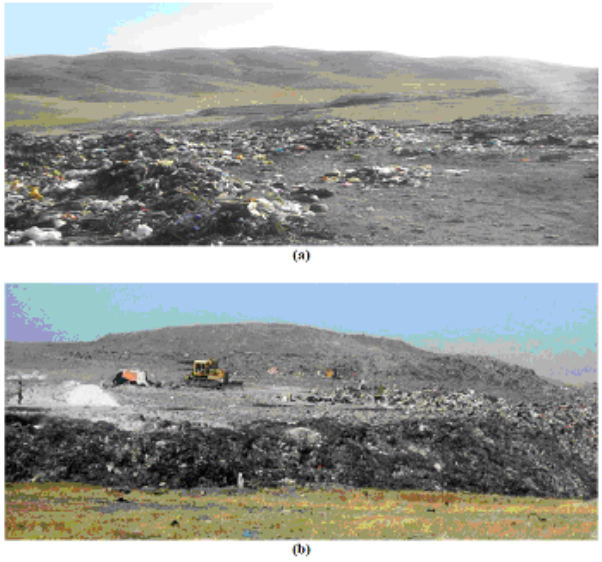

Figure 2 – The landfill used for wastes disposal in the study area

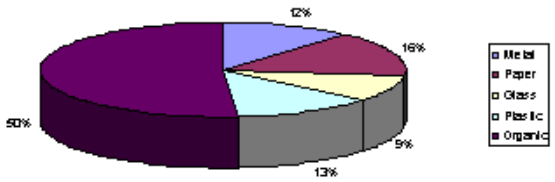

Figure 3 – The physical characteristics of solid wastes at Malayer landfill site

MATERIAL AND METHODS

First step in the methodology consists of development of a digital GIS database in which spatial information is formed. Because of different scales upon which criteria are measured, it is necessary that factors be standardized before combination. In this study, 7 input map layers including geology, hydrology, geomorphology, slope, main roads, faults and distance from cities were evaluated and prepared to be used for the analysis in GIS environment. All data layers were derived from related maps by scanning, geocoding and digitizing the relevant information. The information compiled from literature about the safe distances to a landfill site is used to determine the buffer zones for each layer. An extended collection of these safe distances from various case studies can be found at Sener (2010). After creating the classes for each layer by using buffer zones, each layer is converted into individual raster maps. After the preparation of all input data layers, a method namely, "simple additive weighting method" was selected among the decision rules to analyze the data for landfill site selection by using GIS. Simple additive weighting which is also known as weighted linear combination or scoring method is a simple and most often used mulltiattribute decision technique. The output maps produced by this method include the multiplication of data layers, weights and constraints as represented in Figure 4.The simple additive weighting method evaluates each alternative, A_i, by the following formula:

$$S = (\sum W_j \times S_{ij}) \quad (1)$$

Where S_{ij} is the score of the i[th] alternative with respect to the j[th] attribute, w_j is the normalized weight.

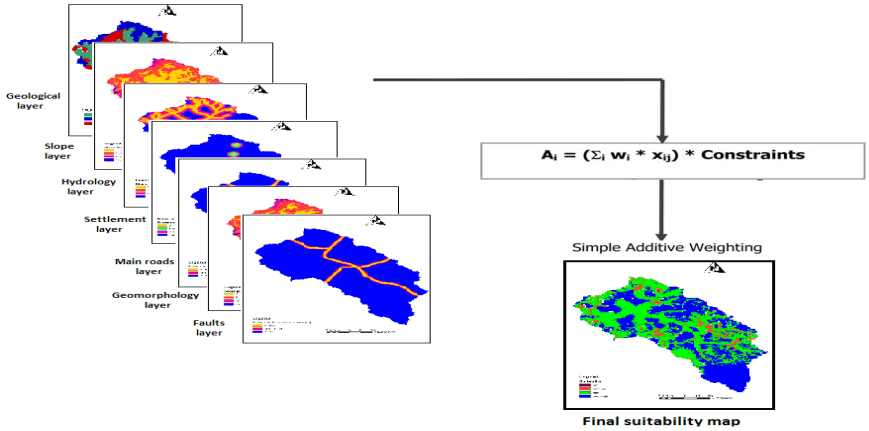

Figure 4 – The procedure for Simple Additive Weighting (SAW) method and illustration of final suitability map

CONCLUSION

Seven important criteria which have principal effect on determination of landfill locations are identified in this paper; these are geology, hydrology, Geomorphology, slope, distance from cities, main road and faults. After determining relative importance weight of each criterion and score value of sub-criteria in GIS environment, Final Suitability map Prepared. In this study the suitability index was applied to rank the proposed candidate sites and summarize the final selection. Based on the final suitability map, suitable areas for landfill construction are located in north, northwest and south parts of study area. On this basis, the total land area of Malayer city can be classified into five groups namely regions with very low, low, medium, high and very high suitability for being as landfill sites.

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PRELIMINARY RESULTS OF A 3-D STRATIGRAPHICAL MODEL OF THE NW SECTOR OF THE URBAN AREA OF ROME (ITALY)

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KEY WORDS: stratigraphical model, urban area, Rome, Italy

INTRODUCTION

The aim of the present work is to illustrate a preliminary elaboration of a 3-D model of the NW sector of the urban area of the city of Rome, Italy. The stratigraphical and hydrogeological information has been mostly taken from the Well National Database, constituted at the Geological Survey of Italy (ISPRA) in appliance of the Italian governmental law N.464/84, the well database of VENTRIGLIA (1989) and other well database from public and private institution. All those who have contributed to the collection of this information are kindly acknowledged.

GEOLOGICAL, STRUCTURAL AND HYDROGEOLOGICAL SETTINGS

The paleogeographical evolution of the Rome area is characterized by differentiated environmental conditions from marine Plio-Pleistocene clayey and sandy deposits to continental Middle-Upper Pleistocene shales and conglomerates. Starting from 0.6 Ma two main explosive alkali-potassic volcanoes began their activity: the Sabatini volcanic district in the NW sector and the Alban Hills at SE. A deep tectonic control has also revealed, clearly connected with the regional features of the Apennines; the associated NW-SE and NE-SW structural-tectonic trends are crossed by N-S youngest elements (FACCENNA et alii, 1995).

The following post-orogenic geological succession, starting from Early Pliocene on an articulated calcareous-silicic-marly substrate, may be outlined, from bottom to top, in the Roman area (PAROTTO, 2008, FUNICIELLO et alii, 2008):

- Pliocene marine units (M. Vaticano Formation and Palombara Sabina Unit), characterized by grey shale with fine sand and conglomerates.
- Lower Pleistocene marine units (Monte Mario and Monte delle Piche formations), sand with green clays and shale and sandy shale.
- Lower-Middle Pleistocene transitional to continental units (Ponte Galeria and Fosso della Crescenza formations), conglomerate, clay, silty sand and sand.
- Middle-Upper Pleistocene volcanic deposits (Sabatini and Alban Hills districts), ignimbrite with lapilli, ash, lava, breccias, scoria and xenoliths layers and inclusions, and conglomerates, sand and silt intercalations.
- Quaternary units (travertine and lacustrine, slope, aeolic, beach and alluvial deposits).

In the Roman area five main hydrogeological units may be distinguished (CAPELLI et alii, 2008): 1) Sabatini Mts unit, characterized by volcanic deposits; 2) Alban Hills unit, volcanic deposits; 3) Ponte Galeria unit, sedimentary deposits; 4) Alluvial unit, recent and present deposits, 5) Tiber River delta unit, alluvial deposits. A hydrogeological complex of clayey-marly deposits of low permeability has also been recognized. The paleo-morphology of the pre-orogenic bedrock top surface has very variable features, thus conditioning the hydrogeological features and the thickness of aquifers.

METHODOLOGICAL ASPECTS

A geo-referenced database of the stratigraphical and hydrogeological information has been realized. The codification of standard criteria for classification and description of lithological and stratigraphical data and terms coming from very different sources was adopted. The database has been prepared with the purpose of carrying out the data exportation in a GIS environment or toward specialized software.

Preliminary stratigraphical cross-sections were realized in different sectors of the study area, aimed to define the geological features of the units constituting the investigated territory. In particular, the relationships among the different units and the low permeable bedrock were defined.

Finally, 3-D models have been elaborated for the improving of the understanding of stratigraphical features of the study area.

DISCUSSION AND CONCLUSIONS

In this work, just a preliminary version of the model will be illustrated, since, for instance, the information about the tectonic lines and alluvial

deposits, as well as hydrogeological features, were not still elaborated and included in the model itself. Then, the model available up-to-date illustrates the general characteristics of the local stratigraphical succession.

Three main stratigraphical units were thus here distinguished:

- A basal clayey marine unit having a good spatial continuity, but variable thickness depending on the morphology and structural asset of the pre-orogenic substrate.
- A following generally thick (with only local width variations) transitional to continental unit characterized by a laterally continuous sedimentation.
- A widespread and generally thick unit constituted by volcanic deposits coming from the Sabatini magmatic district; they actually lack in the sectors constituting paleomorphological and/or structural highs.

Finally, in addition to the refinement of the preliminary stratigraphical model here proposed, a next step of the present study might deal with the hydrogeological features of the distinguished units.

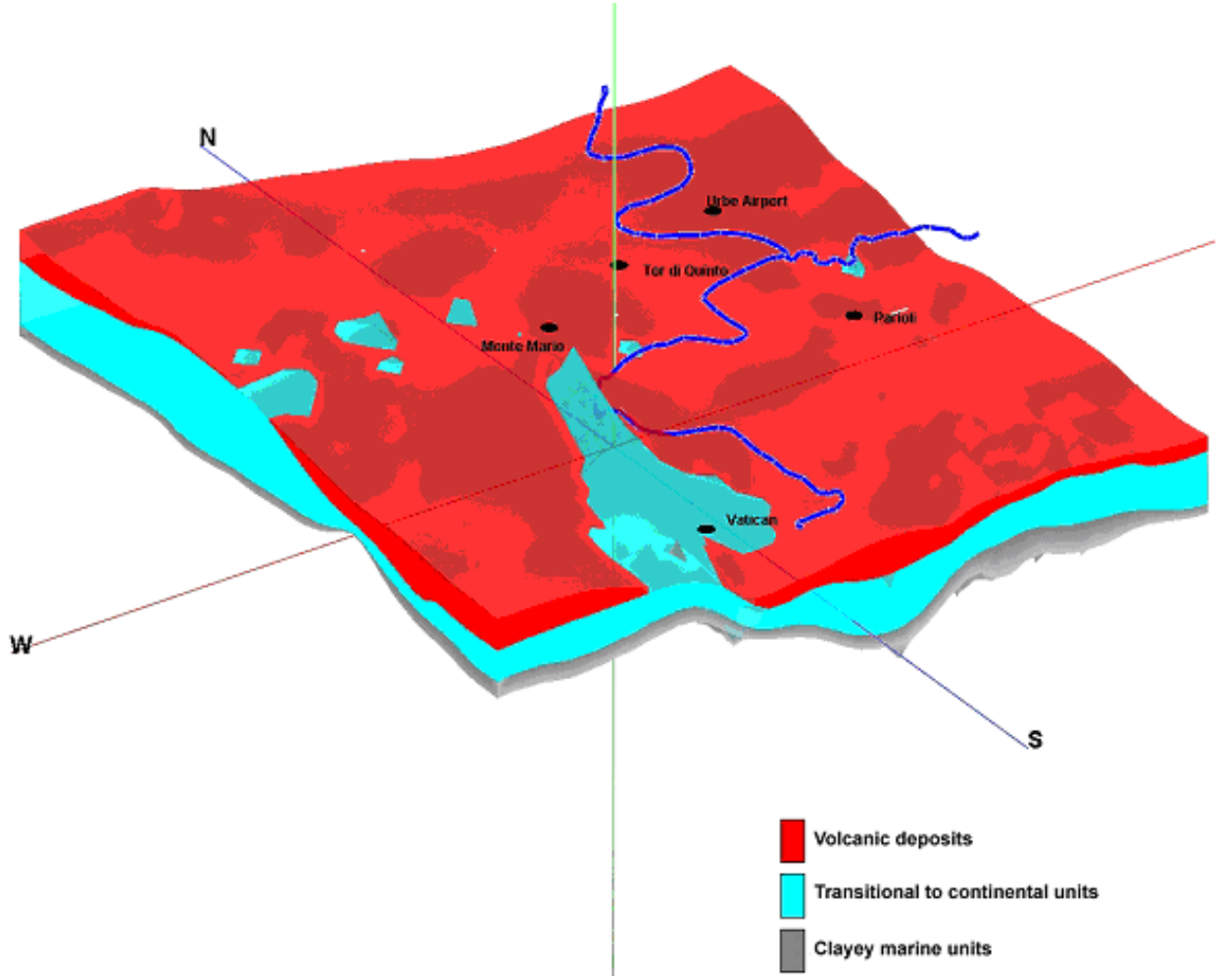

Figure 1 – Preliminary 3-D stratigraphical model of the NW sector of the Rome area. Plane dimensions of the area about 10x10 km; vertical exaggeration x15. Blue lines represent the Tiber and Aniene river courses.

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GIS TECHNOLOGIES FOR MAPPING OF URBAN GEOLOGICAL ENVIRONMENT

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KEY WORDS: urban geology, GIS, 3d modelling, geological maps, environmental maps

By the order of the Moscow municipality geological and environmental mapping of Moscow at scale 1:10000 was fulfilled in 2007-2009. Total area of the mapped territory is more than 1000 km^2. IEG RAS (the director is Victor Osipov) managed the scientific leadership of the project and has designed 7 maps of 12.

The large-scale geological and environmental maps are used for city development planning, engineering-geological prospecting, and environmental studies and protection in Moscow.

The geoinformatics technologies have been developed in this project specially for the map-making [MIRONOV 2011]. The informational interdependences of maps in the project form the complicated logical structure. Maps that display the same spatial information must have coinciding regions or contours. The geohazard and engineering-geology maps use generalized data from geological and hydrogeological maps.

The general scheme of information flows in the project and list of developed maps are shown in the Fig. 1. The two-sided arrows (↔) mark the feedback informational connections: two units must match each other and a modification of one of them forces the modification of another one. In some but not all cases this matching may be provided at the data model level. One-sided arrows (→) mark the connections “source → result”.

The main volume of the source information is the borehole database of the Moscow geological archive that was collected during last 100 years. There were no new special investigations (drilling etc.) for the project.

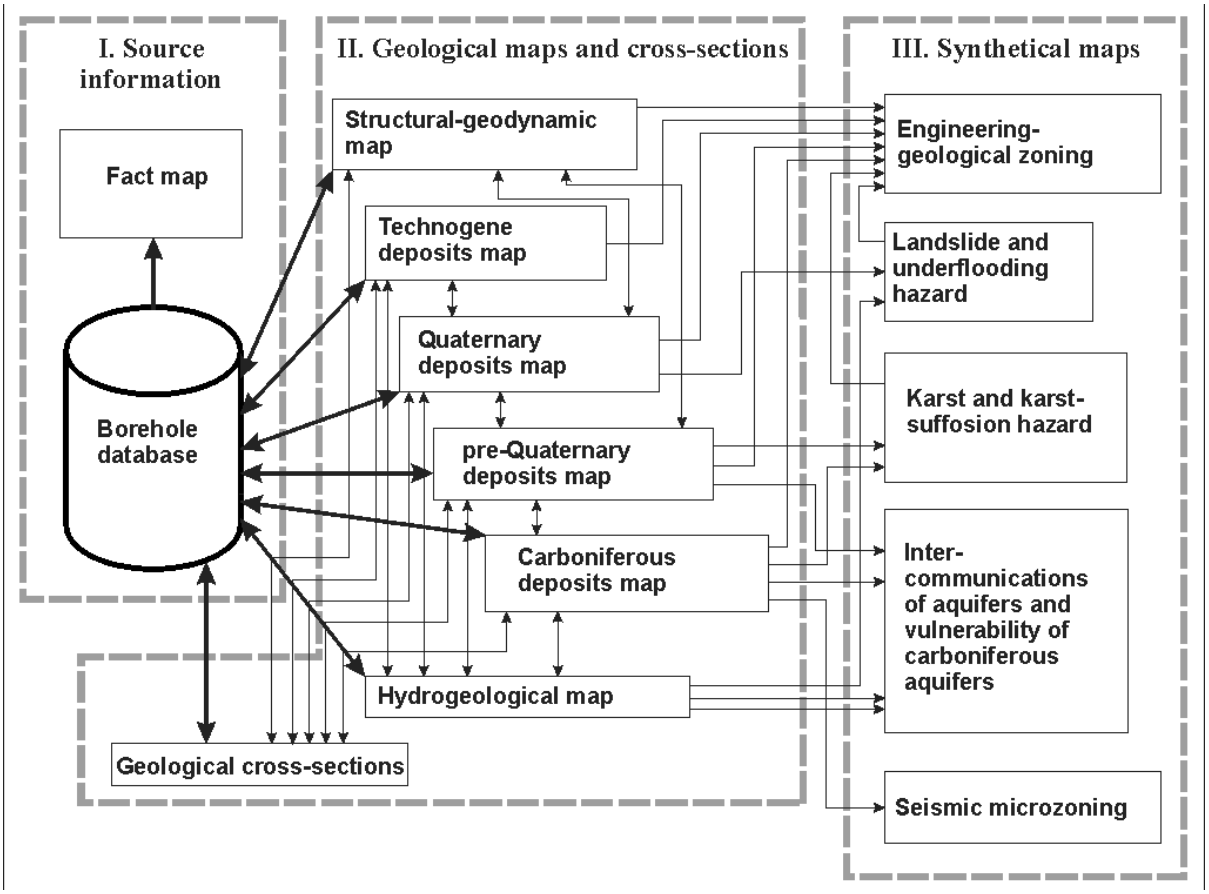

Figure 1 – Informational flows between large-scale geological maps of Moscow.

The database (about 85000 boreholes) contains general borehole information, scanned borehole log documents “as is”, and digitized depth columns with stratigraphical and lithological description.

The archive data collected before must be re-interpretated according the modern geological conception. The final verification of the data may be done only after the design of sufficient amount of geological maps and cross-sections. Therefore the information feedback exists from the maps and cross-sections design to the database maintenance (see Fig. 1). No expert can adequately interpret the isolated borehole data, except trivial cases.

All the processes of data modification in the system have the computer technology support [MIRONOV 2011]. The system provides integrated database maintenance and mapping design. Special tools are developed for design of synthetic maps.

The next step of map’s development and using must be the 3d geographical information system for the city geological environment. This system should have 2 main functionalities:

- Geological data maintenance according the new information and conceptions.
- User’s support: information retrieval system and information services.

The main objective of the first functionality is a permanent correction of the geodata base according to the new incoming data or concept.

The procedures used for primary mapping would be repeated at the sites, where the source data have been changed. Drilling and other data income from the new prospecting works may cause changes in the geological maps and cross-sections in the system (block II at Fig 1). Those modifications cause corresponding changes in maps of geological hazards and the engineering-geological zoning map (block III at Fig 1).

The second functionality is common for GIS technologies but must be extended to the 3d dimension.

The geological information is essentially 3-dimensional. Geologists think in terms of 3-dimensional geological volumes and use 2-dimensional drawings (maps and cross-sections) only because of lack of the suitable 3-dimensional tools.

3-dimensional geological map is the class of 3d-models of geological environment that describes the positions of geological bodies in a non-contradictory way [MATHERS et al. 2009], [MIRONOV et al. 2011].

In the fulfilled Moscow mapping project 3-dimensional modeling was used only at the most complicated sites. In future the 3-dimensional geological mapping must become the principal tool for data maintenance in the information system. The usual 2-dimensional geological maps and cross-sections are just aspects of a 3d model.

A 3-dimensional geological map is a digital model of geological space and may be considered as the original cartographical work. Any geological, geophysical, hydrogeological, etc. information would be integrated into this model and then used in applications.

A 3-dimensional geological map provides source information for calculations of data for new thematic maps, various hydrogeological, geotechnical [KOUTEPOV et al. 2008], direct geophysical and other computational modeling, and civil engineering and mining, e.g. to study the geological condition for the bottom and sidewalls of a pit or a tunnel.

Various visualizations and presentations may be done basing on 3-dimensional geological maps ranging from classic maps to animations (Fig. 2)

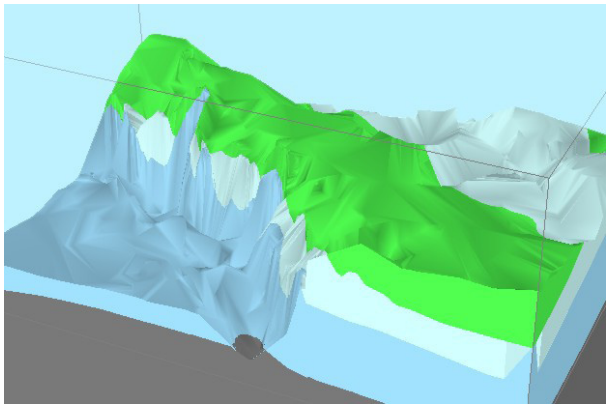

Fig. 2 3d geological map of landslide in Kolomenskoe, Moscow. Pre-Quaternary deposits, scales ratio 1:20.

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REGIONAL PLANNING AND DEVELOPMENT IN BUNA FLAT AREA THROUGH GEO-ENVIRONMENT MAPPING

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KEY WORDS: geology, hydrogeology, geomorphology, geo-hazard, engineering geology, land use planning, map.

ABSTRACT

This work treats the results of study according to the geo-environmental mapping on Buna flat area. The studied area is located in northwestern part of Albania from Shkodra town to Velipoja coastal plain. It is one of the dangers areas according to geodynamics phenomena as earthquake and floods events. Therefore, last year was completed a complexes study, which include the geological, hydrogeological, geomorphologic, geo-hazardous, engineering geological and land use planning mapping on scale 1:10 000. From this study is concluded the several residential centers are endangered from floods and earthquake events. The main goal of this work was the land use effective, efficient, and protective measurements and guidance.

METHODOLOGY

The Buna flat area is located in southern part of Shkodra town on both side of Buna River. This area has been object of geodynamics phenomena as earthquake and floods events. So, on April 15, 1979 from earthquakes occurrence are destructed more 100 building and several people died. Whereas, from Buna River waters this area is flooded several time, where we mention the flooding of 1858, 1962, 2002, 2005, 2010 and 2011 years from which mostly of the buildings have been occupied destroyed from river's waters. In this condition on 2010 year, specialist of Institute of Geosciences, Energy, Waters and Environment at Tirana Polytechnic University have undertaken a geo-environment mapping for urban planning and development, results of which we present here. This work was designed to provide base data information of a geologic nature that can be used by local officials and planners to produce environmentally oriented land use plans. For this study was worked in three phases are:

- Phase 1, collection of bibliographical data as geological, hydrogeological and engineering geological reports, as well as the recording of boreholes.
- Phase 2, are carried out the fields works and laboratories analysis. In this phase are completed the geological, hydrogeological and engineering geological mapping, as well as and laboratories tests.
- Phase 3, the drawing up of the geological, hydrogeological, geomorphological, geo-hazardous, engineering geological and land use planning maps on scale 1:10 000.

GEO-ENVIRONMENTS MAPS

The aim of this study was the land evaluation in relation to geology, engineering geology, hydrogeology and geodynamics mapping. Geological mapping on scale 1:10000 was undertaken with particular attention paid to checking the lithological types of the deposits. The area is characterized by different deposits are the alluvium (gravels, sands and silts), coastal (sands and silts), swamp (peat and loams), diluvium deposits (mixture of rubbles-stones of limestones rocks with irregular shape with sands-silts), flysch (combinations of sandstones, claystones and siltstones layers) and the limestone's formations. The morphology map is compiled basing geomorphologic features of studied area. So, from field works the studied are is divided in two geomorphologic units. They are the flat and hills morphological units. The flat's morphological unit is represented by first terrace of Buna River and Adriatic coastal plain, while the hill's morphological unit represents Velipoja hill's chain with elevation 118.0-135.0m and Dajçi hills, 20.0m-58.0m above sea level, as well. Velipoja hills are built from limestone's rocks and Dajçi hills by flysch rocks. In the hydrogeological map are given the different types of waters bearing complexes. Based on this feature the studied area is divided in three groups are the hydrogeological complexes with low, medium and high waters bearing capacity. So, in the studied are found soils deposits with high water bearing capacity are gravels and sands deposits, which build the first terrace of Buna River. While, the sandstones and claystones-siltstones rocks are respectively classified in hydrogeological

complexes with medium and low waters bearing capacity. In south of studied area extend the other complex represents by limestones rocks is characterized by low water bearing capacity.

The engineering geology map defines the geological engineering zones with homogenous characteristics related to geotechnical properties of soils and rocks. For its compilation is based on the fields and laboratories works. In the fields was worked on oriented profiles (scale 1:10000) by surface observation, pits excavation (4.0-5.5m deep) and drilling operation (boreholes 10.0-55.5m deep). From these works are taken about 120 soils and rocks samples for laboratories analysis. Based on fields and laboratories works the studied are is divided in several engineering geology zones are as followings (Fig.1):

- Engineering geology zone-("I") of cohesionless soils, gravels and sands.
- Engineering geology zone-("II") of cohesive soils, silts and clays.
- Engineering geology zone-("III") of combination loam-peat soils.
- Engineering geology zone-("IV") of hills slopes soils, which is divided in two of engineering geology sites are the inorganic silts-("IV_1") with rubbles soils situated on flysch rocks slopes with inclination 5-10° and engineering geology site-("IV_2") of sand-rubbles mixed with silts soils situated on limestones rocks slopes with inclination over 10°.
- Engineering geology zone of soft rocks-("V"), combination of claystones-siltstone with sandstones layers.
- Engineering geology zone of hard rocks, limestones-("VI").

The geodynamics phenomena map give the negative processes have occurred in the area, identifying a range of features of these phenomena including mass movement's occurrences, areas susceptible to soil erosion and floods plain, as well as liquefaction zones. From the field works results in the geo-hazardous map are mapped all geodynamics phenomena occurred last decades on this area as flood events, mass movements and erosion sites that caused a high damages on privates properties and have been a real threat in population life. Also, this area is most active area in relation to seismic hazards in Albania. Based on these data is compiled the land use planning and development map on scale 1:10000. It comprises the hazardous and safely areas, which will serve the designer specialists for a correct regional planning and development of studied area.

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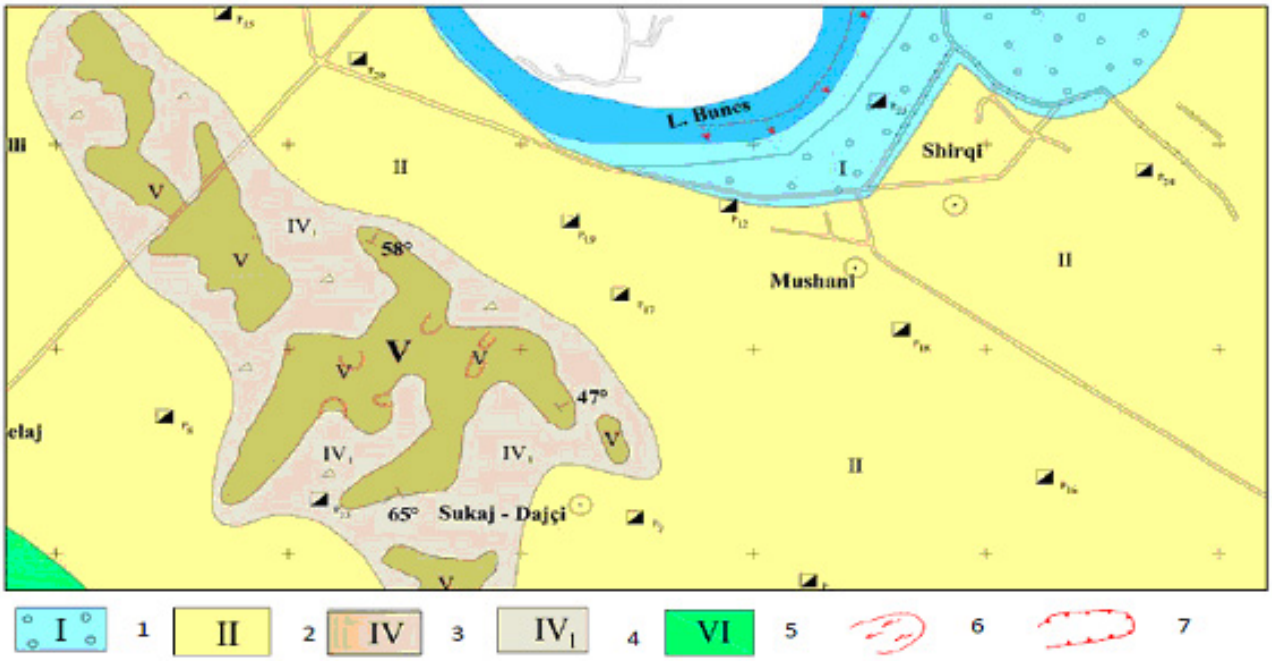

Figure 1. Part of engineering geology map of Shkodra-Velipoja area, scale 1:10000 (1, 2, 3, 4 and 5. engineering geology zones, 6. erosion sites, 7.landslides)

EXTENDED GEOLOGICAL THEMATIC DATA FOR MANAGING GEOLOGICAL AND MINING HAZARDS

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KEY WORDS: karst, landslides, rock falls, mine, shaft, gallery, quarries, WebGIS, Wallonia.

CONTEXT

The geology of Wallonia, although its small superficy, is quite complex, including formations from late Cambrian to Carboniferous, some triasic and Jurassic deposits, and a cover of upper Cretaceous, Eocen and Miocen tabular deposits in center and north. Nearly all the north is covered by Holocen deposits, often quite thick. The Paleozoic bed-rock is intensively folded and faulted, as a consequence of the Variscan orogeny. So, on the field, the geology is changing quickly.

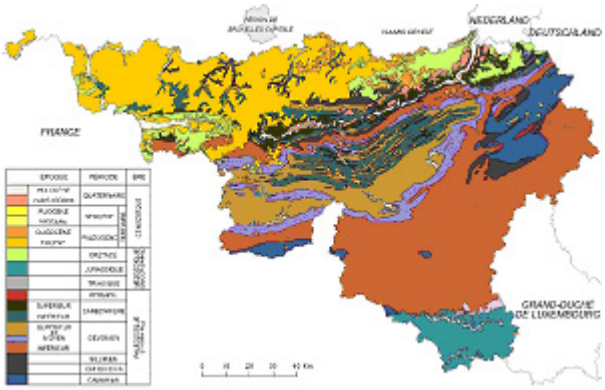

Figure 1 – Synthetic geological map of Wallonia.

The population density in Wallonia is about of 204 inhabitants/km² (to 1.000 in the central zones).

Geological mapping in such conditions needs to be realised on an appropriate scale. The new Geological Map of Wallonia has choosen the 1/10.000 scale (1/25.000 for the published maps).

At this scale, it is important to add thematic items related with geology, to be complete and to stick to the demands of the users (geological, geomorphological, geotechnical and old exploitations items).

The geological mapping program started in 1990 and should be achieved in 2018 for the mapping itself and in 2024 for the publication. The gathering of the thematic items has begun in 1994. All should be done for 2014. All these programs are organised by the Public Service of Wallonia.

The geological map is published on a paper support and on a WebGIS platform (http://carto1.wallonie.be/geologie). Another WebGIS service is dedicated to the thematic items (http://carto1.wallonie.be/soussol). A website comes with them since March 2012.

OUTCROPS AND BORINGS OF THE GEOLOGICAL MAP OF WALLONIA

In order to draw the geological map, ten geologists of five institutions are collecting new data on the field and are reviewing the old data kept by the Geological Survey of Belgium.

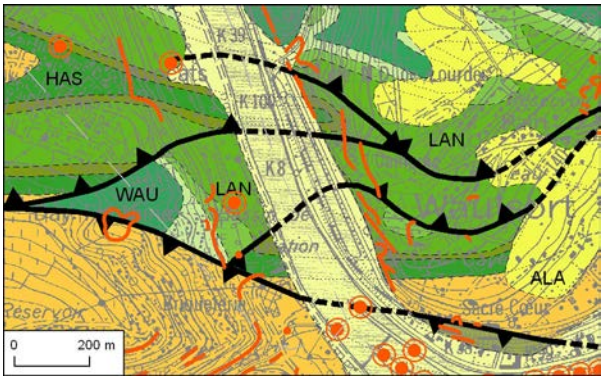

Figure 2 – Outcrops and borings of the Geological Map of Wallonia.

More than 110.000 outcrops and borings (60.000 descriptions) are now recorded in a data base, for 92 maps on 142. The next step is to include about 200.000 descriptions of old points and the future data, to update the geological map.

GEOLOGICAL ITEMS

Some others geological items have been gathered and localised, on the basis of mine files and maps and scientific and historic descriptions :

- metallic ore deposits, by Th. Martin from University of Mons (1.200 objects – scale between 1/1.000 and 1/40.000);
- iron ore deposits and layers, by J. Denayer of University of Liège (3.300 objects – scale between 1/1.000 and 1/40.000);

Geochemical data, collected on the field, are also available (about 9.900 spots).

GEOMORPHOLOGICAL ITEMS

The Thematic application is aimed not only to show the objects and their localisation, but also to inform about the administrative requirements for construction or industry, linked to these objects.

Three items and their relative requirements are showed on the Thematics WebGIS service :

- the Atlas of Walloon Karst (8.000 objects);
- landslides in the western and eastern parts;
- zones of falling rocks.

The two last thematics have been collected by University of Liège, on an initiative of DGO4 - General Direction of Urbanism, Territorial Management, Patrimony and Energy. The Atlas of Walloon Karst is based on an initiative of DGO3 - General Direction of Agriculture, Natural Ressources and Environment, and done by the Walloon Commission for Study and Protection of Underground Sites (CWEPSS), in collaboration with DGO4. The scale of these items is 1/10.000.

MINES AND ANCIENT EXPLOITATIONS ITEMS

Wallonia has a 8 centuries old mining and quarrying history, on various rocks and ores, with a noticeably development of underground works.

The gathering of data has begun in 1997, for the prevention of mining hazards. It was quickly completed by the collect of data on non strict “mines” items. The work is to be achieved in 2014. These items comprise :

- the last perimeter of 354 mining concessions, kept or created after 1793 - scale 1/10.000;
- 12.000 mine shafts or gallery exits (30.000 occurences) - average scale : 1/2.500;
- mine drainage galleries - average scale 1/10.000;
- underground exploitations of coal - scale 1/10.000;
- maps of past soil subsidence (coal mines);
- 5.000 underground quarries, on a base of cadastral plots, and for less than 300 quarries, with plans - scale 1/1.000 to 1/5.000;
- about 1.500 iron ore exploitations (mostly superficial) – scale 1/1.000 to 1/40.000;
- more than 800 slag heaps of collieries;
- zones of recommanded consultation of the Direction of Industrial, Geological and Mining Hazards, because of the presence of underground exploitations;
- zones of administrative and geotechnical requirements linked to mine works *sensu stricto*.

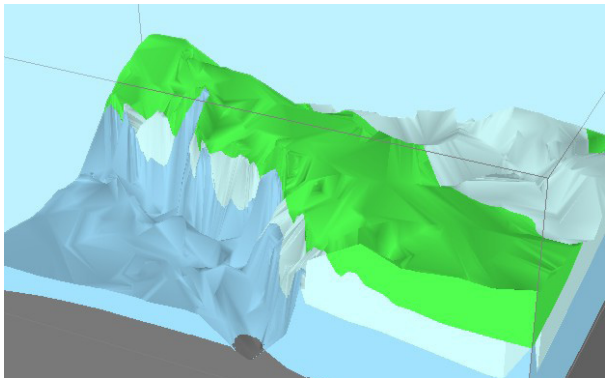

Figure 3 – Mine shafts and underground quarries near Mons.

PERSPECTIVES

A “Certificate of Underground State” will be developed in order to integrate all these data in a document to join to application forms for permits or to real estate transactions. It will also serve data on seismicity and radon hazards

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HYDRO-CHEMICAL INVESTIGATION AND NATURAL GAS HAZARD IN THE URBAN AREA OF ROME (CENTRAL ITALY)

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KEY WORDS: volcanic area, Rome, fluid geochemistry, Natural Gas Hazard

The city of Rome is located in the Comagmatic Roman Province (central Italy, Washington, 1906), where large sectors are affected by volcanic activity linked to the geodynamic evolution of the Italian peninsula, aged Plio-Pleistocene. In volcanic areas, a huge degassing both from soils and aquifers occurs (Pizzino et al., 2002; Annunziatellis et al., 2003; Carapezza et al., 2003; Barberi et al., 2007; Mariucci et al., 2008; Frondini et al., 2008; Cinti D., 2010); gas composition is dominated by CO_2, that can act as a carrier for other minor components such as N_2, CH_4, H_2S and radon. Gases are produced at depth (carbon isotopes of CO_2 indicate both a mantle and a thermo-metamorphic origin, due to decarbonation processes of the thick carbonate basement) and upraise towards surface through fault and fracture systems, thus characterising well defined enhanced permeability belts. Aquifers dissolve gases and can result in an over-saturation state with respect to some species, allowing free phases to escape towards surface, permeating soils. Where hydro-geological, hydro-chemical and lithological conditions are favourable, gases exhaled from soils and aquifers can enter houses (mainly their depressed parts such as cellars, and basements) in highly urbanized areas, potentially reaching harmful indoor levels. Indeed, some gases (CO_2, H_2S) can have a short-term toxicity if they overcome fixed indoor thresholds, while others (i.e. radon) can cause lung cancer at prolonged exposures. As a consequence, an evaluation of the level of Natural Gas Hazard (from now on NGH) to which these areas are exposed, must be done.

By now, detailed information on CO_2 and radon distribution in ground waters was assessed both for the Sabatini and Colli Albani volcanic complexes (located N and S of Rome, respectively). The study performed in ground water allowed to discriminate areas where analysis of indoor-gas levels has to be carried out and deepened, in order to lessen their impact on human health. Such an investigation (i.e. an evaluation of the possible NGH) is still lacking for the urban territory of the Italian capital, where about 2500000 people habitually live.

A detailed geochemical study in ground waters started in 2011 and is currently going on in the roman area; 95 wells and 14 springs were investigated for their chemical and isotopic composition (figure 1). On each site physical-chemical parameters (temperature, ph, salinity, redox potential), alkalinity, major, minor and selected trace elements (Li, B, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Mo, Cd, Ba, Pb, U e Si), dissolved gases (CO_2, N_2, O_2, CH_4, Ar, He, H_2, radon), as well as environmental isotopes (δD and $\delta^{18}O$) and carbon isotopes ($\delta^{13}C_{TDIC}$), were analyzed. The preliminary investigation allowed us to recognise and mark off areas in which deep fluids upraise; generally characterised by the presence of hypothermal and CO_2-rich waters. In particular, isotopic analysis of dissolved carbon allowed the discrimination among the different carbon sources, emphasising the role of deep CO_2 as a sound marker of tectonic structures in this sector of central Italy. Waters rich in deep CO_2 are located in the southern and in the north-eastern sectors of Rome, that can be considered as potential NGH-prone areas; hypothermal waters have been found in the south-western part of Rome. Radon-rich waters roughly mimic the CO_2 distributions and circulate in the southern sectors of Rome. So far, no H_2S-rich waters have been found in the study area.

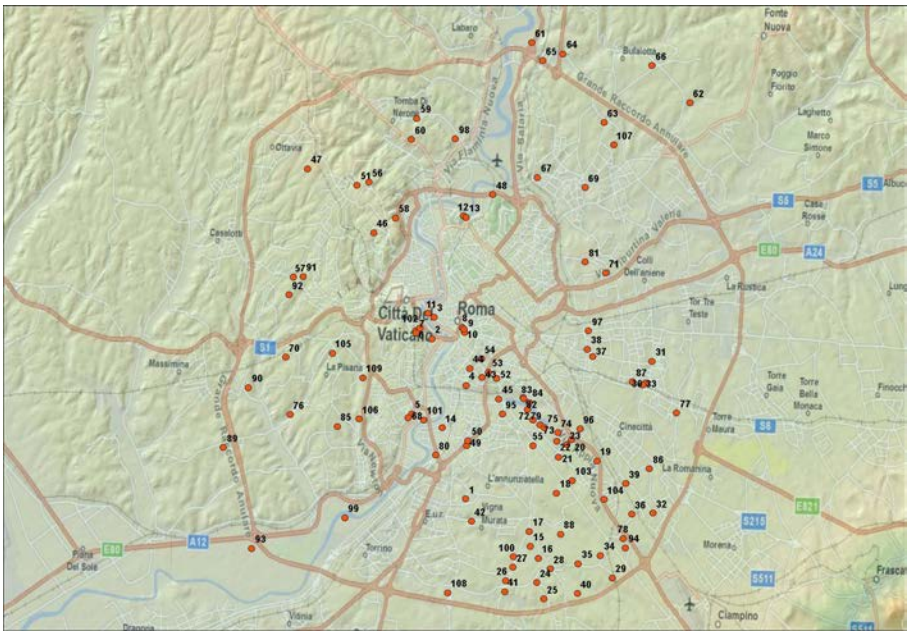

Figure 1: location of the groundwater sites (wells and springs) in the urban area of Rome. Labels refer to the identification number of each site.

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NEW METHODS FOR THERMAL SURVEY IN THE GROUND

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KEYSWORDS: Model heat propogation, Survey's methods, Flow of groundwater, Environment, Thermal data, Heat exchanger.

ABSTRACT

The growing attention to environmental issues and the new energy saving has laid the groundwork for new policies to promote renewable energy sources. An important role can certainly be done by air conditioning systems using heat pumps, particularly geothermal heat exchanger systems with ground, underground and aquifer.

Starting point of the exchanger system's design is the reconstruction of a geological and hydro-geological model of the underground that allows determine:

- characteristics stratigraphic, lithological and hydrogeological ground crossed by geothermal heat exchanger and the follow environmental aspects to be considered at run time, particularly with regard to the aquifers'structure;
- thermal characteristics and methods of heat exchange in the underground, to evaluate the potential of the reservoir and a correct sizing of the geothermal field;
- hydrogeological parameters of aquifers (speed of flow of groundwater and transmissivity) are essential for evalueting the convection contribution in the geothermal heat exchange and heat dissipation into the reservoir;

GROUND RESPONSE TEST

For the definition of the thermal characteristics of the ground certainly the most known and popular method for the thermal measurement is the termal response test (or ground response test) - through the registration of alteration of the temperature inside of geothermal heat exchanger due to the input of costant heat , which occurs in a significant period of time (50-72 hours), that allow to measure the average thermal conductivity of the ground around the tester.

Figure 1 – Geotester working in progress.

This method of research - although internationally approved - has some important limitations that must be properly considered:

- The first limitation is the fact that the test is obtained by the thermal conductivity along the vertical average of the geothermal heat exchanger without considering the inhomogeneous composition and stratified of the ground in almost all cases;
- Moreover, from the test is unable to distinguish the contribution given by the different arrangements of propagation of heat (mainly conduction and convection)

These limitations are particularly important in cases of frequent presence of clear groundwater's active flows

NEWS METHODS OF THERMICAL SURVEY

To overcome the limitations of traditional methods of research in collaboration with the Department of Earth Sciences University of Bologna and the Geological Service of Emilia-Romagna, the workers geologists are identifying methods of thermal experimental surveys. This is a protocol for integrating several types of thermal and hydrogeological surveys, combined with stratigraphic structure of the area generally, obtained during the drilling.

In particular, already in different case studies

it was observed that more detailed information, relating to the behavior of the single layers of ground, are obtained by repetition of steps thermometric measure inside of the exchanger in different conditions of thermal stress (eg. at rest, during and after the test of thermal output or after other thermal stresses such as the cementation of the borehole).The search path hypothesized provides for the modeling of the heat exchange which takes into account the layered structure of the ground and the contribution factor of the convective exchange of heat.

APPLICATION TO A REAL CASE

In the early months of 2012 is in progress the building of a geothermal field in Bologna, for the conditioning of a residential complex of 30 units reclassified. The geothermal field is composed from 14 heat exchangers at a depth of m. 104 from the surface . In this intervention, we proceeded to define a program of surveys and data acquisition that included:

- the definition of the stratigraphy of the area through the implementation of a stratigraphic survey and the subsequent insertion of a piezometer of monitoring (this starting from a depth of m. about 50);
- implementation of measures thermometric in the hole in different situations of heat stress;
- execution of thermal response test;
- hydrogeological surveys for the determination of the hydraulic conductivity of the aquifer (pumping tests in the hole);
- taking of soil samples for the determination of the characteristics of thermal conductivity through specific laboratory analyzes;

The parameters acquired by data acquisition campaign, will be incorporated into a simulation model of heat exchange being developed by the University of Bologna.

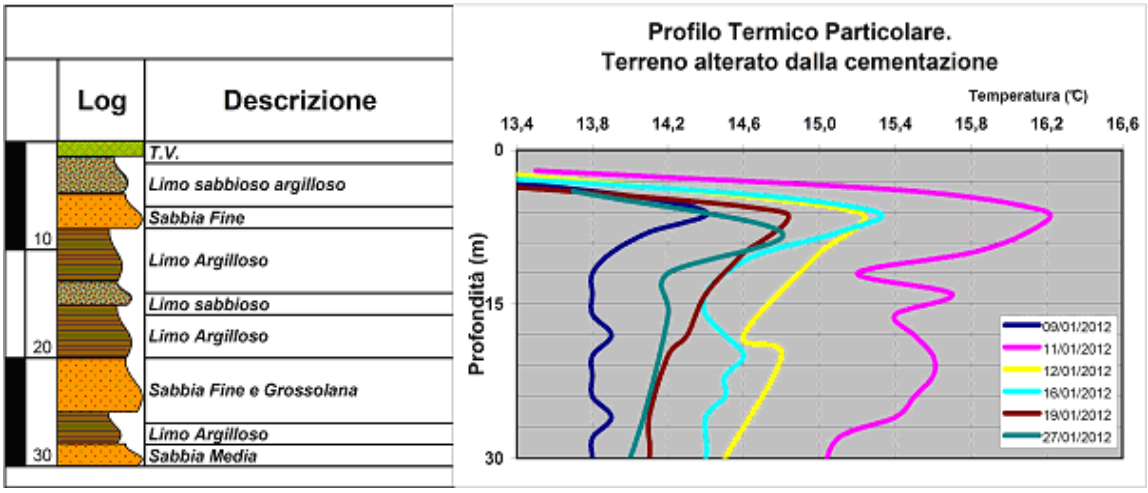

Figure 2 – Temperature monitoring affected by cementation

RIASSUNTO

As part of the building a new geothermal plant in the town of Bologna, are ongoing surveys of new methods for evaluating the characteristics of thermal conductivity of grounds and for determining the contribution of convective flow in the exchange systems.

The parameters acquired allow the calibration of an advanced simulation model, which takes more account of the geological and hydrogeological areas in the design of systems with geothermal heat pumps.

ACKNOWLEDGMENT

Special thanks:

- Geological Survey of Regione Emilia-Romagna to support the sharing of information and the search path;
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THE URBAN DEVELOPMENT OF THE CITY OF VERCELLI

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KEY WORDS: Vercelli, urban development, river diversion, River Sesia, Cervo Stream, Forza di Corilis.

GEOMORPHOLOGICAL SETTING

The city of Vercelli develops on a low E–W trending Holocene fluvial rise pertaining to the distal portion of the debris system generated by the stream network of the Ivrea Moraine Amphitheatre. The rise is located almost at the edge of the historical alluvial plain of the River Sesia and its tributaries, in particular the Cervo Stream (Figure 2).

The portion of the rise on which the more ancient sector of the city developed is intersected by some channelled watercourses which originally ran W-E and provisioned the city with water.

The location of the prehistoric settlement was chosen for its geomorphological configuration: the elevated position ensured protection from the floods frequently affecting the adjacent plains. Similar considerations influenced the positioning of nearby settlements (Palestro, Casalino, etc.).

The risk of flooding in the plain east of Vercelli was exacerbated in historical times by the frequent diversions of the River Sesia in the low-lying plain.

The section of the River Sesia downstream of Oldenico is sinuous, with an average slope of less than 0.05°. It has historically shown a tendency to shift westward, frequently capturing nearby watercourses through the lateral erosion of their banks. The shift is documented by photogeology data and dated through precise cartographic and historical references. The most studied case of stream capture is that of the Cervo Stream occurring in about 1700 (Figure 1). In earlier works the present author suggested that the Coriolis effect was in part responsible for the progressive westward shift of the River Sesia. This is a very likely hypothesis, also in view of the lack of evidence for other neotectonic or geomorphologic causes.

URBAN DEVELOPMENT

The urban center of Vercelli has a prehistoric origin; it was subsequently colonized by the Romans and underwent expansion in the modern period. Although the various stages of ancient urban development are not clearly defined on archaeological grounds, historians believe that the extent of the original settlement was not very different from that of the present historical city centre. The subsequent Medieval and modern expansions have always stemmed from the sector of the historical centre on the highest portion of the rise. Urban expansion has been such that the city now extends to the edge of the rise, on the lower-lying terrains more vulnerable to flooding. Considerable efforts were made to accumulate landfill material that would allow level urban development even on the lower southern edge of the rise. There is still a 5-6m difference between the present street level in the southern reaches of the city and the natural level of the ground in the area of the Roman Amphitheatre.

Figure 1 – 18th century map of the River Sesia. Archivio di Stato di Torino .

The highest portion of the rise, about 136m asl, is in the central sector of the historical city centre, in Piazza Cavour; this elevation decreases slightly westward and more markedly southward, with a maximum drop of about 10m.

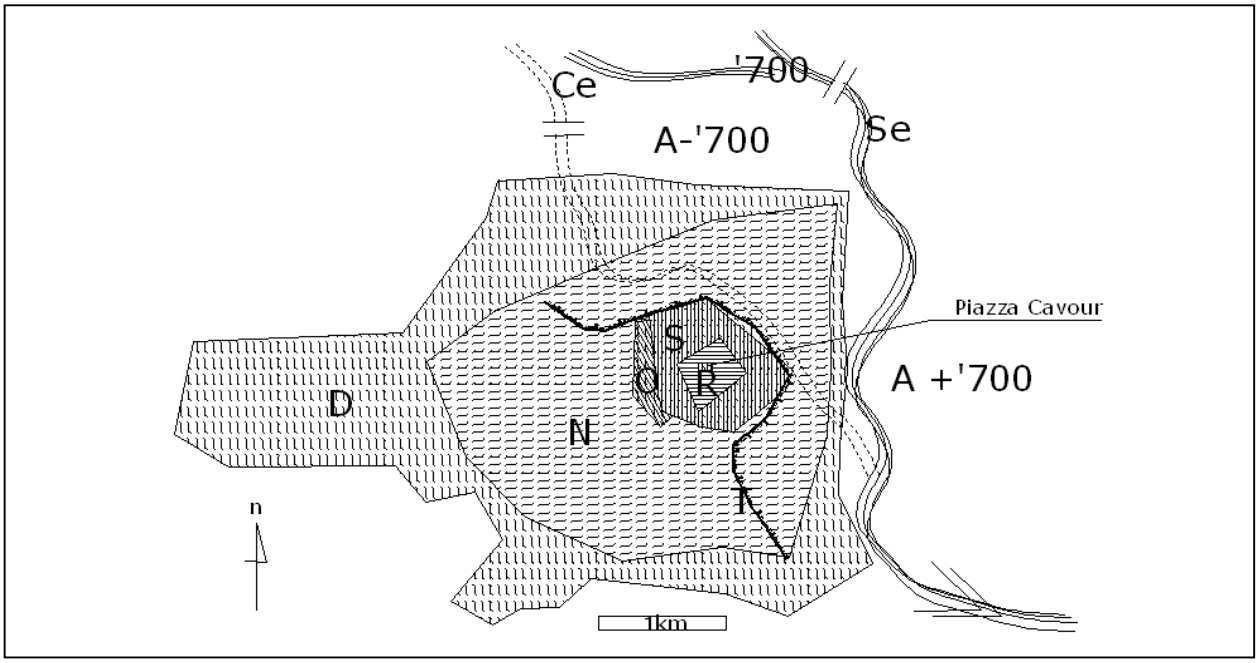

Figure 2 – Plan showing the extent of the main urban area of the city of Vercelli through the ages.
Legend: extent of the urban area in the various periods: R, Roman ; S, up to the 18th century ; O , 19th century; N, 20th century; D, 21st century . T: fluvial terrace; lower elevation to the east. Ce, Cervo Stream. Se, River Sesia. A-18th century: area prone to flooding up to the 18th century. A+'700 : area prone to flooding after the 18th century.

THE IMPACT OF THE RIVER ON URBAN DEVELOPMENT

In contrast to other cities, Vercelli developed only on the right bank of the River Sesia, on a fluvial rise and along its margins, in order to minimize the risk of flooding, which is enhanced by the river's tendency to shift westward.

This tendency is historically well documented in innumerable records illustrating how erosion by waterways on the northeastern margin of the city has posed a continuous threat to the urban fabric of Vercelli. The greatest danger initially derived from the Cervo Stream, until its capture in the18th century, and subsequently from the River Sesia. The "capture" of the Cervo by the River Sesia in the early 18th century freed the Cervo alluvial plain north of the city (Figure 2 : A-18th century). This area was made suitable for construction a few years later, allowing the development of the Novecento industrial area (Figure 2).

Note that the name of the "Cervo" Stream derives from the erroneous translation of the term "Servo" (from servire = to serve). The stream "served" the city with water up until the 18th century, since the River Sesia was more distant (*necessario?*).

Up until the 20th century the dynamics of the Cervo and Sesia rivers always influenced the urban development of the city, which expanded to the north, west and south, avoiding the fluvial area to the east. It is only recently that there is a dangerous tendency to develop the city to the left of the River Sesia, an area with a high risk of flooding.

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ASSESSMENT THE AQUIFER VULNERABILITY IN THE NORTHEASTERN CAMPANIA PLAIN THROUGH A MULTIDISCIPLINAR APPROACH

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KEY WORDS: Campania Plain, Caserta, Southern Italy, stratigraphic architecture, environmental impact assessment.

INTRODUCTION

The alluvial plains represent areas of great development of anthropic, industrial and agricultural activities. As a consequence, these regions are characterized by a strong human pressure, which has often lead to the deterioration of the environmental system, and in particular of the water resources both on surface and in subsoil.

Groundwater is an important resource in the alluvial plains as it is source of water for irrigation and industrial uses, other than drinking. At the same time, groundwater can be contaminated by anthropogenic influences, such as municipal, commercial, industrial and agricoltural activities that can all affect groundwater quality. Among these latter, in particular, the agricoltural/livestock activities are usually the cause for nitrate pollution of groundwaters in many of the EU regions.

As most of the alluvial settings, which represent important natural water reservoir, the northeastern sector of the Campania Plain (southern Italy) is an area with strong anthropic impact caused by urban growth and agricultural and industrial activities. Moreover the presence, in the Plain, of numerous quarrying and uncontrolled waste storage is added. These activities represent a potential risk for soil-subsoil system.

The present work proposes a geological characterization of subsoil derived from the study of a greatly improved dataset including some 600 lithostratigraphic logs from boreholes reaching the depth of 10-to-150 m b.g.l.. In particular, specific insights will be offered on the volcaniclastic lithofacies heteropies across the entire area of study, also considering the contribution of pedogenesis on the reconstruction of the stratigraphic setting and relative implications on groundwater quality concerns. This last tool can result particularly adequate on land surfaces interested by volcanic activity, due to the intermittent deposition of the involved sediments and possible time span for soil development.

The study integrates different sets of geologic and environmental data. The integration of these data with informational technologies provides useful tools to restore the stratigraphic architecture and to assess the anthropic impacts on subsoil; nevertheless, due to the difficulties in carrying out detailed fate and transport modeling owing to the lack of specific works, this elaboration has only been used to identify areas that have a potential of groundwater contamination.

Specific aims of the present paper are: i) to better understand the geologic architecture of the northeastern region of the Campania Plain (Southern Italy) and in particular the geometry and distribution of aquitard sediments above the main groundwater body, on the basis of geological, geomechanical, pedological and hydrogeological data; ii) to assess the anthropic impacts on subsoil by evaluating land-uses; iii) to define the intrinsec potential vulnerability of groundwater.

GEOLOGICAL SETTING

The Campania Plain is a broad, complex graben, or half-graben controlled by NE-SW, NW-SE and E-W normal fault activity, estabilished in Late Pliocene or the Early Pleistocene along the Tyrrhenian side of the Apennine Mountains. In the studied area, above the faulted Apennine carbonate bedrock, marine-transitional deposits have been recognized (referred to the OIS 5e). Between and above them units mainly composed of pyroclastic deposits follow, related to intensive volcanic activity dated back 156 since 116 ky B.P. (Rolandi *et al.*, 2003). The pyroclastic flow deposits of the Campania Grey Tuff (CGT 39 ky B.P.) overlie these units: they blanket the whole area filling morphological depressions and dipping gently towards the central region of the Plain. These deposits underwent successive diagenetic modifications responsible for the formation of different lithofacies (ignimbrite, grey tuff, zeolitic yellow tuff, ash) within the same volcanic unit, variously distributed both laterally and vertically (Di Girolamo *et al.*, 1968; Cappelletti *et al.*, 2003). The uppermost unit of the reconstructed stratigraphic succession is represented by thin deposits of the Neapolitan Yellow Tuff (NYT 15 ky

B.P.) which are locally separated from underlying CGT by a paleosol of 50-200 cm thickness. A subsequent continental stage is witnessed by Upper Pleistocene to Recent alluvial and detrital colluvial deposits covering the two volcanic units (Putignano *et al*., 2007; Santangelo *et al.*, 2010).

DISCUSSION

A detailed reconstruction of stratigraphic subsurface architecture based on remarkable geodatabase was carried out. The geodatabase concerns with well log stratigraphies, interpreted and homogenized in terms of lithologic units. Interpretations have been compared with field and sample analyses. All of these informations inferred from stratigraphic logs have been managed into a GIS project. The geological data processing have been graphically restored with use of software Rockworks 2006 to achieve bi- and tridimensional models of the stratigraphic units, fence-diagram in 2D and 3D. Detailed fence-diagrams that show the stratigraphic architecture of the different CGT lithofacies have been realized in order to highlight the differences in lithification degree and permeability. In order to outline the processes contributing to the formation of the surface framework, a pedostratigraphic reconstruction was conducted in selected sites of the investigated area.

Furthermore, the thickness and distribution of the paleosol developed between the two volcanic units (CGT and NYT) have been reconstructed and restored in an isopache map, in turns overlain to the surface model of the CGT, as the paleosol represents a lithological body also able to slacken the transfer of pollutants from soil to aquifer and/or groundwater.

The main aquifer, supplied by the carbonate backbone, is continuously spreaded and chiefly holded in the pre-CGT deposits, locally included also in the overlying tuffs. Due to the different diagenetic facies which characterize the CGT deposits, the aquifer is locally under pressure. The groundwater surface is about 25 m a.s.l., from 35 to 10 m below surface.

To better understand the relationships between the ground level, the paleosol, the top and bottom layer of GCT and watertable, cross-sections have been restored, in which the different CGT lithofacies have been reported

In order to assess the anthropic impacts on groundwater, land-uses have been considered. Polluted sites, recognized by the National Agency for Environmental Protection (ANPA) have been displayed on the Land-use Map. They are mostly located in correspondence of crop area, expecially those interested by artificial intensive irrigation.

The same analyses have been made for quarries, whose potential impact on subsoil is linked to their use. All the quarries are almost similar: they are rectangular holes about 1-4 hectares long with almost 20 m vertical steep walls below ground level. The analysis of the quarry development through years in the whole area has permitted to highlight the loss of land and also the presence of ancient quarries under the current urban area. Most of them are nowadays partially filled with earthy materials and used for agricoltural pourposes, whereas others are sites of illegal waste disposal. Moreover, in the southernmost part of the study area, the reconstruction of the topographic surface of the open pits has shown the strong reduction of the water table depth, often touched or intersected by the bottom of the pits. In these latter cases, the potential of pollution from any anthropic activity is the highest, as previously pointed out.

Finally, the ANHI method (Agricultural Nitrate Hazard Index; Padovani and Trevisan, 2002; see also Corniello *et al*., 2007) has been applied only in low lands, between 20 and 80 m a.s.l... Referred to the agricoltural areas, it results in low potential hazard for about 45% of the entire area, mostly related to intensive agricoltural activities; if the urban areas and the artificial lands are excluded, the 9% of the territory is characterized by scarce hazard.

If we compare the ANHI map with the stratigraphic setting, expecially in terms of paleosol thickness and CGT lithofacies distribution, it comes that the sites with moderate potential vulnerability occur both in the northern and the southern part of the considered area: with respect to the former, they coincide with settings characterized by high thicknesses of grey and zeolitic yellow tuffs and also the greastest development of paleosol above them. For this reason, the real vulnerability should be considered much lower. By contrast, in the southern sector, the reduced thickness of both tuff and paleosol would increase the attitude to nitrate contaminations. Moreover, taking into account the distribution of the quarries in the same zone, it comes that the higher vulnerability values do not coincide with these latter sites, to which scarce-to-low values have been attributed. From the above considerations, it follows that this sector represents the most susceptible to groundwater contamination and thus the previsional map obtained needs an accurate cross check with the stratigraphic data.

CONCLUSION

The above results are based on a robust dataset that links land-uses and a thorough hydrostratigraphic caracterization of subsoil to detect the susceptibility of groundwater to contamination.

From the above it comes that only the southern part of the territory is at a real risk of pollution, despite the high anthropic impact and the great diffusion of polluted sites and illegal waste disposals all over

the area. This study emphasizes the role of the stratigraphic studies to assess vulnerability to diffuse pollution in an intensively populated area. Although the topsoil features have not been considered, the above approach has allowed to define a qualitative/quantitative method to assess the potential vulnerability for the aquifer and discriminate areas with different hazards. The main benefit of this characterization is to better address the investigation on soil and water, minimizing the costs.

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INFORMATION SYSTEM FOR SHALLOW GEOTHERMAL ENERGY (IOG) IN BAVARIA

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KEY WORDS: shallow geothermal energy, heat exchanger, groundwater, site condition, geothermal efficiency, web map service.

INTRODUCTION

After the nuclear disaster in Fukushima, the federal government of Germany decided to phase out nuclear energy and trigger the transition from fossil to renewable energies. Following this decision, the Bavarian state set the goals of the transition in its “innovative energy concept” (BAYERISCHE STAATSREGIERUNG, 2011). Among other things, the concept foresees to increase the number of installed heat pumps from 80,000 at present to 200,000 within ten years.

According to the concept these targets shall be achieved by direct financial support programs, simplification of administrative decision procedures and the development of information portals in the internet. A first step in this direction was the publication of the "Energy Atlas of Bavaria" (EAB) in April 2011. The EAB contains information on all renewable energies such as biomass, wind, hydropower, solar and geothermal energy. The information is being provided in texts and maps. The maps follow the concept of web map services (WMS).

INFORMATION SYSTEM FOR SHALLOW GEOTHERMAL ENERGY (IOG) IN BAVARIA

Concerning the maps on shallow geothermal energy in the EAB, the “Information System for Shallow Geothermal Energy (IOG)”, which is being developed by the Bavarian Environment Agency - Geological Survey, provides the respective maps. The IOG contains different information layers on the use of shallow geothermal energy. Important themes are the extension of water protection zones, existing drilling risks, the geothermal efficiency, indicating potential heat extraction rates, and a so called “traffic light map”, showing the site specific suitability for the use of shallow geothermal energy.

The site specific classification is based on existing geological, hydrogeological and water management restrictions with respect to the construction and operation of vertical heat exchangers.

Restrictions from the water management side are being imposed with respect to groundwater protection. Based on the Federal Water Act (WHG) and the Bavarian Water Act (BayWG), the “Guideline for vertical heat exchangers in Bavaria” was published (Leitfaden Erdwärmesonden: BUNDESVERBAND WÄRMEPUMPE 2008). Sites with restrictions are:

- drinking water and healing water protection zones,
- contaminated sites,
- deeper groundwater horizons,
- strained and artesian aquifers,
- sensitive catchment areas for drinking water wells,
- aquifers with high permeability (such as karst aquifers).

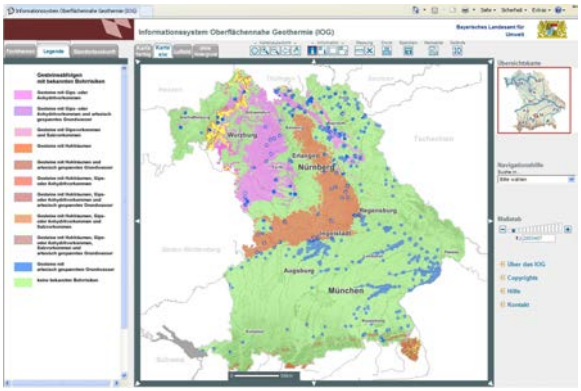

Figure 1 – Drilling risk map of Bavaria within the information system for shallow geothermal energy.

Drilling risks occur in the following rock units:

- sulphate and salt deposits,
- karstic rocks with cavities,
- fault zones.

Regarding the above listed restrictions and risks, the geological and hydrogeological settings were evaluated on the basis of available maps in different scales from 1:25,000 to 1:200,000 and then summarized in the “traffic light map”.

Additionally, the IOG contains the possibility to retrieve site specific information in text form with respect to the requirements and restrictions of vertical ground heat exchanger systems. In order to zoom to the point of interest the user can input his address and the system automatically switches to the respective property. The result of the query is printed to a downloadable document (PDF-format).

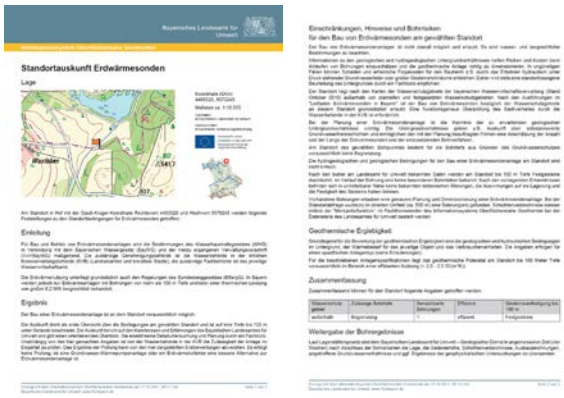

Figure 2 –The site specific information in text form.

GEOTHERMAL EFFICENCY MAP

From the geothermal efficiency map the user gets information on the optimization of geothermal plants, especially required heat exchanger lengths. The collection of the map was performed as follows:

1. Selection of wells from the borehole databank (Soil Information System Bavaria)
2. Allocation of the thermal conductivity values to the lithological description of the bores and calculation of a representative mean value for the 100 m-depth.
3. Regionalization of the mean values within the areal distribution of the associated lithological unit.
4. Outlier detection by box plots and probability net.
5. Cleanup of outliers and re-regionalization.

OUTLOOK

In the future, depth dependent maps of the geothermal efficiency will be produced, so that the planners can dimension the plants in dependence of heat exchanger depths. Additionally an extension of the IOG for horizontal ground heat exchangers and groundwater heat pumps including also the textual site information is being planned. Another planned feature is the so called virtual bore hole – an information on the build-up of the underground based on existing 3D-models.

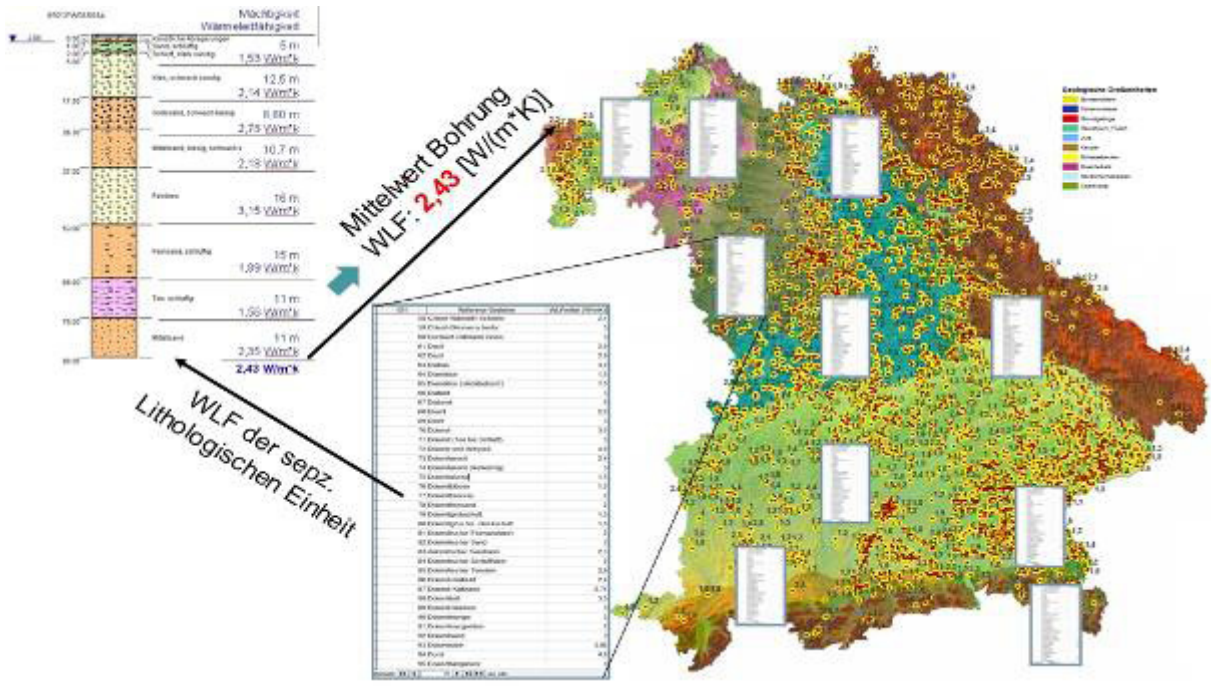

Figure 3 – Regionalization of the thermal conductivity values.

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OBTAINING SOIL DYNAMIC PARAMETERS FROM GEOLOGICAL AND GEOTECHNICAL DATA: GIRONA URBAN AREA (NE SPAIN)

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KEY WORDS: geotechnical database, statistical analysis, soil dynamic parameters, seismic microzonation, Girona, Spain.

INTRODUCTION

As a first approach to assess seismic hazard, soil movements due to amplification of the seismic vibrations can be estimated by means of the geological and geomechanical characteristics of the materials. This study, included in the SISPyr project of the Interreg IVA program between Spain, France and Andorra, focuses on the analysis of a geotechnical database compiled in the metropolitan area of Girona (Catalonia, NE Spain). Geological and geotechnical variables of seismic significance have been selectively extracted from the database (Figure 1). A statistical analysis has been performed in order to get a seismic characterization of the litho-stratigraphical units of the area. Equivalence of geological and geotechnical data to soil dynamic parameters has been done according to the specifications of the Spanish Seismic Building Code (NCSE-02, 2002). This methodology reveals as a good complement to the determination of local seismic response from direct field measurements.

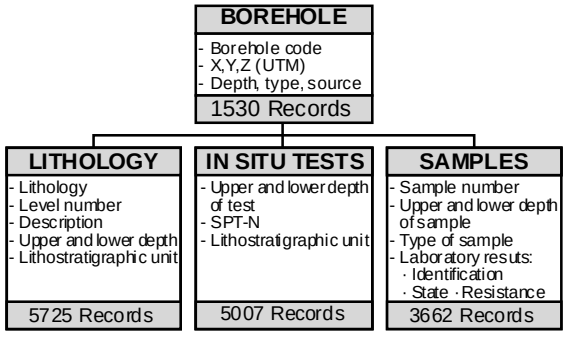

Figure 1 – Basic structure of the geotechnical database.

GEOTECHNICAL DATABASE PROCESSING

Girona is a medium sized province capital with about 150,000 inhabitants in its urban area of roughly 50 km^2. The city lays in a wide fluvial and alluvial plain of Quaternary age. Recent materials overlay a geological substratum cropping out in elevated areas of the city and its surroundings, made up by Tertiary sedimentary formations and Paleozoic metamorphic and igneous rocks. As the result of urban expansion during the last decades, a big amount of geotechnical reports and other geological studies have been deployed around the area. Many of them have been compiled in a database assembled by GEOCAMB.

Methodologycal steps started with a synthesis of the geotechnical data available for each of the 25 litho-stratigraphical units defined by a simplification of those displayed in the IGC geological maps at 1:25,000 scale (Puig *et al.*, 1997; Saula *et al.*, 1997; Cirés *et al.*, 2003 and Picart *et al.*, 2009). The analyzed variables comprise results of: i) standard penetration tests (SPT-N), ii) identification and state laboratory tests on unaltered and representative soil samples (percentages of granulometric fractions, densities, moisture content and plasticity values), and iii) resistance laboratory tests on unaltered soil samples (unconfined shear strength Q_u, cohesion, and effective internal friction angle). In addition to mean results, the characteristic values have been also considered in terms of median and percentiles, which more fairly illustrate the natural variability of the materials.

SEISMIC PARAMETERIZATION

Among the dynamic parameters that determine the so called local soil effects is the C coefficient, defined by the NCSE-02 as a factor of amplification of the ground seismic acceleration for the first 30 meters from the surface. In accordance with the norm, correlations between compacity and consistency of the materials, SPT-N and Q_u (Table 2) have allowed to assign every litho-stratigraphical unit into a seismic soil class. For most of the units C coefficient has been estimated from two different sources: i) C_{SPT-N} based on all SPT-N data, and ii) C_{Qu} after resistance tests results. Thus, a statistically representative coefficient C_R has been adopted for every unit by the integrated consideration of C_{SPT-N}, C_{Qu}, density, humidity, fine content, plasticity, geotechnical behaviour (rock, granular, cohesive or mixed soil) and geological descriptions.

Additionally, correlation between SPT-N and shear wave velocities (V_s) for most of the units has been established by means of empirical equivalences (Kanai *et al.*, 1966) after preliminary field seismic studies done by IGC. Every unit has been assigned to a seismic soil class (Table 2).

Seismic soil class	Amplification coefficient C	Vs (ms^{-1})	Rock	Granular soil	Cohesive soil	
				SPT-N	SPT-N	Qu (kPa)
I	1,0	>750	Unaltered	>50	-	
II	1,3	400 – 750	Fractured	31 – 50	>30	>400
III	1,6	200 – 400	-	11 – 30	8 – 30	100 – 400
IV	2,0	?200	-	?10	< 8	<100

Table 1 – Correlation between NCSE-02 soil class, dynamic parameters and geotechnical data.

Units	Geotechnical behaviour	C_{SPT-N}	C_{Qu}	C_R	Vs (ms^{-1}) (a)	Assigned soil class
A	Heterogeneous	1,87	-	2,0	120 - 351	IV
Qt0	Granular	-	-	2,0	-	IV
Qt1s	Mixed	1,86	1,70	1,8	151 -330	III - IV
Qt1i	Granular	1,64	-	1,6	216 - 584	III
Qcdh	Mixed / cohesive	1,93	1,73	1,8	161 - 279	III - IV
Qcah	Mixed	1,68	1,65	1,7	182 - 468	III - IV
Qt2s	Cohesive / Mixed	1,70	1,75	1,8	163 - 374	III - IV
Qt2i	Granular	1,44	1,60	1,45	275 - 701	II - III
Qt34	Mixed	1,30	1,45	1,3	355 - 676	II
Ql	Mixed	1,70	-	1,8	380 - 679	III - IV
Qtr	Rock / Mixed	-	-	1,3 / 2,0	-	II / IV
Qcdp	Mixed / Cohesive	1,68	1,80	1,7	199 - 453	III - IV
Qcap	Mixed / Granular	1,30	1,60	1,6	372 - 736	III
Qv	Granular	1,77	-	1,8	146 - 378	III - IV
Qb	Granular / Rock	1,47	-	1,45 / 1,15	343 - 648	II – III / I - II
N	Mixed	1,42	1,52	1,45	315 - 701	II - III
Em	Rock / Cohesive	1,36	1,00	1,0 / 1,15 - 1,3	-	I / I - II
PEcg	Rock / Cohesive	1,19	1,27	1,0 / 1,15 - 1,3	-	I / I - II
Egl, Ec	Rock	-	-	1,0	-	I
G, MC, SD, Or, CO	Rock	-	-	1,0	-	I

Table 2 – Results of soil dynamic parameterization of the litho-stratigraphical units. (a) Percentiles 10% and 90%.

APPLICATION TO SEISMIC MICROZONATION

Due to the heterogeneity of available data from the boreholes included in the studied area (i.e. different prospective techniques, existence or lack of SPT and/or laboratory tests from the boreholes, prospections less than 30 meters of depth, etc.) obtaining the normative C coefficient for every point has needed a systematization of the calculation. Up to 25 typological cases have been established in order to attribute an individual coefficient (C_i) to all the litho-stratigraphical units involved in a specific borehole, each case having a weighted percentage between in-situ measurements if available ($C_{i(SPT-N)}$ and $C_{i(Qu)}$) and the statistically representative coefficient for every unit (C_R). Finally, C coefficient has been obtained in 87% of the boreholes. This parameter has been directly applicated in delineating seismic isoamplification zones, as a first-level microzonation of the studied urban area.

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GEODYNAMIC DEFORMATIONS AFFECTING THE UFA CITY (SOUTHERN FORE-URALS, RUSSIA)

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KEY WORDS: geodynamic processes, leveling, karst, tectonics, relief, Southern Fore-Urals.

INTRODUCTION

The Ufa city is the capital of the Bashkortostan Republic (Russian Federation) and it is located in the Southern Fore-Urals (54º47'02,59"N, 56º01'59,77"E) where Permian and Quaternary sediments are exposed. It is built on the eroded slopes of the interfluves at around 120-220 m above the sea level. The historical centre of the city is surrounded by two big rivers named the Belaya and Ufa Rivers.

Failures of rocks and deformation of the buildings have been recorded in the past history of the Ufa city since the XIX century and they become more usual nowadays.

Data concerning the building deformations and the karst evolution under the Ufa city have been analyzed. They were compared with the structural-geological features known under the city. The summary of all the data concerning the geology, topography and the geodesic investigations related with the buildings deformations are given in the paper.

GEOLOGICAL FEATURES OF THE AREA

The Ufa area is built in the Permian and Quaternary deposits. Gypsum, anhydrite and dolomite of the Kungurian form the lower part of the sequence but sometimes these rocks can appear at the surface due to the erosional processes. The total thickness of the deposits is of 200 m. Clay, argillite, limestone and marl of the Ufimian unit (Zhamoida et al., 2006) are characterized by fracturation; the surface and technogenic waters can easily go threw these rocks into the lower layers. These processes are responsible for the formation of karst. Thickness is around 40 m. Quaternary sandy and clay deposits are thinner.

Neotectonic processes (Puchkov, 2010) uplifted the Urals and formed deep depressions during the Neogene and Quaternary periods. These processes led to the formation of faults (corresponding with zones of weakness). Faults limit blocks of different size which can move vertically.

Analysis of the topographic maps of 1892 and 1919 shows that small rivers and ravines crossed the Ufa city area (Fig. 1).

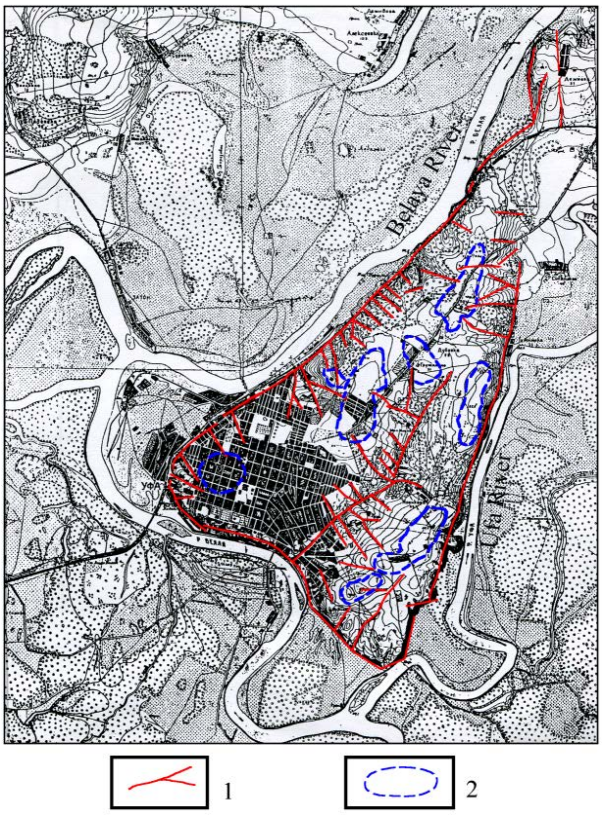

Figure 1 – Fragment of the topographic map of 1919 at a scale 1:42000 with evidences of erosional system. Legend: 1 – tectonic disturbances; 2 – local structures.

TECHNOGENIC ITS IMPACT

Studies have shown that in general the territory of the city downlifted at a rate of 1-5 mm per year in accordance with the increasing pressure of the engineering constructions. Karst processes, faults and block movements are responsible for buildings

deformations. Surface waters and waters flowing from the underground utilities are responsible for the acceleration of the karst processes and the appearance of zones of weakness under the constructions. As a result, buildings are downlifting and destroying (Fig. 2).

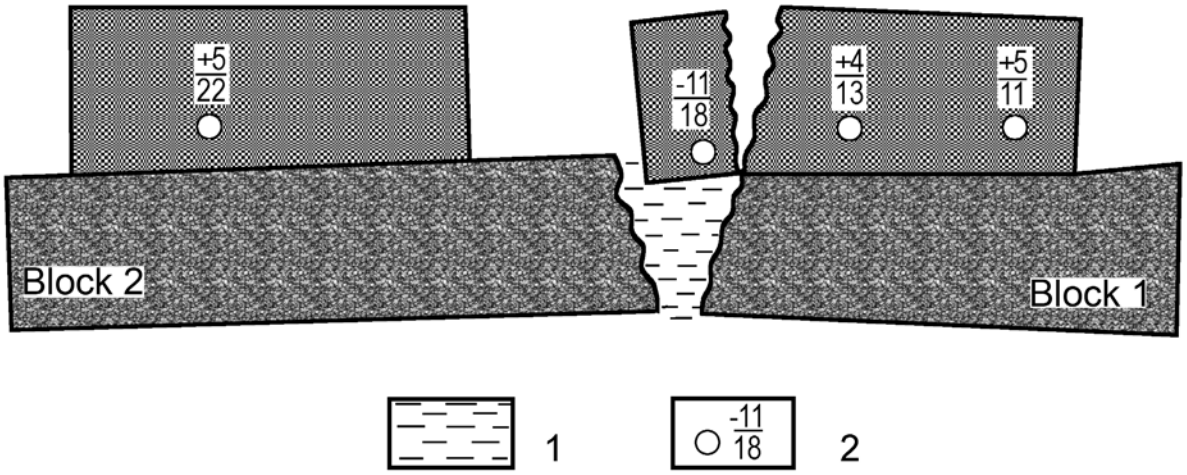

Figure 2 – Process of destruction of the building N 9, Region Halle street, Ufa. Legend: 1 – zone of trust; 2 –sedimentary mark (number of a mark is in the dominator; the rate of vertical movement is in the numerator).

CONCLUSION

The proposals for the prevention of the negative dynamic processes are listed below:

- It is important to renew the geodynamic investigations in the Bashkortostan Republic;
- It is also important:
- To make a large scale mapping of the Ufa area;
- To map at a large scale the big and active faults;
- To put seismic stations in the fault zones;
- To renew the map of karst precesses of the Ufa area;
- To build a geodynamic polygon to make high-precision leveling and to measure the uplift velocity;
- To make a dynamic map of the modern vertical movements according to the high-precision levelling;

To restore a high-precision levelling net of the Bashkortostan Republic area;

Geodynamic processes influence all the territory of the Southern Fore-Urals. Data aboutf the building deformations and karst appearance are known in Neftekamsk, Meleuz, Sterlitamak and other cities of the Bashkortostan Republic.

Data about the recent vertical movements can help to predict the geohazards and to eliminate them.

ACKNOWLEDGEMENTS

The authors would like to thank the General Director V.V. Radaev, the Head of the Department of the Topographic and Geodezic investigations G.P. Ilyin (West Uralian Civil Engineering TRUST Survey, Ufa, Russia) for the help in the authors investigations; Professor Jean-Pierre Lefort (Rennes 1 University, France) for the help with the English translation.

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GEOLOGICAL SURVEY PERFORMED ON THE ST. STEPHEN'S BASILICA SITE IN BOLOGNA. EARLY FINDINGS

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KEY WORDS: St. Stephen's Basilica, Bologna, stratigraphy, hydrogeology.

SCOPE OF THE RESEARCH WORK

St. Stephen's Basilica is an ancient church complex located in the historic center of Bologna. Its ancient structures make the object of a consolidation, reclamation and restoration project. High humidity rates affecting the foundation structures and walls seem to be one of the main causes of deterioration. The survey was therefore designed to thoroughly investigate the complex geology and groundwater flow. It was conducted by means of dry coring surveys, geotechnical laboratory analyses of soil samples, video inspection of the sewerage system and piezometric monitoring of two existing superficial wells and seven piezometers.

EARLY INVESTIGATION FINDINGS

The area of the Basilica is located in a morphological high sector related to the dorsal side of a small alluvial fan belonging to the Fossa Cavallina stream, on the basis of the micro survey analysis and of isophreatic and isopiestic lines trends. The subsoil stratigraphy of the first 10 m deep layers points out the presence of a first archaeological deposit of variable thickness ranging from -1.75 m to -3.40 m, which is followed by a deposit consisting of gravel and sand with clay layers (Lithostratigraphical Unit A) characterized by a marked lenticular geometry and maximum -5.50 m depths. Clayey silt is found at the base of these soils (lithostratigraphical Unit B), which starting from a depth of -5.50 / -6.50 m, include a brown-blackish clayey layer with a metric thickness, attributable to a paleosol dating back to around 8000 BP years, based on literature data.

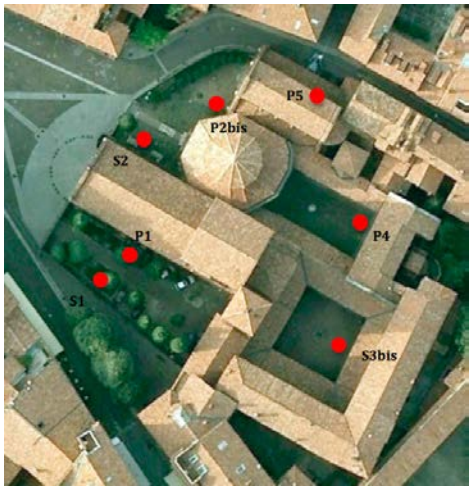

Figure 1 - Layout of St. Stephen's Basilica with the location of the coring surveys

The soil stratigraphic sequence, therefore, seems to be attributable to a succession of predominantly marshy depositional environments, with emersion stages (paleosols), topped by alluvial deposits comprising a hypothetical paleo-riverbed, whose true nature remains to be determined due to recent anthropogenic alterations. The archaeological deposit that closes the depositional sequences follows the geometry of the underlying alluvial deposit, thereby configuring a paleogeographic structure related to a waterway bounded on the east by a bank. From the hydrogeological point of view, the alluvial deposit is the first phreatic aquifer of the city subsoil, whose underlying B unit serves as waterproof barrier. The underlying watertable is located at a depth between -3.50 m and -4.00 m. The isopiestic lines describe a motion field with a main SSW-NNE flow direction and an average 0.001 hydraulic gradient. During these surveys leakage of surface water was also identified in the subsoil, at depths ranging from -0.45 to -2.45 m, largely due to widespread water leakage deriving from obsolete sewers, which would be significantly responsible for the deterioration of the ancient foundations and walls of the Basilica.

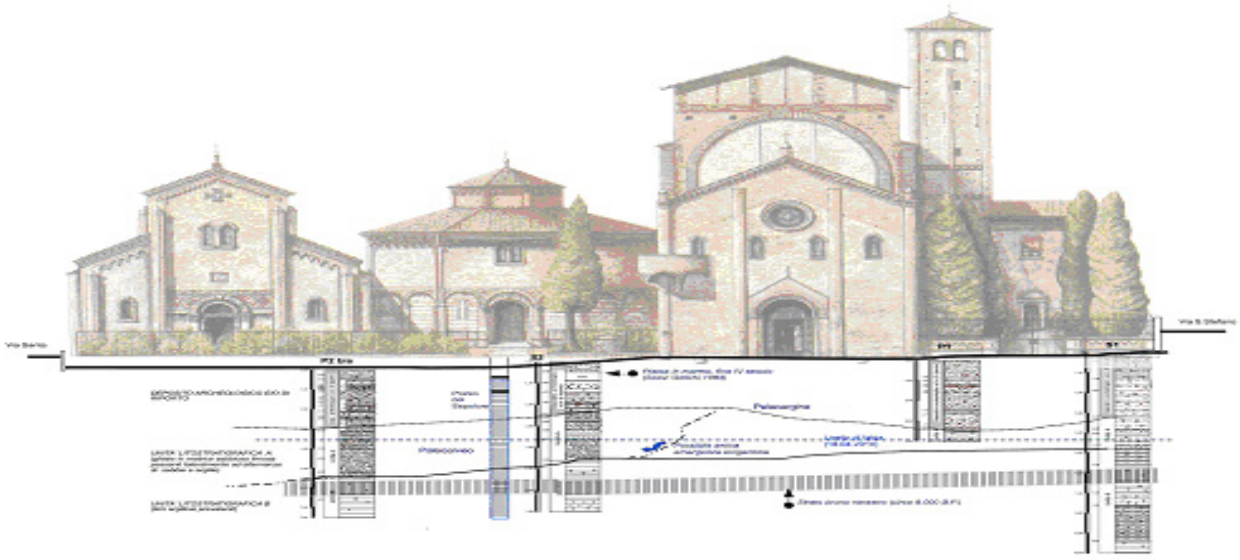

Figure 2 – geological interpretation cross-section.

FUTURE DEVELOPMENTS

According to present knowledge, the impact on the decay of structures due to rising damp linked to seasonal fluctuations in the water table is not known. A continuous automatic monitoring of piezometric levels associated with the continuous measurement of moisture present in the masonry was therefore initiated. The collected data will then be compared with measurements of climatic parameters in order to better understand the ongoing phenomena.

ACKNOWLEDGEMENTS

Special thanks go to Architects Salvatore Fazio and Sabrina Guazzotti and to Prof. Marco Del Monte for their valuable contributions, as well as to Geo-Net srl and Sinergea srl colleagues for the flawless execution of tests, and to Maria Politanò and Giuseppe Mannino for their precious collaboration.

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THE MANTLE-CRUSTAL ORE-FORMING SYSTEMS OF THE PECHENGA DISTRICT (FENNOSCANDIAN SHIELD)

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KEY WORDS: mantle-crustal ore-forming system, Cu-Ni deposits, 3D model, ore mineralization

The Pechenga ore district is an isolated segment of the Pechenga-Imandra-Varzuga the metallogenic zone (Fig. 1 a, b). In the northeast district is bound by the Voron'nya-Kolmozersk fault, in the southeast - by the Litsk-Aragubsk fault, in the northwest - by the Inari-Kirkines fault system, and in the southwest - by a Pechenga-Varzuga system (Kazansky et al., 1994).

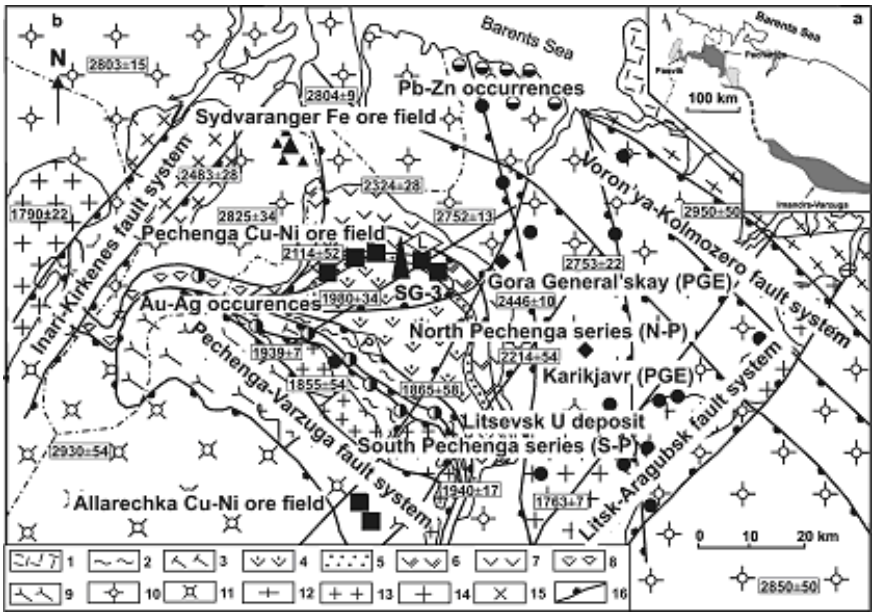

Figure 1. Geographic position (a) and schematic geological map (b) of the Pechenga ore district (Kazansky et al., 1994; Lobanov et al., 2010).
1 - Late Proterozoic sedimentary rock; 2-8 - Early Proterozoic. 2,3 – South Pechenga series: 2 - metavolcanic and metasedimentary rocks, 3 - metavolcanic rocks; 4-6 – North Pechenga series: 4 - metabasalts and metapicrites, Pilgujarvi suite, 5 - sedimentary Productive member hosting Ni-bearing gabbro-wherlite intrusions, 6 - metabasalts metasedimentary rocks Kolasjoki suite;7 - metabasalts and metandesites, metasedimentary rocks Kuetsjarvi, and Ahmalahti suite, 8 – South Pechenga and North Pechenga series undivided; 9 - crystalline schists (Tal'ya suite), 10-12 – Archean: 10 - gneisses, migmatites, granites, amphibolites Kola-Noregian block, 11 - gneisses, cristalline schists Inari block, 12 - strongly granitized gneisses, Murmansk block; 13-15 Early Proterozoic granitoids: 13 - rhemorphic granitoids, 14 - intrusive granitoids, 15 – Early granitoid intrusives; 16 – faults - L - Luchlompol, P - Por'itash.

Within the suggested boundaries the Pechenga ore district, besides the Pechenga and Allarechka Cu-Ni ore fields, incorporates the Archaean banded iron ores of Sydvaranger, the Early Proterozoic PGE and Ni occurrences (Gora Generalskaya, Karikjavr) the Late Archaean-Early Proterozoic U mineralization of different types (Litsevsk), the hydrothermal Pb-Zn veins of probable Riphean age, and enigmatic Au-Ag mineralization discovered at deep levels of the SG-3 borehole and surface in the South Pechenga structural zone (Fig. 1,b) (Lobanov, 2011).

Metallogeny Pechenga ore district is mainly determined by endogenous ore-forming processes and the Karelian and Svekofenian cycles that have occurred in the range of 2,4-1,7 billion years. There are four phases with different geotectonic regimes. With the first phase of the intrusion PGE layered intrusions, with the second rift - the formation of Cu-Ni ores of Pechenga ore field, with the third stage of the conflict of laws - metamorphism and remobilization of Cu-Ni ores, and the fourth postcollisional - hydrothermal mineralization uranium, and gold-silver mineralization (Lobanov et al., 2010). These

types of mineralization occupy a position in the Archean and Early Proterozoic structures of the area and find the regular connection with magmatic complexes of Karelian and Svekofenian cycles of tectonic-magmatic activation of the Baltic Shield

The integrated 3D model regards the Pechenga ore district as a horizontal section of a mantle-derived volcano-plutonic ore-forming system of a central type. The model defines the Northern limb of the Pechenga structure as an imbricated fragment of a volcanic caldera and describes its Southern limb as a sheeted monocline in a juxtaposition with rheomorphic granitoid domes. Development of the system was preceded by rifting of the consolidated sialic crust. The model implies a co-genetic relationship between the Early Proterozoic basaltoid volcanism and the nickel-bearing basic-ultrabasic plutonism.

According to the model the nickel-bearing gabbro-wherlite intrusions primarily were formed as sills and occupied a subhorizontal position. This assumption eliminates restrictions on the possible depths extent of the gabbro-wherlite intrusions and associated Cu-Ni ores up to the Por'itash fault.

The rich sulfide Cu-Ni ores of the Pechenga ore field formed at the collision development stage of the Karelian cycle and are controlled by shear zones of the Svekofenian cycle in the Productive member (Fig. 2).

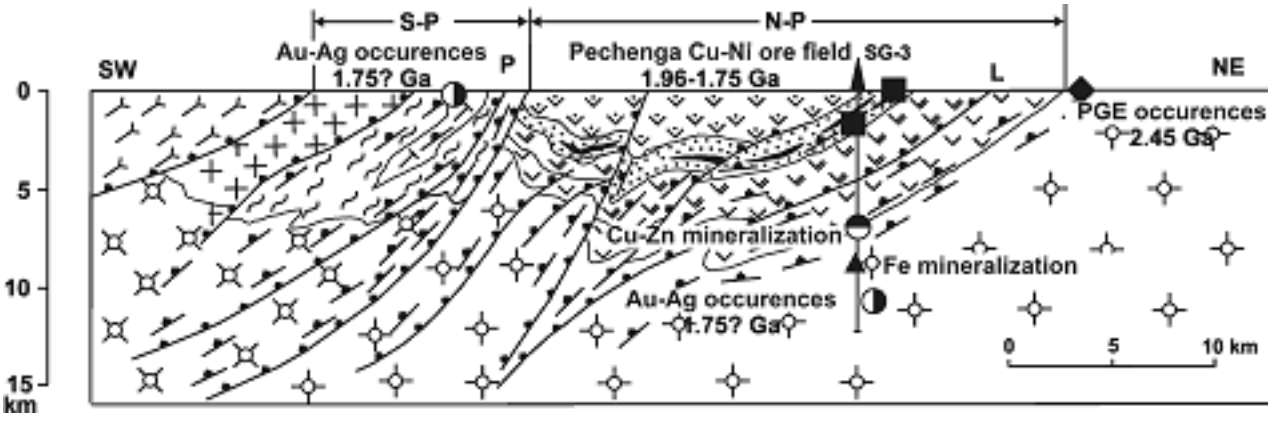

Figure 2. The schematic section of the integrated 3D geodynamic model of the Pechenga ore district in section through Kola superdeep borehole and correlation of ore-forming systems (Lobanov, 2011).
There are age dating ore mineralizations (in Ga). For other captions, see Fig. 1.

Formation epigenetic Cu-Ni ore zones synmetamorphic secondary shearing occurred in Svekofenian tectonomagmatic reactivation in which redeposition of primary-age magmatic from 1960 million years. In this activation were formed Au-Ag mineralization in the context established by the SG-3 on the surface of the rocks South Pechenga series. Established genetic association with gold mineralization and magmatic metasomatic processes (Lobanov, 2011). In the section of the Kola superdeep borehole in the Productive member on textural and structural features, mineral composition and genesis of ores are similar to those which fall to the surface, which proves the consistency of Cu-Ni mineralization down dip for at least 2.5 km. In a series of Archean SG-3 penetrated sulphide copper-nickel mineralization, ferruginous quartzites and iron-titanium ores in the metabasites. In the lower part of the North-Pechenga series and regression zones of metamorphism of the rocks of the Kola series was met with low-temperature hydrothermal sulfide mineralization, and finally, at a depth of 9.5-11 km were found manifestations of native gold (Kazansky et al., 1994).

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HYBRID EXPERT SYSTEMS AT FORECASTING PROBLEM SOLUTION

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KEY WORDS: expert system, hybrid expert system, forecasting problem, gold deposit, gold-silver deposit.

INTRODUCTION

In the modern period the upgrade of geological branch assumes a heavy use of intelligence systems for support of decision-making at level of the organization, region and the country. Similar systems are intended for the problems of operative monitoring, analysis, modelling and forecasting. Among information technologies the important place is occupied by the expert system technology.

THE HISTORY OF EXPERT SYSTEM

The expert system is understood as a computer program which uses knowledge and engineering of expert reasoning for problem solution.

For the first time in geology expert systems have been used for forecasting problem solution. Among them there are most known: PROSPECTOR - for estimation of perspectivity of area on various sorts of minerals [Duda et al., 1979]; DRILLING ADVISOR - for estimation of geological prospecting boreholes [Hollander, Iwasaki, 1983]; GENESIS - for automation technology of construction and usage of forecasting-search complexes (FSC) [Bugaets et al., 1986; Vostroknutov, 1999, 2006]; SERGE – for classification of geochemical anomalies while exploration activities [Bonnefoy et al., 1989];GEO - for regional forecasting of lead-zinc deposits of Bulgaria [Gitis et al., 1989]; TIN - for estimation of tin deposits [Rodionov, Syrkin, 1995]; the expert system for statistical forecasting of average and large deposits [Zhao et al., 1996]; GIS-INTEGRO block [Cheremisina, Finkelstein, 1999]; the expert system for estimation of tungsten ore deposit scale [Mitrofanov et al., 2009].

HYBRID EXPERT SYSTEM

There is the knowledge base at the heart of expert systems mentioned above. It is constructed on the basis of knowledge acquiring from the expert and their further structuring lays. The production rules (type: «if - then») were formulated by the expert and used for decision-making. In 1991 for the first time while the designing of the automated forecasting-search complexes the author offered to use databases for formulation of decision-making rules. The technology of construction of the hybrid expert systems with complex knowledge base was used, including not only knowledge of experts, but also the regularities, which were received as a result of the logic-information analysis of available databases on researched geological objects.

The knowledge base is understood as the organized collection of knowledge presented in shape, which admits their automated usage in the expert system. The knowledge base includes a collection of the facts specific to the solved problem, the purposes and the procedures (decision-making rules), necessary for expert system for solution. Hybrid expert systems are the systems which use different methods of representation and processing of knowledge, and also data processing resources, including optimization algorithms and concepts of databases. Simultaneous knowledge information processing and great volume of the information from database allow to hybrid expert systems to receive not ordinary results.

THE FORECASTING PROBLEM AND DESIGN TECHNOLOGY

As forecasting problem can be considered as the decision-making problem, it is necessary to select all units of system of decision-making: objects of research, the purpose, decision-making rules. According to the principle of consecutive detailing there are selected as the cores space forecasting-metallogenic taxsons: metallogenic zone, ore region, ore knot, ore field and deposit.

The purpose is the definition of ore-formation type of deposits and an estimation of their scale. Carrying out rules for estimation of perspective territory are formulated by the expert-geologist or settled up on standard database objects that raises objectivity of result. The expert system imitates the forecasting solution process by the expert-geologist, giving necessary explanations while decision-making process.

Hybrid expert systems for the forecasting and an estimation of ore deposits can be considered

as recognizing systems. So their construction can be developed on the basis of methodology of the pattern recognition theory. According to [Tu, Gonsales, 1978] in the given theory the main principles for construction of recognizing systems are the principle of generality of properties and the principle of listing of objects. On the base of these principles two technologies are developed: ASTRA and ANALOG. Depending on the selected approach the procedures of construction of knowledge base are developed, which distinctions consist in a choice of the ways for description of research objects and their types, sort of settlement functions and inference engines (decision-making rules).

APPLICATION

The developed technologies were used for expert system designing: ASTRA - for forecasting estimation of gold-silver deposits from Okhotsk-Chuckchee Volcanic Belt (OCVB), Northeast Russia (Delphi 7.0 environment) and ANALOG -for estimation of gold ore deposits on the basis of the choice of the nearest analog among etalon gold ore deposits over the world (on base .Net Framework 1.1). The geologist-experts are Ph.D. M.M.Konstantinov and Ph.D. S.F.Struzhkov.

ASTRA

Describing expert system ASTRA, it is necessary to mark, that it is intended for rendering assistance to experts in an prospecting estimation of ore-bearing squares of various rank and definition of a technique of operations on prospecting sites and allows to spend an express estimation new and overestimation of known perspective squares (to indirect tags and criteria at an early stage of studying). The expert system consists of five levels for estimation of gold-silver objects as potential: ore area; ore knot; ore field; deposit; ore bodies.

For each level there is developed the list of questions for the expert, which are necessary for square estimation and conclusion about the forecast object. At each level the group of the questions is provided for estimation of the level of perspective square scrutiny. In each question three variants of answers are possible (“yes”, “no”, “do not know”). All variants of answers are described by various positive or negative information weights according to results of the logic-information analysis of database of gold-silver objects from OCVB. They are used while making decision, allowing to determine the type of forecasting object and to estimate of its perspectivity. Three main variants of the conclusion about the forecasting object are possible: positive, negative and output about an insufficient level of scrutiny. At the negative conclusion the cessation of work is recommended. In case of insufficient level of scrutiny the list of materials is suggested which are necessary for expert estimation performing in addition.

ANALOG

The expert system ANALOG is intended for estimation of gold ore deposits on the basis of the object-analogue choice among gold ore deposits over the world on the various measures of similarity giving a quantity indicator of similarity. Using the nearest analogue among well studied standard objects from database by analogy method the estimation of unknown properties of the researched object is possible. Considering huge possibilities of the cognitive (i.e. promoting knowledge) properties of graphics information, it is also used while express estimation of deposits for the visualization of tags and geological situations known on the object-analogue, but unknown on poor studied object. Therefore the system is added by graphics database containing geological materials, necessary while the analysis of deposits but which is impossible to present in text or a digital form. Usage of technology of nested HTML-files provides the storage of unlimited number of raster images.

CONCLUSION

The complexity of the solving problem (forecasting and estimation of ore deposits) makes necessary to use the expert systems of hybrid type, in which the combination of various ways of representation of scientific knowledge may be applied (expert’s knowledge; the regularities, received as the result of the processing of available database).

ACKNOWLEDGEMENTS

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GIS-BASED DATASETS OF MINERAL DEPOSITS AND MAN-MADE RESOURCES AS VALUABLE EXPLORATION TOOLS FOR DISCOVERING POTENTIAL ORE DEPOSITS IN GREECE.

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KEY WORDS: GIS Mineral Database, Metallogenetic interpretation, PROMINE, exploration tools, prognostic evaluation.

ABSTRACT

The development of a GIS based data management and visualization system for mineral and man-made resources and the realization of a predictive resource assessment is part of the ProMine project. In order to achieve this objective three types of datasets are being created:

- Assessment of primary and secondary/ anthropogenic mineral resources (including critical raw materials such as Ge, Gr, Mg, Re, Sb, W, PGE and REE)
- Prognostic prospect evaluation to define areas of high exploration potential.

Using existing and new data a multi-layer information system, based on GIS and covering the whole territory of Greece, was created. The system includes databases on mineral deposits, and anthropogenic / mining and metallurgical residues along with relevant geological, structural, geochemical, geophysical layers and other information from a diverse range of sources (Fig.1).

The Mineral Deposit (MD) database is connected with the Anthropogenic Concentration (AC) database (Fig.2). From this database, through integrated analysis and possible incorporation of geological, structural, geophysical and geochemical data will be derived prospective areas. These areas are characterized by their main commodity, genetic type and mineral association. The two new GIS-based map versions on Greek metallic and critical minerals, in conjunction with a new metallogenetic approach (initial approach of the mining districts database) delineate high potential targets for mineral exploration and discoveries at a range of spatial scales, geological environments and commodities (Fig.3). The entire information is contributing to the re-assessment of the economic value and growth opportunities of abandoned, ceased and / or unexploited state mine concessions in Greece.

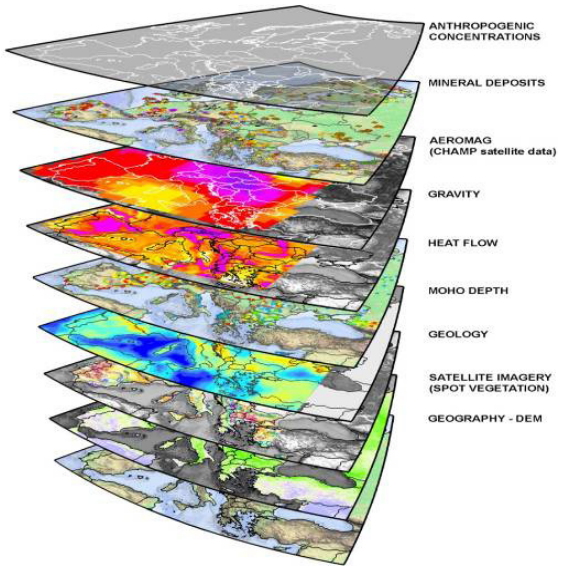

Figure 1 - The GIS multi-layer information system.

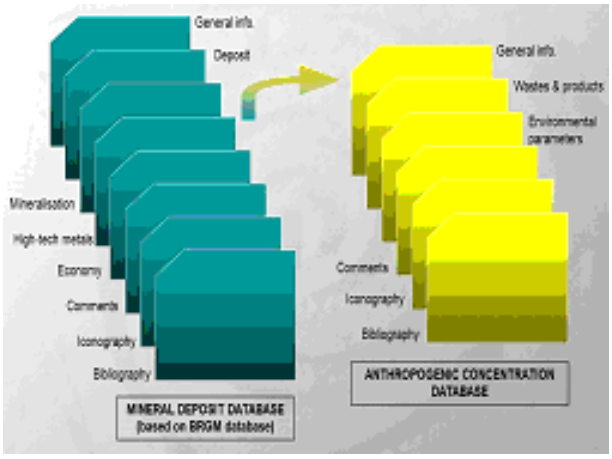

Figure 2 - Interconnecting evaluation of MD and AC databases.

Data interpretation of these datasets is especially important in the subsurface exploration of mature mining fields and regions, and in remote or previously un-explored areas.

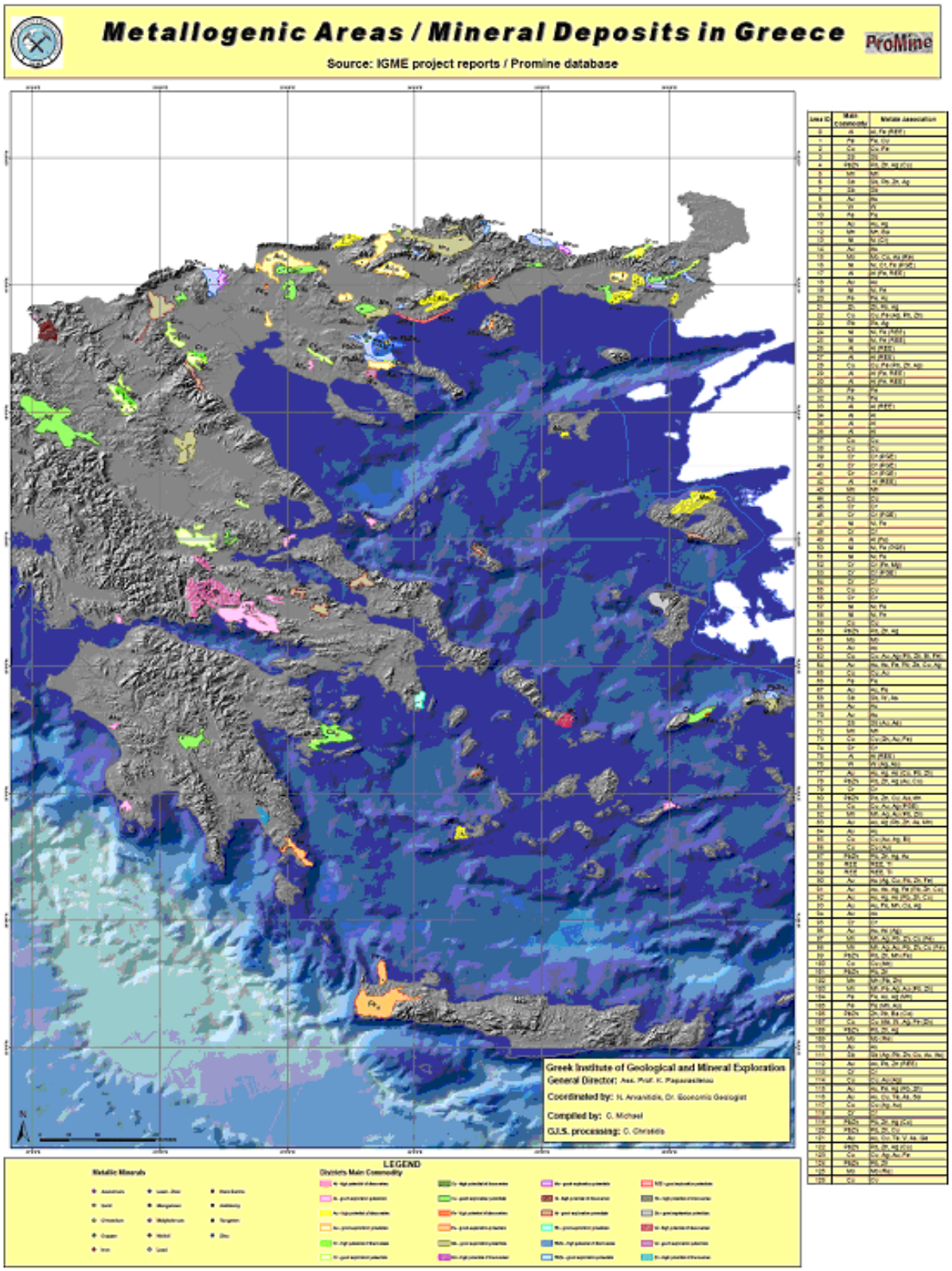

Figure 3 - Metallogenic approach based on main Mineral deposits areas in Greece.

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SUSTAINABLE AGGREGATES RESOURCE MANAGEMENT – SARMA

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KEY WORDS: aggregates, resource management, sustainable supply, resource efficiency, quarrying, recycling

INTRODUCTION

Aggregates are known to humans from ancient years. The importance of aggregates and their role in society has evolved over time. In the last few decades dynamic changes can be observed. Aggregates in a form of a crushed stone or as sand and gravel are used in the construction of housing, commercial buildings, industrial development and in different public infrastructure works. Quarrying takes place all across South East Europe (SEE). Policies and regulations differ markedly from country to country and between political jurisdictions within countries. Policies seldom explicitly address sustainability issues. Moreover, in some locations quarrying has resulted in excessive environmental or community impacts, or is being conducted illegally, all of which contribute to a loss of the social licence to operate for quarrying companies. In 2009, the EU commission approved a project entitled "Sustainable Aggregates Resource Management" which was funded by ERDF. The SARMa project has focused on implementing sustainable aggregates resource management (SARM) across SEE and identifying the components of a sustainable supply mix (SSM) of aggregates for SEE. The 14 partners in 10 countries of SEE joined the project (Fig.1), where scientists and experts formed an important part of the project team.

PROJECT GOALS

The two main project objectives were to: develop a common approach to SARM across the SEE and ensure a SSM in SEE based on fair distribution of costs and benefits of aggregate production, use, waste disposal and recycling, so as to enhance resource and energy efficiency and quality of life. SARM means efficient, low socio-environmental impact quarrying and waste management, while SSM implies the use of multiple sources, including recycled wastes and industrial by-products (slag) that together maximize net benefits of aggregate supply across generations.

Project activities have connected institutional actors, policy operators, civil society and NGOs through workshops and target results at three spatial scales: local, regional/national and transnational, each of which was handled as a separate Work Package having also its own specific goals.

Figure 1 – SEE countries that participated in the SARMa project

Objectives also comprised coordination in managing aggregate resources, increasing the transfer of know-how and supporting capacity building in firms, government and civil society; proposal for the development of a unified information structure.

The follow-up action was preparation of a plan for

Regional Centre or other type of activities on SARM & SSM, to increase capacity of all interested and affected groups through workshops and educational materials.

OUTCOMES AND DISEMINATION

Results of the SARMa project include achievements at three spatial scales. On the local scale good practices in quarrying were proposed for the industry and authorities, recommendations on recycling and prevention of illegal quarrying with the action plan for social license to quarry, LCA methodology, guidelines and scheme for life cycle inventory data collection, as well as guidelines for a quarry restoration.

A number of recommendations were given for the regional/national and transnational level. In the area of regulations and policy, recommendations were proposed for the legal and regulatory solutions and their effective implementation. Furthermore recommendations were given for the effective aggregate policy and management, with regard to SARM. With a review of EU Community legislation a framework recommendation on the European Community law relevant to aggregates was developed. Recommendations for providing and ensuring the SSM were given for land use planners and decision makers at all levels, while the recommendations on SARM were proposed on the transnational level. All recommendations were published in reports and are parts of three manuals created for different levels. The manual "*How to achieve aggregate resource efficiency in local communities"* represents a key public output for stakeholders in the local level. Above all, it explains requirements for and actions needed to enhance resource efficiency. The manual "*The production of recycled aggregates from inert waste"* outlines the state-of-art of inert waste recycling, with emphasis on waste from construction and demolition (C&DW) activities.

Figure 2 – General view of waste material stockpiles at the Gerakini magnesite exploitation mine in Greece.

The manual "*SARM and SSM at the Regional, National and Transnational level"* targets to policy and decision makers at all levels, that are in charge of development and implementation of policies for management and supply of aggregate resources. All three manuals were translated in all partner (10) languages.

For raising the awareness of stakeholders in all participating countries through relevant activities were organized 13 national/regional workshops in 7 countries and 4 transnational workshops and final conference.

While the SARMa project was concluded at the end of December 2011, it continues through dissemination of outcomes in electronic and printed form.

CONCLUSION

The unique aspect of SARMa has been the exposure of important open issues at three scales: local (environmentally-socially acceptable extraction, illegal activities, recycling), and regional/national and transnational (management, supply and information requirements).

The SARMa project has implications for raw materials supply within SEE and beyond. The EU realizes the importance of sustainable supply of raw materials and has launched several Communications, including one in 2012 announcing European Innovation Partnership on Raw Materials.

ACKNOWLEDGEMENTS

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TOWARDS SUSTAINED AND ACCEPTED GEO-SPATIAL INFORMATION PRODUCTS FOR MINING AND RESOURCES MANAGEMENT

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KEY WORDS: resources management, mining environment, remote sensing

BACKGROUND

The enormous increase in production volumes of mineral and energy resources within the last decades has induced sizeable environmental pressures at different stages of the life cycle of products. A significant part of these pressures takes place due to the extraction and processing of these resources. Beside environmental pressures, social issues associated with mining are to be considered, as the social acceptability of the mining activities has become for mining companies one of the key issues to be dealt with.

The project “Earth Observation for Monitoring and Observing Environmental and Societal Impacts of Mineral Resources Exploration and Exploitation” (EO-MINERS, http:\\www.EO-Miners.eu) aims in contributing to the development of environmental, socio-economic, societal and sustainable criteria and indicators to be possibly dealt by using Earth Observation (EO) techniques, carefully considering the scale of observation.

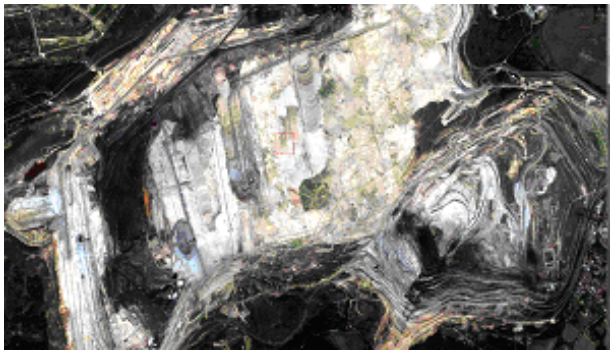

Figure 1 – Active lignite mine at Czech demonstration site.

Methodological developments are carried out on three demonstration sites, located in the South Africa, in Kyrgyzstan and Czech Republic (see Figure 1).

CORPORATE SOCIAL RESPONSIBILITY AND THE PUBLIC

An extensive review of stakeholder policies related to the environmental and societal issues around mining operations has been carried out. Stakeholders investigated include the mineral industry (particularly their Corporate Social Responsibility (CSR) programmes, Public Authorities at local, national and international level, and members and representatives of Civil Society.

A list of indicators relevant to mining industry environmental and societal issues has been developed from the above policy analysis and stakeholder interviews and together with an expert elucidation approach. Thus, 52 indicators have been identified, of which more than half can be supported either directly or indirectly by EO-techniques.

Based on the source – pathway – receptor paradigm used in risk assessment, site conceptual models have been set up for each of the demonstration sites describing the local and regional context situation (topography geology, hydrology, ecology, hydrogeology, water resources, etc.) the history of mining and the known impacts of mining activities (Chevrel e. a. 2009, Puura & D’Allesandro 2005, Verplanck 2008). Thus, these site models and the list of possible indicators form the background for the development of EO-based data products, referenced to technical and no-technical standards.

Earth Oberservation and Remote Sensing Data

Mapping geo-chemical parameter of different land-cover classes and assessment of environmental

changes caused by mining activities are based on local terrain information generated from different digital height models (DHM), e.g. from CartoSat and WorldView-II data (see Figure 2), from pre-processed airborne hyperspectral and multispectral imagery from the HyMAP and AHS sensor systems. Pre-processing includes geometric, radiometric and atmospheric corrections (Richter & Schlaepfer 2001; Gege et. al. 2009) covering the visible to the thermal infrared spectral domain from optical satellite imagery (see Figure 3).

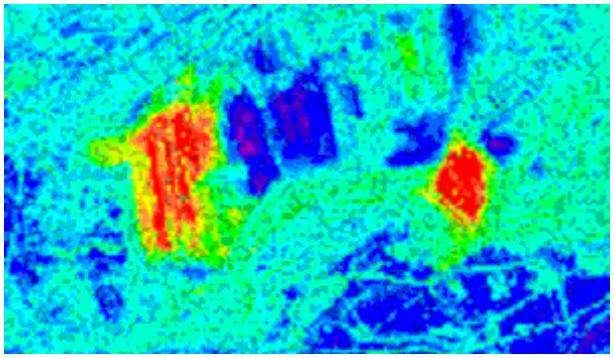

Figure 2 – Active mining front characterization using CartoSat DHM time series.

All information, reference and image-based, has been processed developing standardized work flows to ensure quality and representativeness of the different data sets.

A distinctive approach is the installation of the ALERT (Automated time-Lapse Electrical Resistivity Tomography) system on the South African test site, providing real-time monitoring information of the electrical conductivity of the subsurface environment and the creation of 4-D time-lapse data sets.

DEVELOPING STANDARDS AND PROTOCOLS

EO-MINERS will provide new tools, methods and standards for observing and monitoring the environmental and social footprints of the extractive industry. These outcomes are developed in tight cooperation with industrial partners on the project test sites. Furthermore the project actively participates in GEO/GEOSS relevant activities, workshops and events. We believe that the specific standards and protocols developed in this project will be applicable to any similar monitoring activity worldwide.

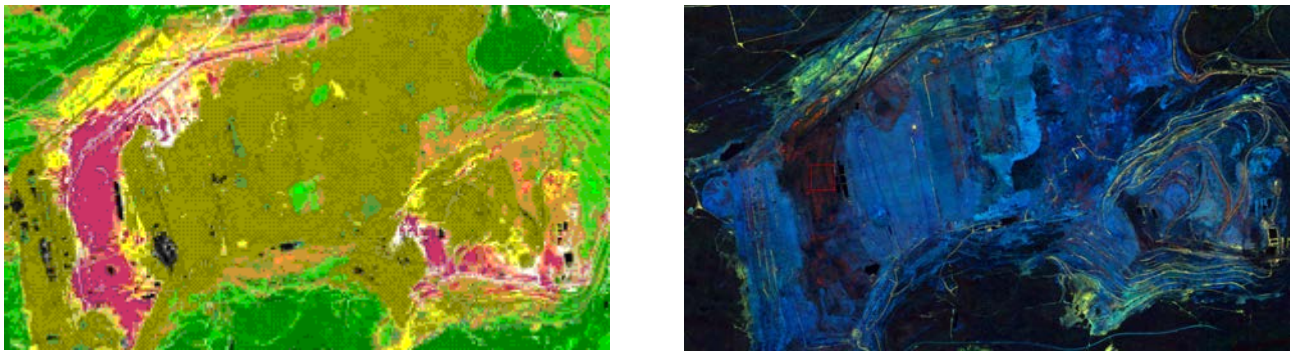

Figure 3 – Mineral & landcover analysis based on airborne hyperspectral reflective (left) and thermal data (right).

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DATABASE MODELING: FROM TYPOMORPHIC PROPERTIES OF TI-ZR MINERALS TO RECONSTRUCTION LITHOLOGY-FACIAL CONDITIONS OF PLACER FORMING

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KEY WORDS: Ti-Zr placer deposits, database, microfacial characteristic, typomorphic properties of minerals

MINING AND NATURAL AGGREGATE RESOURCES

Database are one of the multifunctional systems, in which we can collect, save and process data. Also it can be used as expert system to find out what group in database some sample can belong to. It is very important to singled out the most impornant informative typomorphic properties of Ti-Zr placer minerals to reconstruction lithology-facial conditions of placer forming.

Our research team has field investigations on Ti-Zr placer deposits of West Siberia placer province and collected samples which characterize facial zoning of Umytia and Ordynskaya deposits during 2010 year.

We studied 16 samples from 5 facial zones for the Database of typomorphic properties of Ti-Zr placer minerals (DB TMP TZPM). We used electronic microscope and microsonde analyses for studying of 300 mineral grains of placer-forming minerals.

Structure of DB TMP TZPM consists of: coordinates of the researched point; stratigraphic level of the deposits; structure-facial zone of the sample; granulometric content; mineralogical content of heavy fraction; typomorphic features of placer-forming minerals, such as primary and secondary shape, roundness, fragmentation, re-crystallization and secondary neogenic minerals; chemical content of main grains and secondary neogenic minerals; atlas of photos and energy-dispersion spectrums of the minerals classified by facial zoning and typomorphic features.

Revealed features of placer minerals allow tracing transformation both the mineral associations of the placer field and typomorphic features of the placer forming minerals (so called “microfacial characteristics”) within the placer-forming formation “intermediate host – fluvial paleochannel – paleodelta – lithoral zone of paleobasin – coastal shallow sea zone”. These features are: granulometric content of heavy fraction of the deposits as index of dynamics of sedimentation conditions; structure of the mineral content of the deposits estimates with factor analysis (method of the principal components); typomorphic features of placer-forming minerals and degree of secondary hypergenic changes that are different in different facial zones.

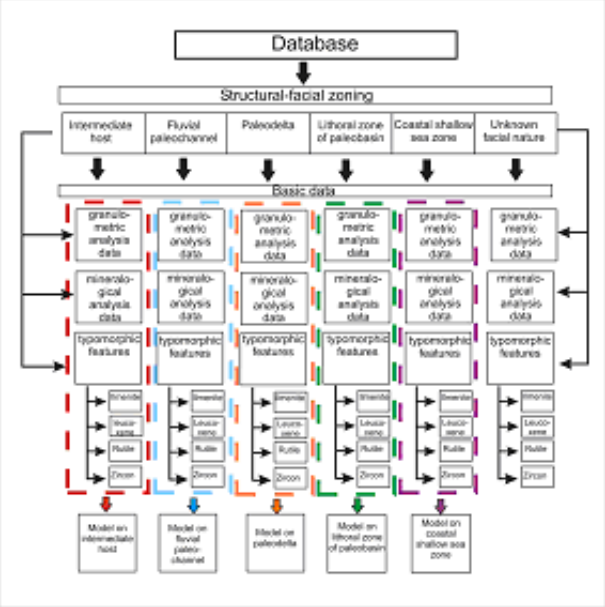

Figure 1 – Scheme of database structure

We reveled that microfacial characteristics allows determination and mapping of facial zoning of the deposits. This conclusion has important application meaning. Without using of lithology-facial information the exploration of complex heavy mineral Ti-Zr placer deposits use random net of drilling hopes that rise the exploration work in price.

Possibility of determination of the facial zoning of the placer field on the base of limited geological information is important especially for exploration of buried placer deposits studies with drilling sampling, where traditional methods of texture analysis is impossible.

ACKNOWLEDGEMENTS

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GIS INTEGRO AND SOME GEOLOGICAL PROBLEMS, SOLVING BY IT

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KEY WORDS: GIS, geological map, forecast of mineral deposits, geophysics, 3-D modelling

INTRIDUCTION

In nowadays the geoinformation systems developed by ESRI (ArcView, ArcGIS), that are initially intended to work in other industries, are most popular in geological industry. There're some reasons of it, except of the reliability and quality of GIS projects based on them. First of all, they were first products in the market and had no business rivals. But there is the most important reason: ESRI software is very effective for GIS control tasks that were considered as the most important in the industry. Geological industry tasks contain two categories: control tasks and properly geological tasks. But geological tasks are specific, operate different spatial localization data, require purpose-designed approaches and processing methods, and couldn't be effectively solved by common software tools. Thus State Science Centre of Russian Federation VNIIgeosystem (Moscow) made the geoinformation system INTEGRO intended for solving the wide range of geological problems.

The system is capable to store and visualize geological maps (scanned and vectorized), the geophysical and geochemical data and so on. The system should meet the following requirements:

- The system should be intended to use a totality of multilevel materials of the Earth researches,
- The system should integrate the spatial data received in the various ways and provide their transformation from one form to another,
- There should be an interface between digital models of maps and sections and attributive data bases,
- The system should contain the blocks focused on solving the basic geological problems,
- The system should be opened and easily extended by new functions for spatial and attributive data processing.

STORAGE AND VISUALIZATION

The developed system provides visualization and editing both two-dimensional and three-dimensional graphic and attributive information, and contains the applied blocks that can be used for solving problems of geological maps drawing, the forecasting of mineral deposits and studying a deep structure of the Earth using the geophysical data.

For the joint visual analysis of the various information types, the system is multi-window and is equipped by the synchronization mechanism in different windows. This mechanism works when there is the visualization of three-dimensional objects too, and also in that case when localization of the data does not coincide (for example, the surface data, the section data and the drill information). For maps of different spatial localization various zummers are used. The base vector data format of the system is *.shp that makes it easier to integrate with ESRI software. Also the converter of styles between systems is done. There are tools, allowing user to change spatial localization (to represent the two-dimensional data, for example seismic section, as a three-dimensional objects).

GEOLOGICAL MAP CONSTRUCTION

One of the main geological problems is geological maps drawing support. There are tools in the system allowing user to carry out a vectorization of maps in automatic and semi-automatic modes. For the vector data the correct topology checking and overlay operations are supported. It is possible to keep not only intralayer, but also interlayer topology while editing. For geological maps drawing support there are implemented procedures of a fast binding and transformation of raster and vector maps by affine and piecewise-affine transformations. The comprehensive set of cartographical projections is supported. There is also a block of geometrical generalization which is separated to procedures, designed for the analysis and generalization of tectonic elements and procedure of simplification of geological borders. It is necessary to notice that all procedures of this block preserve a topological correctness.

GEOPHISICAL BLOCK

The system contains the geophysical information processing block, which includes:

- statistical analysis of the two-dimensional information,
- division of two-dimensional fields into components using methods of a linear and nonlinear filtration,
- detection of weak anomalies of two-dimensional fields,
- calculation of characteristics of two-dimensional fields in a moving window,
- calculation of statistical and correlation characteristics of two-dimensional fields using sequence of the enclosed moving windows.

The system also contains the modules designed for solving various assignment formulations of direct and inverse problems.

FORECASTING

The forecast block, including in a three-dimensional variant is done. It consists of a set of different algorithms for results of remote sensing, geologo-geophysical, geoecological, geochemical, etc. information processing, united to program complex using the intellectual interface, based on formal knowledge about the problems definition and the problems decision. The knowledge base includes classification of the main problems, representations about stages and functions of the data analysis, and constructing from them a uniform processing graph. Also it includes the rules of problems definition updating, corrections of the data and movements along the processing graph. First of all, it allows user to organize the access to necessary functions for each of data processing stages, and, the second, to provide the analysis of the current status of a problem with development of recommendations about correction of the data, specification of problem definition, a choice of methods etc. Specification of the data and a choice of specific problem definition are executed in the block of the data analysis. It contains the one-dimensional and multidimensional data analysis, transformation according to a solving problem.

There is the vector-to-grid transformation subblock in system containing various methods of interpolation. A results of this subblock becomes the information base of forecasting block. Algorithmic support of this block is the wide spectrum of traditional algorithms and original methods of taxonomy, ordering and pattern recognition. The choice of algorithm to solve a problem is defined by problem definition, results of the data analysis, and also an arrangement of the initial data in characteristic space.

THREE-DIMENSIONAL TERRITORY MODELING

The technology of three-dimensional territory modeling is based on the implemented tools. For creation of three-dimensional territory model the system of the profiles constructed by the expert-geologist is used. For support of this process GIS INTEGRO contains the special tool. Thus the profile can be constructed on any curve, and there is provided profile and map synchronization (plane XY) and synchronization of two profiles (planes XZ and YZ). The profiles that were received have to be harmonized among themselves and a geological map. Thereto the system of editing is used. This system provides:

- simultaneous editing of several scenes, for example, three profiles in a point of their crossing;
- formation of group of editing from several layers of different geometrical localization;
- joint editing for groups and separate layers in group that allows to edit simultaneously coincident points of all objects specified to joint editing;
- the control of self-crossing of input object;
- the control of crossing of objects for a polygonal covering.

Also the system contains the tool allowing user to define a hade of geological object using the outcrop of geological border.

After the adjustment the structural surfaces of a sedimentary cover interpolation is made (by profiles and outcrops to a day surface). Special feature of the methods of interpolation which were discussed above is the option to interpolate using a thin network, taking into account breaks and restriction of area of interpolation.

By the means of the geophysical information processing block three dimensional models of superfluous density and effective magnetization can be calculated, as well as receiving a relief of a base surface and further carrying out their combined visual analysis with the geological information.

CONCLUSION

In conclusion we will list the basic advantages of GIS INTEGRO:

- INTEGRO is based on ESRIs vector data format (shape file);
- INTEGRO has multi-windows user interface that supports data synchronization of the different windows that allows user to conduct visual analysis and data integration (including various spatial localization data);
- INTEGRO contains cartographical objects editor that allows geologists to edit maps in a habitual mode (in usual style registration, without transfer to arc-node representation) jointly in different layers.
- INTEGRO contains built-in programming language that makes it easier to customize and extend;
- INTEGRO contains tools for large-scale geological maps generalization;
- INTEGRO contains a block for geophysical information processing and a forecasting block.

A GEOTECHNICAL INVESTIGATION OF THE EFFECT OF GRAIN SIZE AND TEXTURE OF CALCAREOUS ROCKS ON THEIR ENGINEERING BEHAVIOR

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KEY WORDS: Aggregate, Engineering behavior, Sulfate soundness test, Calcareous rocks, Grain size.

INTRODUCTION

From an economic and engineering point of view, aggregates are very important and are one of the most widely used construction materials in civil engineering projects. Normally, aggregates and other borrow materials are used in high volumes in engineering construction. For this reason, the study of the engineering properties and geological factors affecting the behaviour of calcareous rocks is very important, Kazi and Almansour, (1980). Figure 1 shows a map of the study area. Calcareous rocks are used as rip-rap, the base and the sub-base of roads, highways, railways, and as aggregate in the preparation of concrete and asphalt. Therefore, the evaluation and study of the quality and durability of calcareous rocks in comparison with the other types of rocks becomes increasingly important.

Figure 1 – Location of the study area within the circle on the map.

It should be noted that calcareous rocks have a high potential for solubility and erosion under adverse chemical conditions and under adverse environmental conditions. Therefore, it is very important to study the engineering behavior of calcareous rocks, before using them in engineering construction. Normally, in any engineering project, aggregates which are needed are chosen based on the international standards or based on the standards of each country. In this research work, an attempt has been made to clear the differences between the grain size and the durability of calcareous rocks.

MATERIAL AND METHODS

Sampling has been undertaken based on Business, Transport and Housing Agency standard (1995). It should be noted that in this research work, un-weathered and fresh samples have been tested. From the thin section studies, it is clear that the texture of rocks can be used as the main factor in distinguishing calcareous rocks. Therefore, in this research work, the texture of different types of calcareous rocks was studied and their textural differences were catalogued. Sulfate soundness tests have been carried out on different samples according to the ASTM C88 standard, American Society for Testing and Materials (1996).The study of the textures of different types of calcareous rocks has been carried out on the thin sections from different type of rocks. In order to recognize dolomites within the thin sections, they were painted with red alizarin liquid, Gupta and Seshgiri (2001).

ENGINEERING PROPERTIES

Both, physical and mechanical index tests have been carried out on each type of calcareous rocks. The physical index properties include: dry density (γ_d), saturated density (γ_{sat}), effective porosity (n), slake durability index (I_{d2}), Loss-Angeles test (LOS) and water absorption (QAI). The mechanical index properties include: uniaxial compressive strength (UCS), tensile strength (σ_t), schmidt hammer test (SHT), impact value (AIV), tangent modulus (Et) and point load index (Is_{50}).

As can be seen from Table 1, samples from Abshineh and Hamekasy show a lower dry density

in comparison with the other type of samples. This is due to the effect of their texture, because they have bond stone and bioclasstic textures, respectively. The Hamekasy samples show the higher degree of porosity, because it has formed from particles of fossils. Due to this reason, Hamekasy samples show the lower degree of durability, because of its bioclasstic texture. As can be seen from Table 1, the higher degree of loss is related to Hamekasy sample, because its texture is not cemented very well. From the results of Table 2, it can be concluded that Abshineh and Hamekasy samples have lower degree of compressive and tensile strength. Because, their bond strength of particles are weak and they are not well cemented. In comparison, samples from Nahavan and Ekbatan dam with breccias limestone and conglomerate with limestone cement, show higher degree of compressive and tensile strength, respectively. These samples have higher amount of elasticity modulus and point load index. The results from Schmidt hammer and impact value tests, show the effect of texture on engineering behavior of calcareous rocks. Consequently, it can be resulted that breccias limestone and conglomerate with limestone cement, show the highest engineering properties and bondstone and bioclasstic packstone show the lowest engineering properties of calcareous rocks.

Table1 - Physical properties of different types of calcareous rocks

Sample name	γ_d (gr/cm^3)	γ_{sat} (gr/cm^3)	QAI (%)	n (%)	Id2 (%)	LOS (%)
Nahavand	2.63	2.65	0.28	0.80	99.32	30.2
Malayer	2.60	2.62	0.28	0.75	99.31	23.6
Hamekasy	1.87	2.08	11.48	21.88	95.03	72.7
Ali –Sadr Cave	2.62	2.62	0.34	0.92	99.47	24.7
Abshine Dam	2.51	2.53	0.82	2.11	98.94	34.5
Ekbatan DAm	2.63	2.66	1.14	3.00	99.25	37.5

Table 2 - Mechanical properties of different types calcareous rocks

Sample name	UCS(MPa)	σ_t (MPa)	Et(GPa)	Is(50) (MPa)	AIV (%)	SHT
Nahavand	106.73	15.69	14.44	3.01	8.73	49
Malayer	112.81	16.43	14.29	2.13	5.97	49
Hamekasy	17.09	3.46	7.79	0.216	22.00	24
Ali –Sadr Cave	126.26	7.99	17.80	2.54	8.03	39
Abshine Dam	39.00	6.65	3.47	1.87	9.92	44
Ekbatan DAm	142.08	12.28	14.86	5.49	7.94	49

CONCLUSIONS

In this research, general tendencies of the sulfate soundness test results have decrease tendency. The uniformity of rocks caused the results tendency of Malayer and Ali-sadr samples are reversed manifest tendencies. This tendency is acceptable for Abshine Dam samples as well. Regarding to heterogeneity of the Nahavand, Ekbatan Dam and Hamekasi samples, the results of sulfate soundness test results haven't reversed manifest tendencies. Also, the lowest weight decrease of Hamekasi samples during soundness tests has been seen with finer grain sizes (G5 and G7). It could be described that the durability strength of fossil particles is more than the welded particles from the same fossils. For all samples (except Hamekasi samples) the lowest weight decrease during soundness tests has been seen with G2 grain size (37.5 to 50 mm) that could be optimized size against corrosion. Based on the results of the different sulfate soundness tests, it was concluded that the smaller grain size calcareous rocks influence the durability of calcareous rocks. In addition, it was found that, there is a reasonable relationship between the texture of calcareous rocks and their durability, such that the rocks with a uniform and homogenous grain size and texture show a very good durability according to the sulfate soundness test.

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THE MINING ACTIVITY IN THE APULIA REGION (SOUTH ITALY) AND THE RELATED ENVIRONMENTAL PRESSURES

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KEY WORDS: Mining activity, quarries, state indicators, pressure indicators.

INTRODUCTION

In the common opinion, soil and subsoil has been usually considered as unlimited resources, so that an intensive mining activity has been developed in many countries causing high pressure factor in the surroundings of the mining areas and generating a significant and not always reversible transformations of the natural ecosystem in a wide range around the mining areas.

The Apulia (Southern Italy) is the second italian region in the production and working of natural lithic materials (860.000 t/y, Assomarmi 1994)) and Italy is the first country in the world in this industrial sector.

In contrast to the economic and social significances of this activity an heavy environmental impact on the area there exist, due to marked alterations of morphological, hydrogeological and ecological characters of the territory. Together with the environmental damages, economically not quantified, it has to be added the effect of abandoned caves, at moment, used to stock different type of waste materials, such as urban and dangerous wastes.

It is necessary to assess the state of the mining activity by taking in account the distribution of both active and abandoned quarries in the territory and collecting their main characteristics in a database, so that it can be possible to analyse the associated environmental risks and to define the possible solutions for the restoration of the sites and the requalification of the territory as a social resource.

GEOLOGICAL SETTINGS

The main mining districts in the Apulia region are located where Cretaceous carbonatic sequences outcrop, since limestone are widely used for both marbles for building purpose and rubble.

The carbonatic sequence represents the foreland structure of the Appenninic Orogenic System and is formed by homogeneous geological and geomorphological units made up of calcareous and dolomitic rocks. The Mesozoic sequence about 6000 m thick, characterized by a similar tectonic-sedimentary evolution (Iannone & Pieri, 1980).

The mesozoic carbonatic sequence outcrops over the three main geographic areas of the region: the Gargano Promontory, the Murge Plateau and the Salento Peninsula (Fig. 1).

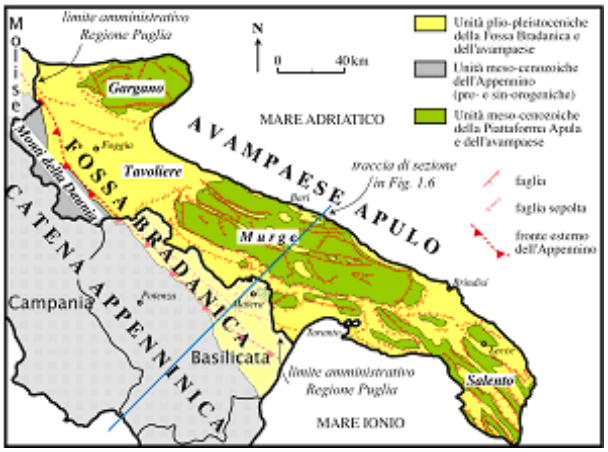

Figure 1 – Schematic geological map of the Apilia region (from Pieri et al., 1997).

The carbonatic basement is locally covered by upper Pliocene calcarenite and by terraced marine deposits (Pleistocene in age), which are displaced at different topographic level, from 300 m down to the sea level along the coast. Alluvial heterogeneous deposits also cover the carbonatic basement in erosive endoreic river and in shallow areas.

The morphology of the Apulian foreland in the Murgia plateau is characterized by a flat terraces landforms extended in W-NW – E-SE direction, with a topographic elevation decreasing from about 300 m a.s.l., in the inner zones, to the sea level toward the coast line, and divided by steep structural slopes.

Large and shallow depressions known as "Lame" locally crosses the Murgia plateau, which drains rainy water to the sea.

The morphology of the Gargano Promontory is quite different since it is characterized by higher topographic elevations and steeper slopes.

The Murgia Plateau and the Salento areas are characterized by gentle folds and faults, produced by a not too intense fragile deformation of the carbonatic basement (Ricchetti et al., 1988), whereas the Gargano Promonrory is interested by a

more intense and active fragile deformation, so that limestone basement is much more faulted than in the other territories.

Faults and fractures with a W-NW – E-SE, E – W and N – S trends determine the variability of technical characteristics and the rock mass quality.

Karst aquifer structures lies in the carbonatic rocks where the groundwater circulation takes place in different layers, interbedded with impervious strata and locally confined by less permeable dolomitic and carbonatic layers, not fractured and not affected by karst processes. Three main carbonatic hydrogeological complex are located in the Gargano, Murge and Salento regions, with quite similar hydrogeological properties. The groundwater flow toward the coast where discharges in the sea by some springs. In the pedemurgian areas, where the mining district is essentially localized, the groundwater level is not too deep (about 30-40 m) deep and sometimes it rises above the bottom of the caves. Moreover, the removal of the surface alluvial and marine deposits covers and the so called "cappellaccio", reduces the attenuation processes of the subsoil and increase the aquifer vulnerability. For these reasons the mining areas represent an important source of groundwater and sea water pollution.

THE MINING ACTIVITY IN THE MAIN APULIAN DISTRICTS

The number of caves and the volume of the extracted rocks in the apulian districts increased rapidly in the last tens years and actually a total amount of 4385 quarries are present in the region both active and abandoned, which cover a total surface of about 90 Km^2 over about 19000 Km^2 of the total regional territory (Tab.1).

About 492 of these quarries are now active, whereas over the 50% results as abandoned quarries (2198).

Marble slabs are produced at about 50% of active quarries, while crushed stones are produced mainly in sites where the limestone formations are highly fractured.

A serious problem is represented by the abandoned quarries which are located over a large area in the territory. Only 1696 sites can be considered as restores quarries, whereas a considerable number of abandoned sites are still empty and they represents a serious problem for the geomorphological and hydrogeological settling and for the groundwater pollution.

Using all the collected data (geometry and the state of the caves) it is possible to quantify the pressure conditions developed on the physical environment of the territory by the mining activity. The indicators allow us to numerically evaluate these conditions. The state indicators show the actual environmental setting respect of the original conditions. The pressure indicators show the state of pressure on the natural heritage due to anthropic actions and the modifications in time.

In the table 2 are summarized some state and pressure indicators for the main mining districts that can be considered in the Apulia region.

Geographic area	Area (km^2)	% of the regional soil
Active: 492	40.5	2.09 %
Abbandoned: 2198	27	1.3%
Restored: 1696	23	1.18%

Table 1 – State of the mining activity in the Apulia region.

Mining district	Municipality area (km^2)	% of the soil
Apricena (FG)	172.5	3.79
Trani (BAT)	103.2	3.87
Taranto (TA)	268	0.48
Fasano (BR)	132	0.75
Cursi-Melpignano (LE)	16.1	8.87

Table 2 – Pressure indicators of the mining activity in the main districts of the Apulia region.

It can be seen that mining areas with both active and abandoned quarries covers about 1% of the total regional territory, even if the distribution is quite different in different sectors of the region.

The mining districts in the Apricena (FG) and Trani (BAT) territories are characterized by soil consumption percentage higher than the regional values since the mining areas are concentrated in certain portions of territory. On the contrary, in the southern sectors of the region the quarries are sparsely distributed over large areas so that the soil consumption percentage resulted to be lower than the regional value for each of the considered municipality, although the total value on the Salento peninsula, for example, is quite close to that region.

The state of the mining activity in the Apulia region need to be analyzed in terms of relative distribution in different sectors of the territory and more information about the stone extraction need to be quantified and crossed with environmental matrix to evaluate the local pressures.

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INFORMATION AND ANALYTICAL SYSTEMS IN MANAGEMENT OF NATURAL RESOURCES: PROBLEMS AND SOLUTIONS

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KEY WORDS: Information and analytical systems, databases, analysis, GIS, geology, mineral deposits, geoinformatics

INFORMATION AND ANALYTICAL SYSTEMS: TASKS AND PROBLEMS

Information and analytical systems (IAS) (a special class of information systems for analytical data processing) - used for combine, analyze and store as a single entity the information extracted from a variety of user databases. The main objectives of IAS in management of exploration and exploitation of mineral, energy and other natural resources are follows:

- Creating and maintaining a unified geological information resources
- Information support for monitoring of explotation of mineral resources and environmental protection
- Information and analytical support for planning the study and exploration of natural resources
- Receiving, analyzing and aggregating information on the various levels of government management of subsoils with the generating of material for the regulated and unregulated reporting (fact sheets, reports, thematic maps, analytical diagrams, etc.)

As a consequence, the information and analytical system in application of management of exploration and exploitation natural resources is a complex of technological and software system including relational database management systems (RDBMS), geographic information systems (GIS), decision support systems (DSS), .analytical tools (OLAP, Data Mining and so on).

Effective development and application of IAS in subsoils management complicated by a number of difficulties:

- Weak formalization of application area, permanent changing requirements (“float” specification)
- Heterogeneous source data (structured, unstructured, spatial, expert, etc.)
- Need of support of different platfroms (Windows, Web, Mobile, etc.)
- Need of integration with existing systems and databases
- High cost of software and solutions
- Limited time
- Limited professional resources

TECHNOLOGICAL PLATFROM “IAS CONSTRUCTOR”

To ensure the effective development of information and analytical systems in subsoils management, in Laboratory of Geoinformatics (VNIIgeosystem) was established software technology platform, “IAS Constructor”, which based on the theoretical and practical results that were obtained in VNIIgeosystem during the process of automation of information and analytical activities of industry organizations and institutions.

At the framework of this problem we developed original software platform allowing for quick and effective construction of multi-tier computer information and analytical systems. The presented platform provides full visual design of client applications without any coding and powers of modern relational databases.

The key features of the platform are as follows:

Based on integration of most effective models of life cycle of IT-project development – prototyping, rapid application development (RAD), increment model

- Complete visual approach to the client applications design without the need of the writing of the program code
- Common approach to the creating of the client desktop and web applications
- Advanced tools for the aggregation, processing and analysis of the heterogeneous data (incl. OLAP, DataMining, Decision Support)
- Open architecture for the integration between “IAS Constructor” and the third-party applications, extendable plug-ins support
- Spatial data built-in support and integration with the third-party geoinformation systems (GIS)

The visual development environment allows you to build any client applications by adding special customizable elements of the IAS (user interface forms, analytical tools, reports, GIS applications,

decision support tools) . These elements can be grouped by semantic and functional load within the system as a hierarchical model and stores in the server database. One of unique feature of the platform: one common environment allows to create information systems as a desktop application for use in local area networks, so as Web- and Mobile-based applications that are supported by all popular browsers.

Thus, after the definition phase of the general requirements, you can immediately build a model of client applications, which also will be a prototype of the ready system. Such approach allows to minimize time, financial and professional resources during developing the programme systems.

Software and technology platform includes tools for working with spatial data, both in desktop and Web-based applications. “IAS Constructor” provides a basic set of GIS functions, the most commonly used in information and analytical systems. However, the technology platform supports open software architecture. This approach allows us to extend the functionality of the system due to plugins and third-party applications and libraries. In particular, ensure communication and data exchange with third-party geographic information systems (ESRI, MapInfo, etc).

EXAMPLES OF APPLICATION

The platform was successful used for development of applied information and analytical systems in different fields of subsoils management. Some of them are presented below.

MONITORING OF THE GROUNDWATER STATE AND ACCOUNT OF RESOURCES AND RESERVES FOR FEDERAL AND TERRITORIAL LEVELS

The main purposes of the system - collection, storage and synthesis of information on objects of monitoring of groundwater, maintenance of public accounting of groundwater, assessment of resources and groundwater resources and their use analysis of groundwater, including a forecast of the level and quality assessment of groundwater.

MONITORING OF LICENSING OF MINERAL DEPOSITS EXPLORATION AND MINING

The main purposes of the system - effective information support to the process of licensing, monitoring and control of subsoil use license for management decisions.

MONITORING OF OIL AND GAS FIELDS EXPLORATION AND EXPLOITATION

The main purposes of the system - provision of information, analytical and GIS decision support in monitoring and management of the fund for subsurface hydrocarbon, providing remote access to system resources via Internet

INFORMATION SYSTEM OF MINERAL DEPOSITS OF RUSSIAN FEDERATION

The main purposes of the system - to ensure planning for the reproduction of mineral deposits, by means of presenting and analysis of the information on the geological and economic evaluation, and utilization of the resource base of mineral deposits.

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ENERGY TURNAROUND – CHANCES AND RISKS FOR THE RAW MATERIAL INDUSTRY IN BAVARIA

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KEY WORDS: energy turnaround, raw materials, mineral resources, wind power, solar energy, subsequent land use

INTRODUCTION

The Bavarian land development program (LEP) regulates that mineral resources are the main basis for every industry (BAYSTMWIVT 2006). As an essential requirement for the economic development of the country the main goal is to secure the supply of the raw materials. The LEP makes also clear that a shortage of the resources through the competing usages leads to extensive rising prices in the building sector. Therefore the production of mineral resources is of public interest. One of the main goals of the LEP is to secure the usage of raw materials.

SECURING THE SUPPLY OF RAW MATERIALS

The mining for raw materials leads to different conflicts of interests. It is necessary for the regional development and country planning to coordinate these different interests by dint of regional planning. Different conflicts for the land usage occur with nature and water protection areas or renewable energy areas. Therefore it is very important to secure the raw materials with priority and reserved areas.

PROBLEMS

Conflicts also occur in regional planning because of the safety zones for wind power plants: For example a safety zone of 300 m is necessary in the surrounding area of quarries which use rock blasting, for gravel-pits a minor distance is generally adequate.

In the worst case a reserved area for wind power can indirectly reduce a priority area for raw materials: If a wind power plant will be built on the border of the reserved area an expansion of the quarry in this direction is not possible anymore because of the 300 m safety zone (Fig. 1). The priority area for raw material extraction CA 7 in Fig. 1 is reduced up to 50%, the reserved area CA 104 up to 90 %.

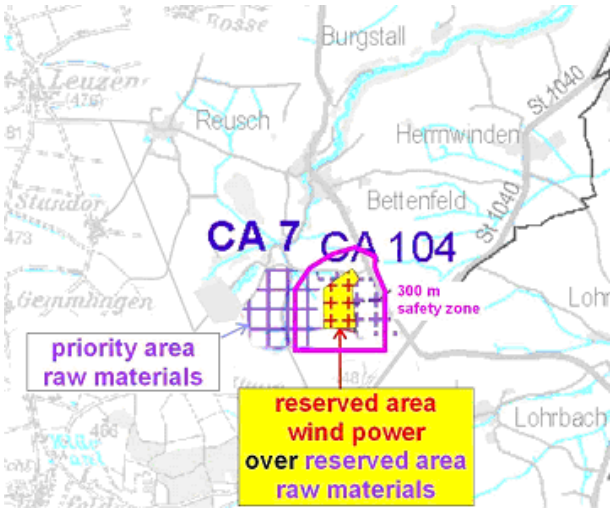

Figure 1 – Reduced priority area for raw material extraction through the reserved area for wind power.

Overlap planning is very often applied because of the limited durability of wind power plants of 25 years. Such planning may be considered very critically because there is no legislation that the wind power plants have to be dismantled after this period of 25 years. Through the repowering of wind turbines the durability of wind power plants increases and access to raw materials is blocked for a longer period.

Another problem is that there are no areas reserved in regional development plans for solar panel surface areas.

The largest solar park in Germany was planned close to Straubing (Lower Bavaria). But the park overlapped approximately 40% of an existing priority area for clay mining (for roof tile production). Following a decision of the Bavarian Ministry of Economic Affairs the plan for the solar park in its former size was rejected and the clay mining area was preferred.

CHANCES

But we also see chances for the raw material industry in the energy turnaround:

Dredging lakes can be used for floating solar platforms (Fig. 2) after the raw material production.

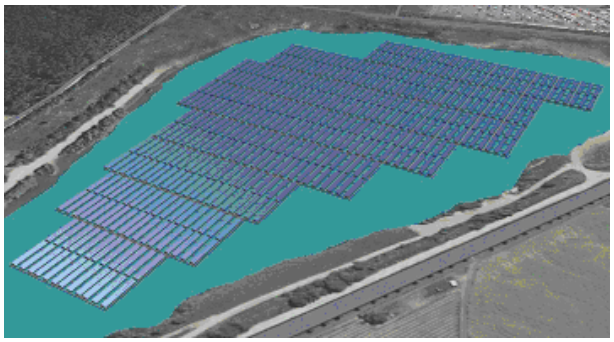

Figure 2 – Floating solar platforms (© http://www.perebo.de).

A very important fact is that (filled) gravel pits are the ideal location for solar and wind power plants because these areas are conversion areas which are predestined for alternative energies, according to the Bavarian energy turnaround (Fig. 3).

Figure 3 – Solar park after gravel mining.

Another important fact is that big solar panel surface areas also secure raw material areas for the future and other land usages: The economic useful life is limited to 25 years!

CONCLUSION

The energy turnaround involves risks, but we have to work together to use the chances for both sides: The energy turnaround and the raw material industry.

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CENOZOIC STRUCTURES AND POLYMETALLIC MINERALIZATIONS IN THE CENTRAL PART OF THE SERBO-MACEDONIAN MASSIF

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KEY WORDS: Serbo-Macedonian massif, morphostructures, Cenozoic activization, polymetallic mineralizations, ore systems.

INTRODUCTION

Serbo-Macedonian massif (SMM) represents remarkable geotectonic unitwithin central parts of the Balkan Peninsula where have been confirmed numerous structures, morphostructures and significant ore mineralizations. From the geological point of view the SMM has been built mainly of gneisses, mica-schists and Paleozoic schists, while the structural construction has been dominated by plicative structures and disjunctive ruptures. Tertiary magmatism, intruded along Cenozoic structures has been related to the polymetallic mineralization of Pb, Zn, Cu, Au, Ag, AS, Sb (Jankovic and Serafimovski, 1997 etc.).. Significant morphostructural forms in the central parts of the SMM have been related to the productive mineralizations of Cu-Pb-Zn (Plavica type), Cu-Au (Borov Dol type) and Cu±Au±Ag±Mo (Bukovik-Kadiica type). Neo-tectonic structures are of SW-NE to E-W direction and within this area they are not related to the mineralization, but they are just seismically active.

REGIONAL GEODYNAMIC EVOLUTION OF THE CONSIDERATION AREA

From Paleogene to Recent time, FYR Macedonia was part of the South Balkan extensional region, the northern part of the Aegean extensional regime. Extension began in the middle to late Eocene in Eastern Macedonia with the formation of a NNW-trending east-tilted half graben lying east of a forearc basin in central Macedonia.

The tectonics of FYR Macedonia from the late Eocene to the present is dominated by two periods of regional extension separated by a short interval of shortening deformation in late Oligocene–early Miocene time. Extensional deformation in Macedonia is part of the broader South Balkan extensional regime that in addition to Macedonia affects northern Greece, Bulgaria, Albania, Serbia, Montenegro, and probably parts of south-western Romania (Fig. 1; Dumurdzanov et al., 2005).

The Serbo-Macedonian massif (SMM) consists of Riphean/Cambrian mafic plutonic and volcanic rocks and early Paleozoic schist and phyllite all intruded by large bodies of Paleozoic granite.

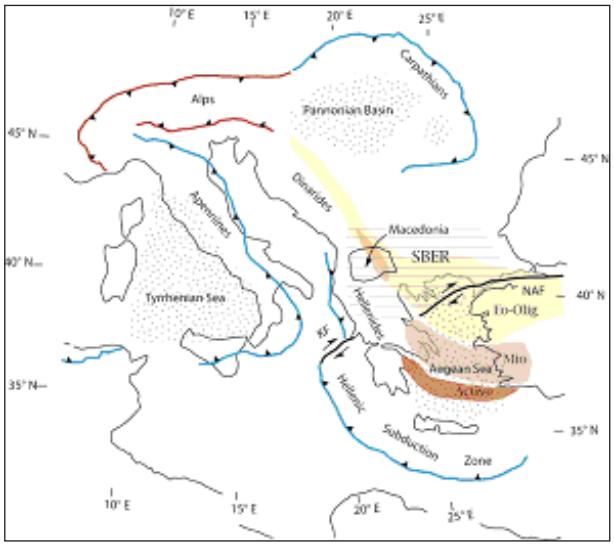

Figure 1 – Simplified tectonic map of Eastern Mediterranean region showing Southern Balkan Extensional Region (SBER; horizontal lines) in relation to selected tectonic features (Dumurdzanov et al., 2005). Retreating subduction zones (blue) and related areas of backarc extension (dotted pattern) and advancing subduction zones (red) are highlighted. In Balkan region, position of the volcanic arcs of Eocene-Oligocene age (Eo-Olig: yellow), Miocene (Mio: pink), and Pliocene to Recent (Active: red-brown) are shown. The location of Macedonia is outlined. KF—Kefalonia fault zone; NAF—North Anatolian fault zone

With the exception of the north-plunging nose of the Pelagonian anticlinorium, the structures in the pre-Cenozoic basement rocks are dominated by NW-trending foliation, folds and faults that form an important crustal anisotropy that controlled many of the basin bounding faults in Cenozoic time.

CENOZOIC MORPHOSTRUCTURES AND POLIMETALLIC MINERALIZATION

The morphostructural analysis and detailed scientific studies have enabled us to understand

the processes which preceded the formation of the zone of Cenozoic activation. The zone of Cenozoic autonomous activation of the Balkan Peninsula is characterized by a specific structural plan, multiphase volcanic-intrusive magmatism and interesting mineral deposits (Fig.2).

A special characteristic of the zone of autonomous activation is its many ringlike structure. These megastructures correspond to broad, gentle arches, are elliptical or circular in shape and have a diameter of 60 to 100 km.

There are numerous and varied mineral deposits in the zone of Cenozoic autonomous activation. Interesting occurrences of tin and niobic tantalum are the only ones genetically linked with the granites (Cer, Bukulja). All the other endogenous deposits are paragenetically linked with the volcanic-intrusive complexes of granodioritic magma. The magnetite deposits (Suva ruda type) magnetite and hematite (Damjan type) - belong to typical metasomatic scarns. The copper deposits are either porphyric (Bucim) or vein-impregnation (Zlatica, Plavica). The molybdenum deposits are stockwork impregnated (Mackatica). The lead and zinc deposits are of scarn type (Rudnik), hydrothermal-metasomatic (Sasa, Toranica) or vein type (Zletovo). The antimony deposits are usually monomineral (Krstov Dol), but there are also transitions to lead-antimony, arsenic-antimony deposits. Logical metallogenic analysis was made possible for the first time by the distinguishing of the megastructures in the Tertiary autonomous activation zone. Thus the megastructures correspond to the ore districts and coincide with the centres of-magmatic activity, while the distribution of mineral deposits in them is found to be distinctly laterally zoned. The lesser ringlike structures correspond to the structure of the ore fileds or mineral deposits, as we are showing that later on the Bukovik-Kadiica polymetallic ore system.

CONCLUSION

FYR Macedonia experienced two periods of extension separated by two abbreviated periods of shortening in Cenozoic time.

The Cenozoic activization of NW-SE strike diagonaly crossed through the large tectonic units Dinarides, Vardar Zone, central parts of the Serbo-Macedonian Massif and Rhodope massif. This activization significantly contributed to the localization of the Cenozoic mineralizations within the Eastern Macedonia

The disruption structures of of NW-SE direction control three major Cenozoic metallogenetic zone. Two of them are characterized by the Oligocene-Miocene magmatism and mineralization in the major ore region Kratovo-Zletovo and Bucim-Damjan-Borov Dol and the third one has been characterized by Miocene volcanics and related mineralization in the Osogovo ore region (Bukovik-Kadiica).

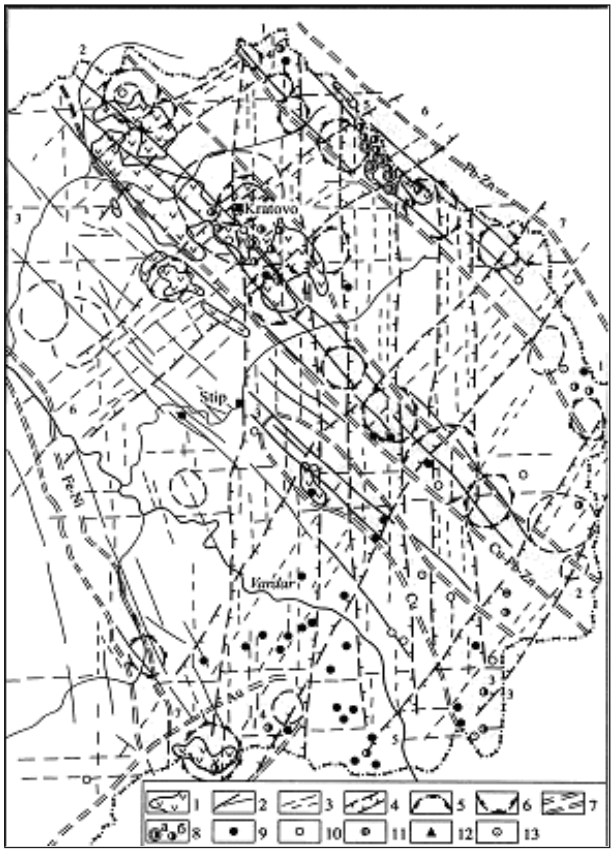

Figure 2 – Scheme of the Cenozoic metallogeny in the Eastern Macedonia (FYR).
1. Cenozoic magmatic rocks, 2. Followed fissure, 3. Faults defined by satellite images and morphostructural analysis, 4. Fissure zones and cracking systems, 5.Semi-curved structures and calderas, 6.Pericline structures, 7. Metallogenetic zones, 8. Polymetallic deposits (a) and ore occurrences (b), 9.Copper deposits and occurrences, 10. Uranium deposits, 11.Tungsten deposits, 12. Antimony deposits, 13. Iron deposits.

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ALGERIA - REVIEW GEOLOGICAL AND GEOTECHNICAL AGGREGATE RESOURCES OF THE REGION BEJAIA-SOUMMAM

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KEY WORDS: aggregates alluvial geology geotechnical GIS Soummam Algeria massive rocks

THE NEED FOR AGGREGATES

Aggregate, whether based on massive rock or alluvial, constitute a national wealth as well as metal ores. They are used in areas as important for the development of the countries that are the great road works, highways, railways, ports, water supply or construction of bulding. Their exploration is very important for the economy and the development of Algeria which is an emerging country in fully construcion. This study has been dictated by the launching of major projects in the regionsome of which are already under construction. These include:

- The intense urbanization of this region (cities of Bejaia, Akbou, Sidi Aich El Kseur Tazmalt, Tichy, Aokas, Boulimat).
- the rehabilitation of roads (National Road No. 26-Bejaia Sidi Aich 45 km) and National Road No. 9..
- duplication of the railway track Beni-Mansour Bejaia
- Construction of new port of Tala Yilef (30 km west of Bejaia)
- The construction of the highway penetrating Soummam (90 km), and the construction of the East-West Highway that runs along the region in the southern portion of 30km (100km)

LITERATURE REVIEW

This work will require large volumes of aggregates that it must secure. In this perspective the following work aims to estimate the resources in alluvial materials and resources in massive rocks of the Soummam valley and coastal region of Bejaia. This study consisted of the development of a GIS in order to bring together on one computer support all available data, both on careers as massive rock mining sites in the alluvial valley Soummam. . This was accomplished after the synthesis the work already done by various authors in the region.

It has been established subsequently a plurality of maps, of the natural potential of the area, its more or less capacity to provide for its development as part of major regional projects. He was then drawn conclusions and recommendations for the appropriate use of aggregates in the context of the environmental The methodology that was used to conduct this work consisted in the different step:

- The Topographic maps at 1/200 000 of Tizi Ouzou and Setif to locate the valley Soummam in its regional context.
- Geological maps at 1/50000 Bejaia, Amizour of Sidi-Aich and that allowed us to have the first data on the nature and distribution of deposits.
- Administrative files concerning quarries, sand and gravel available at the Direction of Mines and Geology and the Directorate of Hydraulic Affairs in the region of Bejaia.
- The reports of the results of laboratory tests on samples submitted to the Laboratory of Public Works of eastern Algeria, the records of road projects in progress at the Public Works Department of Bejaia.

Figure 1 – situation of the Soummam valley

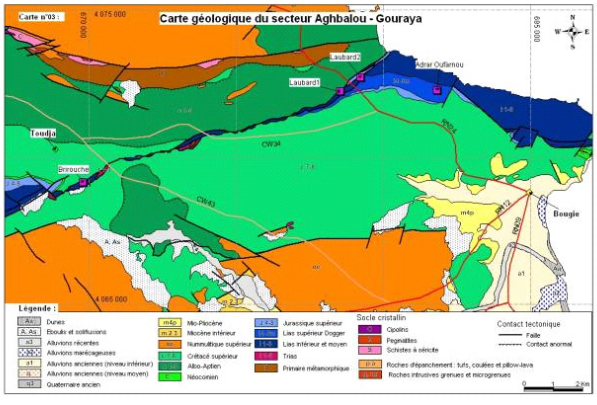

Figure 2 – geological map of the Soummam valley

FIELD WORK

During this phase it was made visits to the sites of quarries and sand pits in this order:

- Make sure the data provided by previous phase.
- Sampling for additional analysis in the laboratory of the University
- Update the data and correct them if necessary (state of the operating characteristic of rocks etc
- Locate sites in their natural (environmental constraints
- realize the geological map of careers

OFFICE WORK AND CONCLUSION

This phase it is necessary to realize a geotechnical report and geological resources of the region in which aggregates will lead to:

- Conduct a database aggregate at the level Régionnal
- Creation of a sig
- Engage in the sig major regional projects
- Determine the needs of these major projects Locate the large deposits most appropriate for each project depending on the distance of transport, characteristics of aggregates, their destination in the project and the optimum transport distance.

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USING 3D/4D MODELING TOOLS IN EXPLORATION FOR GOLD-POLYMETALLIC POTENTIAL AREAS IN GREECE

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KEY WORDS: Mineral, map potential, 3D/ 4D modeling, polymetallic gold deposits, exploration tool, gold potential areas.

ABSTRACT

Greece's geology favours a potent and dynamic use of mineral resources, which became a major incentive of the country's mining business, and economic and social growth. Among the Non-Energy Metallic Minerals commodities, base and precious metals, in particular zinc, lead, copper gold, and silver are becoming an increasingly important and rapidly growing target of the mining industry. In NE Greece, where most of the potential resources and feasible deposits are hosted, gold-polymetallic mineralizations occur in a wide range of genetic types comprising magmatic, hypothermal/ meso-thermal manto-type, orogenic, epithermal and supergene mineralization types. The **magmatic porphyry copper** type deposits and mineralizations show economic gold grades (e.g. Skouries, Fisoka, Pontokerasia), the **hypothermal/ meso-thermal manto - type** polymetallic sul-phides form high - grade gold ores (e.g. Olympias, Mavres Petres, Piavitsa, Thermes, Pangeo, Farasino) and the **epithermal gold systems** lead to potential high-sulphidation mineralizations (e.g. Aghios Demetrios, Viper, Perama, Kirki, Pefka) (Fig.1).

The genetic link between porphyry copper and large polymetallic manto style sulphide deposits can be incorporated into regional exploration strategies in a complex metamorphic terrain of schists, gneisses and marbles, whereas the epithermal type deposits were emplaced within a broad volcanic belt, which developed first in Bulgaria and then moved south through northern Greece to the region of Thrace.

Figure 1: - The main genetic types of gold-polymetallic mineralizations in Northern Greece.

The epithermal gold mineralization occurs in hydrothermal breccia zones, related to volcanic rocks of andesitic, dacitic or shoshonitic composition as well as hosted by sedimentary rocks. All previous types of sulphide minerals (particularly those hosted by Rhodope and Serbo-Macedonian marbles) were overimposed by post-Pliocene co-active supergene oxidation and karstification processes (e.g. Angistro, Menikio). All the main types of gold mineralization are linked to plate tectonic movements during the Tertiary. From the global metallogenetic point of view the post-Alpine Tertiary geodynamic systems in SE Europe are potential in producing high-grade ore deposits of base and precious metal sulphide minerals. Local, semi-regional and regional scales of 3D / 4D gOcad models were applied in most of the above mentioned deposit types achieving new metallogenic inter-prettations and exploration perspectives in relation to,

- The geology, the structural setting, the stratigraphy, the ore bodies, the alteration zones and part of the ore grades distribution of Perama Hill (Petrota graben), Aghios Demetrios and Viper epithermal Au deposits (Kirki Tertiary basin), along with their metallogenetic evolution within Carpathian-Balkan belt (Fig.2).

- The geology, the ore controlling structures, the host-rocks stratigraphy and the ore bodies geometry of Olympias manto polymetallic sulphides (Fig.3).
- The geology, the stratigraphy, the tectonic evolution with respect to ore deposition and its extension in depth and along the strike of the main mineralized fault, the ore body geometry and the geostatistics of the ore grades of the Mavres Petres manto polymetallic sulphides,
- The gold grade distribution of the Skouries porphyry Cu, and the genetic links between the spatially related porphyry and manto systems, based on airborne geophysics, along with further interpretations for across border regional exploration potential.

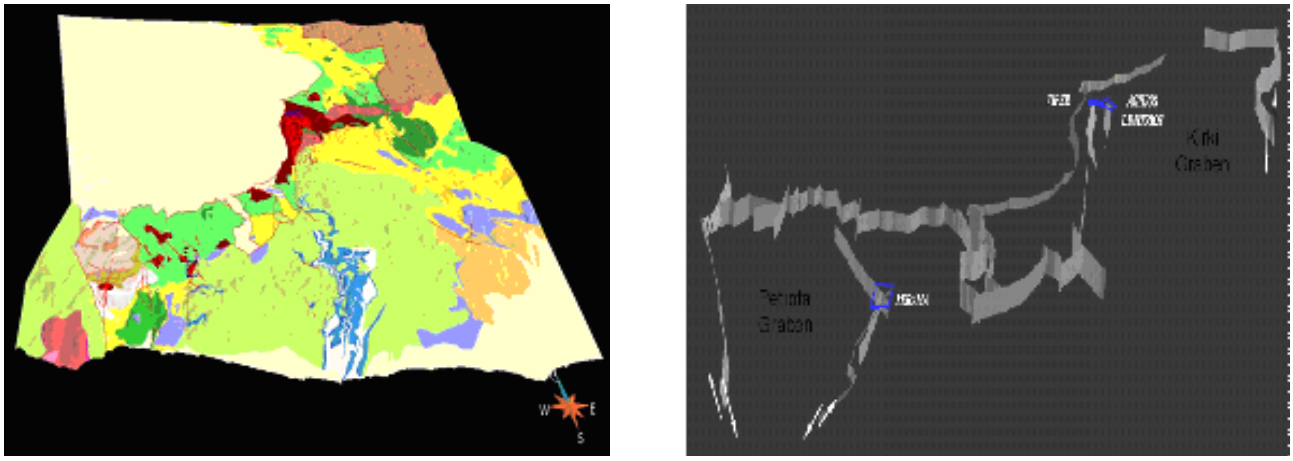

Figure 2 - Geology and structure of epithermal Au in Petrota and Kirki Tertiary rift basins.

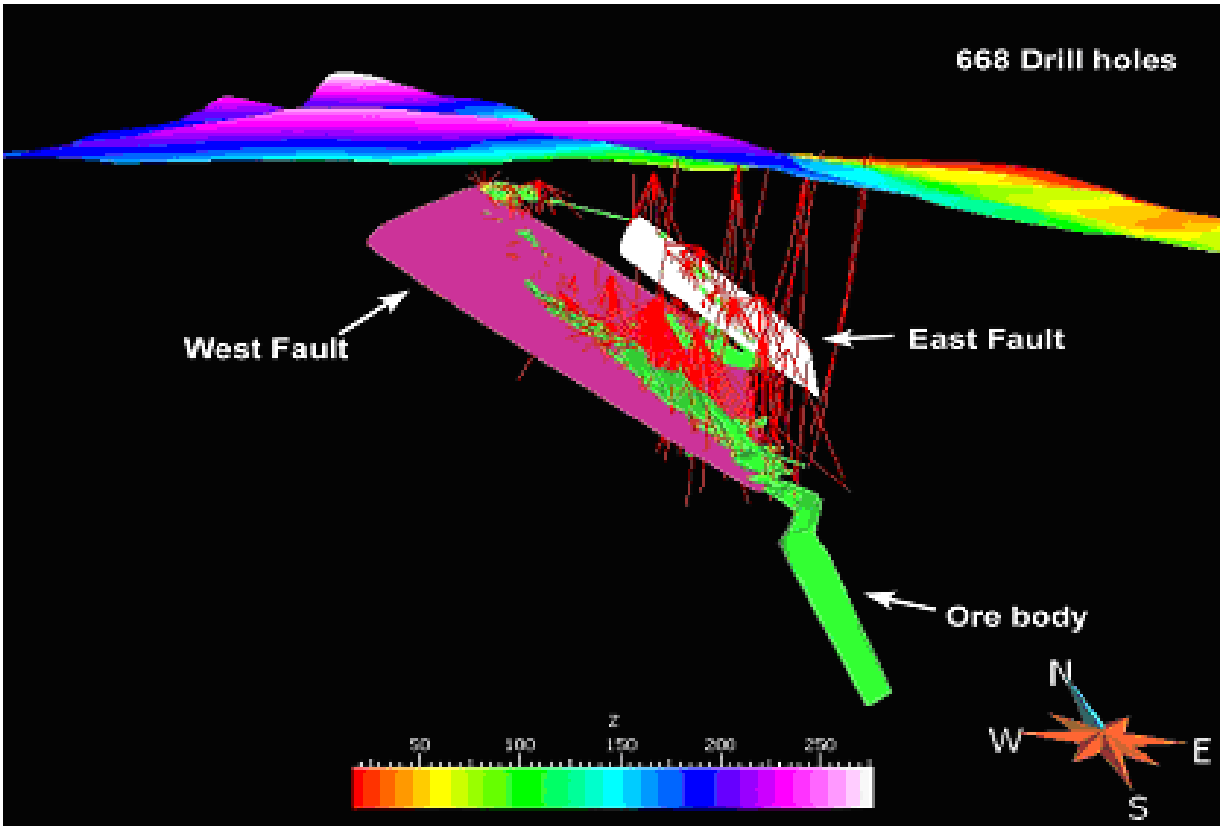

Figure 3 - Fault controlled ore deposits of Olympias manto polymetallic sulphides showing extension of potential mineralized structures to depth.

The research leading to these results has received funding from the European Community's Seventh Framework Programme ([FP7/2007-2013] [FP7/2007-2011]) under grant agreement n° 228559. This publication reflects only the author's view, exempting the Community from any liability.

FLUID INCLUSION & GEOCHEMICAL STUDIES OF QAHRĀBĀD FLUORITE DEPOSIT, WESTERN IRAN

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KEY WORDS: fluorite, geochemistry, fluid inclusion, REE, Qahrābād, Iran

INTRODUCTION

Fluorite occurs in a diverse group of mineral deposits with varied host lithologies, mineralogies, and styles of mineralization. These deposits range from low- to moderate-salinity epithermal veins and replacements to high-temperature and high-salinity magmatic deposits. Fluorite is associated with base and/or precious metals ores in epithermal veins and replacements, skarns, and porphyry systems.

General classification of fluorite deposits are as follows:

- Magmatic deposits.
- Structure-related deposits.
- Sedimentary dposits.

THE ORE DEPOSITE

Qahr-abad fluorite deposit is located ~58 km of southeast Saqqez city, northwest of Kurdestan province.(Fig.1) This deposit is developed as scatter lenses, veins, and veinlets (stockwork structure) within carbonate rocks of Elika formation (Triassic). In field investigations, based on physical feature of color, three fluorite types are distinguished as well:

1) Colorless to light yellow.
2) Blue to greenish blue.
3) Violet.(fig. 2)

Two different types of contact between fluorite and host rock, fluid inclusion data, paragenetic suit and REE geochemistry give us important informations about the deposition conditions of this orebody. The textures observed in the mineralized area include: impregnation texture, open space filling texture, colloform texture. Fluorite, barite (fig. 3), quartz, sparite calcite, micritic calcite, dolomite, clay minerals such as kaolinite are the minerals observed in the first sight in the area. (fig. 4)

Figure 1 – geography position of QahrAbad orebody in Iran.

Figure 2 – fluorite mineral types in Qahr-abad deposit. (C= colorless fluorite, G= blue to greenish fluorite, V= violet fluorite.)

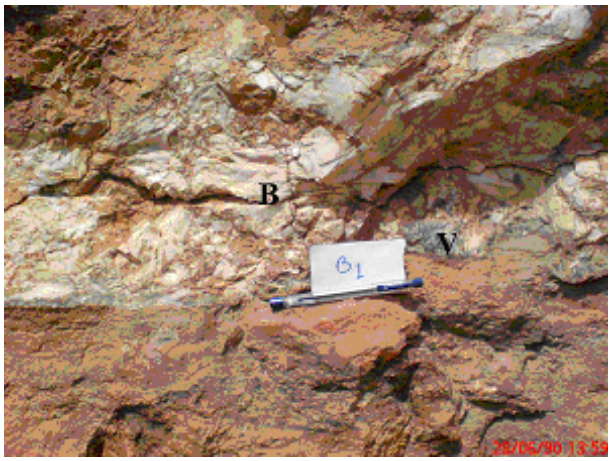

Figure 3: barite and fluorite association(B= barite.)

Further petrographical investigations show that fluorite mineral in this deposit is accompanied by minerals such as hematite and magnetite. Incorporation of the obtained results from mineralogical data and elemental geochemistry studies (enrichment factor) shows that factors such as change in mineralization environment physicochemical conditions (pH and Eh), change in pressure and temperature, alteration, metamorphism, oxidation of organic matters, surface adsorption, activity and solubility of associated anions, residual enrichment, and leaching of clay minerals have important role in distribution of major, trace, rare earth elements and development of this deposit.

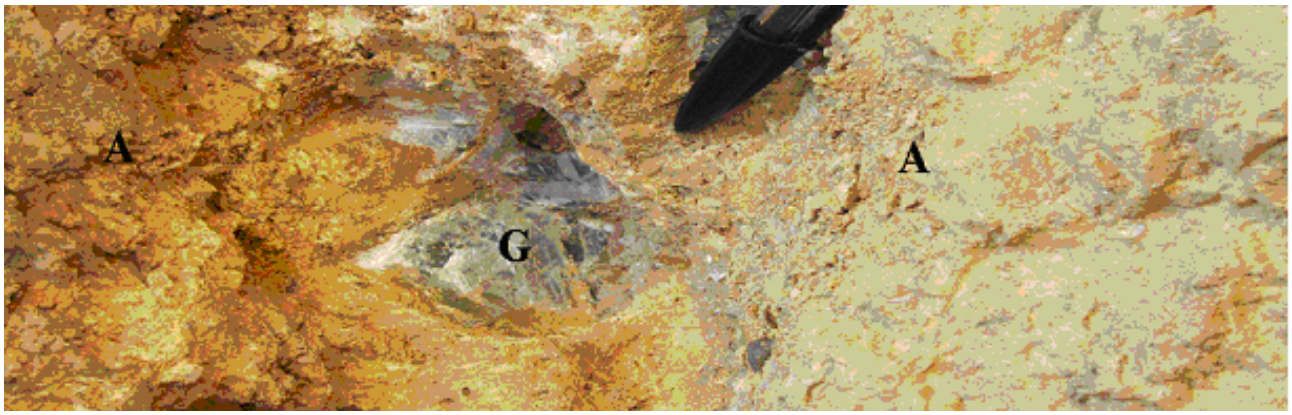

Figure 4 – argillic altration halos around small greenish fluorite lens. (A= argilic minerals (kaolinite))

FLUID INCLUSION & GEOCHEMICAL STUDIES

Each microscopic inclusion is a recording geothermometer that provides us with data on the temperatures of the past geologic events.

Fluid inclusions study in this research shows that the temperature of fluorite precipitation in Qahr-abad area ranges between 150 to 185 centigrade.

There are 2 types of inclusions in violet fluorite, and colourless to blue coloured fluorite in other hand have 3 types of inclusions, liquid filled with small bubble are common in all types. Inclusions with L+V+S are found in violet fluorite types and L+V+S+S are found in other types of fluorite in Qahr-abad ore deposit.

Geochemistry of rare earth elements (REEs) has been widely used by numerous researchers to understand the geologic conditions under which fluorite is deposited, and Moreover, many researchers, [Talaie et al (2011)], and combined geochemical data with fluid inclusion studies to unravel fluorite genesis. On the other hand, some workers applied the geochemistry of REE as an exploration tool to differentiate between precious-metal-bearing fluorite deposits and barren deposits, , [Hill et al., 2000] and . The aim of the current study is to present the geological setting, petrographic and fluid inclusion findings, and geochemistry of REEs to constrain a genetic model for the Qahr abad fluorite deposit. The geochemistry of REEs is also used to evaluate the potential of precious-metal mineralization in the Qahr Abad deposit and to reexamine this exploratory tool.

Qahr-abad fluorite deposit is enriched in LREE in violet fluorite ore body but the other kinds of fluorite are enriched in HREE more than LREE specially in coloreless fluorite.

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EXPLORATION FOR MOLYBDENUM MINERALIZATION AT KAP SIMPSON COMPLEX, CENTRAL EAST GREENLAND, USING AIRBORNE HYPERSPECTRAL REMOTE SENSING DATA

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KEY WORDS: hyperspectral remote sensing, mineral alteration, Greenland, image processing.

INTRODUCTION

A large number of intrusions and magmatic complexes are localized in East Greenland. These intrusive complexes host a wide range of economic mineralizations, among others, porphyry molybdenum deposits and occurrences (Geyti and Thomassen, 1978). Due to its remoteness and severe climate the East Greenland igneous province remains vastly underexplored.

The Kap Simpson igneous rocks complex occurs in the southeastern part of the Traill Island in central East Greenland (Fig. 1). The eastern part of the Kap Simpson igneous rocks complex is composed of a caldera with extensive hydrothermal alteration. The alteration includes zones of intense sulphide mineralization and iron oxide staining. The area has been explored for porphyry molybdenum deposits (Harpøth et al., 1986). However, despite the localization of several molybdenum anomalies no deposits have been found. If porphyry molybdenum mineralization is present it must be deeply located (Harpøth et al., 1986). Detailed mapping of the spatial distribution of the alteration minerals could guide future mineral exploration activities.

This poster presents the analysis of HyMap airborne hyperspectral remote sensing data for mineral alteration mapping at the Kap Simpson complex in central East Greenland. The analysis of high spatial resolution HyMap hyperspectral imagery is carried out in order to obtain detailed maps of the spatial distribution of the alteration minerals in the Kap Simpson complex.

The results of this study should have considerable potential to evaluate the use of hyperspectral remote sensing for geological purposes in the Arctic regions of central East Greenland.

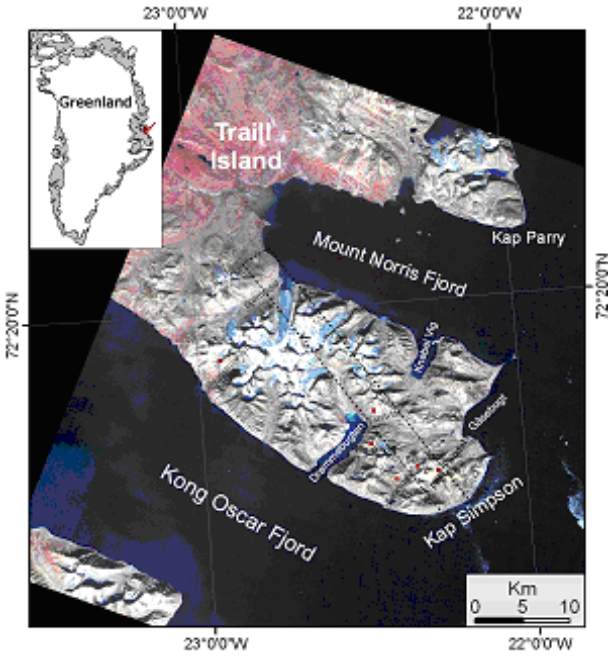

Figure 1 – The Kap Simpson study area shown in an ASTER satellite image. The dashed black line shows the spatial extent of the HyMap airborne hyperspectral image.

REFLECTANCE SPECTROSCOPY AND DATA ANALYSIS

Reflectance spectra of altered rocks from the Kap Simpson complex display absorption features due to electronic processes involving Fe^{3+}, and to molecular vibrational processes in OH-bearing minerals. The VNIR and SWIR-active alteration mineralogy in the reflectance spectra of these samples consists mainly of goethite, jarosite, muscovite, phengite and kaolinite.

In Fig. 2 are shown representative ASD laboratory reflectance spectra of rock samples from the Kap Simpson complex. Matched filter processing was applied to analyze the HyMap data. The matched filter is a partial spectral unmixing technique that aims to detect the known spectral class of interest while suppressing the background. The resulting mineral maps are shown in Fig. 3.

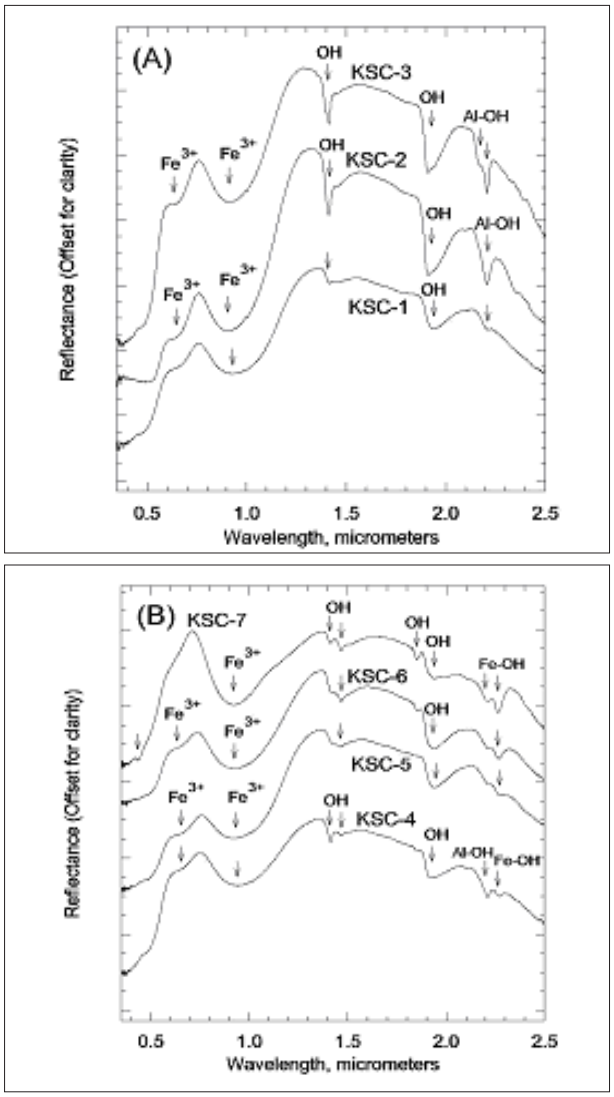

Figure 2 – Laboratory VNIR-SWIR reflectance spectra of altered rock samples from the Kap Simpson complex. (A) clays and goethite (B) jarosite-rich samples.

CONCLUDING REMARKS

A detailed picture of the spatial distribution of the alteration minerals in the Kap Simpson complex was obtained by the analysis of HyMap airborne hyperspectral data. This detailed information for the spatial distribution of several alteration minerals in the Kap Simpson complex has not been obtained by previous field-based studies in the area. The hyperspectral mineral mapping results integrated with other geophysical and field-based data may be useful in future mineral exploration activities at the Kap Simpson complex. Especially of interest are localities where the mineral phengite was detected. As shown in another study in a similar environment the mineral phengite occurs within the alteration zone of underlying molybdenum mineralization (Bedini, 2012).

The study also indicates the potential of hyperspectral remote sensing for mineral exploration in the Arctic regions of East Greenland.

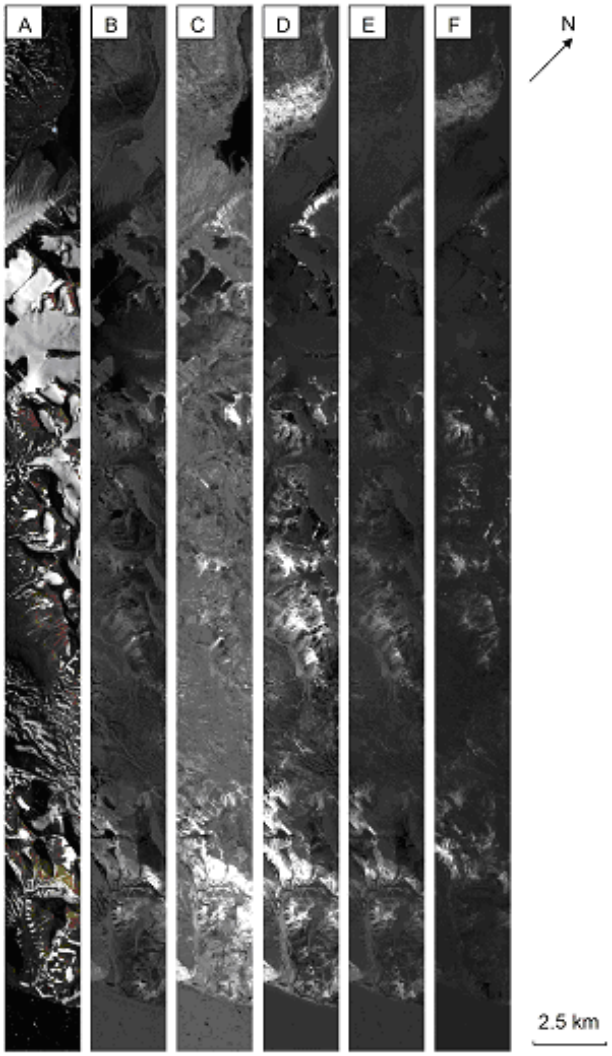

Figure 3 – (A) The HyMap hyperspectral scene of the Kap Simpson complex. (B-F) Results of matched filter analysis for (B) jarosite, (C) limonite, (D) sericite, (E) phengite and (F) kaolinite.

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REGIONAL VARIATIONS OF GOLD-SILVER RATIO IN EPITHERMAL DEPOSITS OF PACIFIC VULKANIC-PLUTONIC BELTS

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KEY WORDS: database, gold-silver deposit, gold-silver ratio.

INTRODUCTION

One of tendencies of development of modern Russian geology under conditions of personnel deficiency is the active implantation of GIS-technologies. The various informational-analytical systems are the result of their application, which provide monitoring of bases and banks of geological data. Using the GIS-project for prognostic-metalgenic problem we spend comparative studying of regional variations of gold-silver ratio in epithermal ore deposits of vulkanic-plutonic belts of the East of Russia and the world. In the present theses the main results of this operation are stated.

ABOUT THE GOLD-SILVER RATIO IN ORES

Previously (Konstantinov, 1984) among gold and gold-silver deposits there have been selected gold-telluride, gold and gold-silver types (corresponding to them ranges of gold-silver ratios are: 10:1-1:1; 1:1-1:20; less 1:20). The specified typification was based mainly on materials of the leading foreign deposits. Among epithermal gold-silver deposits of Chukotka we (Volkov, etc. 2006), have selected the following geochemical types: gold (1:1-1:10), gold-silver (1:10-1:100), essentially silver (1:100-1:1000). However the most reliable value of this metric can be received from the relation of the common stores of gold and silver in each studied object (Silver …, 1989), as private results of any approbation will give considerable dispersion of the received data owing to ash value and heterogeneity of allocations of concentration of these metals.

In this connection using the published materials the specialized database has been created for the comparative computer analysis of regional variations of gold-silver ratio in the epithermal ore deposits of the East of Russia and other regions of the world. It includes the data about ore reserves, contents of gold and silver, geographical co-ordinates of 305 deposits, including: more than 100 objects – from the Northeast of Russia, about 50 objects – from Oceania, including Australia and New Zealand, the South America and 25 objects – from Japan, Central and Northern Americas. While statistical data processing it is installed, that the distribution of gold and silver contents submits to log-normal law, and their average values, are, accordingly, 8.33 g/t and 234.67 g/t, medians - 4.29 g/t and 39.39 g/t (i.e. 50 % of sampling less than these values). It is significant, that about 70 % of the common reserves of gold is concentrated in the largest deposits: Cripple Creek (276), Comstock (274), Round Mountain (283) (USA); Veladero (201), Pascua Lama (205), El Indio (217) (Chiles); Yanacocha (234), Pierina (235) (Perus); Kupol (35) (Russia); Hishikari (135) (Japan), etc. In addition about 75 % of the common reserves of silver are concluded in the largest silver objects, and three of them (Mexico) - Pachuca (266) (49.3 thousand ton), Guanajuato (265) (31 thousand ton) and Guanacevi (264) (13.9 thousand ton) - contain about 65 % of the common reserves of the American continent. It is necessary to underline, that the high level of the average contents of gold and silver of the region, indicated above, are defined by the high contents of gold and silver of these and other main deposits.

THE COMPARATIVE ANALYSIS OF REGIONAL VARIATIONS OF AU-AG RATIO

Using comparative analysis of materials on 305 epithermal gold-silver deposits of the Pacific ore belt their typification was defined more exactly by the value of gold-silver ratio. Results are set out on fig. 1 and 2.

On fig. 1 the lines spent under the corner 45°, are the lines of equal ratios of gold content to silver content, these values are inside the frame on the right. Deposit Yanacocha (234) is unique on gold reserves among gold-silver of objects; deposits Pachuca (266) and Guanajuato (265) - are unique on reserves of silver and simultaneously possess of large reserves of gold; deposits Guanacevi (264) and Dukat (18) have unique reserves of silver and averages - gold, and Comstock (274) - large reserves as gold, and silver too.

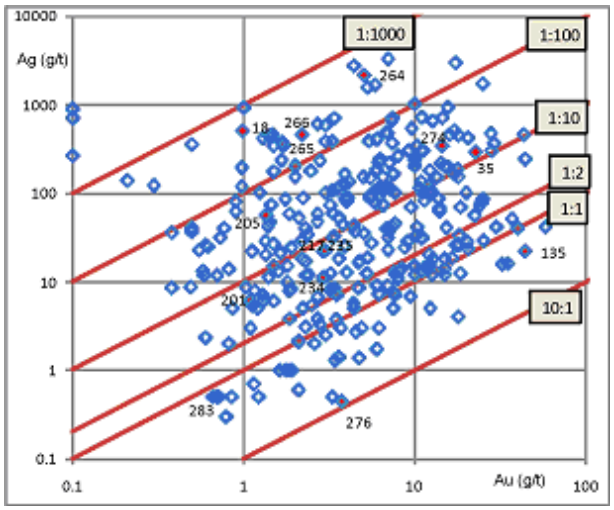

Figure 1 – The logarithmic diagram of gold-silver contents. The object's numbers have corresponded to database list. The object's names are indicated in the text.

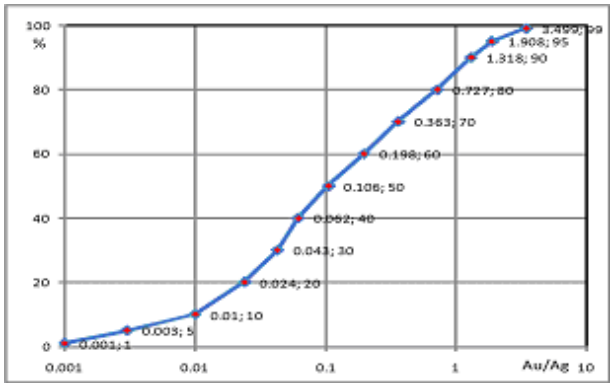

Figure 2 – The accumulation curve for 305 gold-silver deposits.

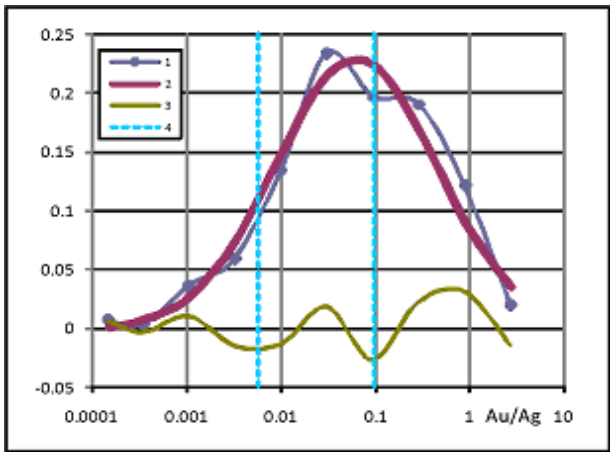

Figure 2 – The distribution curve for 305 gold-silver deposits:
1 – experimental; 2 – theoretical (log-normal) model; 3 – non-log-normal behavior (deviation); 4 – boundary line between mixture component centres

Using the value of gold-silver ratio in ores the classification of deposits is carried out statistically by determining of component centres within the domain of this parameter. It has been determine (fig. 2,3), that the sample of this geochemical tag in the common collection is submited to log-normal distribution law.

Checking hypothesis, that there are 3 classes of deposits, characterised by various gold-silver ratio, we have simulated the empirical gold-silver ratio distribution in the form of mixture distribution, in which separate components are log-normal. The procedure of mixture decomposition was spent by *EM*-algorithm (*expectation-maximisation).*

As the result we have received the mixture component centres of these samplings with log-normal distribution. They are determined by medians accordingly: 0.002, 0.034, 0.497 (ratios of gold to silver – approximately 1:500, 1:30, 1:2).

The boundaries for extraction of 3 classes of deposits: essentially silver, gold-silver, essentially gold objects (with small (25 deposits), average (122 deposits) and high (158 deposits) value of gold-silver ratio). They are equal to 0.005 (Au/Ag=1:200) and 0.1 (Au/Ag=1:10) (fig.3).

The same boundaries were outlined as 0.01 (1:100) and 0.5 (1:2) by M.M.Konstantinov (1984).

CONCLUSION

The criteria for outlining of 3 types gold-silver of deposits are defined. The results well illustrate the known regional specialisation of gold-silver objects. We have: mainly gold specialization for deposits from Asia, Oceania and the North America (mainly territories of the USA); essentially silver with the subordinate value of gold specialization for deposits from Central America (mainly territory of Mexico; gold - silver specialization for deposits from East of Russia and the South America.

ACKNOWLEDGEMENTS

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EURASIA AND GLOBAL BELTS OF OIL AND GAS ACCUMULATION

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KEY WORDS: global belts, continental margins, petroliferous basins, collectors, seals, source rocks.

POPULARIZATION OF GEOSCIENCE AND GEOHERITAGE

Most of recent oil- and gas-bearing basins are incorporated in the group of five belts of oil-and-gas accumulation. They are confined to continent/ocean transition zones, which existed in the Mesozoic and Cenozoic [Konyukhov, 2009]. Three of them (Tethyan, Laurasian and West Pacific) are situated around Eurasia and include continental margins of this continent in the Atlantic, Arctic and Pacific oceans as well as in the Mediterranean Sea.

In the Tethyan (Median) or arid belt of oil-and-gas accumulation, the largest basins are represented by the Persian Gulf and the Oman basins in the Arabian plate, the Sirte and Western Desert basins at the African margin in the Mediterranean Sea. The belt also includes basins confined at one time to active margins of the Tethys Ocean e.g. the Adriatic Aquitanian, Austrian, Ciscarpathian, East Caucasian, South Caspian and other basins. Carbonates (limestone and dolomite) predominate in the sedimentary cover of these basins. They comprise giant oil and gas reservoir, while evaporates usually serve as seal. The most liquid and gaseous hydrocarbons (HC) were produced by black carbonate shale and marls of Late Cretaceous (Albian-Cenomanian and Cenonian) and Eocene ages.

The Laurasian or boreal belt comprises, in addition to basins of the Atlantic margin of North America (Scotian and Jeanne d'Arc), the Norwegian-Greenland, North Sea and Barents Sea basins, as well as basins of the Kara and Laptev seas, the West Siberian Basin and Arctic margin of Alaska. Moat of them were formed in the course of complicated multistage rifting that involved the northern sector of Pangea after completion of the Hercynian folding. The major petroliferous complexes mainly comprise deposits of riverine deltas and coastal alluvial plains, more rare of the submarine slopes: turbidites and debrites. Collectors are represented by sandstones and siltstones, seals are by clayey rocks. The HC-generation potential was primarily governed by black shale of Middle-Late Triassic and Late Jurassic (Kimmeridgian and Tithonian) ages [Konyukhov, 2010a].

The basins in both global belts composed of depressions exhibiting different stages of evolution. Between them there are structures, inheriting from the rift, continental margin, collisional and foredeep stages. The geological history of largest ones is as long as several hundred million years. Taken together, they units with more than 50% of oil and gas reserves discovered to date in our planet.

The West Pacific belt extends for over ten thousand km from New Zealand in south to the Bering Strait in north. It includes Pacific margins of the Eurasia and Australia continents, more than ten marginal seas and tens of volcanic island arcs, deepsea trough and deepwater rises. Among the large petroliferous basins must be mentioned North Sakhalin, Anadyr, Bohai Bay, Pearl River and Mekong basins, which were formed by rifting during Cenozoic. In the Oligocene, lacustrine sediments in many basins were overlain by sands of river deltas, which rapidly prograded from the North and South China platforms and East Siberia towards centers of sea depressions.

The West Pacific belt is marked by the lack of evaporates and the wide development of coaliferous deposits, which can generate both gaseous and liquid HC. Prolonged accumulation of terrigenous material produced thick sequences of deltaic and deepwater slopes sediments. HC-generation in them was related to transformation of the mixed sapropelic-humic organic matter. Reservoirs are represented by not only sandstones and siltstones, but also siliceous deposits: diatomites and opochs. The role of collector sometime play rocks of volcanic and even igneous origin: trachytes, basalts and granites (for example, in Bohai Bay and Mekong basins) [Konyukhov, 2010b].

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USING AERIAL ORTHOPHOTOMAPS FOR THE MONETARY EXPRESSION VALUE OF BIOTOPES ON THE AREA AFFECTED BY INDUSTRY ACTIVITIES

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KEY WORDS: orthophotomap, ash pond, biotopes, biotopes evaluation, Hessian method, Trinec, Dolni Listna

FOREWORD

The present contribution describes partial results of research, which focused on long-term biotopes mapping of the former ash pond from coal power plant. For more accurate statement of time changes of vegetation were used aerial orthophotomaps of 1958, 2000, 2003, 2006 and 2009 years (1:7500), where you can explore the area without the ash pond (1958) and then after the end of the activities on the ash pond (2009). Missing data map from 1958-1998 do not allow accurate calculation of the ash pond when it was fully functional. The value for 1970's was calculated based on the documentation.

The aim of this contribution is to show the possibilities of using today's air orthophotomaps and introduce a method for evaluating the ecological and monetary value of habitats (Seják & Dejmal 2003), which is based on the method of Hessian for financial statements of environmental damage area. Recently, Hessian method is also recommended by the European Commission White Paper of Environmental Liability, for assessment of damage to biodiversity.

MATERIAL AND METHODS

The research area is located in the cadastral area of town Trinec, Dolni Listna (see Figure 1) in the Northeast of the Czech Republic. The research aimed at the ash pond with a total area of 26.87 hectares. Pond was used from 1964 to 1998, there were 100,000 tons of ash hydraulically deposited per year. On the area was consecutively built 13 terraces of the dam system, see Fig.1. Some terraces were reclaimed with soil and planted with trees, the youngest of the terraces were seeded with grass. Since 1998 the surface has been left to independent development, nowadays it is covered by initial stages of succession.

For purposes of determining the ecological and monetary value of area was used the method to evaluate the habitat of several different aspects and assigns them to specific points, which are subsequently converted to cash value. Into the orthophotomaps from different years were drawn polygons (biotopes) with some attribute data (area, name, code, point value of biotope). Each biotope has according to the chosen methodology (Seják & Dejmal 2003) defined a certain number of points on one square meter of its area. 0 points are completely anthropogenic habitats such as sedimentation basins, concretes built-up areas, etc. while the highest values of 80 points / m^2 have the highest quality natural habitats. Subsequently, the point value of biotope is recalculated by the actual size of the biotope in the terrain and this value is multiplied by the value of CZK 14.50 \ point = 0.57 EU (United National Bank, January 25, 2012). This calculation was used 6 times: for years 1958, 1970, 2000, 2003, 2006 and 2009 shown in Fig. 2 and 3.

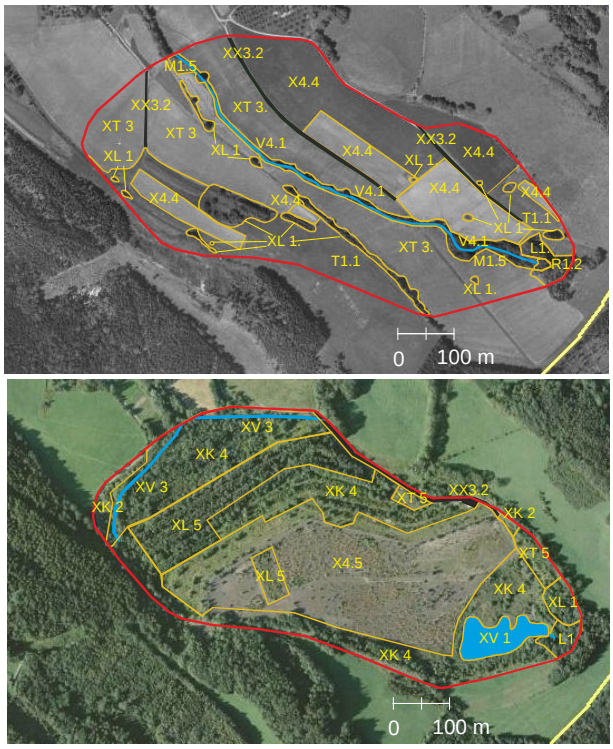

Figure 1 – Indication of biotopes on the orthophotomap of the year 1958 and 2009. (source map: www.kontamonivanamista cz)

Biotope type	Point value (1m²)	1958	2009
		Area m²	
R1.2 Meadow springs with tufa formation	56	401.35	0.00
L1 Alder carrs	55	3,760.25	2,969.63
V4.1 Spring ditchies	41	1,998.35	0.00
M1.5 Reed vegetation of brooks	33	10,366.19	0.00
T1.1 *Mesic Arrhenatherum meadows*	33	28,098.48	0.00
XL1 Hedgerows and alleys	25	13,876.59	3,546.16
XK2Fallow land with bushes amd trees	24	0.00	2,868.09
XL5 Glades, forest plants and restoration forest planting	17	0.00	32,770.83
XV1 Vegetation of new water surfaces	16	0.00	7,780.20
XT5 Plants of railway or road embankments	15	0.00	32,770.83
XV3 Drainage channels	14	0.00	1,086.75
XT3 Intensively managed and degraded mesic meadows	13	123,247.27	0.00
XK4 Pioneering vegetation of anthropogenic areas	13	0.00	84,984.94
X4.4 One-year and autumn plants on arable land	10	83,462.72	0.00
X4.5 Herbaceous vegetation on degraded areas, unrecultivated waste dumps	10	0.00	99,648.41
XX3.2 Impermeable surfaces and surfaces permanently without vegetation	0	3,471.28	256.63
XX1.1 Sedimentation basins, sewage treatment plants (1970)	0	0.00	0.00
Ecological poin value of area (Area m²x point value)		**4,364,312.27**	**3,610,70.39**
Monetary value of area (Ecological point value x 0,57 EU)		**2,487,657.99**	**2,057,968.12**

Figure 2 – table of each habitats and their area for years 1958 and 2009

- Natural and quasi-natural biotopes, - Semi-natural biotopes, - Anthropogenic biotopes

RESULTS AND DISCUSSION

The research former ash pond area of coal power plant have been identified with 17 different biotopes which are specific for a mapping year. The highest value was calculated for the year 1958, ie. before building the pond, the lowest value was determined for the year 1970, when the pond was fully functional and its area is occupied almost with 80% of the total surveyed area and 20% were terraces with spontaneus vegetation. In comparison with 1958 this represents a difference 1,913,467.31 EU. Obviously there is a big damage of the landscape, which was caused by anthropogenic intervention. In the years 2000, 2003, 2006 and 2009 the monetary value exponentially increased because of growing ecologically valuable biotopes which increase their size also. For the year 2009 the monetary value represents the amount of 2,057,968.12 EU and it is assumed that this amount will increase in the following years. Using method (Seják & Dejmal et al. 2003) can easily determine the degree of anthropogenic influence territory or reduce its financial and environmental values. On on other hand, the final amount is very questionable, because as the results show over several years, the monetary value may change. And also the newly created biotopes, mainly semi-natural biotopes have a low point value although we can expect to rise value with respect to self-regulation and the spontaneous regeneration.

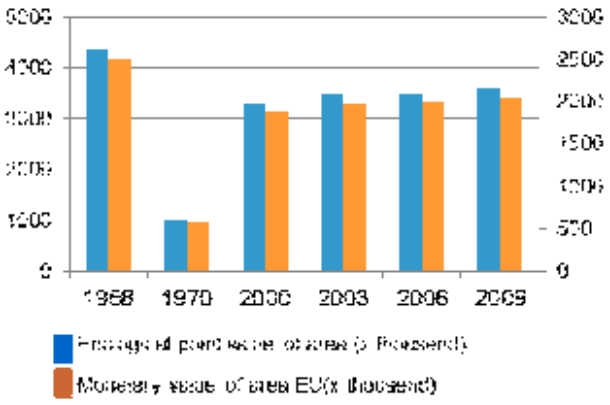

Figure 3 – Scheme of ecological and monetary value of area

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A PETROLEUM SYSTEM RESEARCH SUPPORTED BY GIS (CAMEROS BASIN, NORTH SPAIN)

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KEY WORDS: Petroleum System, Cameros Basin, paleothermometers index, geological data base, GIS.

SCIENTIFIC STUDY CONTEST

The Cameros Basin (north of Spain) is an inverted rifting basin formed during the Mesozoic rift extensional phase, relative to the opening of the Western Thetis Ocean. It records more than 7000 m of sediments with a mainly continental fluvio-lacustrine nature with some marine incursions (Mas et al., 2011). During the post-rift phase hydrocarbon generation and circulation have been inferred from numerous evidences (Mas et al., 2011; Ochoa et al., 2007; Mantilla Figueroa et al., 1998). A subsequent metamorphic hydrothermal event could be the responsible of the reservoirs destruction (Mas et al., 2011).

The peculiarity of the basin structural elements, the unusual geometrical characteristics of the syn-rift infill (Omodeo-Salé et al., 2011), the great variety of depositional environments (consequently of sedimentological features) and the complex thermal evolution of the basin, gives that in the last 20 years the Cameros Basin has been subjected of numerous multidisciplinary studies (see references in Mas et al., 2011). In fact the study and the comprehension of this basin could be very interesting to improve the knowledge of the geologic evolution and characteristics of a rifting basin and to give more data about the functionality of petroleum systems in a rifting geodynamic contest.

GEOGRAPHIC INFORMATION SYSTEM FOR GEOSCIENCE RESEARCH

To plan a multidisciplinary basin scale study it is necessary to build a strong and articulate data base that can integrate schematically all the different disciplinary data available and to collocate them in a geographical contest.

For this reason, for the first time, the geological data of the Cameros Basin have been implemented in a Geographic Informatics System using ArcGIS 10.0. This could be considered a great increase of the usability of the Cameros Basin scientific data and of the possibility to combine them. The integration of different levels of information (geological vs. geographical vs. paleothermal) in a geographical representation allows a better understanding of the distribution and variation of the basin characteristics.

WORK FLOW

The spatial data base of the Cameros Basin has been developed considering data from different sources, scales and multidisciplinary data. Geologic, mineralogical, petrologic and stratigraphic data with different scales, resulting from previous Cameros Basin researches (Mas et al., 2011 and its references), have been integrated in a sole spatial data base. Orthophotos of “Plan Nacional de Ortofotografía Aérea”, and the Digital Terrain Model and National Topographic Base of “Centro Nacional de Información Geográfica” of the Spanish “Instituto Geográfico Nacional” have been used like auxiliary spatial information. All data have been georeferencing respect the ETRS89 reference system.

In order to enforce the comprehension of the geological data, stratigraphic sections information (i.e. spatial localization, stratigraphic unit’s names and thickness, top and bottom contacts, section author, etc...,) have been incorporated to the spatial data base in a schematic way.

Finally, to calibrate and to characterize the thermal evolution of the Cameros basin, the previous described data base have been superimposed with paleothermometers index data obtained from illite and chlorite crystallinity, fluid inclusions characterization and vitrinite reflectance measures.

The combination of all the different levels of data base allows creating different thematic maps of the Cameros Basin.

RESULTS AND CONCLUSIONS

This work want to demonstrate how the management of the enormous quantity of multidisciplinary data, each one characterized by different format and structure, with a geographical informatics system greatly simplify a multidisciplinary basin scale research study focused on the characterization of a petroleum system.

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EURASIA-PACIFIC TRANSITION ZONE AND ITS MINERAL RESOURCES

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KEY WORDS: mineral resources, transition zone, continental margins, subduction zone, deep structure, lithosphere, asthenosphere, sulfides.

The transition zone from the Eurasian continent to the Pacific Ocean is the area of recent intense tectonic movements, hydrothermal processes and accumulation of different kinds of minerals. Thereupon it is the object of detailed study under the international and national geophysical projects.

The role of the deep processes proceeding in the mantle, particularly in the asthenosphere, in formation of earth crust structures in the transition zone from the Eurasian continent to the Pacific Ocean is considered. Since the Cretaceous period these processes led to the splitting of asthenosphere, magmatic and seismic activity, displacement of separate blocks of crust in the transitive zone. The paleogeographic situation of the region was changing under such conditions (Rodnikov et al., 2001; 2008)..

A distinctive feature of the Eurasia-Pacific transition zone is the presence of an asthenospheric layer in the upper mantle and the upwelling of the diapirs of a hot anomalous mantle, which controlled the formation of the geological units of the active continental and oceanic margins. Obviously, there are correlations between geological features, tectonomagmatic activity, and structure of the upper mantle. The active regions, such as the island arcs and the rift structures of marginal seas, correspond to thick and most distinct asthenosphere generating magma. It is expressed as the growth of heat flow in the younger tectonic zones caused by the upwelling of asthenospheric diapirs into the lithosphere, which involves tectonomagmatic reworking. Rifts in the marginal seas and island arcs may be accompanied by intense mineralization. The combination of high heat flow, volcanic and hydrothermal activity in these structures, in the past and at present, can lead to the formation of sulfides and other mineral deposits (Rodnikov et al., 2009; 2011).

On figure 1 the deep structure of a transition zone from the Eurasian continent to Pacific Ocean, distribution of an asthenosphere and the sulfides fields connected with upwelling of an asthenosphere is shown. Rift structures are emphasized in deep basins and interarc troughs. A rupture of lithosphere continuity, rifts, tholeiite effusions and formation of sulfides are developed where the asthenospheric diapirs rise to the crust.

The tectonic processes in deep basins of margins seas are apparently analogous to the processes active in the mid-oceanic ridges. Manifestations of hydrothermal activity are restricted to active interarc troughs (Mariana and Lau troughs) and deep basins like the Okinawa basin. Beneath these structures the asthenosphere is closest to the crust (depth of 10-20 km). Upwelling of an asthenosphere to a crust leads to lithosphere split, formation rifts on a surface, to erupt of basalts and formation of sulfides deposits. Modern and ancient rifts structures can be objects of detailed geological researches for discover of new sulfides fields.

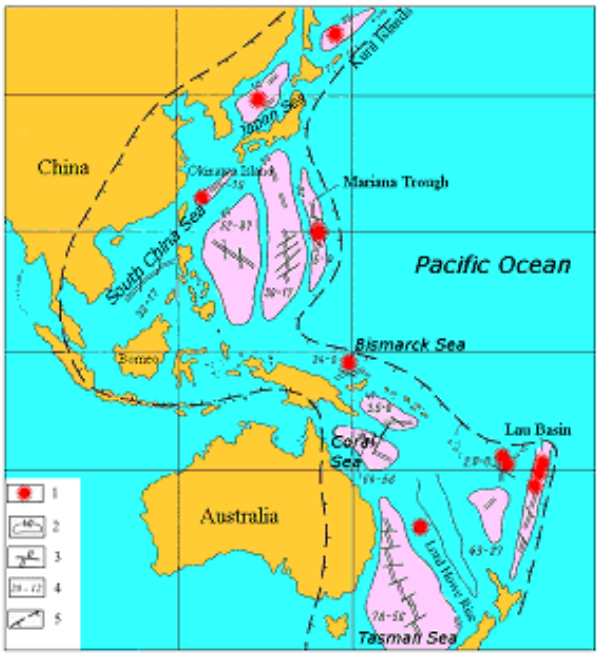

Figure 1 – Correlation between deep processes in asthenosphere and hydrothermal activity in the crust. 1 – hydrothermal processes as sulfide activity, 2 – depth of deep basins (numerals on isolines designate a *depth to the asthenospheric diapir's top), 3 - rift structures, 4 – formation age of deep basin (Ma), 5 - asthenospheric lens contours.*

Three orientations of geological correlations are considered (Rodnikov et al., 2010):

- Endogenic processes in the mantle, the upwelling of the asthenospheric diapirs towards the crust and formation of sedimentary basins. Phases of mantle out gassing and relation with hydrocarbon-bearing formation are studied.
- Correlations of endogenic regimes in the mantle

with the asthenospheric depth, composition and time of eruptions of basalt magma.

- Endogenic processes and hydrothermal activity. The interrelation is established: upwelling of hot asthenosphere to the crust – formation of the magmatic centers – formation of rift structures in the crust – eruptions of basalt magma - hydrothermal processes – formation of sulfides.

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APPLICATION OF AEROPHOTOGRAMMETRY FOR MONITORING SURFACE SUBSIDENCE DUE TO UNDERGROUND COAL MINING

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KEY WORDS: surface subsidence, underground mining, aerophotogrammetry.

INTRODUCTION

Velenje Coal Mine is one of the largest and most modern deep coal mining sites in Europe. The thickness of the coal deposit ranges from 20 m to 160 m. The coal layer is 100 m thick at the depth of 400 m and the greatest amount of the coal can be found at the depth of 290 m. The mining method used is known as Velenje Mining Method (VMM) and is unique in world mining technology (Medved & Golob, 2011). The VMM is characterized by continuous caving-in of the hanging wall layers and the length of longwalls amounts from 80 m to 210 m and the length of panels varies from 600 m to 800 m. Underground coal mining excavation leads to surface subsidence. Thus Velenje Coal Mine predicts and monitors surface movements by standard methods. In order to upgrade and improve existing methods, we studied the usefulness of aerophotogrammetry for monitoring surface subsidence in the area influenced by mining.

MEASUREMENTS AND ANALYSES

The impact of mining excavation reflects on the surface soon after excavation and reaches 90% of its final value of approximately three months after the excavation is finished. Measurements to determine the movements of grounds cover geodetic measurements of planar and height networks. Further, our own computer model for predicting the movements of the surface is used. The basis of this complex model is consolidation model and statistical analysis of measured subsidence. With the development of photogrammetry the useful engineering applications became possible. Aero-photogrammetry is part of photogrammetry, where the camera is placed in the air and images of Earth's surface are taken. On the basis of this images a digital elevation model (DEM) is produced (Kraus, 2007). With the desire to upgrade the methods used for monitoring and prediction of subsidence and to gain additional experiences, aerophotogrammetry of smaller area was conducted.

As experimental polygon the area of excavation plate G2C was used. Excavating of plate G2C began in 05/16/2010 and finished in 01/31/2011. G2C plate was horizontal with dimensions 200 m x 700 m with average height of 5.2 m and 220 m below surface (Mining Project - G2C, 2010). Aerophotogrammetric measurements were made in April 2010 and April 2011. From each term measurements a DEM (Figure 1a) and further a triangulation irregular network (TIN) (Figure 1b) were created for the representation of a surface. With mathematical operations between these two TINs, values of subsidence in approximately one year were determined (Figure 1c). In areas, where vegetation is low (tilled ground, pasture) acquired DEM is practically identical to digital terrain model (DTM). On the contrary, in the forest areas the difference between DEM and DTM could be enormous. With appropriate filters that eliminate points on vegetation a DEM could be obtained. However, that was not our goal.

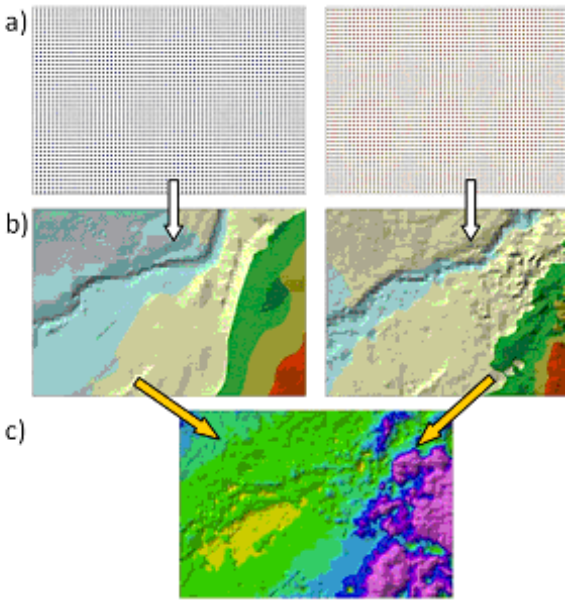

Figure 1 – Data processing: from points through TINs to computation of subsidence.

On figure 2 a comparison between calculated values of subsidence determined from TINs (colour plot), geodetic observations (red points), which are conducted once a year, and predicted surface subsidence from a computer modelling (iso-contour in black) is shown.

From figure 2 a typical elliptical surface subsidence trend due to horizontal rectangular panel underground excavation is evident. The maximum values are characteristic for panel centre, then decreasing towards the edges and in a certain distance subsidence is equal to zero. Subsidence values in the central area of excavation panel obtained from aerophotogrammetry range from 1 m to 5 and more meters, which correspond well with point observations (subsidence of point B4 in the centre is approximately 4 m). The maximal subsidence values from computer modelling are 3.6 m. It is necessary to add that the aerophotogrammetric and geodetic observation results comprise the overall subsidence impact of all previously excavated plates in this area, whose influence on the surface is not yet completed (in particular plate G2B, which excavation started on 06/26/2008 and finished on 05/21/2009). In the north-eastern part of acquired aerophotogrammetrical data an anomaly with subsidence values higher than 20 m (Figure 2, brown colour) and also the rising of the terrain for more than 20 m (Figure 2, white and rose colour) is visible. The reason of this anomaly is the ground overgrown by forest and the aerophotogrammetrical records represents the height of trees. Thus, in this part interpretation of aerophotogrammetrical data is not possible.

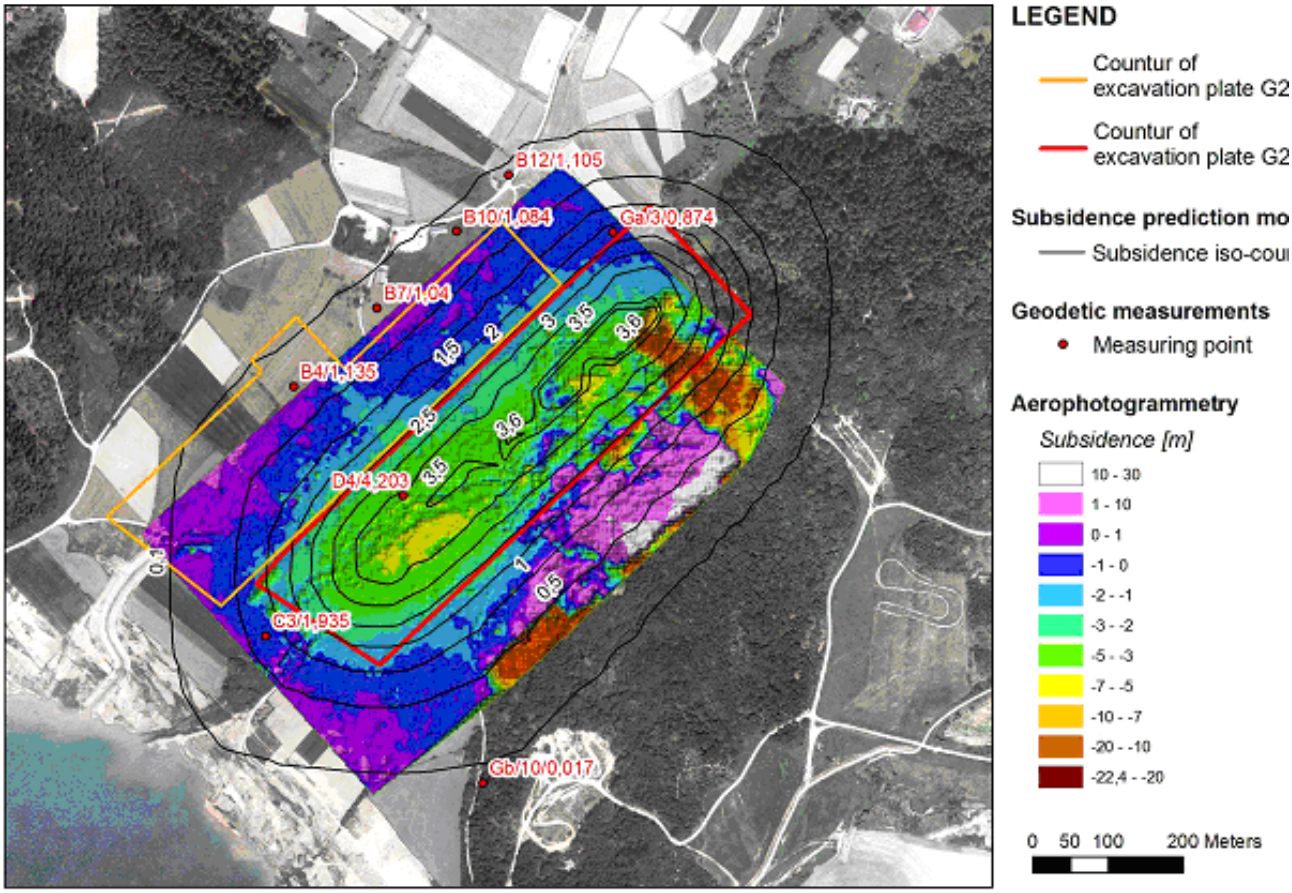

Figure 2 – Comparison between calculated values of subsidence determined from aerophotogrammetry, geodetic observations and predicted surface subsidence from a computer modelling.

CONCLUSION

We can conclude that in general in the areas with no or low vegetation coverage aerophotogrammetry is useful for monitoring surface subsidence due to underground mining. In forest area this method is not effective. As an alternative method, the LIDAR (LIght Detection And Ranging) may be mentioned, which can discriminate between intermediate surfaces like vegetation coverage and hard ground. However, in comparison with described aerophotogrammetry method, LIDAR is much more expensive.

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MICROTREMOR HVSR STUDY IN THE AREA OF ŠALEŠKA VALLEY

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KEY WORDS: Coal mine, Horizontal-to-vertical spectral ratio, Microtremors, Seismicity, Site fundamental frequency.

INTRODUCTION

The Šaleška Valley is located in northeast part of Slovenia and boasts the largest Slovenian coalmine Premogovnik Velenje – Velenje Coal Mine, which is one of the largest and most modern underground thick layer coal extraction mines in Europe and has been operational for more than 135 years. The results of the existent micro-seismic monitoring system of the Velenje Coal Mine shows that at most seismically active days three to five seismic events occur with maximum peak particle velocities from 2–3 mm/s at frequencies of 2-4 Hz. These tremors don't cause damage to the buildings, as they are much smaller then allowed values according to the safe vibration limit standards. In order to find out if the effects of seismic tremors on the buildings are in relation with a site's fundamental frequency, the site fundamental frequency was determined.

MEASUREMENTS AND ANALYSES

First applied by Nogoshi and Igarashi (1970) and made well known by Nakamura (2000) the use of the horizontal-to-vertical spectral ratio (HVSR) method to derive the fundamental frequency of soft sediments overlying bedrock has become increasingly popular because of its simplicity in terms of application and its low cost. The HVSR value at each frequency is defined as

$$HVSR(f) = \frac{\sqrt{H_{NS}(f) \cdot H_{EW}(f)}}{V(f)}$$

where H and V denote the spectra of the horizontal (North-South and East-West direction) and vertical components, respectively. An overview of the method was presented by Bard (1999).

Free-field microtremors measurements were performed by using portable Tromino seismographs (Micromed, 2005). Altogether, 159 free-field measurements were performed. The sampling frequency was 128 Hz and the recording length 20 min, which allows spectral analysis down to 0,5 Hz (SESAME, 2004). GIS was used for planning measurements and later for drawing maps.

RESULTS AND DISCUSSION

HVSR analyses of free-field measurements showed that most of them fulfil the criteria defined by the European SESAME project for reliable measurements (SESAME, 2004). The graph in figure 1 shows the experimental HVSR curve (in a red colour, the blue lines present the 95% confidence interval). The maximum HVSR value is 2,78 Hz and the standard deviation of that frequency peak is 0,02 Hz. Main difficulties in microtremor measurements arose from industrial noise (the Velenje Coal Mine and the Šoštanj thermal power plant) and complex local geology.

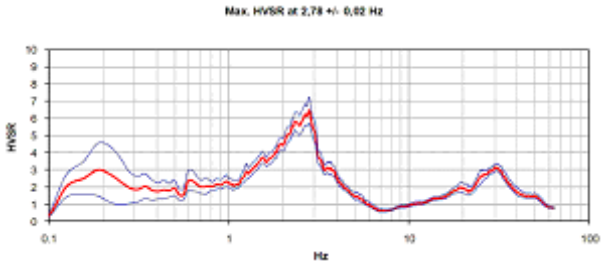

Figure 1 – Microtremor HVSR analysis.

On the basis of HVSR measurements the fundamental frequency map of sediments with a distribution in the range of 0,7 Hz in the centre of the basin to more than 10 Hz on the slopes of the surrounding hills was produced (Figure 2). The fundamental frequencies roughly coincide with the topography, surface geology and thickness of sediments. Further, we calculated the fundamental period of buildings relating in complaints from 2008 to 2010 by using equation (Gallipoli et al., 2010) and from that their fundamental frequency. Buildings locations with their fundamental frequencies are also shown in figure 2.

$$T[s] = 0,016\left[\frac{s}{m}\right] \cdot H[m]$$

In general, the majority of buildings, where the tremors are felt, are located on sediments. It is also noticeable that these locations are close to edges of the sedimentary basin, where additional seismic amplification due to wave-interference is possible (Pitilakis, 2004). Four building are located on grounds with a fundamental frequency of around 3 to 5 Hz which is approximately the same frequency range as of the seismic tremors. In this case there is potential resonance occurrence, which can result in the tremor amplitude amplification. Moreover, additional two buildings' fundamental frequency is similar to the free-field frequency, which can also lead to the resonance effect. In some cases relations between acquired frequency parameters do not show any conclusions. One reason could be the presence of inclined rock basement of the basin, which could result in shifting the tremors fundamental frequency and thus have unfavourable effect on buildings.

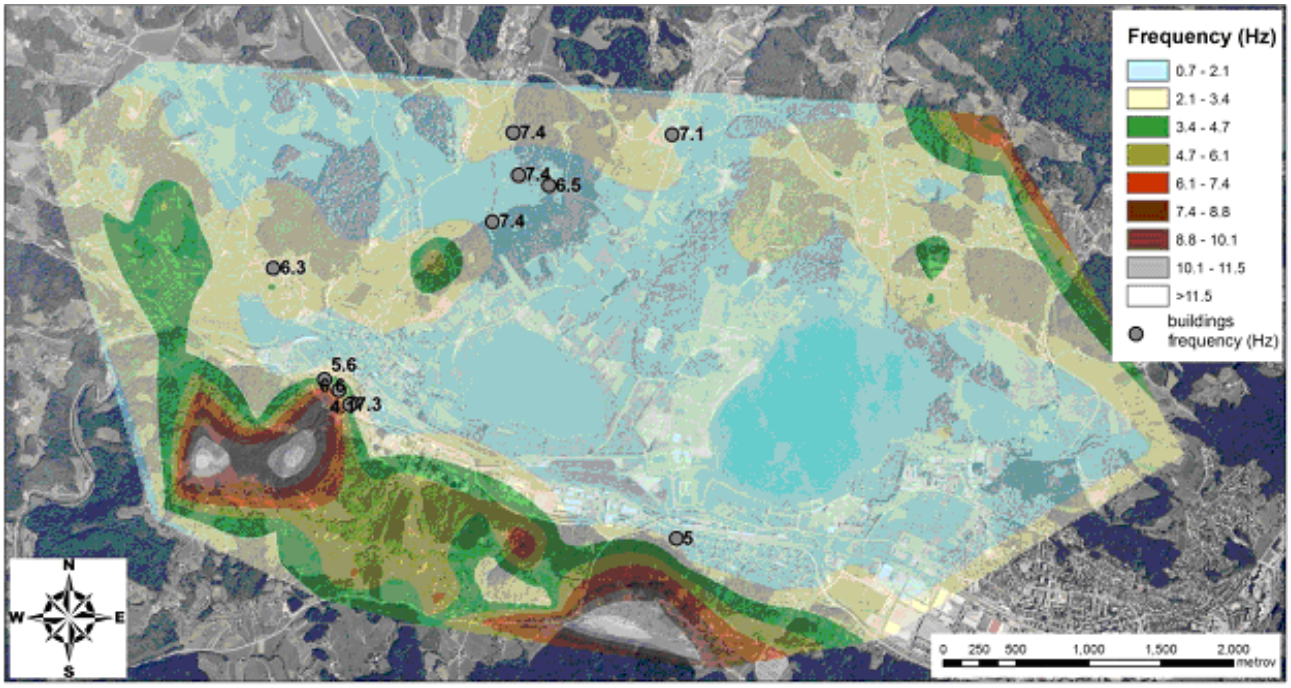

Figure 2 – Map of sediments fundamental frequency derived from free-field microtremor data and calculated fundamental frequency of appointed buildings (grey circles).

CONCLUSION

With known frequencies of seismic tremors and acquired data about the fundamental frequency of sediments in the wider area of the Velenje Coal Mine, together with known fundamental frequencies of certain buildings, it is possible to make a quick estimation of the seismic tremors' influence on buildings where tremors have been felt. The main factor for perceiving seismic tremors only in certain locations is certainly a complex geological structure.

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QUARTZ GRAVEL – RAW MATERIAL FOR MANUFACTURERS OF PHOTOVOLTAIC SOLAR MODULES AND SILICON WAFERS

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KEY WORDS: quartz gravel, silicon, photovoltaic, wafer.

INTRODUCTION

High-purity quartz is - due to its silicon - one of the most important raw materials of our time. In different degrees of purity, its silicon is used in metallurgy, photovoltaic, microelectronic, and as semiconductor. Because of the rapidly increasing demand for silica bearing raw materials, the prospection of high and highest purity quartz deposits is one of the main tasks of the department Economic Geology & Raw Materials at the Bavarian Environment Agency.

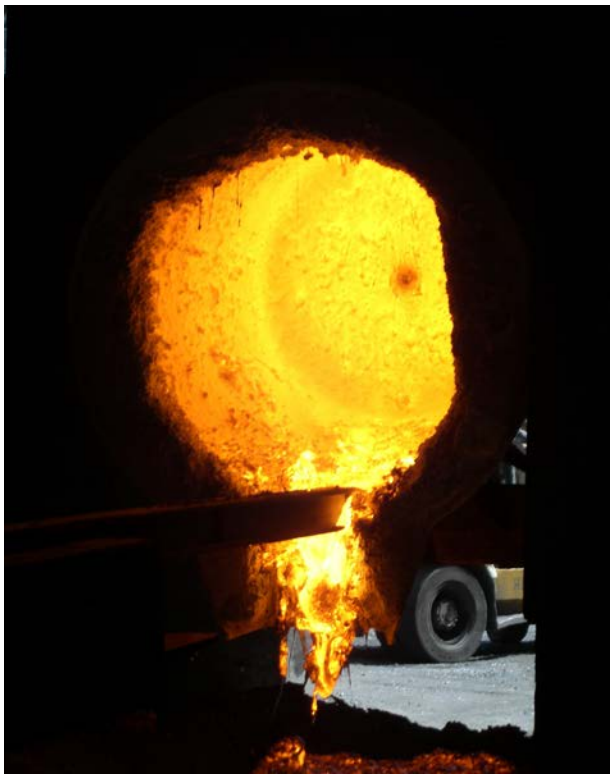

Figure 1 – The run off of hot fused silicon.

In Germany raw silicon is currently only produced in Pocking (Lower Bavaria). The raw silicon is produced by quartz gravels and pieces of quartz in an electric arc furnace at a temperature of about 2000 °C by presence of carbon.

DEMANDS AND APPLICATONS

The quartz gravel needs to have a grain size between 16 and 80 mm and has to meet the following criteria (in percent): SiO_2> 99.6, TiO_2 <0.008, Fe_2O_3 <0.05, Al_2O_3 <0.1 - 0.2.

Figure 2 – Quartz gravel.

Figure 3 – Raw silicon after the enrichment.

Silica with 98-99 % purity is used to produce silanes, siloxanes and silicones as well as in alumina refinement. To gain polycrystalline high purity silicon (99.99 % SiO_2) for solar grade silicon or monocrystalline high purity silicon (99.9999999 % SiO_2) for wafer production, the raw material is cleaned in several processes.

Figure 4 – Silicon wafer and silicon single crystal.

Figure 5 – Solar modules.

PROSPECTIONS

High purity tertiary quartz gravels in sediments of Lower Bavaria have been prospected during the last 5 years. To prevent the impending shortage of quartz raw materials quickly, the prospection has been limited to three target areas with high quality quartz ("Haarschedler Schotter", "Ortenburger Schotter" and "Quarzrestschotter"). 36 wells were drilled there. Four places of high interest for the silicon industry were located.

At one location quartz gravel mining has already been started.

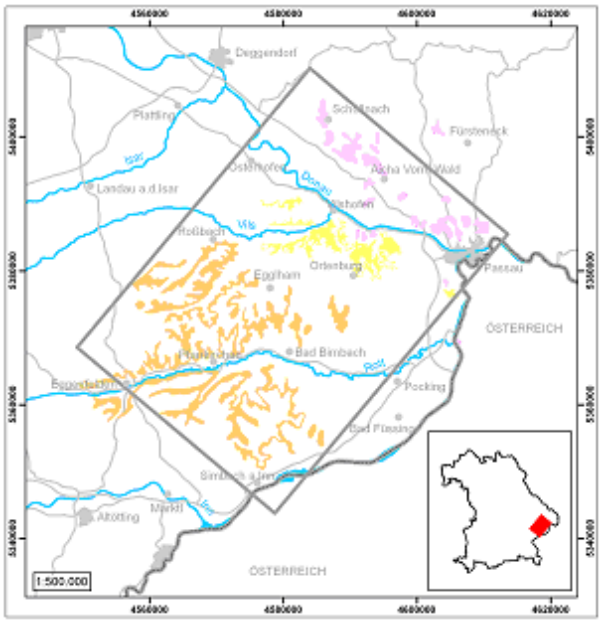

Figure 6 – Prospection areas in Lower Bavaria (violet = "Haarschedler Schotter", yellow = "Ortenburger Schotter", orange = "Quarzrestschotter")

ACKNOWLEDGEMENTS

We are grateful to the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology for financial support.

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MINERALOGY, FLUID INCLUSION AND SEM STUDIES AT DARREH-NOGHREH MINE, GOLPAYGAN, IRAN

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KEY WORDS: Fluid inclusion; SEM studies; Sulfid mineral; Darreh-Noghreh; Golpayegan

INTRODUCTION

The study area is located at the eastern longitude of 14º 50́ and the northern latitude of 32º 33́ at northwest of Golpayegan in the northern, which is a part of Sanandaj–Sirjan zone (Figure 1).

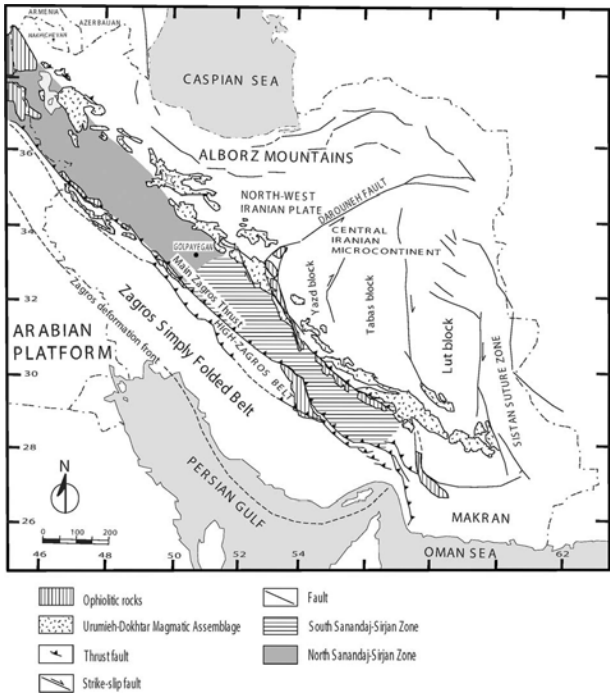

Figure 1: Map of Iranian geo-structure units and the location of the study area (Ghasemi&Talbot, 2005).

MINERALOGY AND SEM STUDIES

The exposure of different units, including Precambrian diorite and gabrodiorite, sedimentary exposures and Precambrian metamorphic rocks of phyllite and Quartzite (Shahrokhi, 2011). In order to get fresh samples, 20 samples taken from inside the tunnel at the SGS laboratory with ICP_AES analysis method. The average grade of lead was about 2%, over 0.5%, and the amount of copper and silver does not exceed a few PPM. The small amount of gold is also reported. The reticulum of minerals in Dareh-Noghreh revealed that there are a lot of different minerals including: pyrite, chalcopyrite, galena, sphalerite, bornite, hematite, goethite, limonite, iron hydroxides, malachite, azurite, and cerussite. (Figure 2).

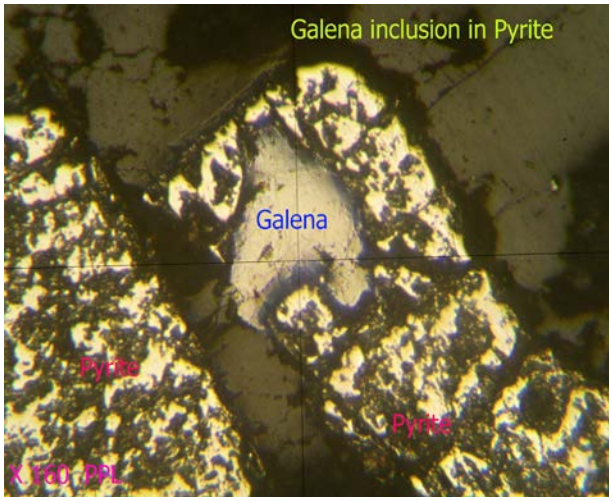

Figure 2: Galena inclusion in pyrite

Point analysis of pyrite, galena, silica and calcite veins was performed using SEM. Based on these studies; there are the elements of copper, lead and zinc along silicic vein (Figure 3).

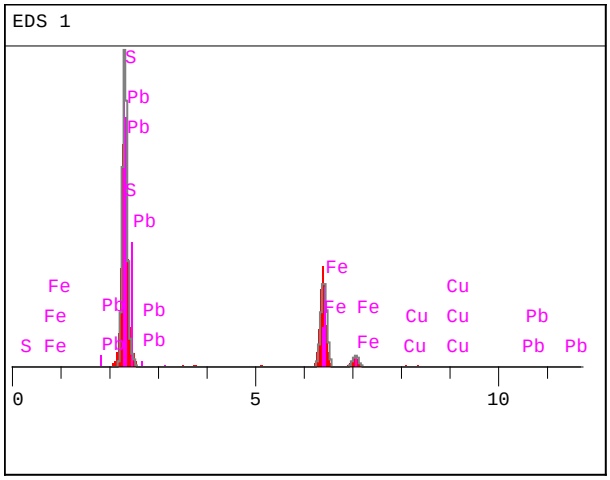

Figure 3: conclusion of SEM and presence of CU, Pb, Zn and Fe with Si-vein.

FLUID INCLUSION STUDIES

There were four types of fluid inclusions in the samples of the study. In this study, type A, two phase

fluid inclusions were employed(Figure 4). According to studies conducted on samples, the amount of TM is variable and ranges from -4.5 to -0.2. So, salinity in the studied samples ranges from 0.33 to 7.33 of Wt%NaCl On average.

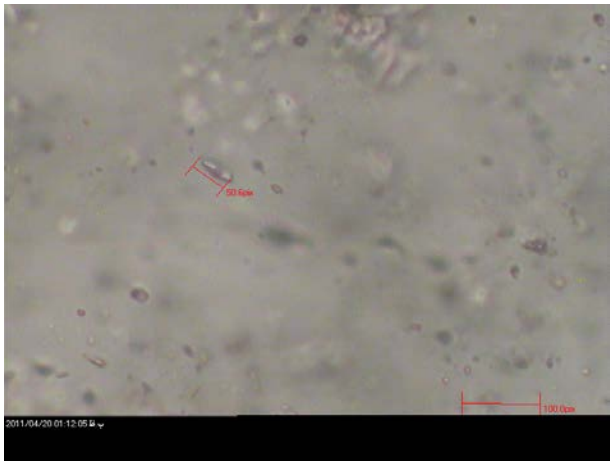

Figure 4: primary and two-phase fluid inclusions on the presence of gas and liquid phases in them

On the other hand, the Gunter et al (1983) and the homogeneous temperature and salt concentration can be used t calculate the boiling depth or the depth of trapping in fluid inclusions.

In studied samples in homogenization temperatures of two-phase fluid inclusions is measured by converting steam to liquid. And in samples containing high vapor, it is measured by converting liquid into homogeneous vapor. The histogram of homogenization temperatures is changing between 165 to 355° C for different groups. The most frequent homogeneous temperature ranges between 215 to 235 ° C. The boiling depth also ranges from 200 to 1600 ° C. Three types of fluid inclusions were identified in this study. The first had an atmospheric source. The second group which can have a magmatic origin regarding the presence of penetrating mass with the same age as mineralization and the low salinity of fluids. The third group of fluids included mixed and intermediate fluids that seem to have caused mineralization in this area. In fact it can be concluded that a mixture of magmatic and atmospheric waters has caused a decrease in the temperature of mineralizing fluids which has made the instability of complexes containing lead, zinc, and copper ending in mineralization. As a result, based on diagram 5, despite the opinion of Baharvandi, et al (2010), who considered the mineralization of the area of the MVT type, almost all the studied samples were in the epithermal category. This conclusion is compatible with the field evidence, microscopic analysis, and isotopic studies. This study indicated that none of the samples is even in the vicinity of the MVT range.

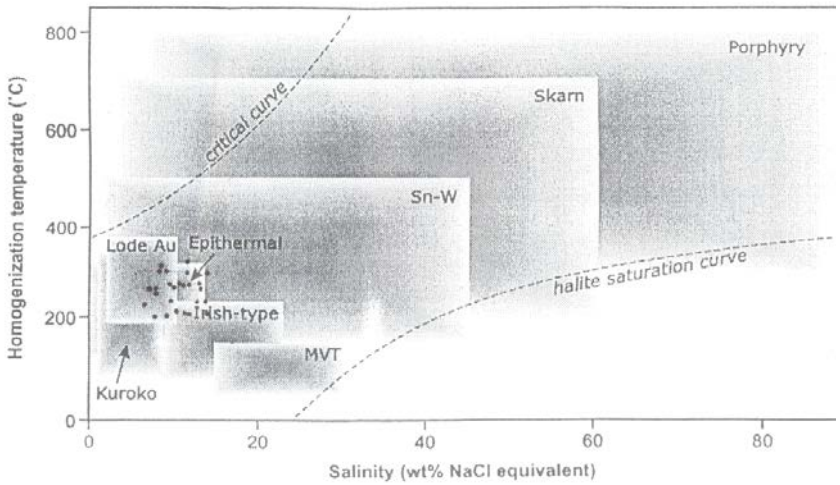

Figure 5: Homogenization temperature graph compared with related salinity and mineralization (Wilkinson, 2001)

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HIGH PURITY LIMESTONE OF FRANCONIAN JURA - THE IDEAL RAW MATERIAL FOR PAPER INDUSTRY

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KEY WORDS: limestone, paper industry, slurry, Franconian Jura.

INTRODUCTION

Limestone (calcium carbonate) occurs throughout the world and is readily available. This explains why it has been among the most widely used raw materials for more than 5,000 years. However, the mining of high-quality limestone is possible only in a few deposits world-wide. Extraction is only worthwhile if the purity, whiteness, thickness and homogeneity of the stone is appropriate (like limestone in Haunsheim quarry, Fig. 1), and even then intensive treatment is necessary to process top quality natural calcium carbonates (ground calcium carbonate (GCC)). Precipitated calcium carbonate (PCC) is a synthetic calcium carbonate, which in most cases is produced industrially by means of recarbonization (high energy costs !).

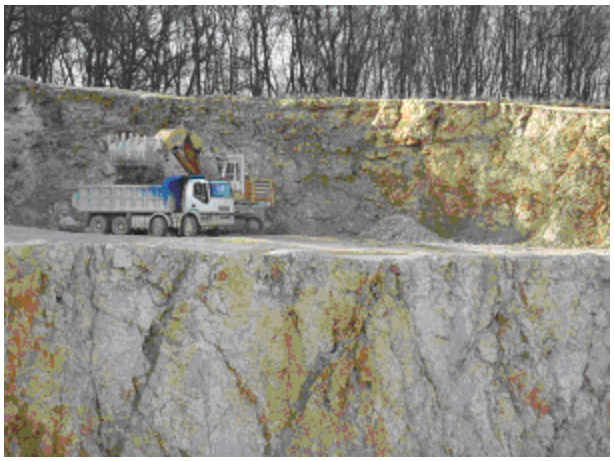

Figure 1 – Limestone mining in Haunsheim quarry (Bavaria).

Limestone (see Fig.2) has a wide range of applications. There is a tailor-made product for each application in the plastics, paint/coatings/adhesives industries as well as construction, environment, agriculture, food and pharmacy, where fineness and particle size distribution are optimally balanced for whatever the special purpose happens to be. One of the most important user is the paper industry, where this special limestone (GCC) is used in various applications. Because of the rapidly increasing demand for top quality limestone for paper industry, the prospection of high and highest purity limestone deposits (see Fig. 4) is one of the main tasks of the department “Economic Geology, Raw Materials” at the Bavarian Environment Agency.

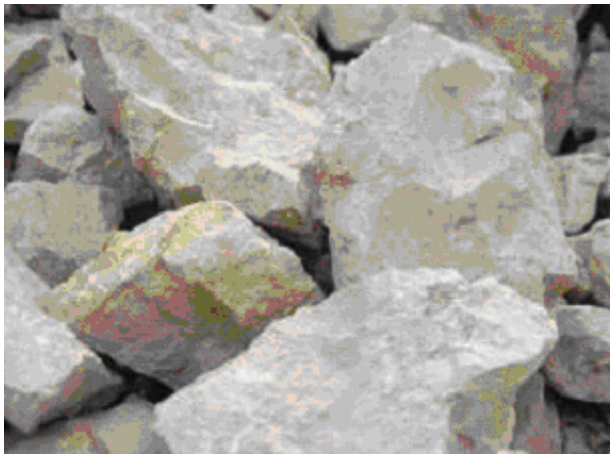

Figure 2 – Pieces of white limestone.

DEMANDS AND APPLICATONS

Limestone (GCC) for paper industry has to meet the following criteria (in percent): $CaCO_3$ > 98.5, SiO_2< 1.0, Fe_2O_3 < 0.3 and the colorimetric values (whiteness) L > 91, a < 0.6, b < 7.0 (see Fig. 3).

Figure 3 – Spectrophotometer for whiteness measuring.

Limestone for use as paper fillers and paper coatings is produced by dry grinding the limestone to a fine powder. It might be then further refined by air classification. Particle size range from relatively fine grades, with maximum particle size of 50 microns and 50 % less than 2 microns (paper fillers), to very fine grades with maximum particle size of 10 microns and 90% less than 2 microns (paper coatings). Limestone powders are transported in water based slurry to the paper manufactories.

PROSPECTIONS

High purity limestone in sediments of Franconian Jura has been prospected during the last 10 years. To prevent the impending shortage of “paper limestone” quickly, the prospection has been limited to seven target areas with high quality limestone (Malm Epsilon compact limestone). 39 wells with a total length of 1935 meters were drilled there. Six places of high interest for the paper industry were located (Fig. 4).

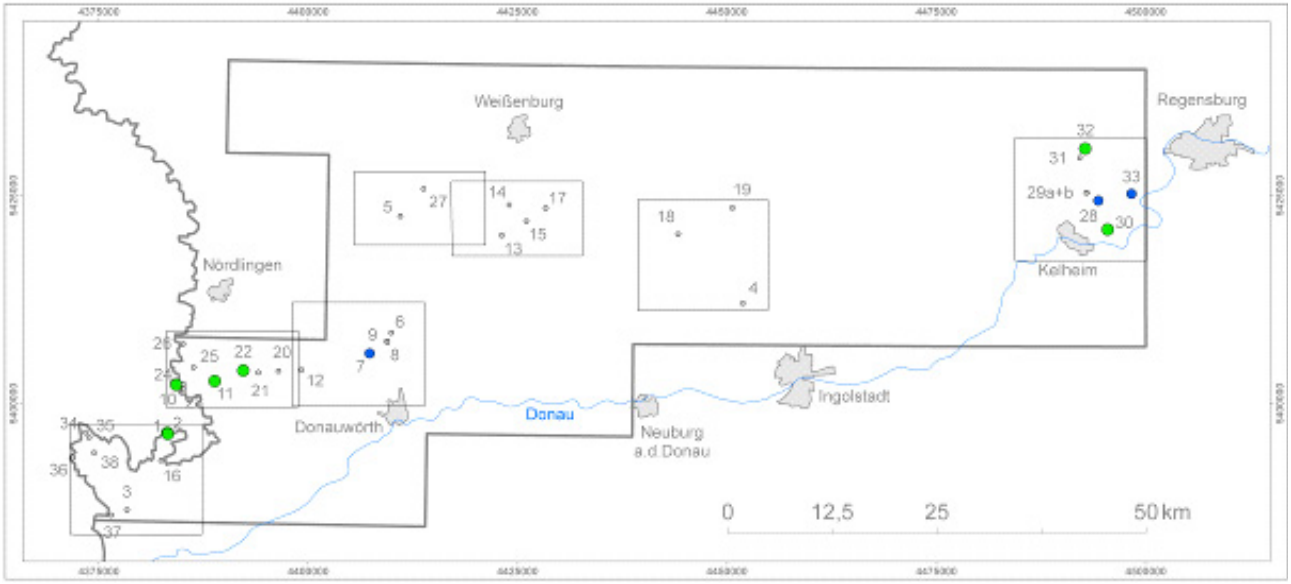

Figure 4 – Prospection areas in Franconian Jura, Bavaria (green point = limestone of top quality, blue point = limestone of good quality, black points = limestone of normal quality).

ACKNOWLEDGEMENTS

We are grateful to the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology for financial support.

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LEVEL II SEISMIC MICROZONING IN THE SAN GIMIGNANO AREA (CENTRAL ITALY)

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KEY WORDS: Seismic Hazard, Seismic microzoning; Geological mapping; Geomorphological Mapping; Geographic Information System;

1). INTRODUCTION

The availability of succeeding tools to be used in the field of the mitigation of natural risk effects is strictly linked to the evolution and progress of scientific knowledge and the adoption of a multidisciplinary approach in order to analyze the complexity of natural phenomena. Recently, Guidelines for Seismic Microzoning have been published by the Italian Authority (GDL Microzonazione Sismica, 2008). Utilising a multidisciplinary and multiscale approach, three levels in seismic micro-zonation have been established. The levels are defined by an increasing degree of details, weight and quantification. In particular, Level I aims at the identification and mapping of areas characterized by homogeneous seismic behavior (stable areas, areas where 1-D stratigraphic amplification effects may occur) or areas where the possible presence of more complex seismic phenomena requires more detailed analyses (2D modeling, etc.). At Level I, only qualitative indications are provided. Level II provides quantitative estimates (amplification factors FA) for each of the areas mapped at Level I. More detailed investigations for specific zones (seismic response studies) are provided at Level III.

Here we present an example of application of the Microzoning guidelines aiming at the definition of the Level II seismic microzoning map. The case study is the historical town of San Gimignano (Tuscany, central Italy) and the surrounding slopes. The study was carried on in the frame of a wider scientific project (RiSEM) funded by the Regional Government of Tuscany (FAS funds) aimed at the seismic risk assessment of the monumental Middle Age heritage in San Gimignano. A key element of the present analysis was the systematic use of cost effective procedures that make the present study a useful test for future applications to smaller municipalities where available funding can be very scarce.

A basic element of seismic microzoning is the definition of the geological and geomorphological model of the studied area. This model was determined by:

a) Acquisition and processing of available topographical, geological (surface and subsurface) and thematic data

b) Geological field survey and photo-interpretation

c) Creation of a synthetic map of geological, geomorphological, and geotechnical data including the subsurface geological model

2) Extensive seismic characterization of the explored area (resonance frequency, representative V_S profiles) monitoring the ambient vibration (single station and array configurations)

3) Creation of a GIS based geodatabase where geological, geomorphological and geophysical information are stored.

4) Integrated elaboration of geological and geophysical data using a spatial analysis technique to create a Level I map

5) Creation of the Level II map by developing specific correlation rules between available observations and representative FA values (abacus) by the use of 1D modelling.

2). THE GEOLOGICAL AND GEOMORPHOLOGICAL MODEL

Collection and validation of any pre-existing geological and geomorpholological data was carried out with an extensive inquiry at the municipality, county and regional archives; data were digitized and geo-referenced in order to verify and validate their coherence. A preliminary geological map was drawn. A series of cross sections relative to the subsurface geology (with the indications of top and bottom of the different geological layers) was produced in this phase.

The map was used to drive new geological and geomorphological field investigations and photo interpretation studies. Main outcrops of the expected seismic bedrock and softer deposits were mapped in this phase. Major attention was paid to the identification of landslides potentially active under seismic loads and to possible active faulting processes. Acquired data were re-interpreted in order to determine the main geological (buried morphology of the seismic bedrock, main lithological contacts), and geomorphological (landscapes, landslopes, etc.) features of the area.

Single station ambient vibration measurements (HVSR technique) were extensively performed in the whole area. These measurements aim at the identification of seismic resonance phenomena and the assessing of resonance frequency of shallow deposits.

Array measurements of ambient vibrations (ESAC technique) were performed at a number of sites in order to assess surface waves dispersion curves for the main geo-lithological units. These curves where jointly inverted with HVSR data in order to estimate the representative V_S profiles. This information was use to infer buried morphology of the seismic bedrock in the whole area by considering geological constraints and resonance frequencies estimated by the HVSR survey (Figure 1).

These data were later organized in a spatial database structured taking into account the reccomendation provided by the Italian Civil Protecion Organization (Standard Di Rappresentazione E Archiviazione Informatica), and according to "Data Specification on Geology", recently published by the INSPIRE board (section library http://inspire.jrc.ec.europa.eu/index.cfm/pageid/6).

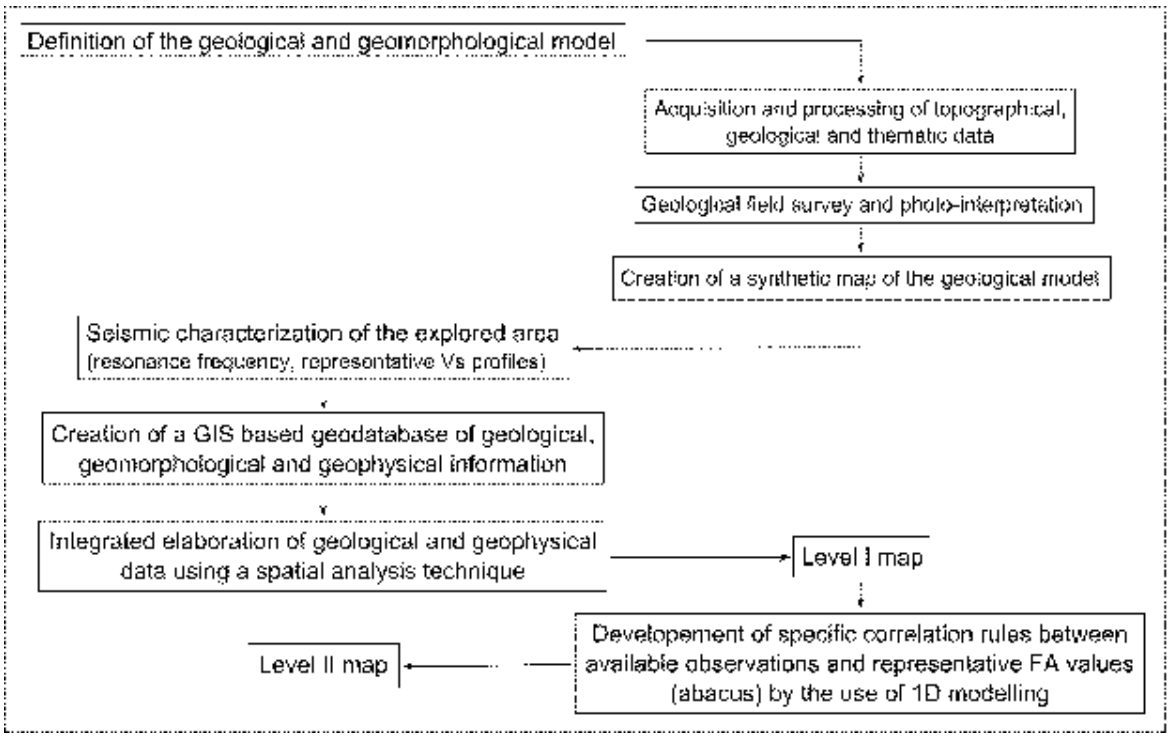

Figure 1 – Flow chart of the activity carried on for Level I seismic microzoning in San Gimignano (Italy)

The following thematic maps were produced:

- Location of geological/geotechnical and geophysical data (boreholes, mabinet vibration measurments, etc.)
- Geological and geomorphological map
- Geological cross sections
- Engineering Geological map
- Level I Microzonation of the area (i.e. a map indicating geometries of the areas characterized by a homogeneous seismic behaviour).

The procedures for this map are based on a reclassification of the stratigraphical units and using techiques of generalization and spatial analysis.

2). LEVEL II MICROZONING

By considering available geotechnical and geological information and V_S profiles deduced from borehole (down-hole configuration) and inversion of ambient vibration measurments, a set of V_S profiles representative for the different zones of Level I map were developed. A site-oriented seismic hazard evaluation was then perfomed in order to deduce magnitude/distance pairs representative of local hazard (disaggregation analysis). With this information, numerical modelling of expected seismic response in the seismic microzones was computed by 1D modelling. To this purpose, in order to account for actual uncertainties and lateral variations in the same microzone, the STRATA software was considered to deduce the relevant FA values. The results of this analysis were used to provide Level II map of the S.Gimignano area.

ACKNOWLEDGMENTS

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TIME-SEISMICITY EVOLUTION AND SEISMIC RISK ASSESSMENT IN THE ARABIAN PLATE

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Key words: *Arab plate, seismicity-time evolution, seismicity risk map.*

The Arabian plate roughly appears as a polygon, located between the major African plate (including Nubian and Somalian ones), and Eurasiatic and Indian plates, respectively. It is delimitated by the Red Sea in the South-West, the Aden Gulf in the South, and the Zagros and Taurus chains in the North and North-East, respectively.

Dead Sea Fault, the North continuity of the Red Sea, and the Syrian rift, which links the rigid Arabian plate to the mobile ophiolite belt of Cyprus-Southern Turkey, plays an important role in the regional geodynamic structure. They make, with their related fracture system, the Arabian plate a seismic centre. The time- seismicity evolution, and the assessment seismic risk implications, concern an important research subject.

The movement rate-displacement, calculated by different methods, varies from 2 to 6 mm/year. This rate increases from 2-3mm/year in the North, to 6mm in the South. These estimations are confirmed by historical seismic data, the recent seismic recorded by the Arab seismic centers, and physical effects on the building structures in the region.

Historical and recent seismic data recorded in the seismic centre show that the seismicity in this plate tends to fade out with time (Fig.1).

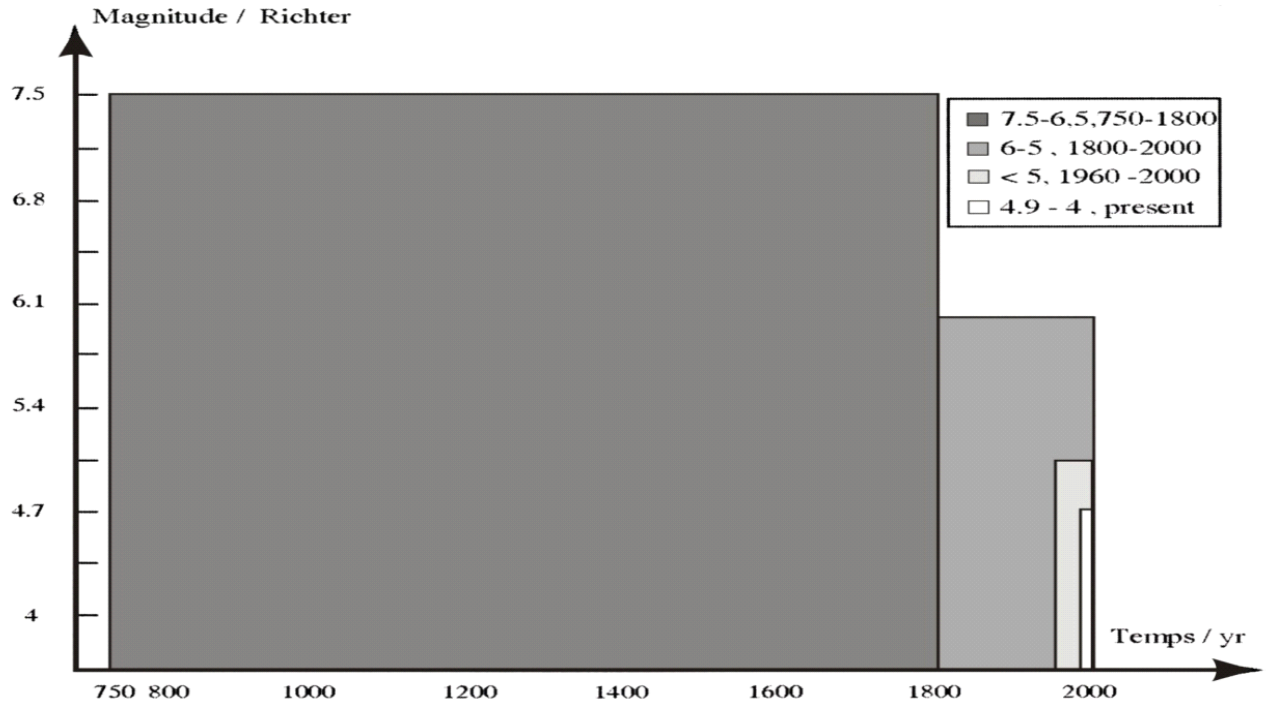

Fig.1. Seismicity – time evolution, after their magnitude and their age.

Using seismic data, and tectono-geodynamic analysis, a seismic zoning map is established (Fig.2).

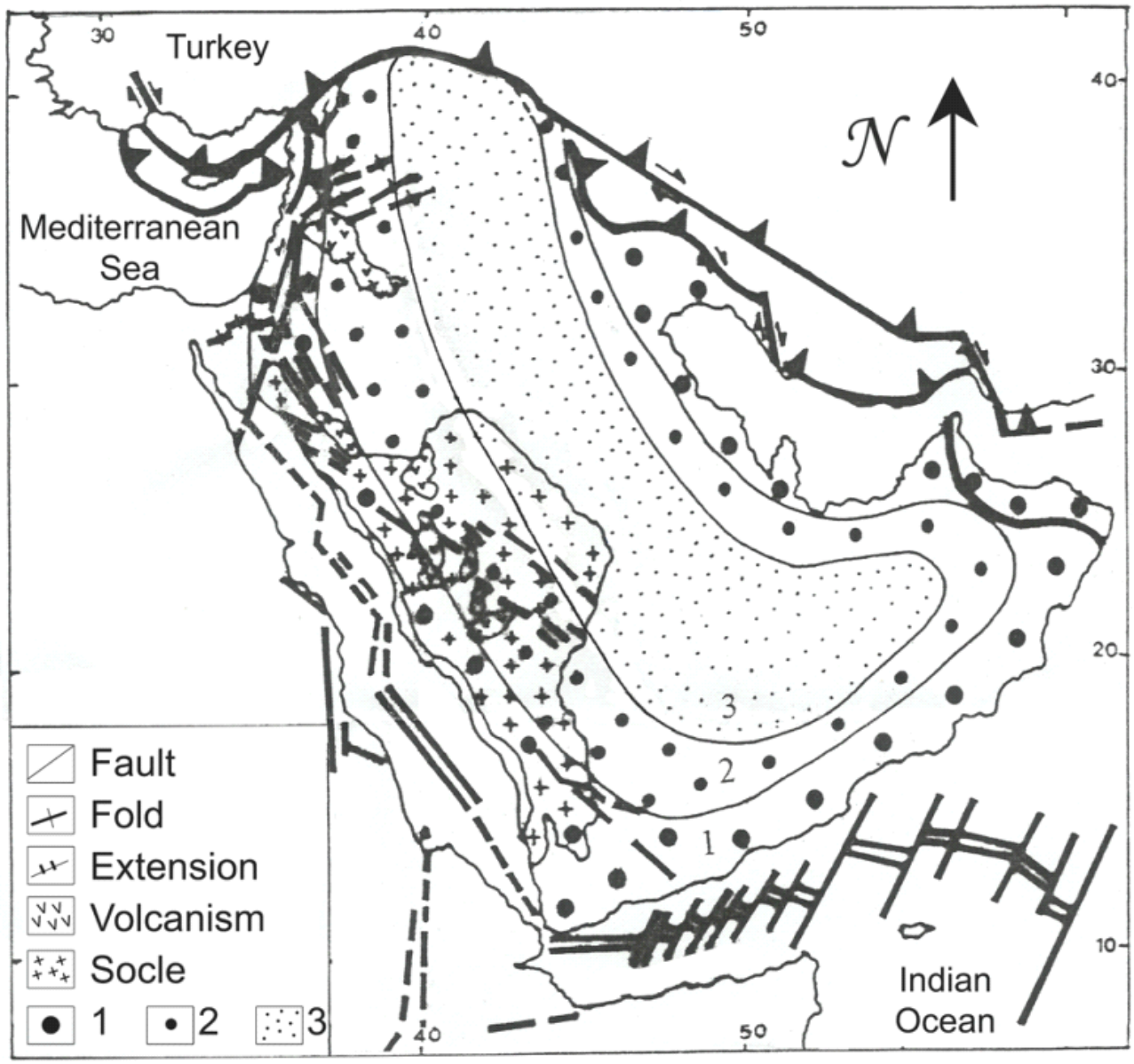

Fig2. A seismic zoning map of the Arab plate. Zone 1, the highest seismic intensity zone; zone 2, the intermediary one, and zone 3, the lowest one.

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FROM DRAWING ANTICLINE AXES TO 3D MODELLING OF SEISMOGENIC SOURCES: EVOLUTION OF SEISMOTECTONIC MAPPING IN THE PO PLAIN

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KEY WORDS: 3D geological modelling, seismogenic sources, slip rates, Northern Apennines thrust fronts, Po Plain.

INTRODUCTION

The Northern Apennines fold-and-thrust belt developed since Neogene with a NNE convexity and vergence, and includes a frontal belt buried under the alluvial sediments of the southern Po Plain (south of the Po River), and an outcropping belt exposed in the mountain chain. The Po Plain is a sedimentary basin filled with a thick syntectonic sequence deformed by blind thrusts and folds that controlled the deposition of the sedimentary wedges, with the Plio-Quaternary sequence locally up to 7-8 km thick. The fast sedimentation hid the growing structures, and, as a consequence, today there are few direct surface evidences of the possible ongoing activity of the thrusts. The buried thrust front of the Northern Apennines shows three main folded arcs, from west to east: the Monferrato arc that underwent the minor amount of shortening; the Emilia arc, partly deformed during Messinian time and with its maximum activity during Middle-Upper Pliocene; and the Ferrara-Romagna arc, active since Late Pliocene.

Present-day activity of the buried Northern Apennines frontal thrusts is testified by historical and instrumental seismicity, the latter characterized by contractional focal mechanisms (European-Mediterranean RCMT Catalogue http://www.bo.ingv.it/RCMT/), by the influence on the drainage network (Burrato et al., 2003), and by folding and faulting of recent sediments in the plain and along the foothills of the mountain chain (Scrocca et al., 2007; Picotti et al., 2009). The historical and instrumental Italian seismic catalogues show that the southern Po Plain is affected by low to moderate seismicity (CPTI11 catalogue, Rovida et al., 2011; database ISIDe, Italian Seismological Instrumental and parametric database: http://iside.rm.ingv.it).

The recent relatively deep seismic activity of January 2012 although of moderate energy was widely felt all over the plain, and showed that potential sources of earthquakes are probably located also below the basal décollement of the Northern Apennines outer thrusts, a portion of the seismogenic crust that is poorly known due to the lack of data. However, these earthquakes highlighted once more the importance of identifying and characterizing the seismogenic sources, especially in areas such as the Po Plain where the exposure is high and hence also the risk is potentially high.

Borehole breakouts and focal mechanisms both show Shmax oriented perpendicularly to the trend of the buried thrust fronts (Heidbach et al., 2010), confirming that tectonic and seismic activity must be related to the ongoing Africa-Europe relative convergence that led to the build of the Northern Apennines chain. In this framework, GPS studies constrain a weak SW-NE shortening across the Po Plain, with rates of about 1 mm/a (Devoti et al., 2011). The shortening is accomplished in the frame of a CCW relative rotation of the Adriatic promontory respect to Eurasia, with a pole of rotation located in the western Alps. As a consequence the rates of convergence are expected to diminish westward in agreement with the observed lowering of the seismic moment release.

Due to the blind geometry of the outer Northern Apennines thrusts and related folds, these structures have been traditionally studied by means of the extensive oil exploration geophysical surveys, whose results were published in the form of structural maps of sedimentary horizons (e.g. the map of the base of the Plio-Quaternary sequence in the Structural Model of Italy, Bigi et al., 1990), or interpreted regional geological profiles (e.g. Pieri and Groppi, 1981; Fantoni and Franciosi, 2010).

More recently, the rich subsurface dataset acquired in the framework of the new geological mapping was used to produce maps of recent sedimentary horizons younger than 1 Ma (R.E.R. and ENI-Agip, 1998) that highlighted in great detail the geometry of the buried structures and showed the potential for active tectonics studies.

Following this geological and geophysical background, the DISS database recognizes the activity of the Northern Apennines fronts and includes seismogenic sources that follow their pattern (DISS Working Group, 2010). However, while the geometry of the sources is well constrained by the available data, their kinematics (i.e. rate of deformation) is so far inferred from regional geodynamic and tectonic considerations.

METHOD

In this study we present 3D geological models of different sectors of the Northern Apennines outer thrust fronts, supporting the evaluation of their late Tertiary and Quaternary slip rates.

We reconstructed in 3D the subsurface geometry of pre- and syn-tectonic strata, using for the deep portion of the models structural surfaces derived from interpreted cross-sections (e.g. Fantoni and Franciosi, 2010; Toscani et al., 2006), constrained by the stratigraphy of deep oil well logs. The shallow portion of the models were derived by stratigraphic data used for the reconstruction of the regional aquifers (R.E.R and ENI-AGIP, 1998), further elaborated for the geological sheets of the Geological Map of Italy at 1:50,000 scale, and integrated with data of the Geognostic Database of Regione Emilia Romagna.

A decompaction workflow was applied to the 3D models in order to remove the effects of rock volume changes due to porosity reduction through time, and allowing a better definition of the tectonic strain. The horizons backstripping allows the underlying rocks to vertically decompact, as a result of the overburden removal . For our analysis we chose sections located in the central part of each thrust, in order to prevent the effects of curvature and reorientation common along the fault tips. For each section some structural culminations were analyzed in order to restore the observed deformations and to calculate the relative strain. To restore the displacement along the analyzed structures and to calculate the slip on the fault planes, we used different methods: for faulted horizons we used the fault parallel flow algorithm; for fault propagation folds, we used the trishear algorithm; and for the shallower and unfaulted horizons we used elastic half-space dislocation models of surface deformation. The horizons we analyzed are of Pliocene and Pleistocene age, including also the top of the Messinian deposits.

Our results indicate an increase of the slip rates toward the easternmost sections, in agreement with the GPS convergence data. Moreover, the reconstruction of the evolutionary history of the structural culminations both in the Emilia and the Ferrara arcs, highlights that the total deformation is partitioned among different parallel tectonic structures that are active alternatively during different time intervals.

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GEOLOGICAL BASED SEISMIC MACROZONATION FOR PYRENEES

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KEY WORDS: seismic hazard, site effects, shake-map, EC8, GIS mapping, Pyrenees.

INTRODUCTION

The Pyrenean Region is one of the highest seismic hazard areas in France and Spain. Many disastrous seismic events were related in past, e.g. the 1428 earthquake with an estimated epicentral intensity of IX in Catalogne, Spain. The recent seismicity is characterized by low-to-moderate magnitude events which can locally affect people located in urban areas as the 2006 Lourdes earthquake in France.

This study is part of the European project SISPYR, which aims at mitigating seismic risk in Pyrenees. Part of the work of this project consists in building an operating system able to produce real time Shake-Map for all Pyrenees. Actually, a reliable evaluation of ground motion shortly after a main earthquake is critical for an efficient organization of emergency services.

This system, based on the USGS ShakeMap tool (Wald *et al*., 2005), works as follows:

- acquisition of real strong motion data (PGA, PGV..) at bedrock condition
- acquisition of interpreted macroseismic data
- modelling strong motion parameters on the target area from a grid of regularly spaced stations
- ensuring consistency between measured and simulated data, bias correction
- taking account soil amplification
- producing maps

The paper presents the geological based method used for determination of site effects, necessary to take into account for local soil amplifications. This method follows the above steps:

- geological zonation according to geomechanical behaviour for basement and quaternary deposits for all Pyrenes
- definition of representative soil columns
- assignment of main soil classes from soil columns and EC8 building code
- mapping of soil classes on 500 m grid mesh
- attribuation of amplification coefficient from soil classes.

LITHOLOGICAL QUALIFICATION

For shake-map implementations, amplification factors are usually derived from Vs30 values (or classes) using, for example, Borcherdt (1994) method. The way we take is to consider the geological description attached to Vs30 classes as the proxy for evaluation of amplification factors.

We perform the geomechanical map of Pyrenees (or “site condition map”) from two geological maps describing Quaternary deposits and geological structure of Pyrenees at 1:400.000 scale (Courbouleix *et al*., 2008; Baudin *et al*., 2008). In the two maps, after analysing the materials, each geological unit is characterized by a qualitative soil class according to its genesis and its age. We define the following classification

- HR (hard rock) for Paleozoic, Mesozoic and Paleogene materials and volcanic rocks
- SR (soft rock) for Neogene deposits
- SRa (alterd rock) for altered granites
- SS (soft soil) for glacial, fluvial, alluvial and colluvial quaternary deposits
- VSS (very soft soil) for coastal, deltaic and swamp Holocene deposits

The result is a “2.5D” geomechanical classification map which represents a soil column zonation all over Pyrenees (Figure 1).

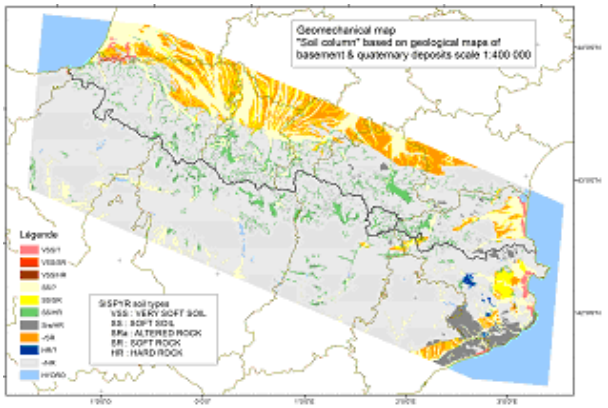

Figure 1 – 2.5 D Geomechanical map.

GROUND TYPE ZONATION

To account for the influence of local soil conditions on seismic ground motion, EC8 building code defines 5 main soil classes (A, B, C, D, and

E) based on lithological description of a soil column and on geotechnical or geophysical parameters (C_u, N_{SPT}, Vs_{30}). Following Convertito (2009) and from our experience of seismic microzonation in Pyrenees, we adapt this classification considering depths superior to 30 m. We modify the EC8 soil classes adding two classes B' and F corresponding respectively to deep tertiary basins lithologicaly described as soft rock (clays, marls) and deep soft or very soft quaternary deposits.

CHARACTERIZATION OF THE THICKNESS OF DEPOSITS

We use different approaches from both sides of the border to estimate thickness of superficial deposits:

- Deterministic approach in Spain
- Global GIS approach in France

In Spain, work is done at the polygon scale. Thickness is evaluated for each geological unit and for each location from bibliographic resources of different research groups and government agencies, supplemented with boreholes information. This work leads to a synthesis of Quaternary deposits and Neogene basins in the Iberian sector.

In France, the approach is based on the definition of the main geological domains of Pyrenees regarding of the depth of seismic basement. Information of classes of thickness of quaternary deposits is collected from the Pyrenean's quaternary map and from comparison of geological and quaternary map. Back analysis is built from boreholes database available in BRGM.

MODIFIED-EC8 MAP & SEISMIC LOCAL HAZARD

Finally, we assign the geomechanical classification defined in SISPyr project (A, B, B', C, D, E, F) to each polygon of both maps (Fr.Sp.), considering superficial geological formations and the vertical soil column concerned (Figure 2):

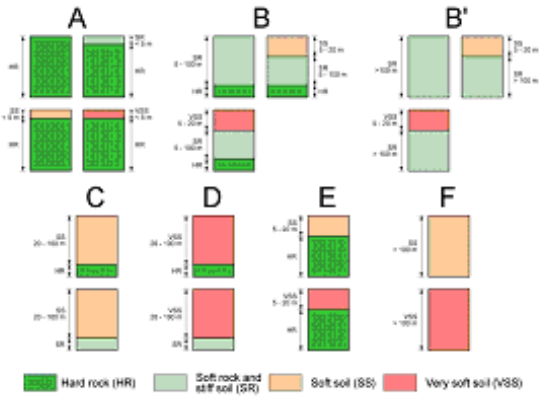

Figure 2 – SISPYR soil columns vs modified EC8 classes

A final step of validation and harmonization across the border leads to produce a final site condition map provided as a 500 m x 500 m grid for all Pyrenees (Figure 3):

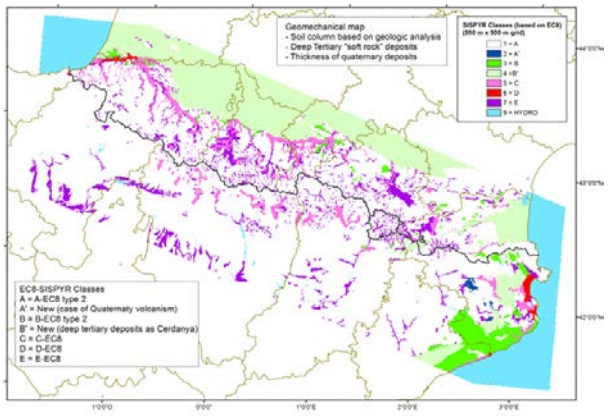

Figure 3 – Modified EC8 soil classes map.

Finally, to evaluate site effects, we propose to calculate the values at the surface from the strong motion data at bedrock condition via a computed amplification coefficient. The computation is done at each node of grid of the mesh, for all Pyrenees, according specific assignation of a response spectrum and amplification factors for each modified-EC8 classes.

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THE BUILDING UP PROCESS OF A MACROSEISMIC INTENSITY DATABASE

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KEY WORDS: intensity, macroseismic, databases, mapping, web-publishing.

INTRODUCTION

Since the late nineties Italy has a well-established tradition of making available on the Internet a national macroseismic intensity database. The last updated version called DBMI11 was released in December 2011.

By using this public database everyone can obtain information about the effects caused in a populated place by an earthquake of the past. A huge quantity of well organised historical information can be effortlessly retrieved and used as the background information of the seismic hazard assessment.

Other similar activities are carried out by the same DBMI working group: the creation of a trans-national European database called AHEAD (Archive of historical Earthquake Data) and the related effort of supporting the growth of other European intensity databases (Catalonia, Spain, Portugal, Greece and UK) and, at world-wide scale, the support for the "Global Earthquake History", the GEM (Global Earthquake Model) global component.

This presentation will describe how these databases are built, how they are structured and which tools are used both for managing data and for the Internet publication.

MIDOP, THE MACROSEISMIC INTENSITY DATA ONLINE PUBLISHER

One of the fundamental tools used by the working team while building up an intensity archive is MIDOP, a web application which allows users to publish their macroseismic intensity data-points following a standardised format. The process of publishing an interactive website only requires two tables in order to start: the list of events and the corresponding list of MDPs (Macroseismic Data-Points). The output website can be easily customized using a friendly control panel.

The tool was initially developed in the frame of the NA4 module "Distributed Archive of Historical Earthquake Data" of the EU NERIES Project (2006-2010), and it is now supported by the EU Project SHARE task 3.1 "European Earthquake Catalogue".

The underlying standard format for describing historical macroseismic intensity data is described in the NERIES NA4 Deliverable 4 and 7, dealing with the "European Macroseismic Database".

THE ITALIAN EFFORT, DBMI11

Thanks to the hard work of seismologists who have published many historical studies during these years, the newly released DBMI11, the 2011 edition of the *DataBase Macrosismico Italiano*, has greatly increased the number of archived earthquakes in the time-window from year 1000 to year 2006. From the last public release called DBMI04, the number of earthquakes has increased by 60% (now 1684) and the corresponding number of MDPs has increased by 50% (now 86,071).

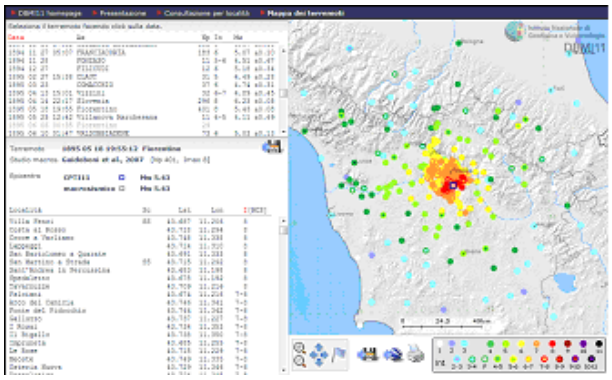

Figure 1 – A screenshot from the DBMI11, a query by earthquake example.

The database can be accessed through its website at http://emidius.mi.ingv.it/DBMI11. It can be queried by earthquake, selecting the event from both a list and using an interactive map, or queried by place, in order to retrieve the corresponding seismic history. Tables, maps and diagrams are all freely downloadable.

THE TRANS-NATIONAL EUROPEAN EFFORT, AHEAD

AHEAD is the European Archive of Historical Earthquake Data, through which researchers can easily: 1) trace back the information supporting each earthquake in order to reappraise and improve the knowledge of it; 2) compare the different studies on

each earthquake and select a preferred one; 3) help keeping the archive as much up-to-date as possible, commenting studies, data, and parameters and feeding it with fresh studies. AHEAD can be found at the address http://www.emidius.eu/AHEAD/ or by accessing the historical module of the European Earthquake Data Portal http://www.seismicportal.eu/ .

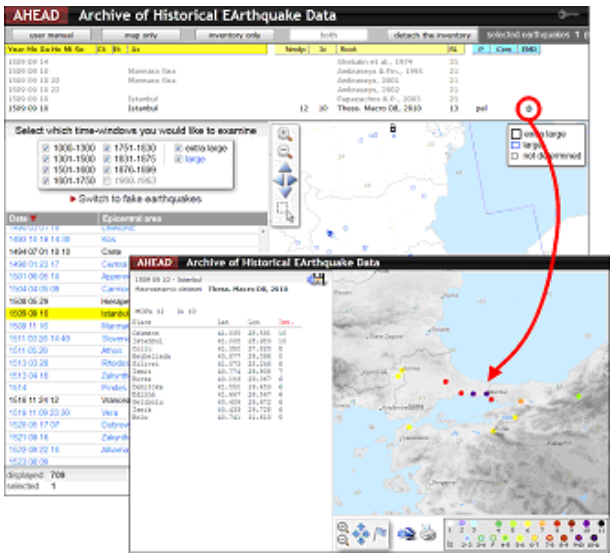

Figure 2 – The web interface of AHEAD, the Archive of European Historical Earthquake Data.

Among the activities of AHEAD, some energy is spent in order to keep some level of coordination among the European Institutions dealing with intensity data. Collaborations are on-going with Catalonia (IGC), Spain (IGN), Portugal (IM), Greece (University of Athens and Thessaloniki) and UK (BGS).

THE WORLD-WIDE EFFORT, GEM GLOBAL EARTHQUAKE HISTORY

One of the scopes of the GEM "Global Earthquake History" global component is to establish a distributed, online resource, called "Global Archive of Historical Earthquake Studies", where both reports and macroseismic data points can be uploaded, organized and made available to public. This resource will provide a framework for future development, so that the Global Earthquake History can be updated as new results become available. The task will mainly consider earthquakes with M ≥ 7.0 at minimum, in the time-window up to 1903; events with lower M will be included on a case by case, or region by region, basis.

ACKNOWLEDGEMENTS

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SEISMIC MICROZONATION AS A FUNDAMENTAL STEP TOWARDS SEISMIC RISK REDUCTION

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KEY WORDS: Seismic Risk, Microzonation, Urban Planning

RISK ASSESSMENT

Several decades ago UNESCO defined seismic risk as the combination of 3 factors: Natural hazard, Vulnerability of structures and lifelines, Exposition or the social and economic valuables at risk. However a common methodology to assess the risk, and in particular seismic risk, does not exist. One of the main reasons is that the seismic risk is a dynamic parameter strongly time and site dependent as the vulnerability and exposition are strictly related to the social and economic evolution of the region concerned. As an example let us consider the 3 most important recent earthquakes of Italy. The Friuli 1976, the Campania-Basilicata 1980, the 1997 Umbria-Marche. Besides the casualties, the economic losses of the first 2 earthquakes were mainly due to the building's vulnerability. The 1997 Umbria -Marche revealed the uprising of a new typology of risk linked to the relevant and increasing importance of the media: in few words, the images of the earthquake broadcasted worldwide froze for at least 3 years the main income source (the tourism) of towns of the region, like Assisi, that actually did not report damages because of the quake.

To cope with seismic risk everyone presently agrees about the relevance of GIS based methodology capable to compute and update the space-time dependent risk parameters and visualize the spatial relation between them. However to enforce a risk reduction program 2 factors appear to be essential:

- the awareness of the seismic risk must be spread to local authorities and population
- the risk scenarios, fundamental for prevention, emergency and recovery planning, should be based on reliable and statistically significant databases

THE ROLE OF SEISMIC MICROZONATION

In this respect the Terre di Castelli microzonation (that concerns several municipalities of Modena Province), established on the basis of the microzonation regulations of Emilia-Romagna region, performed by a trained geologists, supervised by Emilia-Romagna responsible persons and CNR seismologists, conducted with the full agreement of the municipalities and of Modena province, could be thought of as good starting point.

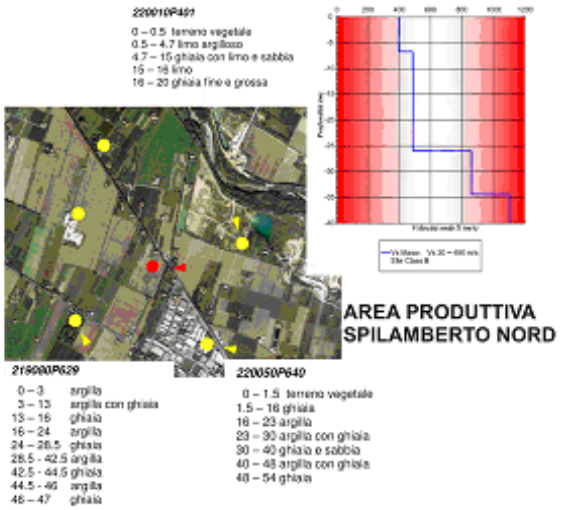

Figure 1 – Spilamberto spatial distribution of data.

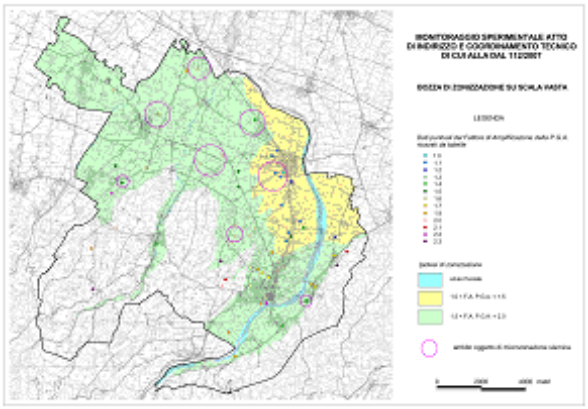

Figure 2 – Terre di Castelli zonation map

Besides the practical application for land-use planning of the area, the microzonation is also a test site to validate the microzonation regulations issued by the Emilia-Romagna region and could be a teaching example for similar projects. The

quality and the amount of data , together with the flexibility of the approach and the full involvement of local authorities could make Terre di Castelli the core of a more ambitious project of seismic risk reduction. To note that the term ambitious must be read as " project that doesn't remain on paper , but will be adopted to plan and reduce the seismic risk".

ACKNOWLEDGEMENTS

We are grateful to R. Pignone and L. Martelli.

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WEB-GIS APPLICATIONS FOR SEISMIC HAZARD ANALYSIS

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KEY WORDS: seismic hazard, Italy, webGIS, dissemination.

SUMMARY

Seismic risk analysis requires some input data, namely the seismic hazard at the site, the exposure and the buildings vulnerability.

While the evaluation of exposure and vulnerability generally pertains to economists and engineers (it includes evaluation of value, type and state of conservation of buildings or infrastructures), seismic hazard assessment is performed by seismologists which use information about past seismicity data, geological evidence, ground-motion attenuation models, to provide probabilistic evaluations on how often a shaking exceeding a given threshold will occur.

Our work is focused on the presentation of some tools designed for helping users in probabilistic seismic hazard assessment (PSHA) and for disseminating the relevant results. These tools are all web applications using GIS functions on georeferenced data.

An additional tool is designed to be used when an earthquake occurs and one wants to quickly know the seismic protection of the affected area. The target of this application is to show the evolution of the seismic zoning for the epicentral area.

Our solutions were all designed to have GIS functionalities and to be accessible over the Web, as we found it the most useful way to produce and share data. Furthermore our applications manage the general and basic thematic layers, so that the users (even non-expert GIS users) may concentrate on the production and retrieval of the required data.

SEISMIC HAZARD ASSESMENT

Starting with the project S2 (http://nuovoprogettoesse2.stru.polimi.it/), funded by the National Department of Civil Protection (DPC), a tool to perform PSHA was enhanced and made available as Web application. Among others, PSHA requires several georeferenced input data, such as the seismic sources (e.g. area sources, faults, points) or the sites where to perform the computations. For this reason we added to the application a layer where it is possible to view the input data and display the output on an interactive map.

Additionally we added the possibility to automatically evaluate the parameters of the earthquake occurrence (e.g. maximum observed magnitude, magnitude-frequency distribution, etc.) using alternative earthquake catalogues as input and several approaches for the estimation of catalogue completeness or for the fit of raw data.

The user can easily define and select the input elements having the opportunity to analyse also the sensitivity of the outputs to the input, by comparing the resulting maps or the relevant hazard curves.

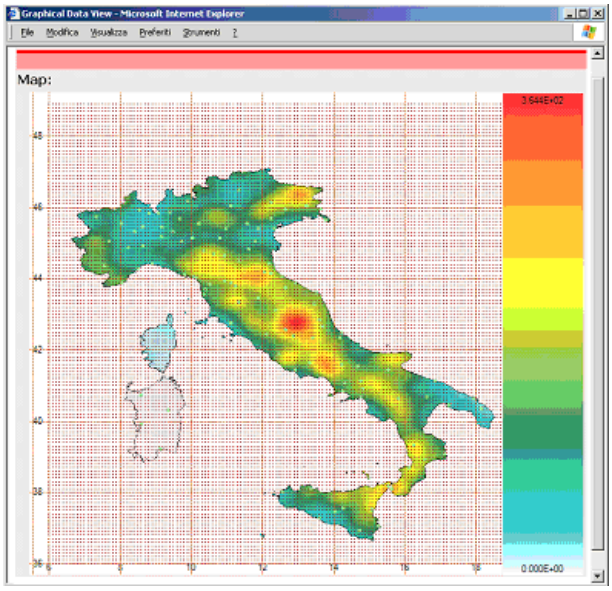

Figure 1 – Example of hazard map in terms of PGA (cm/s²) with 10% probability of exceedence in 50 years resulting from the Seismic Hazard Assesment tool.

VIRTUAL SEISMIC HISTORIES

In the seismic hazard analysis one of the basic input elements is the seismic history at a given locality, which in turn is based on the studies on historical documentation on earthquakes.

We developed a tool to help identifying potential lacks of information for a given place. The tool compares, for a locality, the expected virtual intensities (estimated from the epicentral intensity by applying an empirical attenuation relationship) with the observed intensities (as reported in the macroseismic database).

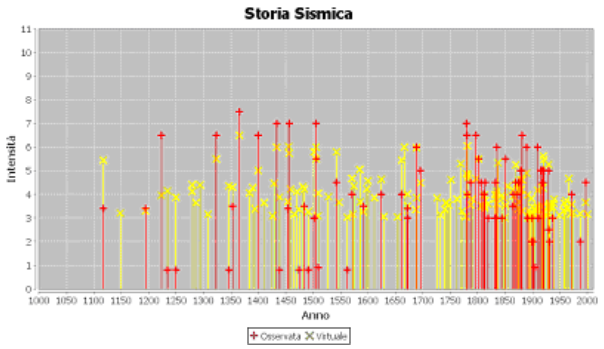

Figure 2 – Example of virtual (yellow) and observed (red) seismic history for the city of Bologna.

DISSEMINATION

Not only the scientific community, but also local administrators and professionals, typically engineers and geologists, use seismic hazard values: administrators use them to define the appropriate level of protection for the territory they oversee, while professionals refer to them to determine the proper seismic action according to the building code or for microzoning studies.

The 2004-2006 S1 Project (http://esse1.mi.ingv.it/index.html), funded by DPC, was aimed at the release of a set of elaborations that fully describe the seismic hazard in Italy. This resulted in a set of maps showing the PGA (Peak Ground Acceleration) and Sa (spectral accelerations) estimated for 9 different return periods.

We developed an interactive webGIS application that combines high level of interactivity and ease of use. The application provides different rendering of the whole set of data: interactive thematic maps, plots of significant parameters on single points and tables for those requiring raw numerical values.

The monitoring of the access to our web site shows a constant growing. The application has very short response time, also with high workload, as recently happened after the earthquakes occurred at the end of January in northern Italy.

In terms of interoperability, our application still offers an advanced example of dissemination of seismic hazard data.

SEISMIC ZONING

The last tool we present is mainly devoted to provide in a very short time a series of maps reporting the evolution of the seismic zoning and the seismic hazard for any area in Italy where an earthquake occurs. The user only provides the coordinates of the epicentre and the application produces a brief report with maps and tables.

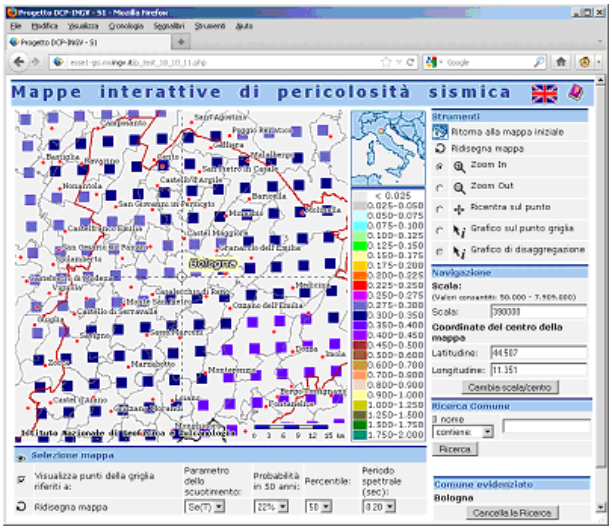

Figure 3 – Example of map showing one of the hazard parameters for the area around Bologna: Sa 0.2 sec, with 22% probability of exceedence in 50 years.

STUDY OF DEEP STRUCTURES IN THE SEISMIC DANGER REGIONS TO DECREASE SEISMIC RISK

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KEY WORDS: geodynamic, deep structure, lithosphere, asthenosphere, dangerous zones, seismic risk.

During the past few years the numerous natural hazards have essentially changed approaches to studying seismic, volcanic and other natural dangers. As a result of this the new strategy and tactics for research of modern geological processes are required.

The most dangerous zones all over the world are transition zones between continents and oceans. They are characterized by the tremendous seismic activity, volcanic eruptions, tsunami and other catastrophic events. More than thirds of population of globe live in seismically dangerous zones of the Earth. Therefore the study of a deep structure and geodynamic conditions of such regions is necessary to minimize the population losses and destructions in case of natural hazards.

As an example, we consider deep structure and geodynamic conditions formed in northern Sakhalin after the large Neftegorsk earthquake in 1995. On the basis of complex interpretation of the geological and geophysical data the geodynamic model of deep structure of this area has been constructed. It was possible to establish what deep processes permit the occurrence of earthquakes in Sakhalin, what faults reached a surface during and after the Neftegorsk earthquake.

Sakhalin Island was initially a part of the east coast of the Eurasian Continent. In the Late Cretaceous the Okhotsk Plate was being subducted under Sakhalin. In the Early Miocene the lithospheric plate movement has led to formation of the Tatar Strait rift. In the Late Miocene the subduction of the Okhotsk Plate has come to the end, but tectonic activity proceeded and the frequent earthquakes testified to the continuity of these processes beneath. Sakhalin belongs to the zone with intensity of earthquakes up to 9-10 EMS. Most earthquake hypocenters are concentrated in the crust. In the Kuril-Kamchatka zone the deepest seismic foci can be fixed as far down as 700 km.

The Neftegorsk earthquake has occurred with magnitude Ms=7.2 on May 27, 1995 in the North Sakhalin caused victims and destructions. The location of the earthquake was 52.6^0 N, 142.8^0 E. The hypocenter of Neftegorsk earthquake was determined at depth of 18 km. As a result of this disastrous earthquake seismic rupture of north-northeast strike of an overall length of 40 km appeared which caused right-lateral strike-slip fault displacement with amplitude of the horizontal shift component up to 8 m and vertical upthrust component up to 2 m (Rogozhin, 1996). The earthquake was followed by hundreds of aftershocks within the following 1-2 months.

All the results of the investigations of the Neftegorsk earthquake have been preserved in the geological and geophysical database created earlier for constructing deep structure models of active continental margins of the Earth. The database comprises data for bathymetry, seismology, deep seismic sounding, gravity, heat flow, magnetic, geology, the results of marine geophysical survey and deep seafloor drilling, dredging and others.

The geodynamic model of the lithosphere for the Neftegorsk earthquake region was constructed by (Rodnikov, 2007; Rodnikov et al., 2009). It represents the depth section crossing the North Sakhalin sedimentary basin, Deryugin Basin and ophyolite complex between them.

The Deryugin Basin was formed at the site of an ancient deep trench after the subduction of the Okhotsk Plate under Sakhalin Island which had been completed in the Late Miocene. The basin is located above a hot plume in the mantle at a depth of 25 km. The ophiolite belt of ultramafic magmatic rocks is an ancient (K_2-Pg) paleosubduction zone (Granik, 2003) separating the Deryugin Basin from the North Sakhalin Basin. The North Sakhalin Basin was formed at site of the Late Cretaceous – Paleocene back-arc basin.

As a result of movement along ancient subduction zone, considerable displacements in the crust along numerous faults and deformation of the earth surface go on. On a surface the subduction zone manifests itself as deep faults running along Sakhalin. The focus of the Neftegorsk earthquake was directly formed by burst of activity of this ancient subduction zone. The position of ancient subduction zone under Sakhalin is a cause of strong earthquakes here. Therefore this region is one of seismic dangerous in Russia.

Constructed on the basis of complex interpretation of the geological and geophysical data the geodynamic models of seismically active regions give the chance: (a) to study a deep structure of the

Earth under seismically dangerous zones, volcanic areas, mineralization regions and sedimentary basins; (b) to investigate a role of the deep processes in the mantle which have an influence on formation of crust units; (c) to represent dynamics of development of continental margins; (d) to **establish** a correlation between the geological features, tectonomagmatic, hydrothermal activity and the processes in the upper mantle; (e) to plot detailed maps with allocation of zones of increased risk to prevent active building or other economic activities in such dangerous regions**.** The risk will always be, but it should be estimated and minimized.

ACKNOWLEDGMENT

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PERFORMING SEISMIC SCENARIO IN THE LUCHON - VAL D'ARAN AREA, CENTRAL PYRENEES

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KEY WORDS: Pyrenees, Val d'Aran, Bagnères-de-Luchon, site effects, seismic risk, vulnerability.

INTRODUCTION

For both Spain and France, the Pyrenees are one of the most active seismic zones. Seismic risk mitigation is then a priority in this area. In this context, European project SIPYR aimed at developing rapid response systems to help planning emergency interventions in case of major seismic crisis. One of the developed tools for seismic risk mitigation is seismic risk scenario to help evaluating consequences of a seism on a limited area.

In this study, we will focus on the Luchon - Val d'Aran area, which constitutes one of the pilot zones of the project, chosen by its specific seismicity and its issue as a main touristic area. We present here the seismic risk scenario performed in this area through the three main steps of the study: local hazard calculation and mapping, vulnerability assessment, seismic risk scenario calculation.

LOCAL HAZARD MAPPING AND CALCULATION

Local geology can be responsible for important modifications of seismic ground motion both in amplitude and frequency content. It is then essential to take it into account in seismic scenario generation.

In this study, site effects are taken into account through maps of homogeneous seismic response zones and corresponding specific acceleration spectra for each mapped zones. Specific acceleration spectra have been calculated through 1D linear equivalent simulations.

In the French part of the area, we realized a campaign of 75 H/V measurements, 21 MASW profiles and 3 seismic noise arrays measurements to fulfill the poor existing geological and geotechnical data (figure 1). These measurements show unexpected low frequency resonances in the alluvial formations, with frequencies reaching 0.5 Hz in the central part of the Luchon valley.

In the Spanish side, 98 H/V measurements were carried out. Soil fundamental frequency ranges between 1.7 and 9.0 Hz, typical values of thin soils. Ambient noise array measurements were carried out in 8 sites. Mean shear-wave velocity obtained from array techniques ranges from 300 to 500 m/s, and thickness of the soil layer varies between 20 and 50 meters.

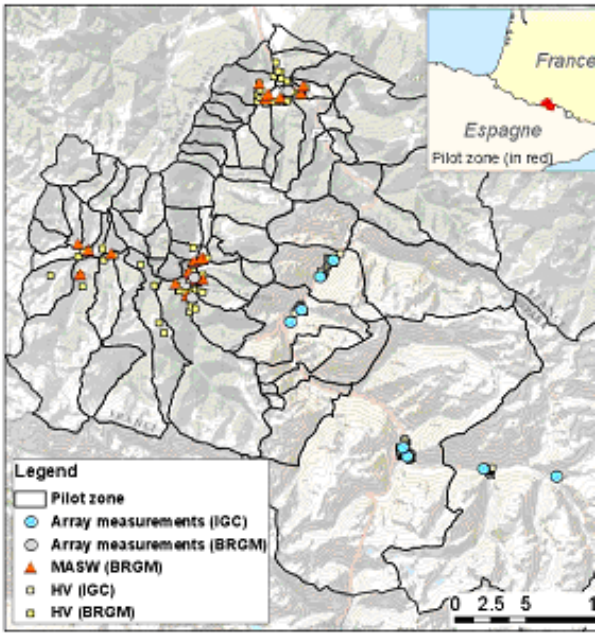

Figure 1 – Geophysical measurements location.

We then performed a combined interpretation of geological, geotechnical and geophysical data to map zones with homogeneous geology and frequency resonance and define representative 1D soil columns for each zone. With those soil columns, and for each defined zone, we calculate specific acceleration spectra using results of the probabilistic

seismic study performed in ISARD project (Secanell et al., 2008) as acceleration input data.

VULNERABILITY ASSESMENT

The current building vulnerability has been assessed using the RISK-UE method of vulnerability indices. This method was developed based on the vulnerability classes defined by the EMS-98 intensity scale. Semi-empirical functions transform vulnerabilities indices into physical damage distributions as a function of seismic intensity.

The main typologies of current buildings and their respective distributions have been identified during field surveys. For the whole pilot zone, we also mapped the different types of soil occupancy as follows: downtown areas, residential areas, sky resorts. Old maps and aerial images have been used to date the built areas. This information has been integrated into a GIS.

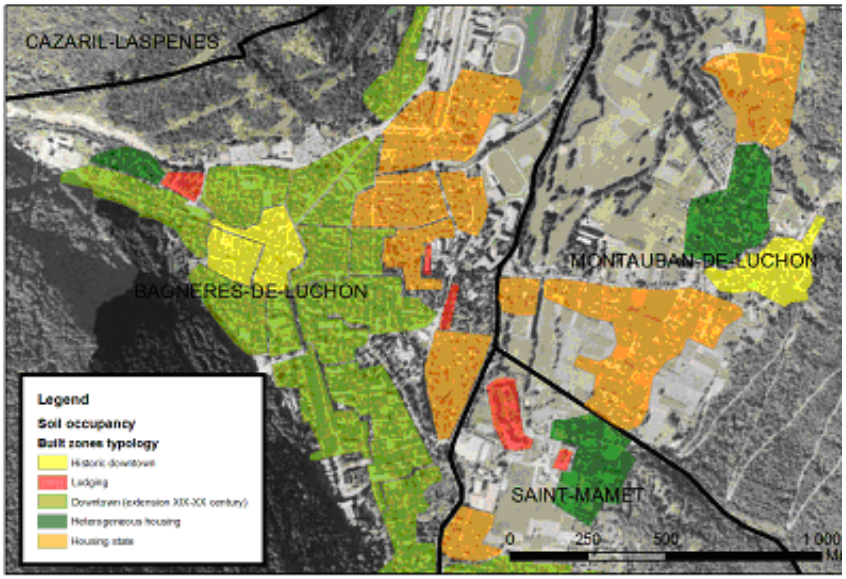

Figure 2 – Example of cartography of soil occupancy and built areas in Bagnères-de-Luchon town.

SEISMIC RISK SCENARIO

The seismic risk scenario consists in evaluating potential da mages of an earthquake, crossing regional hazard, local hazard and current building vulnerability. In the pilot zone of Val d'Aran-Luchonnais, we performed two kinds of scenario. The first one is a deterministic one, considering the observed intensities of the 1923 earthquake in Vielha (Val d'Aran, intensity VIII-VII). The second one is a risk map based on the probabilistic expected accelerations from the hazard map of Pyrenees (ISARD project). This risk map considers the soil amplification measured and mapped in the first step of this work showing the effect of different soil conditions in terms of damages to current building.

Results show that heavy damages (partial or complete collapse) are few and mainly concentrated at historic downtowns. These zones, characterized by a high concentration of old stone masonry buildings, are highly vulnerable and mainly located on soft soils with potential amplification effects. Results also show that moderated damages can't be neglect as they could be important in number, generating important number of people without shelters and important economic losses.

ACKNOWLEDGEMENTS

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HISTORY OF SEISMIC EVENTS IN GARHWAL HIMALAYA, INDIA.

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KEY WORD - Himalayan thrust, Recurrence time, elapsed time, rupturing

The studies on the history of the seismic events in the part of Garhwal Himalaya has been carried out. On the basis of the seismic records of seismic events in Garhwal, review of the events have been done and probabilities of the earthquake has been workout in the part of Garhwal - Kumaun -Himalaya in Uttaranchal. In the southern part of outer Himalaya thrust zones are expected to produce a long term probabilities of large earthquakes of magnitude more than 6 on Richter scale which have on average 5 to 20 mm reactivation and neotectonic upliftments along the shear zones. These zones have estimated to have future probabilities of earthquakes on these areas which are based on the historical seismic records, the long term slip rate and the displacement caused by the previous seismic events. The historical records of seismic events in these part of the Himalaya have the earthquake intensities varying from 4 to 6.0 on Richter scale in the geological past. The Kangra earthquake (1905) was recorded more than 7.0 Richter scale, Garhwal Earthquake (1883), (6.0), 'Uttarkashi earthquake' (1920), 1991 (5.6, 6.8) respectively, Chamoli earthquake (1999), 6.5 and the Dehradun earthquake of (1970). The approach followed for calculations of probabilities employ the estimated recurrence times with a model that assumes probability increases with elapsed time from the large earthquake on the fault / thrust zone areas. Through the calculated probabilities the estimated natural disaster/hazards in the newly born state of Uttaranchal in Himalayan belt can be reduced.

SUMMARY

By using the available information, reasonable assumption, and simple models, recurrence models, renewal models, it strives to make projections about the location size and times of future earthquakes. The types of basic information used are as follows:

- Identification major thrust /fault zone ridges to be capable of producing large earthquake in future.
- Estimate of the amount of displacement and thus the magnitude of future large earthquakes likely to occur during rupture these thrust zones.
- Estimate of the median recurrence intervals and their uncertainty for major earthquake on the thrust zones.

There are considerable uncertainties associated with each of these types of basic earthquake information. In particular, knowledge of the average time interval between segment rupturing earthquakes, which might be learned from palaeo-seismic studies, might permit major revisions of the consensus forecast presented here. In the part of Uttaranchal Himalaya the possibilities of earthquakes have been calculated that in the coming 20 years there is a chance of experiencing a major earthquake of more than 7.0 magnitude in the Thrust zone areas. In the present calculation for the 20 year probability of one or more earthquake of magnitude 6.0 to 7.0 in Uttaranchal Himalaya along MCT zone and MBT zone to be 5.0 to 7.0 value. The probability was aggregated from the probabilities computed for individual thrust zone, which includes the Almora thrust (3.0 – 4.0), Garhwal - Krol thrust zones (4.0 to 5.0) and MCT - MBT zone have higher probability 5.0 to 7.0 value.

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SEISMIC MICROZONATION OF THE GIRONA URBAN AREA (NE SPAIN) FROM STATISTICAL ANALYSIS OF GEOTECHNICAL DATA

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KEY WORDS: geotechnical data, soil effects, amplification coefficient, seismic microzonation, Girona, Spain.

INTRODUCTION

Territorial planning is an important tool when dealing with seismic risk. It is useful to provide decision makers of accurate studies including detailed mapping of the predictable effects related to damaging seismic events. In urban areas, most of the subsurface information comes out from geotechnical reports, which are often available as databases compiled by public administrations or research centres. The seismic microzonation presented is the result of collaboration between GEOCAMB and IGC as a part of the SISPyr project of the Interreg IVA program between Spain, France and Andorra. A statistical analysis of a geotechnical database has been conducted for the seismic parameterization of soil and rock units in the studied urban area. Combined contribution of representative values and on site results has led to determination of soil amplification coefficients for more than one thousand boreholes and, therefore, to the cartographic delimitation of seismic isoamplification zones based on soil effects.

REGIONAL SETTING AND INPUT DATA

The metropolitan area of Girona, with 150,000 inhabitants in 50 km^2, is located in the north-eastern corner of Catalonia, NE Spain. The region is characterized by moderate seismicity and low rates of strong events up to maximum magnitudes of 6.3-6.8 for a 475-year return period (Secanell *et al.*, 2008). The urban framework extends over a Quaternary alluvial and fluvial plain mainly overlying Neogene alluvial sediments. Peripherical areas include a hilly terrain composed by Paleogene sedimentary formations and Paleozoic metamorphic and igneous rocks.

The geotechnical database compiled by GEOCAMB contains information from 1,530 boreholes regarding to situation, lithology profile, standard penetration test blow count values (SPT-N) and laboratory results from unaltered and representative soil and rock samples. After a multi-variable statistical analysis, each of the litho-stratigraphical units has been assigned to a seismic soil class according to the Spanish Seismic Building Code (NCSE-02, 2002) by correlation of geotechnical data to soil dynamic parameters from equivalences therein.

SOIL COEFFICIENT

The soil effect has been determined by a coefficient C related to the local amplification. It is defined in NCSE-02 as the mean C_i value for all the soil classes identified at a site in the first 30 meters from the surface. Both C and C_i range between 1.0 (class I) and 2.0 (class IV). The degree of available information from each individual borehole is extremely variable because of the specific survey carried out in it. Since one of the goals of this study was to extract as much seismological data as possible from the database, a systematic standardized C_i calculation method must be set. A casuist matrix has been designed with up to 25 typological cases for the attribution of C_i to every litho-stratigraphical unit present in a borehole profile. It takes into account weighted percentual contribution of C_i values derived from: i) on site data after SPT tests ($C_{i(SPT-N)}$), ii) unconfined shear strength and cohesion from laboratory resistance tests ($C_{i(Qu)}$), and iii) representative C_R value deduced from the statistical analysis. In order to discriminate the confidence of C_i values, each case has been attributed to a quality index (Iqc_i) ranging from 1 to 4 (Table 1), which helps to check the consistency of the method. Calculus of C and Iqc has been done after normalization of Ci and Iqc_i for every individual unit thickness (e_i), and successfully achieved in 87% out of 1,530 boreholes (Table 2).

In situ tests		Laboratory tests		Extrapolation		Iqc_i
Criterion	C_i	**Criterion**	C_i	**Criterion**	C_i	
N1	$0.5C_{i(SPT-N)}+0.5C_R$	M1	$0.75C_{i(Qu)}+0.25C_R$	-	-	4
		M2	$0.5C_{i(Qu)}+0.5C_R$			
N2	$0.25C_{i(SPT-N)}+0.75C_R$	M3	$0.5C_{i(Qu)}+0.5C_R$	R1, S1	C_R	3
N4	$0.5C_{i(SPT-N)}+0.5C_R$	M4	$0.25C_{i(Qu)}+0.75C_R$			
N3	C_R	M5	C_R	R2, S2	C_R	2
N5	$0.25C_{i(SPT-N)}+0.75C_R$					
N8	C_R					
N6	C_R	M6	C_R	R3, A1 S3, S4, S5, S6	C_R	1
N7	C_R					
C = $\sum (C_i \cdot e_i) / 30$						**Iqc** = $\sum(I_{qci} \cdot e_i) / 30$

Table 1 – Equivalence between criteria to set C_i and confidence index Iqc_i, and formulae to obtain C and Iqc.

Unit	e_i (m)	SPT-N		$C_{i(SPT-N)}$	Unaltered samples		$C_{i(Qu)}$	C_R	Criteria	C_i	Iqc_i
		(m)	$\%e_i$		(m)	$\%e_i$					
A	0.5	0	0	-	0	0	-	2	A1	2	2
Qcah	6	3	50	1.8	0.45	7.5	1.6	1.7	N1, M4	1.71	3.5
N	3.5	0.6	17.1	1.6	0	0	-	1.45	N2	1.49	3
N	20	-		-				1.45	S1	1.45	3
Borehole code: 200401610										**C** = 1.51	**Iqc** = 3.08

Table 2 – Example of C and Iqc calculation for a given borehole.

SEISMIC MICROZONATION

In a similar way like other published microzonation studies in Spain (Cid *et al.*, 2001; Macau *et al.*, 2006; Clavero, 2007), isoamplification zones after C intervals have been defined and mapped (Figure 1). Zone A-1 mainly corresponds to areas where rock substratum crops out or is covered by a thin layer of Quaternary sediments. In zone A-2 rock is overlaid by Quaternary sediments between 5 and 20 meters thick. Zones B and C coincide with the extension of Neogene materials and Quaternary alluviums and fluvial terraces, where most of the town is founded. The resulting microzonation maps are a basic source for planning future field measurement surveys, numerical simulations in selected emplacements within the area and performance of risk scenarios. It may also be a useful tool in engineering preliminary construction plans.

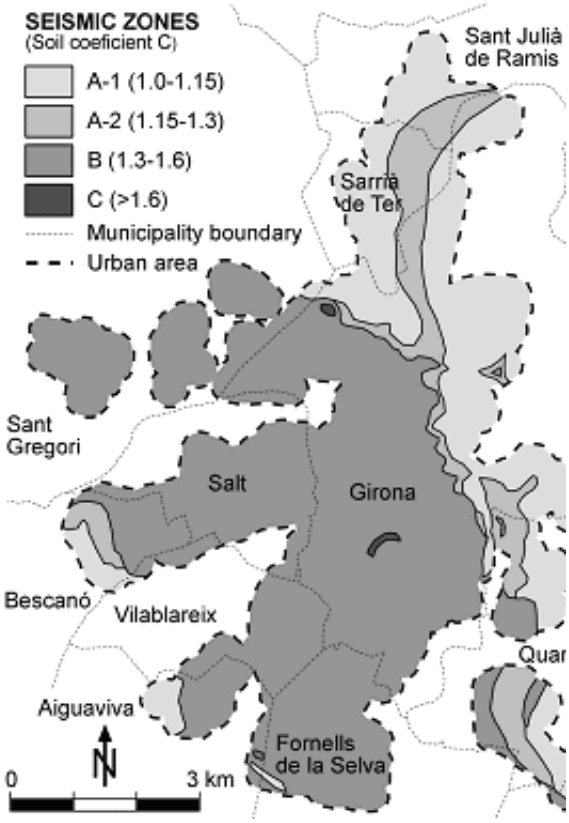

Figure 1 – Seismic microzonation map.

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ESTIMATION OF V_S VALUES BASED ON GEOSPATIAL ANALYSES AS A TOOL FOR SEISMIC MICROZONATION STUDIES: APPLICATION TO THE L'AQUILA PLAIN (ITALY)

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KEY WORDS: Seismic microzonation; Vs; Kriging with External drift.

INTRODUCTION

The evidences of damages in urban areas due to earthquake shaking points out that significant differences can occur also within small distances. If similar vulnerability conditions can be assumed, this effect can be mainly related to the local seismic response (LSR). In a first stage of seismic microzonation studies is requested to map micro-zones (MZ) which are characterized by similar seismic response LSR (Gruppo Di Lavoro MS–AQ, 2010). In this regard : stable zones, stable zones susceptible to amplification and zones characterized to seismic-induced instability might be distinguished.

This paper proposes a contribution to the definition of MZs , by using different techniques of geospatial analysis. These techniques allowed the reconstruction of a 2-3D model of the seismic wave velocities in the Plain of L'Aquila, a densely populated seismic area recently hit by the strong earthquake of the 6th April 2009. The model was elaborated by the use of geophysical and geotechnical data which were collected by various Agencies and freelands, from 1991 to 2009. The database has been available thanks to CNR-IGAG.

PROCESSINGS

All the available geophysical and geognostic data collected in the Plain of L'Aquila was selected and organised in a geodatabase within a GIS environment for further geospatial analysis that provided the creation of various thematic maps.

For these calculations shear wave velocities values (Vs) obtained from Down Hole and MASW tests were used. Moreover, Vs values were computed, on the basis of SPT tests, by applying empirical various relationship from the literature.

Factorial ANOVA was used to verify the reliability of empirical correlations for calculating Vs values from SPT tests, then selecting the most suitable for the study case (Hasanceby et al., 2007). Furthermore, the validity of correlations between the measured Vs and categorized soil-types, has been checked.

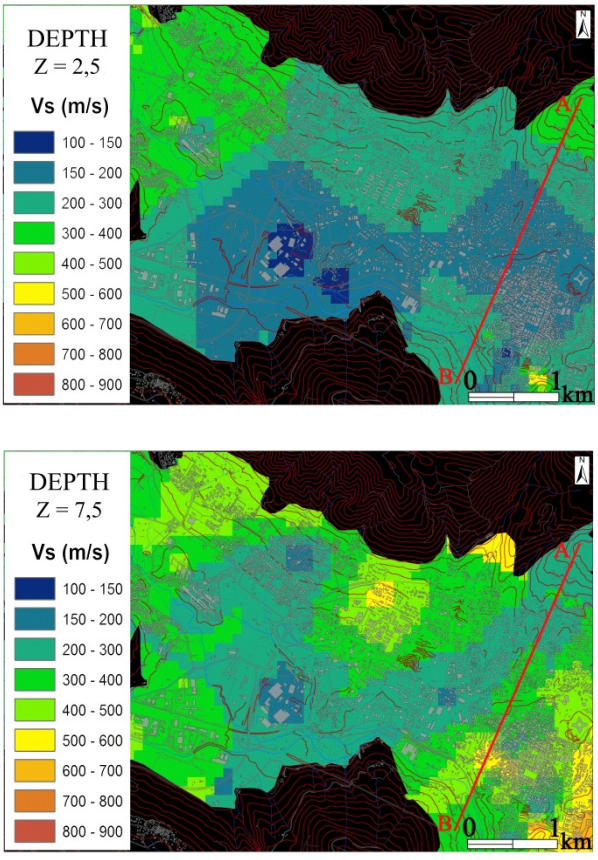

Figure 1 – Map of Vs, at different depths.

The relationship between the soil-type and the available Vs values was established and used to experience appropriate methods for attributing within all the considered study area Vs values and for the construction of a 3D lithotecnical model of the subsoilas well as to elaborate Vs maps (Fig. 1).

The estimation of Vs values has been obtained by using a probabilistic algorithm, Kriging with External drift (KED) (Ciotoli et al., 2011).

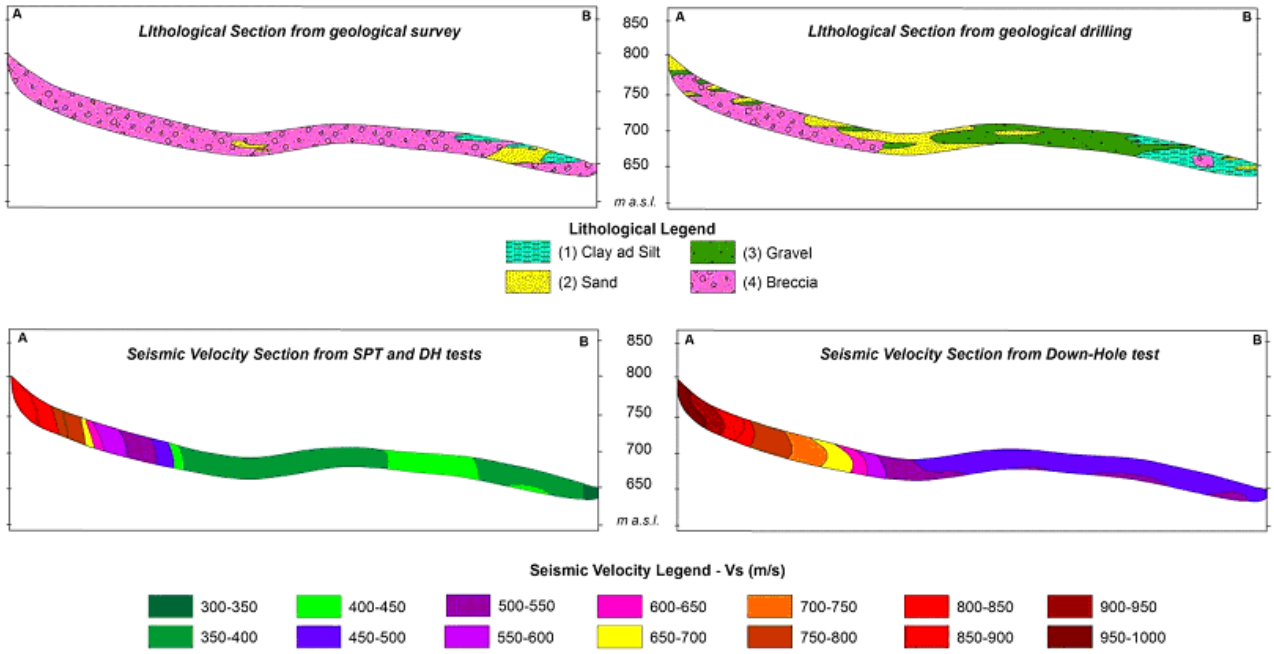

Figure 2 –a); Lithotechnical cross-sections derived from the geological model b); Vs sections derived from the here obtained 3D model c).

The KED is a particular case of Universal Kriging (UK) that allows the prediction of a variable Z, note only at a limited set of points in the study area, through another variable S, exhaustively known in the same area. Variable Z is modeled with a random function Z(x) and S as a deterministic variable S(x).

The KED method thus consists in incorporating into the kriging system additionally universality conditions about one or several ED variables measured exhaustively in the spatial domain. In this study the auxiliary variable is represented by lithology expressed by means of numerical codes linearly correlated with the value of Vs expected for a specific lithology. The Vs values has been estimated at different depths from ground level up to the maximum depth of the available boreholes (about 30 m).

A validation procedure of the obtained results was performed by comparing the geological sections obtained from the Geological Map of L'Aquila 1:6000 (Seismic microzonation project for the reconstruction of L'Aquila area) merged with the here assumed lithological codes (Fig. 2a) and the geological cross-sections derived from the lithotecnical 3D models (Fig. 2b and 2c).

CONCLUSIONS

The presented application provides a 2D and 3D model of shear wave velocity well suited to the different types of deposits occurring in the L'Aquila plain.

The obtained results demonstrate that the application of geospatial analysis techniques to geotechnical and geophysical data can be regarded as a valid support for deriving MZ maps in the frame of Microzonation Studies.

ACKNOWLEDGEMENTS

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NEW URBAN GEOLOGY INFORMATION USING GEOTECHNICAL TESTS DATA FOR THE IMPROVEMENT OF MICROZONATION STUDIES IN BUCHAREST CITY AREA

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KEY WORDS: urban geology, geotechnical parameters, risk mitigation, better seismic safety

Bucharest, the capital of Romania, with approximately 2.5 million inhabitants, is considered after Istanbul the second-most earthquake-endangered metropolis in Europe. It is identified as a natural disaster hotspot by a global study of the World Bank and the Columbia University (Dilley et al., 2005). Four major earthquakes with moment-magnitudes between 6.9 and 7.7 hit Bucharest in the last 70 years. The most recent destructive earthquake of 4th March 1977, with a moment magnitude of 7.4, caused about 1.500 casualties in the capital alone. All disastrous earthquakes are generated within a small epicentral area – the Vrancea region - about 150 km north-east of Bucharest. Thick unconsolidated sedimentary layers in the area of Bucharest amplify the arriving seismic shear-waves causing severe destruction. Thus, disaster prevention and mitigation of earthquake effects is an issue of highest priority for Bucharest and its population.

According to the plan of the NATO SFP 981882 project (2006-2008) ten boreholes with a depth of 50 m were drilled and geotechnical analysed in the metropolitan area of Bucharest. The target pursued was to fill gaps in knowledge concerning seismic and geotechnical parameters in the shallow (h < 50 m) Quaternary layers in Bucharest. The main objective was earthquake risk mitigation and better seismic safety of Bucharest City, and to obtain the necessary input data for a new and modern map with site effects related to earthquake wave amplification. The boreholes are placed near URS stations (URban Seismology project 2003/2004, Ritter et al., SRL, 2005) or K2 stations (a strong-motion recording network) of the National Institute for Earth Physics, Bucharest (NIEP) to allow a direct comparison and calibration of borehole data with actual seismic measurements.

A number of approximately 270 samples were gathered from the 10 drilling sites in the Department of Engineering Seismology, National Institute of R-D for Earth Physics. These samples were partly not disturbed (sampling as it was recovered in the tube of the drilling machine) and partly disturbed (sample had no consistency). A database was created with these samples, containing the following parameters: drilling location, GPS coordinates, date of drilling, date of arrival in the laboratory, short geotechnical characterisation of each sample.

After a thorough examination of the database, samples from representative layers were chosen for further testing. The following tests were performed: 1) resonant column test. One sample from the soil layers was chosen. For this test the Drnevich resonant column is used. This apparatus is used for the experimental determination of the dynamic soil response at harmonic oscillations through soliciting a cylinder sample with harmonic stationary vibrations in torsional resonance mode. 2)dynamic triaxial tests for the determination of the deformability properties of the samples from the boreholes was done in accordance with international specifications, but also with the restrictive Japanese norm (JGS 0542-2000). 3) CU triaxial test (for soft and granular materials), 4) specific gravity, 5) natural humidity, 6) granulometric composition (fractions), 7) material identification due to international standards (ternary diagram), 8) appreciated value of the mineral skeleton density, 9) solid particle percentage with the dimension less than 2 μm, 10) plastic limit determination (soil cylinders and cup method), 11) tests of compression - settling (edometric compressibility for soft and granular materials), 12) angle of response. Detailed results of all these tests, together with the equipment used to perform them, will be presented.

The values of the mean weighted seismic velocities computed in the present study are within a narrow range as others obtained by seismic in situ measurements. These tests suggest that near-surface material has the tendency to amplify earthquakes waves. This means that the near-surface layer and its anelastic properties are crucial for understanding the seismic hazard imposed to Bucharest City.

The elastic and dynamic parameters from geotechnical measurements at samples from the near surface layers were added to the already existed database. The data are to be used for further studies on the seismic microzonation of Bucharest City using the equivalent linear approach and will contribute directly to an improvement of the seismic hazard evaluation in the city area and to a better understanding of the links between the geological characteristics of each layer, the geotechnical parameters and development of future ground motion scenarios.

THE BENI-ILMÈNE EARTHQUAKE SEQUENCE (MW=5.5, 5.3, AND 5.3) FROM 14 TO 23 MAY, 2010, IN THE BIBAN REGION (MANSOURAH, ALGERIA): DETERMINATION OF SOURCES PARAMETERS AND STRESS TRANSFERT.

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KEY WORDS: Algeria, CFF, Focal mechanism, Sub-Bibanique region, waveform modelling

ABSTRACT

A moderate earthquake with moment magnitude Mw=5.5 (first shock) hit the Sub-Bibanique region in the East of Algeria at the locality of Beni-Ilmène (NW of Msila) on 14 May, 2010 at 12h29mn (GMT). The earthquake was located by the CRAAG at latitude 35.99° N and longitude 4.19° E, the depth was 6 km. Three persons were killed, hundred injured and huge damages were observed in the epicentral area (Béni-Ilmène, Samma, Bendaoud, Ounougha). The Focal Mechanism (FM) of the seismic source obtained by waveform modeling (near-field) shows left-lateral strike-slip for the nodal plane oriented N345° and right-lateral strike-slip for the second nodal plane oriented N254°. A second shock stroke the region on 16 May 2010 at 06h52mn (GMT) with moment magnitude Mw=5.3. It is localized 9 km SW of the first shock at latitude 35.96° N, longitude 4.06° E and 5 km of depth. The FM obtained by waveform modeling shows reverse faulting with nodal planes oriented NE-SW. A third shock hit the region on 23 may 2010 at 13h28 (GMT) with moment magnitude Mw=5.3, localized 7 km at the south of the first shock at the latitude 35.93° N, longitude 4.12° N and 6 km of depth. The FM obtained shows a left-lateral strike-slip plane oriented N355° and a right-lateral plane oriented N85° similar to that of the first shock. Field investigations, geologic and sismotectonic analysis lead us to conclude that the fault plane of the first shock is oriented NNW–SSE, i.e corresponding to the nodal plane [strike, Dip, Rake: 345°, 85°, 16°]. The second and the third shocks were generated by separate faults [strike, Dip, rake: 250°, 55°, 120°] and [Strike, Dip, rake: 355°, 90°,-12°] respectively. We show that the first shock raised the Coulomb Stress Failure level on the fault planes that generated the two following shocks of Mw 5.3.

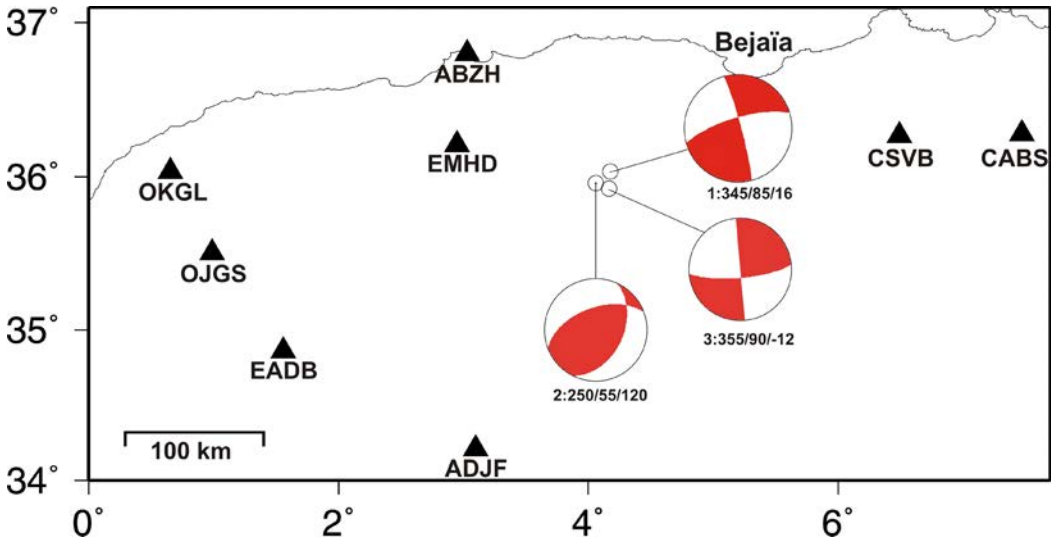

Figure 1 – Map showing focal mechanisms of three shocks. Triangles show broadband algerian seismologic stations

AN INTEGRATED SEISMIC MICROZONING AND GEOLOGICAL MODEL TOWARD INSPIRE

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KEY WORDS: Inspire, spatial data infrastructure, application schema, Standard Interoperability, Seismic microzoning model; Geological mapping;

1).INTRODUCTION

This paper aims at contributing to the research and testing activity for the design and creation of interoperating spatial data models, in full compliance with the INSPIRE European Directive, 2007 and with the requirements of the seismic microzoning (SM). Seismic microzoning is a very crucial theme recently ruled by the Italian Civil Protection and the Regional Administrations (for full bibliography see “Indirizzi e criteri per la microzonazione sismica”,2008, published by Dipartimento della Protezione Civile e Conferenza delle Regioni e delle Province Autonome and “Standard per la Rappresentazione ed archiviazione informatica”, published by the Dipartimento della Protezione Civile). In the current guidelines for SM, many detailed indication for several type of geological, gemorphological, geotechnical and geophysical analyses to be carried out, and for the production of maps which express the level of seismic risks for a detailed area.

2). TARGETS AND METHODS OF DESIGN

The targets of the research activity are the study and design of a data model which is functional to the needs of SM and fully compliant with the following requirements:

-The adoption of the European Directive INSPIRE (2007), in terms of the constitution of an interoperable Spatial Data Infrastructure congruent with Annex II theme “Geology” (Inspire GE, 2011);

-the design and implementation of a spatial data base according to the application schema (cfr INSPIRE), which supports the relational and topological constraints among the target objects and proposes a structuring of the interaction levels between the data models;

-the adherence to the international geographical standard defined by OGC and ISO, such as the standard used for the symbology (SLD and SE);

-the elaboration of MS maps according to the current guidelines (see the above citation).

Currently the data bases that interact with SM are referred to several thematic contexts such as geology, geophysics and topography. As an initial approach, the modeling activity is referred to the existing relationship between the seismic and the geological and geomorphologic contexts, as data surveyed on to these themes are more widely diffused and available all over the territory. Furthermore the scalability of the data base allows the implementations of the three levels of analysis (liv.1, liv2, liv3) requested by the SM guidelines. The main steps of our design activity are still provisional, but they can be summarized as follows:

-preliminary structuring of the data base according to the existing information for Level 1 as defined by Livello 1 (MS Guidelines, 2008);

-elaboration of the required data model for the Livello 1 e Livello 2 (MS Guidelines, 2008);

-correlation with exiting geology data bases

-compliance with the representation criteria (portrayal) defined for MS maps;

-evolution and transformation of the model towards the INSPIRE model.

3). FUTURE DEVELOPMENTS

Since the above described activities are still in progress, at the moment there are no relevant and consolidated results. Currently we are carrying out the experimental stage in order to implement a data model which fulfills the requirements of INSPIRE and of the interoperability between the different data bases and specific applications for Geology and Seismic Microzoning. The major critical aspect of the new data base design is the difficult integration of multi-source and multi-accuracy information. For example most elements derived from geological and geomorphological surveys are (for their nature) partially interpretative, while geophysical, geotechnical and topographical data are quantitative or metrical, so the new data base must be adequately structured in order to guarantee a useful processing of these different data.

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NEW MAP FEATURES IN PROJECT ON THE FIRST LEVEL SEISMIC MICROZONATION OF 61 MUNICIPALITIES IN THE FOGGIA PROVINCE (APULIA REGION, ITALY).

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KEY WORDS: Seismic microzonation, GIS, Database, Cartographic MOPS Representation.

INTRODUCTION

The strong earthquake of the 6th April 2009 that recently struck L'Aquila area has increased the necessity of new studies for seismic risk reduction.

At this regard in 2010 the Puglia Regional *Basin Authority* and CNR Institute of Environmental Geology and Geo-engineering started "Project on first level seismic microzonation of 61 municipalities in the Foggia province" (MZS). The project was financed by Interministerial Committee for Economic Programmer (CIPE) and coordinated by the Department of Civil Protection.

In the framework of the project "Indirizzi e Criteri per la Microzonazione sismica" (hereinafter ICMS) guidelines and criteria for seismic microzonation in Italy have been applied (Gruppo di lavoro MS, 2008).

The first level MZS aims to identify areas of homogeneous behavior with respect to seismic response with a variable degree of approximation depending on density of previous data. In particular, it is based on the definition of stable, stable susceptible to amplification and unstable zones on the basis of stratigraphic, morphological characteristics of the site and so of areas potentially subject to seismic-induced instability (i.e., slope, active and capable faults, geomechanical properties of lithologies, etc.).

The final products of first level MZS are exclusively cartographic: i) lithotecnical map; ii) map of the previous data ("Carta delle Indagini", CI) and iii) map of microzones with homogeneous seismic behavior ("Carta delle Microzone Omogenee in Prospettiva Sismica", MOPS), which is a "derivative" map obtained by the selection, interpretation and processing of geological, geophysical, geotechnical and subsurface data.

The ICMS does not define cartographic standards for the elaboration of CI and MOPS,and the subsequent technical specifications (Martini et al., 2011) only described some of the elements constituting the geolithological map (legend and field map). Furthermore, the "Commissione Tecnica per il monitoraggio degli studi di microzonazione sismica" (2011) only defined database codes and cartographic symbols for existing survey data.

The MZS Project provides innovative and more complete map symbology (i.e. nested symbols), as well as user-friendly templates (i.e. summary forms and layouts) and tools for the management and creation of CI and MOPS.

MOPS FRAMEWORK

MOPS framework of level 1 have been elaborated according to the following steps:

- collection, evaluation and selection of geological, geophysical, geotechnical, and hydrogeological data available for each municipality;
- encoding and storage of the input data in a GIS environment;
- extraction of geological, geophysical and hydrogeological data useful for the reconstruction of the subsurface geological model;
- evaluation of the local amplification on microzones on the basis of geomorphological and topographical characteristics of the site;
- elaboration of a "descriptive form" of all geothecnical and geological parameters used for the identification of the microzones (Summary Form, SF);
- elaboration of a synthetic stratigraphic model of the MOPS that includes physical-mechanical parameters (Columnar Profile);
- definition of a suitable template for the printing in a GIS environment of the final maps.

SYMBOL STYLE

The nested symbols have been created to simplify the reading of data represented in the CI and include all the geognostic information (Fig. 1). Each nested symbol joins together more than one simple symbol used to indicate the different type investigation techniques and/or instrumentation. In this way the CI reports most of the information without having to query the database stored in the GIS.

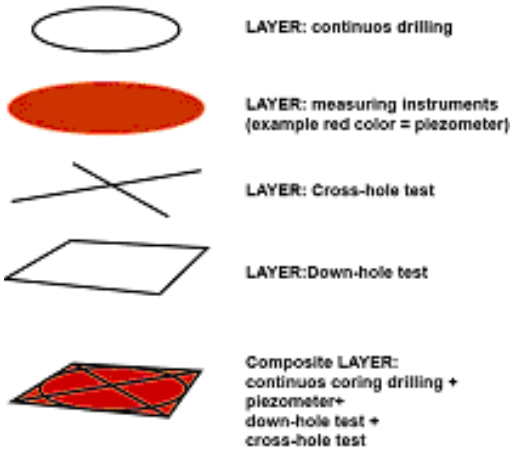

Figure 1 – Composite layered structure of a nested symbol

THE SUMMARY FORM

The Summary Form contains the geomechanical and geophysical descriptive parameters of the surveys according to ICMS. As the form includes schedules and correlation tables among different parameters, it can be considered an useful tool for providing the methodological and operational guidelines to be adopted for:

- the extraction of geotechnical parameters to use in the characterization of lithological units;
- the indirect calculation of the Vs values on the basis of in situ tests and geotechnical parameters;
- the discretization of the cover thickness and the creation of MOPS "Columnar Profiles" on the basis of their geophysical and geomechanical characteristics;
- the preparation of summary reports on microzonation studies;
- the creation of the attributes of the polygonal feature class (MOPS) as relational table in the geodatabase of MZS;
- the development of complex models for further geostatistical and geospatial analyses in GIS environment (Ciotoli & Finoia, 2005).

COLUMNAR MOPS PROFILES

The MOPS "Columnar Profiles" are created as digital objects (shapefile) with the same attributes of the SF and related to the MOPS and to the previous survey database. This approach allows an easier editing and filling phases by linking each object to the symbol library.

In the MOPS map the Columnar Sections were represented by an indipendent Data Frame. Each object of the carthographic layout has been obtained by using a single software for data management and editing in a GIS environment.

THE DIGITAL TERRAIN MODEL AND THE SLOPE FRAME

A Digital Terrain Model (DTM) with a resolution of 8 meters was generated starting from the elevation points and contour lines of the Regional Technical Map of Puglia (CTR) at 1:5.000 scale.The "hillshade function" was applied to DTM in order to generate a raster map representing the areas with slope values above 15 degree where the topographical gradient can trigger local seismic amplification phenomena.

The final Data Frame is constituted by the following layers:

- unstable zones;
- stable and stable susceptible to amplification zones;
- areas with slopes > 15°;
- urban structure derived from the CTR;
- DTM "hillshade" (to give a 3D perspective to the topography).

All the information organised in the Data Frame are added to the layout, on side of the field map, to makes it easier to read.

CONCLUSIONS

The main innovative aspects of the cartographic scheme designed for the Level 1 MZS project of the Foggia Province are:

- a mapping system based exclusively on editing techniques in a GIS environment;
- the development of a coded GIS database of geognostic surveys;
- a new Data Frame feature which identification of areas with slope > 15 °;
- the creation of MOPS database according to the last edition of the "Standard representation and computer storage" of October 2011 edited by "Commissione Tecnica per il monitoraggio degli studi di microzonazione sismica" (2011);
- the creation of a "Summary Form" containing the geological, geotechnical and geophysical microzone parameters. This tool is also useful for the representation of the "Columnar Profiles" descriptive of the MOPS;
- the creation of a library with nested symbols;
- the creation of the final map layouts by using all the features and/or information of the database contained in different Data Frames.

These points allowed an example of template for first level sismic microzonation.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support from working group CNR-IGAG UrbiSit.

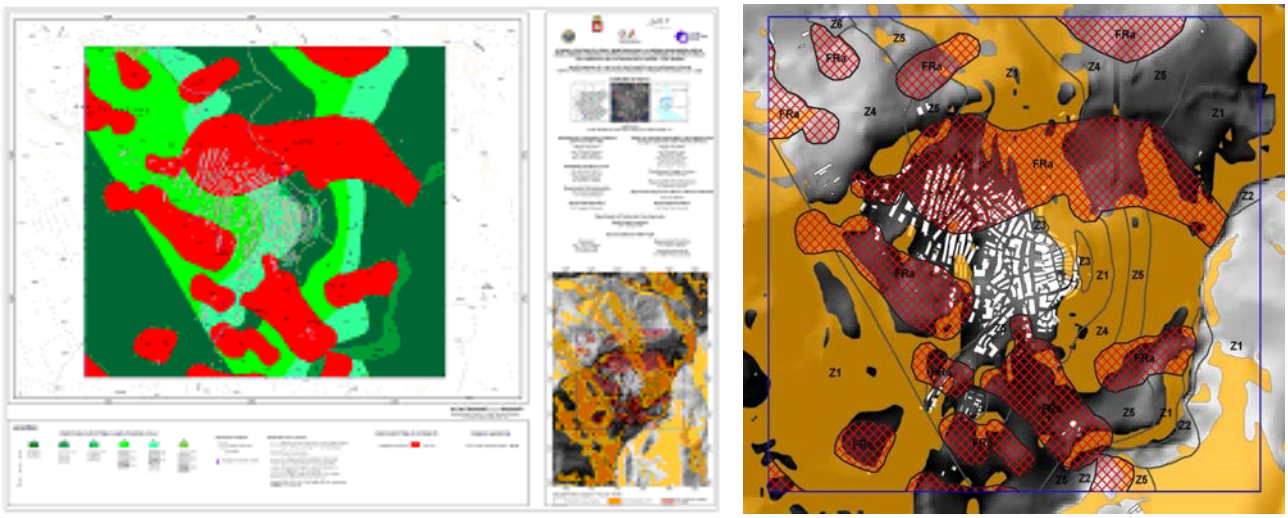

Figure 2 – The schematic layout of MOPS (left); zoomed area of the Data Frame "slope" (right)

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NEOTECTONIC COMPLEXITY AND SEISMIC HAZARD OF KOSOVA

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Kosova is part of the Alpine folded belt and is extended in the western segment of the Eastern Mediterranean. The tectonic structures of Kosova territory are mainly encompassed within the Dinaride-Albanide-Hellenide belt, and only its eastern corner is related to Alpide-Carpathian-Balkan arc. The principal structural inflection of Dinaride-Albanide-Hellenide belt occurs just in the central-western part of Kosova corresponding to Shkoder-Peje transversal fault belt.

The neotectonic studies in Kosova's territory are intimately related to morphologic structural units produced by the youngest tectonic movements occurring through Pliocene and Pleistocene-Holocene time span, which is defined as the neotectonic phase. It is comprehensible that the neotectonic activity panorama of Kosova is closely related to early geologic - tectonic structure shaping in grosso modo the Kosova's architectural edifice.

During the neotectonic phase, the large areas of Kosova are affected by the intensive tectonic activity leading to the installation of the different morphologic structural units with relative uplifting and subsiding tendencies.

On the worldwide seismic zonation, Kosova takes place on Alpine-Mediterranean seismic belt. This belt comprises the wide zone of contact between lithospheric plates of Africa and Eurasia, from Azore Islands up to the eastern border of Mediterranean basin. In this zone, the concept of plate tectonics is especially complicated from the presence of numerous blocks and the release of stress through plastic deformation on a large part of the zone.

Contacts between these blocks are expressed through normal faults, along which differentiations of the order of amplitude of about 2000 m have occurred during the neotectonic phase. A large number of these tectonic faults represent seismogenic alignments that often are not active along their entire length due to the intersection with other transverse faults.

Key words: Neotectonik, Kosova, Seismic Hazard, Zonation, Plate Tectonics.

SEISMIC-GEODYNAMIC MONITORING OF THE MAIN POWER-STATIONS SITUATION WITHIN EAST EUROPE AND NORTH ASIA

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KEY WORDS: Electric Power-Station, Seismicity, Active Fault, Lithosphere Plate, Transit Zone, Crust Block, Seismic Energy, GPS Vector

SEISMIC RISK

In Russia and adjacent countries the majority of nuclear power-stations as well as large hydro-electric and thermal electric stations are located within the north Eurasian lithosphere plate, which is characterized by the low seismicity and low modern tectonic activity besides the different exogenetic processes. Some operating and projected nuclear stations are relatively near to zones of the moderate seismicity in the Kaliningrad Region of northwest Russia and in south Ukraine. Hydro-electric and thermal stations in Baltic, Byelorussia and Ukraine are in the same position. Zones of more intensive seismicity and existence of active faults include electric stations of all types in the Urals, the Kola Peninsula, south Siberia, Transbaikal and Far East regions of Russia. Some of these stations are situated within crust blocks in transit zones, which separate main lithosphere plates and are characterized by increased tectonic mobility. The Central Asian zone and east Asian zone the main among these transit zones. Electric power-stations are in the most danger situation in the Alpine-Iranian transit zone between north Eurasian and Arabian lithosphere plates and partly in the Central Asian zone between north Eurasian and Indian lithosphere plates, where collision processes have yet not stopped. This concerns electric stations in central Asia and Caucasus including the nuclear station in Armenia. Seven schemes of the seismic energy distribution are composed for different parts of east Europe and north Asia. The location of nuclear and main other electric power-stations on them makes it possible to form a correct estimate of negative consequences connected with the up-to-date inner-continental tectonic activity.

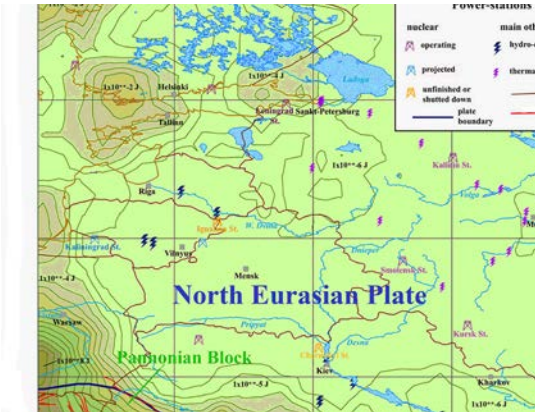

Figure 1 – Main power-stations and the seismic energy distribution in the west and central parts of east Europe. Each increasing of the color intensity corresponds to increasing seismic energy volume on $1x10^{-1}$ J or $1x10^{1}$ J. Some energy values are shown in the scheme.

ACKNOWLEDGEMENTS

We are grateful to the Presidium RAS, Moscow (Program 4 “Appraisal and means of decreasing consequences of up-to-date tectonic movements and earthquakes in regions of existing and projected nuclear power-stations in the territory of Russia and neighbouring foreign countries”) and Russian Foundation for Basic Research (Project no. 12-05-01140-a).

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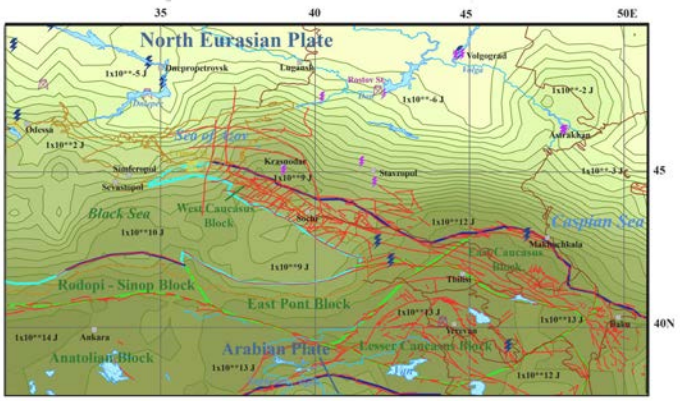

Figure 2 – Main power-stations and the seismic energy distribution in southwest part of European Russia, the Caucasus and Transcaucasus. Green lines – block boundaries, light blue lines – supposed boundaries. For other captions see Fig. 1.

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CATALONIAN SEISMIC MESOZONING MAP (1:100.000)

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KEYWORDS: Mesozoning, EC-8, Catalonia

INTRODUCTION

Eurocode-8 (EC-8) (Eurocode, 2004) proposes standard response spectrums forms to represent the seismic amplification of soil columns characterized by shear waves velocity.

To perform the zoning map of Catalonia at a scale of 1:100,000 (that we call “mesozoning” to distinguish from microzoning referred to detailed scale), a simplification of the geological map was contemplated considering 4 classes of ground based on geomechanical behaviour and the simplification of vertical layers structure in different ranges of thickness. These simplifications allowed us to accomplish a seismic mesozoning proposal for the whole territory, in an EC-8 sense.

MODIFIED EC-8 CLASSIFICATION

To perform Catalonia seismic mesozoning a modification of EC-8 was used. Unlike EC-8, modified EC-8 does not take into account S1 and S2 classes and introduces 2 new classes: B’, which includes soft rocks thicker than 100 m, and F class, representing soft or very soft soils of a single layer with a thickness of more than 100 m (Figure 1). This modified EC-8 classification is also used to propose a seismic zoning for the whole Pyrenees (Colas et al., 2012).

Mod. EC-8	Description
A	Hard rock
B	Soft rock, thickness less than 100 m
B’	Soft rock, thickness more than 100 m
C	Soft soil, thickness between 20 and 100 m
D	Very soft soil, thickness between 20 and 100 m
E	Soil, thickness between 5 and 20 m, on hard rock
F	Soil, thicker than 100 m

Figure 1 – Ranges and ratings for modified EC-8

METHODOLOGY

The methodology used involves 3 steps:

i) Categorization of geological units of the geological IGC map at scale 1:50,000 into 4 groups based on shear-waves velocity (Vs) (Figure 2). The assignment was made based on a qualitative assessment of geomechanics behaviour applied to Catalonia’s municipalities (Fleta et al., 1998; SISMICAT, 2000), recently extended to the entire territory (Saula, 2011), and revised on the occasion of this work, considering correlations with geotechnical tests (SPT, uniaxial test and pressuremeters).

Lithological Class.	Velocity $V_{S,30}$
HR	>800 m/s
SR	360-800 m/s
SS	180-360 m/s
VSS	<180 m/s

Figure 2 – Lithological Classification according to Vs,30

ii) Assignment of thickness interval to geological units (Figure 3). In the Quaternary it was used a generic approach depending on the type of deposit (e.g. terrace). This approach was modified when additional and contrasted data coming from boreholes or references was available. On the other hand, in the Neogene deposits and weathering granite, the thickness was determined according to their localization using data coming from boreholes and bibliography.

Thickness range	Thickness (m)
Very thin	0-5
Thin	5-20
Thick	20 a 100
Very Thick	>100

Figure 3 – Thickness ranges considered.

iii) Cross variables. This process was performed with GIS software, using polygons from initial data files of the geological map 1:50.000, which were assigned a representative soil column with a maximum of 3 layers. As the geological map did not have a continuous basement, new contacts were drawn where bedrock is fossilized by Quaternary deposits. These situations were detected in geological boundaries such as edges of basins, changes of weathering degree or alternating levels of different hardness. These new contacts generated new polygons that fit better to the vertical ground sequence. There are 61,644 polygons in the original geological map, whereas in the mesozoning map, 65,847 polygons were generated.

RESULTS

Type A grounds correspond to the hardest bedrocks, especially located in the Pyrenees and the Central depression. Type B deposits include coastal areas with granitic weathering and the oldest Quaternary deposits (Plio-Quaternary). Type B' are located in deep Neogene basins like the Valles-Penedès depression, Empordà, Cerdanya basin, etc. Type C and D soils are situated mainly in the deltas of rivers Ebre, Llobregat, Besós, Tordera, Ter and Fluvià. Finally, type E grounds are located in the valleys of these rivers and their major tributaries (Figure 3).

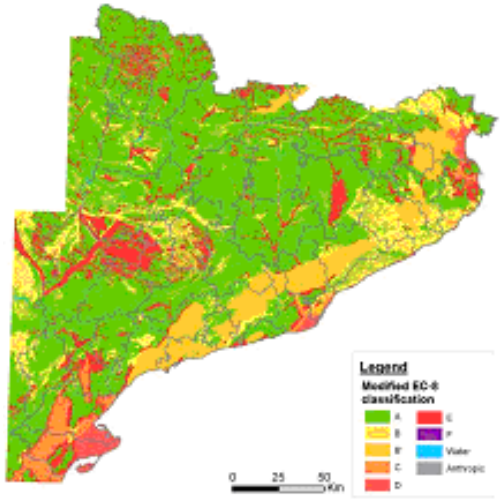

Figure 3 – Catalonian seismic mesozoning map (1:100.000).

VALIDATION RESULTS (BARCELONA)

Subsequently, the map has been compared to other maps and documents with a more detailed scale in order to validate the mesozoning map. Specifically, in Barcelona area, it was compared with the seismic microzoning map of Cid et al. (2001), which considered only four types of ground according to their seismic behaviour. There is a good agreement between both maps, except for areas where weathering granite is located, which are classified as type B on the mesozoning map, and as zone R or zone III (if they are covered with Quaternary deposits) on de microzoning map (Figure 4 i Figure 5).

Microzoning map	Mesozoning map
Zone I	Types C i D
Zone II	Type B'
Zone III	Types B i E
Zone R	Types A i B

Figure 4 – Correlation between ground types of the microzoning map and mesozoning map.

We have also performed comparisons with works in Neogene basins (Cerdanya) and Pyrenean areas (Vall d'Aran), obtaining good results for both locations.

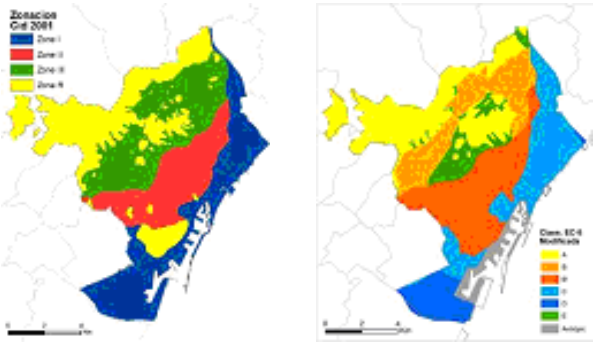

Figure 5 – Comparison of the microzoning map and the mesozoning map.

CONCLUSIONS

This article shows the seismic mesozoning map of Catalonia at a scale of 1:100,000, adapted to the EC-8 classification. Previously, maps of seismic zoning had been made (Fleta et al. 1998; Saula, 2011) without considering the vertical sequence of layers.

In Catalonia, 6 of the 7 classes of modified EC-8 classification are represented, which reflects its geological diversity. The grounds type A and B are those that have a major representation (80% of the surface), however, most urban areas are located on soils of class B, C and E, which correspond to areas with higher amplification.

In order to facilitate future work based on the seismic zoning classification EC-8 or modified EC-8, we recommend the use, as a reference, of a geological base provided with a continuous basement map and the use of a database related to geotechnical and geological units with information on dynamic parameters.

ACKNOWLEDGEMENTS

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ON THE ADDITIONAL SEISMIC RISK OF THE WESTERN ITALY

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KEY WORDS: sedimentary basin, heat flow, anomalous mantle, tectonic activity, seismic risk

THE POSITION OF ITALY IN THE SYSTEM OF THE MEDITERRANEAN SEDIMENTARY BASINS

From West and East Italy is bordered by Tyrrenian and Adriatic Seas which in term of tectonic structure are the sedimentary basins. On the whole within Mediterranean Sea the several sedimentary basins are distinguished – from West to East these are: the Alboran, Balearic, Tyrrenian, Ionian, Adriatic and Levant basins. These basins sharply differ in the heat flow, thickness of the Earh's crust and depth of the anomalous mantle. It is possible to say about hot (the heat flow > 70 мВт/м^2) and cold (the heat flow < 70 мВт/м^2) basins. Within hot basins (Alboran, Balearic and especially Tyrrenian basins) the thickness of the consolidated crust correlates to the depth of the anomalous mantle (astenosphere). Such condition of the deep interior caused the incresed tectonic activity and closely connected seismic activity of the appropriate areas.

THE ADDITIONAL SEISMIC RISK RESULTED FROM PECULIARITY OF THE TYRRENIAN BASIN DEVELOPMENT

The critical values of both parameters – consolidated crust and depth of the hot anomalous mantle are observed in the Tyrrenian basin: 5 km and 30 km, respectively, what together with high heat flow causes the high tectonic activity of this area. Analysis of additional geological data shows the recent displacement of the mantle source from central parts of Tyrrenian basin towards its eastern margin and even to the coastal Italy. The analogous geodynamic pattern can be seen in the paragenesis of the South-Adriatic basin and Albanian coast as well as Egean Sea and Turkish massive. In all the cases the recent tectonic activity, influenced by shifting the elevated hot mantle body, may provocate the increased seismic risk in the adjancent western regions of Italy.

THE SEISMIC MICROZONATION: A WELL-ESTABLISHED TOOL FOR URBAN PLANNING AND SEISMIC RISK REDUCTION IN EMILIA-ROMAGNA

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KEY WORDS: seismic microzonation, territorial and urban planning.

Approximately 75% of the regional territory comprises areas susceptible to site effects in the event of an earthquake. Given this situation, it is therefore clear how important seismic microzonation is for the mitigation of seismic risk.

In Emilia-Romagna, attention to prevention and mitigation of risk, including seismic risk, is manifest in the body of regional legislation since 1978.

However, it was only following the Ministerial Decree of 14/09/05 and the coming into force of the Prime Ministerial Decree n. 3274/2003, that in 2007 the Region approved "Guidelines for seismic microzonation studies in Emilia-Romagna to support territorial and urban planning" (DAL 112/2007).

These guidelines establish criteria and operational instructions for the identification of areas subject to site effects and for seismic microzonation, in order to guide planning towards areas with lower seismic risk. Based on the criteria proposed, seismic microzonation studies prescribe two distinct phases of analysis and three levels of investigation, depending on the aims and final uses as well as the local risk scenarios (Fig. 1).

The first phase coincides with the first level of investigation and its purpose is to establish local seismic hazard scenarios, identifying areas subject to site effects.

The second phase is limited to areas already urbanized or designated as susceptible to urbanization where they fall within areas identified in phase one as subject to site effects. It is in this phase that seismic microzonation of the study area is carried out. On the basis of the scenarios identified in phase one, two different levels of investigation apply (level 2 or 3) characterized by different programmes of investigation depending on the local geological and morphological characteristics.

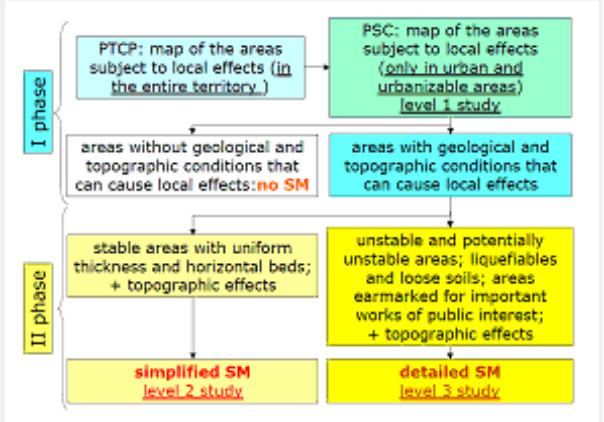

Figure 1 – Flow diagram of the seismic microzonation (SM) studies in Emilia-Romagna, according to regional guidelines (DAL 112/2007).

In order to implement the above-mentioned policies and strategies, it is essential to have suitable topographic and geological maps which enable to identify elements of natural hazard present.

For the entire regional territory, maps and geological maps at various scales, also in digital format (GIS) are now available. A digital terrain model (DTM) is also available, with definition up to 5 m x 5 m. For more in-depth investigations (levels 2 and 3) it is equally important to establish regional databases for the stratigraphic and geotechnical characterization of deposits based on the results of drillings and available in-situ and laboratory tests. In particular, for the geological map of the plain and coastal areas, the Region's Geological Survey carried out numerous bore-hole drillings and penetration tests in addition to gathering existing data. All the data was organized in a geo-referenced database which today comprises over 60,000 stratigraphic logs from bore-holes, oil- and water-wells and penetration tests.

In the first 5 years following the introduction of the guidelines, the Region was able to create a good knowledge base on local seismic hazard.

All Provincial Authorities have carried out analyses of areas susceptible to local effects and kind of expected effects throughout the entire territory (level 1 analysis at provincial scale).

As regards seismic microzonation at municipal and sub-municipal scale (level 2 investigation) until

now these studies have mostly been carried out in areas of greatest seismic risk (Romagna; Apennine-Po Plain margin, Apennine watershed), where awareness of the problems associated with it is also heightened (Fig. 2).

New impulse to the study of seismic microzonation is derived from the National Law No 77/2009, see in particular article 11, establishing a fund for the prevention of seismic risk and provides for contributions to the Regions for studies of seismic microzonation. Thanks to these contributions, new seismic microzonation studies of second level in 39 municipalities in the Region are in progress. For the realization of these studies, the Emilia-Romagna Region defined specific criteria (DGR 1051/2011) also derived from the national addresses (Working Group SM, 2008) and from the experience of seismic microzonation of L'Aquila basin for the reconstruction after the 6/4/2009 earthquake (Working Group SM-AQ, 2010).

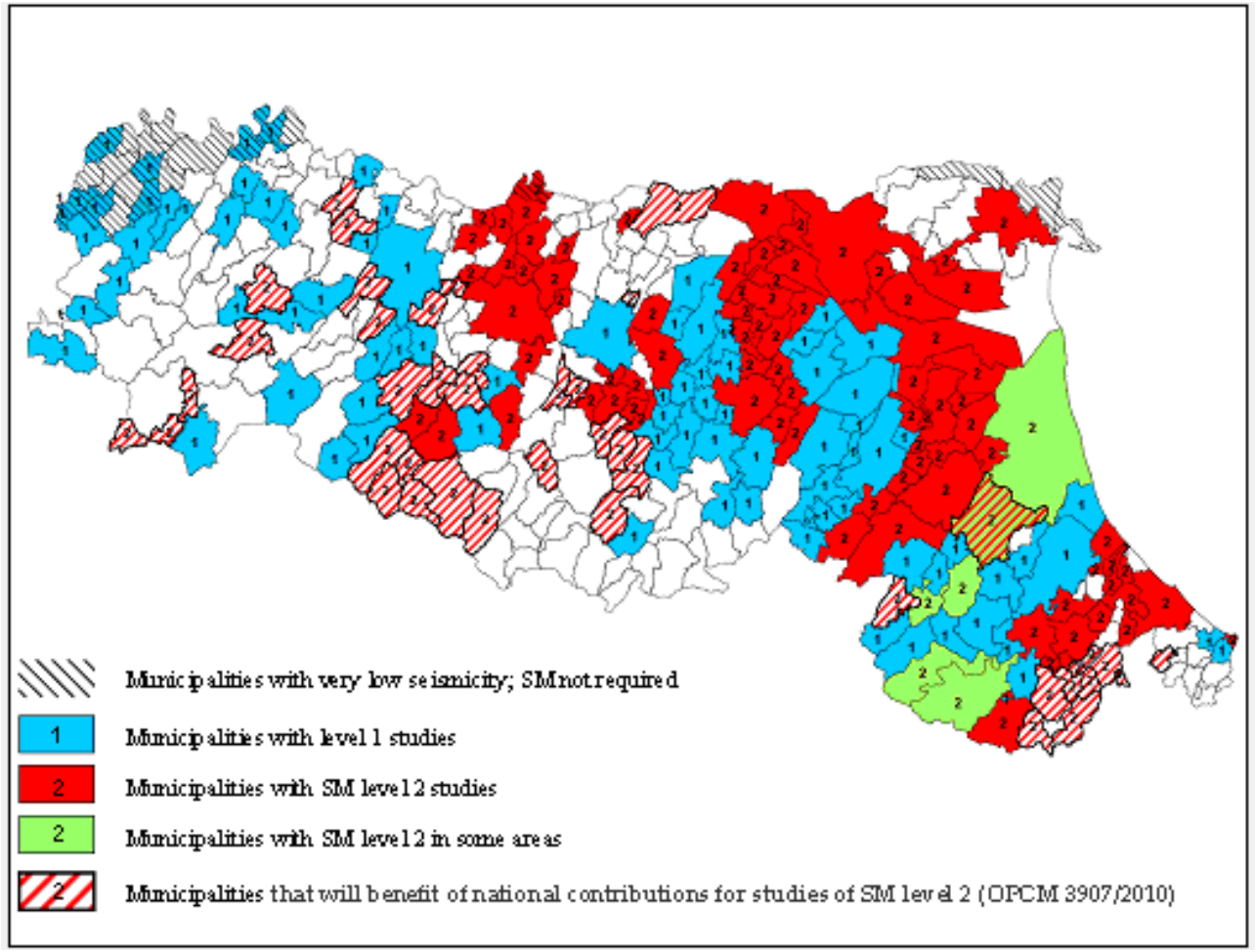

Figure 2 – Index map of the seismic microzonation (SM) studies in Emilia-Romagna.

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SEISMIC RISK TO INDIA'S CITIES

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KEY WORDS: seismic risk, India, cities .

India's situation geographically and geologically puts in a position where seismic risk has become greater. The north-east region and the Himalayan mountain belt were considered to be most seismic.-prone But the 1967 earth quake that hit the Koyna region in Maharashtra made geologists sit up and revise their earlier ideas about the aseismic nature of peninsular India .Subsequently earthquakes hit that region and in particular the Gujarat area on 26th January 2000 . The seismic zone map of India has been revised in the light of these experiences and now it is found that many cities of India which were formerly considered to be outside the seismic-prone area, are now exposed to that risk. Several steps have been taken to make a detailed study of the seismic phenomena at the National Geophysical Research Institute, Hyderabad. Further, a tsunami warning centre has also been established in that Institute, and is connected to the Pacific warning system Recently warnings about the impending tsunami have also been issued and mock rehearsals were held. Cities like Delhi and Mumbai are no longer free from seismic risk. Certain dams built on rivers in different areas that were supposed to be safe , are now seen to be facing seismic risk .

NEW MAPS FOR AN UPDATED GROUND MOTIONS CHARACTERIZATION AND SEISMIC HAZARD ASSESSMENT IN PIEMONTE REGION (NW ITALY)

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KEY WORDS: thematic maps; ground motion; Piemonte

INTRODUCTION

The Piemonte region is characterized by low magnitude instrumental seismicity (usually minor than 5 Richter's scale), mainly concentrated in correspondence of the western Alpine chain, in its western sector, and in the Alessandria province, in its south-eastern part. In the new seismic classification (O.P.C.M. n.3274 20th March 2003) many areas of Piemonte, including 409 municipal territories, fall in class III, with a low seismic risk, whereas the rest of the regional territory falls in class IV, with very low seismic risk. Since the 1st July 2009, the passage of the new rules contained in the D.M. 14th January 2008 (*Nuove norme tecniche per le costruzioni*) obligates the anti-seismic building design and the characterization of the ground motions for the entire regional territory. These technical rules are based, following the Eurocode 8 directives, on the definition of the Vs_{30} parameter.

In order to achieve an updated Vs_{30} map of the entire Piemonte regional territory, ARPA Piemonte and the Earth Sciences Department of the University of Turin stipulated an agreement for the elaboration and production of updated thematic maps aimed to the characterization of the ground motion of this area. This note synthetically describes the preliminary results of this study.

Preliminary results

The main problem in the realization of the maps is the lack of an updated geological-structural mapping for the entire analysed territory. Only about 20% of the regional territory is, in fact, covered by the sheets of the new Geological Map of Italy at 1.50.000 scale (Project CARG). The thematic maps were therefore obtained integrating the different existing geological and geomorphological cartography available for the overall regional territory, which include:

the first and second edition of the Geological Map of Italy at 1:100.000 scale;

the surficial deposits of the Geological Map of Italy at 1:250.000 scale (in phase of realization by the CNR-IGG section of Turin);

the IFFI/SIFRAP landslides Inventory;

the Structural Model of Italy at 1:500.000 scale (Bigi et al., 1990);

the published data regarding faults and their possible relations with seismic activity.

Through the integration of these different cartographic products resulted a preliminary version of the *Geological-Geomorphological Map aimed to the seismic characterization of the Piemonte region, at 1:100.000 scale.* In this map the different outcropping geological units were grouped in twenty-five different categories on the basis of their presumed mechanical response to the seismic shaking. The criteria utilized for the subdivision include the age, density and competence of the rocks. Two main groups of categories were distinguished: the superficial deposits and the pre-Quaternary substratum. Also the landslides, the Deep-seated Gravitational Slope Deformations (DGSDs) and the main faults were considered.

From this map was realized the *Seismic Characterization Map of Piemonte region at 1:100.000 scale,* in which the regional territory has been subdivided in different sectors, qualitatively characterized by an homogeneous mechanical behaviour during seismic shaking. This thematic map was realized following the general criteria outlined for the seismic microzonation (Gruppo di Lavoro MS, 2008) even if at a different scale. On the basis of the lithological characteristics, fracturation, thickness of the different categories the regional territory was subdivided in:

stable areas,

stable areas susceptible of seismic amplification,

instable areas.

These three typologies of areas were further subdivided in 37 different Zones, characterized by a roughly homogeneous stratigraphy for the first 30 meters of depth, in which a homogeneous seismic response is awaited. A stratigraphic column indicating also the range of thickness of each lithotype and a qualitative estimation of the Vs was provided for each Zone. A qualitative measure of the fracturing was also furnished for the areas affected by faults or DGSDs.

Limitations of the current version of the maps and future implementations and perspectives

The integration of different version of the

Geological Map of Italy, deriving from field surveys carried out at very different times, induced problems in the correlation of the geological limits between the adjoining sheets. Moreover translation of the geological data was also caused by the different projection utilized in this study (UTM ED50) with respect to that of the original cartography (IGM).

The integration of the current version of the maps with new geological information at the regional scale, like the pre-quaternary basement of the Geological Map of the Piemonte at 1:250.000 scale, should allow to eliminate most of the incongruence of the geological units of the different sheets.

Finally the integration of the final version of the *Seismic Characterization Map of Piemonte region* with Vs_{30} measurements will constrain more accurately the ground motion and seismic amplifications. This map will therefore represent a valid tool for the realization of updated and detailed Vs_{30} map and shakemaps for the Piemonte.

ACKNOWLEDGEMENTS

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SEISMIC MICROZONATION IN THE WESTERN ALPS (ITALY): THE EXAMPLES OF SUSA (PROVINCE OF TURIN) AND DRONERO (PROVINCE OF CUNEO) VILLAGES

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KEY WORDS: seismic microzonation, geological mapping, Weaìsetrn Alps

INTRODUCTION

This contribution briefly describes the methodology and the results of the studies conducted for the production of thematic maps for the first level of seismic microzonation, as defined by the Gruppo di Lavoro MS (2008), of mountainous territories characterized by an high geological and geomorphological complexity, like the western Alpine chain.

Two sites were considered in this study, carried out in an agreement between the Civil Protection of the Regione Piemonte and the Earth Sciences Department - the University of Turin, that include the Susa (in the province of Turin) and the Dronero (in the province of Cuneo) villages.

Due to the different geological updating and data supply the *Homogeneous microzones maps* of these two sites, which represent the final product of the first level of seismic microzonation, reached a different quality level.

THE SUSA VILLAGE

In the last decade several geological and geophysical surveys were carried out in the Susa village, mainly related to the production of the Geological Map of Italy (1:50.000 scale; Carraro et al., 2002) and to the realization of the Turin-Lion railway (Sacchi et al., 2004).

The territory of Susa, which fall in Zone III (under low seismic risk) of the seismic classification of Italy (OPCM 3274 – 2003), is located in the Lower Susa valley, at the confluence between the Cenischia and Dora Riparia river. In this area different ocean- (Piemonte Zone) and continental- derived (Dora-Maira Unit) tectonic units belonging to the Penninic Domain of the Western Alps crop out. The most important brittle structural feature is represented by the Colle delle Finestre Deformation Zone (CFZ), which extend in a N-S direction from the Susa to the Chisone valley. Even if some evidences suggest a recent activity for this structure, its relation with the seismic activity is currently under debate. The geomorphological setting of this part of the Susa valley is very complex, as glacial and fluvial deposits and landforms are widespread and many Deep Seated Gravitational Deformations (DSGD) affect this area. This relatively large amount of data, inserted in a GIS georeferenced environment, allowed to realize a detailed geological-geomorphological map at 1:5.000 scale and a map of the thickness of the superficial deposits at 1:25.000 scale of the entire Susa territory. These informations were further integrated with the geophysical data available for this area to realize *Homogeneous microzones map* of the Susa village (attached in Gruppo di Lavoro MS, 2008), where almost the buildings and infrastructures are concentrated. On the basis of the lithological, geomorphological and geological features the analysed area was subdivided in stable areas, stable areas susceptible to local seismic amplification, instable areas. The stable areas include the outcrops of the pre-quaternary rocky substratum, corresponding to the Zone 1, mainly widespread along the valley slopes. The stable areas susceptible to local seismic amplification include 5 classes (Zone 2-6) distinguished on the basis of the type and thickness of superficial deposits. The instable areas include faults and the areas where seismically induced gravitational phenomena could occur.

THE DRONERO VILLAGE

The Dronero village, which is located at the Maira valley mouth at the limit with the western Po Plain, falls in Zone III of the seismic classification of Italy (OPCM 3274 – 2003).

Both the geological studies and the official geological map regarding this area, located at the limit between the Dora-Maira Unit and the Piemonte Zone, are rather outdated (Michard, 1967; Vialon, 1966; Crema et al., 1971). Due to this scarce updating of the geological information, the large extent of its territory (60 km^2) and the very limited availability of geognostic boreholes, the seismic microzonation study was only carried out for the Dronero village. The geological and geomorphological field mapping of this area, aimed to the detection of the local conditions that potentially could cause amplification of earthquake ground motion, emphasized that further investigations were needed to characterize the geometry and thickness of the fluvial deposits (mainly constituted by conglomerates) outcropping

along the terraces of the Maira river, bounded by steep scarps up to 30 metres high. Subsequent geognostic and geophysical investigations (electrical tomographies, seismic down-hole, seismic refraction profiles) allowed to infer a buried river beneath the fluvial deposits of the Maira river. Due to the variable degree of cementation of fluvial deposits also the ground-water level was considered to investigate possible soil liquefaction phenomena.

All these information were considered in the realization of the *Homogeneous microzones map* (Fig. 1) where Dronero village was subdivided in stable areas, stable areas susceptible to local seismic amplification, instable areas. The stable areas include the outcrops of the pre-quaternary rocky substratum, corresponding to the Zone 1, mainly widespread along the valley slopes and along the Maira river bed. The stable areas susceptible to local seismic amplification include 5 classes (Zone 2-6) distinguished on the basis of the type and thickness of superficial deposits, whose distribution is strongly influenced by the occurrence of the buried -river inferred beneath the fluvial deposits of the Maira river. The instable areas, include both landslides and faults.

The results of this study also suggest that in this area liquefaction soil potential should not expected, even if a more accurate characterization of the fluvial conglomerates constituting the Maira river terraces is strongly recommended.

FINAL CONSIDERATIONS

This study show that especially in areas characterized by an high-geological and geomorphological complexity, like that analyzed here, the availability of updated and detailed geological and geomorphological informations is fundamental in the realization of thematic maps aimed to the seismic microzonation. Only on the basis of these data is possible to plan the further geophysical and or geognostic investigations necessary to reconstruct the geometry of the geological bodies or to their mechanical or physical characterization.

This experience also indicate that the lack of an updated geological cartography for wide areas of the Piemonte region should not allow, especially in the areas with moderate to high seismic risk, to realize microzonation maps with an adequate standard.

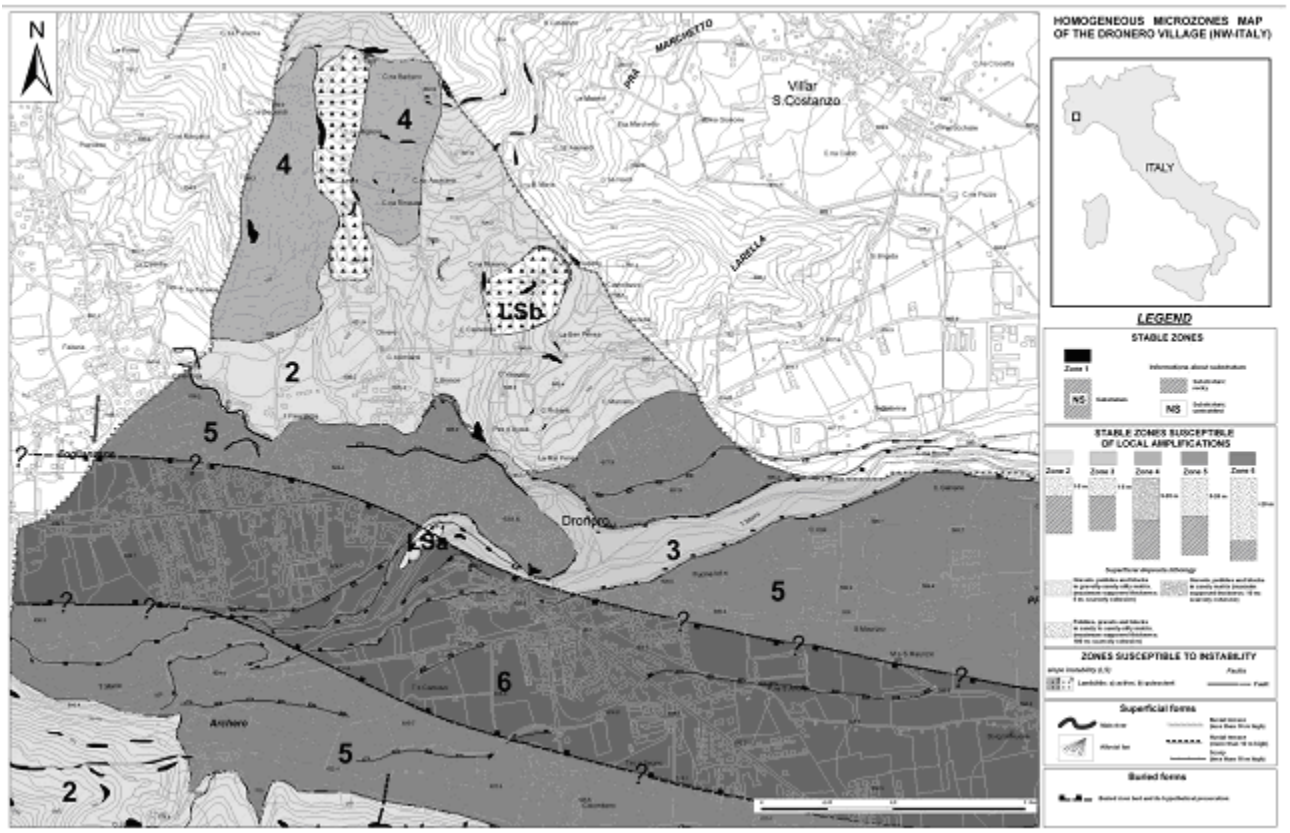

Figure 1: Homogeneous microzones map of the Dronero village

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REALIZATION OF A GEOCHEMICAL MONITORING NETWORK IN TUSCANY (ITALY): POSSIBLE APPLICATION OF HYDROGEOCHEMICAL PRECURSORS TO THE STUDY OF EARTHQUAKES.

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KEY WORDS: hydrogeochemistry, earthquakes precursors.

SCIENTIFIC SESSION: SEISMIC RISK

The variations of the chemical-physical properties of spring waters in tectonically active areas have been shown to be of interest in the earthquake prediction. Nevertheless the interpretation of the several anomalies recorded in different areas in correspondence of seismic events is still argument of debate, both for the significance attributed to the specific parameters and also because it is necessary to define the range of their variability in time and space (background level). In this respect and in the framework of a project funded by Seismic Service of Tuscany Region (Cioni et al., 2007) some areas of highest seismic risk in Tuscany (Garfagnana, Lunigiana, Mugello, Tiberina Valley and Amiata Mount) has been selected to identify possible hydrogeochemical precursors of earthquakes.

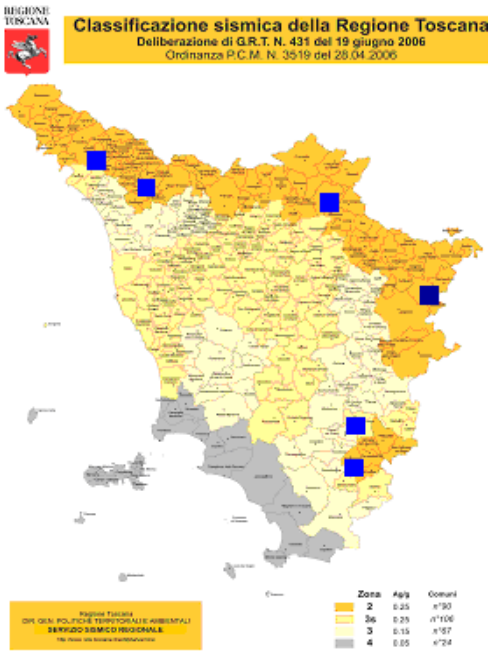

Figure 1 – Geochemical monitoring network in Tuscany to study possible relationships between variations in water chemistry and seismic events.

In this framework six continuous automatic monitoring stations were designed, built and installed in these areas since late 2002 and a systematic study of the hydrogeochemical characteristics, both chemical (Na, K, Ca, Mg, Cl, SO_4, SiO_2, F, B), isotopical ($\delta^{18}O$, δD, Trizio) and chemico-physical (T, pH, CE) has been carried out. The continuous automatic monitoring stations operate with flowing water (about 5 litres per minute) and record the following parameters: temperature (T), pH, electrical conductivity (EC), redox potential (ORP) and the content of CO2 and CH4 dissolved in water. Frequency of data acquisition is 1 second for all parameters; the average, median and variance values are locally calculated over a period of 5 min and recorded with a local data logger (DT80). Data are finally transmitted once a day to CNR–IGG by router GPRS and available for processing and interpretation.

A geological and hydro-structural characterization of the Garfagnana and Lunigiana areas has also been integrated, to define a bidimensional model of the circulation, to reconstruct the geometry of the aquifers, the geometry of the fault systems and the emergency typology of the deep circulation.

The IGG-CNR "*Tuscany Geochemistry Network*" has been realised based on general criteria resulting from a critical examination of the literature on the subject and by a thirty-years experience on volcanic systems monitoring. These criteria are currently accepted by most of the scientific community operating in this field of research and are briefly described in the following points below:

- Monitoring stations are all multiparametric (Toutain & Baubron,1999) and the choice of the sensors/hardware has been guided by the current availability of high precision instrumentation. For CO_2 and CH_4 determination a cell extraction of the gases dissolved in water has been specifically designed.
- In order to get a better understanding of the occurring geodynamic processes, the choice of parameters to be measured, very critical, has been done based on the current knowledge of possible chemical and physical processes that occur deep in the early stages of an earthquake, that is, during the accumulation of seismic energy. In these phases, as a consequence of the change of system permeability, we may

expect i) variation of the concentration of He, Ar, Rn, H_2, CO_2, CH_4, H_2S in soil gases and in deep water, ii) mixing of waters of different origin, iii) changes in T, salinity, etc.

- The monitoring must be strictly continuous. In fact, the continuous automatic monitoring is the only way to detect the real temporal variability of a system: the interpolation of discontinuous measurements, even if frequent, cannot reproduce the real evolution of parameters over time, especially in highly variable systems. Is now universally recognized that the continuous automatic monitoring is the only method to identify geochemical precursors of seismic activity, since the variations of the concentration values of various substances, whether induced by environmental factors and/or seismic events, can last a few hours Therefore the sampling time interval has to be adjusted according to the expected changes of the parameter value that we intend to identify.
- The acquired data must be validated using standardized procedures - manual or automatic - performed periodically and/or at times of maximum variation of signal. In fact possible observed variations in parameter measurement may be also due by instrumental disturbances (e.g., occasional instrumental drift, problems related of water flow in the hydraulic circuit, etc.). For this reason monthly calibrations of the chemical and chemical-physical parameters (T, pH, EC, CO_2) are performed, and samples of water for analysis in the laboratory (Na, K, Ca, Mg, Cl, SO_4, HCO_3, SiO_2, F, B) are periodically carried out.
- In order to identify anomalous variations in parameters, a properly long time-series needs to be acquired so that the background values of each parameter can be accurately and precisely defined. For the stations of Equi Terme, Gallicano, Bagno Vignoni and Bagnore have been acquired more then 700.000 data.
- The possibility of prediction depends on the knowledge of the system under monitoring (Cioni, 1989). In fact, the relationship between earthquakes and anomalous variations is not general, but seems to be different depending on the seismogenic zone (Biagi www. http://www.nature.com/nature/debates/earthquake). For this reason a multidisciplinary study (geological, hydrostructural and hydrogeochemical) has been carried out for the Lunigiana and Garfagnana sites.

The results of almost ten years of continuous monitoring in Tuscany can be summarised as follows: i) the monitoring stations made possible to detect even small variations of important parameters possibly related to seismic activity. ii) acquired data allowed to characterize the groundwater circulation patterns; iii) in all locations, the observed trend of the automatically acquired parameters is consistent with the calibrating periodic manual sampling results. iiii) When a hydro-geochemical study is integrate with a hydro-structural model (e.g. Lunigiana and Garfagnana), the overall study can better characterize the significance of detected anomalies, disentangling variations in parameters due to natural phenomena (recharge from specific areas, mixing processes…) from variations possibly due to change in permeability of the system and therefore related in some way to seismic activity. The absence of seismic events with a sufficient energy precluded the possibility to locate anomalies, with two exceptions: Equi Terme and Bagno Vignoni sites. At the Equi Terme station an anomalous increase in the dissolved CO_2 content was observed twelve days before a M=3.7 earthquake occurred at a distance of 3 km north of the monitoring station. At the Bagno Vignoni station an anomalous decrease in the temperature and electrical conductivity signal was observed nine days before a M=3.3 earthquake occurred at a distance of 12 km of the monitoring station.

The Tuscany Geochemical Network resulted as being a suitable tool in order to investigate the anomalous variations of the physical, physicochemical and chemical parameters of aquifer systems as earthquake precursors.

It should be stressed that in order to establish a reliable and sounded relation between anomaly of chemical-physical parameters and seismic activity, a significantly high number of “events” need to be validated, especially in view of possible forecasting purposes in Tuscany.

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A WEBGIS APPLICATION FOR VISUALIZATION AND DISSEMINATION OF ITALIAN SEISMICITY

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KEY WORDS: real time seismicity, webgis, map services, ArcGIS on line

ITALIAN SEISMICITY DATA

The national seismic monitoring service is an advanced real-time analysis of seismic data managed by the Centro Nazionale Terremoti in Rome of the Istituto Nazionale di Geofisica e Vulcanologia (INGV).

The service provides a first location within a few seconds of any Italian earthquake and a definite location within few minutes.

The national seismic network allows to record every year more than 10,000 earthquakes throughout the country: as agreed with the Civil Protection Department of Italy, the events with magnitude ML greater than 2.0 are published on the website of the Centro Nazionale Terremoti (*http://cnt.rm.ingv.it*). At the same time all the earthquakes, also the ones with magnitude less than 2.0, are published in **ISIDe** "*Italian Seismic Instrumental and parametric data-base*" (*http://iside.rm.ingv.it*), a database-catalog where earthquakes are stored together with the seismic data of the "Italian Seismic Bulletin" since 2005 (*Figure 1*).

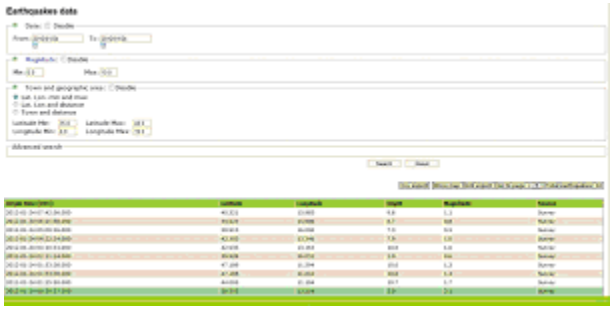

Figure 1 – The ISIDe web portal

THE GEOSIS PLATFORM AND THE REALIZATION OF MAP SERVICES

To integrate the real-time seismicity in a single environment with numerous spatial, geological and seismological data, it has been created a synthesis GIS tools to "frame" the location of an earthquake not only in its local context, but extending it to other useful information derived from databases and studies produced by INGV in the last years.

This is the purpose of the platform **GEOSIS** which is composed primarily by GEOSIS EARTHQUAKE REPORT but also a more complex web interface GEOSIS WEB where it is possible to create custom scenarios with the data of seismic hazard, the historical and recent (1981-2011) seismicity of Italy. These data are available through map services made by ESRI ArcGIS Server.

To extract seismicity data from the database ISIDE has been developed a procedure which involves the creation of map services implemented within the platform ESRI ArcGIS.

This application, called XEQDAC (Xml Earthquake Downloader And Converter), runs in the background and downloads individual seismic events from an internet address, published and updated by the ISIDe database, also used for other applications such as the Apple IPhone INGV Terremoti application (*Figure 2*).

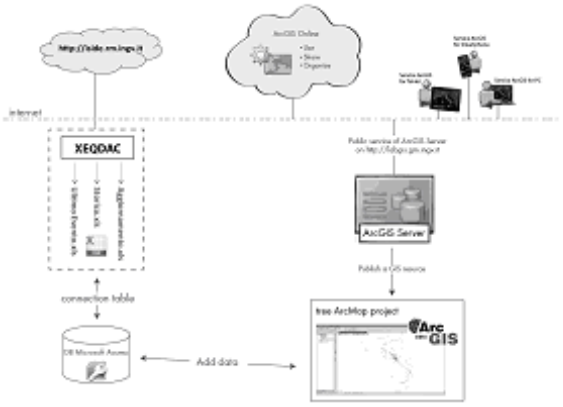

Figure 2 – The XEQDAC workflow

The application creates two separate files: a list of all events (storico) downloaded since its first run; a list with the events of the last three days.

These files are updated every 5 minutes. The Microsoft Excel files created with XEQDAC are imported into Microsoft Access and then upload and classified in a ESRI ArcGIS ArcMap project. From three ArcMap projects have been created three services (*map services*) by the ArcGIS Server:

1. “storico”, containing earthquakes from January 1, 2012;
2. “aggiornamento”, with the last 3 days of events;
3. “ultimo evento”, the last earthquake.

THE INTEGRATION IN ARCGIS ON LINE

It was decided to develop the platform GEOSIS, previously used only for internal INGV, even for a more substantial use also external.

Therefore the integration of GEOSIS in **ArcGIS Online** has been a logical consequence to share the information relating to the Italian real time seismicity in a geographical environment open and free with the possibility to interact with other geographic data.

ArcGIS Online is a cloud-based geospatial content management system for storing and managing maps, data, and other geospatial information. Built on Esri’s cloud infrastructure, it gives you access to geographic content shared and registered by Esri and GIS users around the world.

As a first step it was created the web map in **ArcGIS.com** containing the three map services related to seismicity and the map services developed for the platform GEOSIS. In detail the layers are the following:

1. *Real time seismicity layers,*
   - *Ultimo evento (last event)*
   - *Sismicità ultimi 3 giorni*
   - *Sismicità dal 1 gennaio 2012*
2. *GEOSIS layers,*
   - *Rete Sismica Nazionale*
   - *Sismicità 2011*
   - *Sismicità strumentale 1981-2010*
   - *Sismicità storica*
   - *Mappa pericolosità sismica*
   - *Classificazione sismica su base comunale*

For all the layers have been set the display properties (classification and thematization) and query (identify) by configuring the pop-up. When the web map starts there are only two layers visible: the last event and the seismicity of the last 3 days.

As a background map (*ERI Base Maps*) has been chosen the last published by ARCGIS.com, called National Geographic, that allows a clear reading of all the symbols in the various layers and also gives us important information on the morphology and bathymetry of the area as well as main roads and place names.

Using ARCGIS.com tools it was generated the web map application using the default client BASIC VIEWER and it has been configured its properties.

The result is a geographic web application that will soon be made available for all to see the seismicity of Italy in real time allowing the construction of custom scenarios going to superimpose all the information in the map services of GEOSIS.

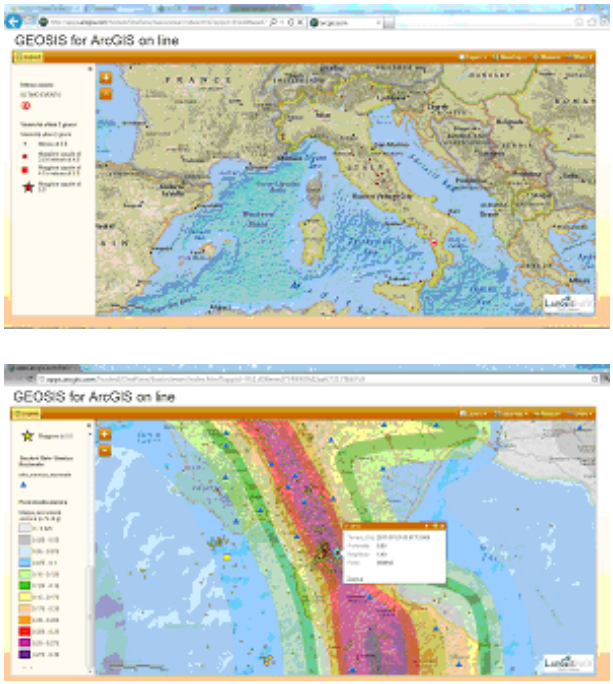

Figure 3 – GEOSIS for ArcGIS Online

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SEISMIC RESPONSE ANALYSIS OF A DRY DETENTION BASIN ON THE TORRENT SAMOGGIA (LOC. LE BUDRIE, S. GIOVANNI IN PERSICETO).

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(3) Regione Emilia-Romagna, Servizio Tecnico Bacino Reno (STBR)

KEY WORDS: local seismic response, earthquake, seismic analysis, liquefaction, seismic, geotechnical, engineering.

This work has been developed for an engineering thesis made by joint work with the University of Bologna and Regione Emilia-Romagna.

THE CONTEXT

The dry detention basin is 6.5 km from San Giovanni in Persiceto and occupies an area of about 100 ha in the left bank of the Torrent Samoggia about 1 km downstream of Budrie's bridge.

Springs and snowfield don't fed the Torrent, so it presents a torrential rate extremely variable, with full rapid and sudden flow of lean practically dry for large part of the year it happens because.

SEISMIC ANALYSIS

Budrie's dry detention basin is considered a work of strategic interest, like all the others national and regional important reservoirs. Emilia-Romagna Regional law nr. 1661 of November 2, 2009 – imposes to do a dedicated analysis of local seismic response for this category of works.

This analysis has already been done for some basins near the main tributaries of the Po River, for seismic verifications of spillway, embankments and other hydraulic structures. These studies have been taken as guidelines for conducting seismic tests performed in the thesis.

Before preparing the detailed geotechnical investigation, it has been done a research in archives and georeferenced database in order to find useful information for the characterization of the subsurface.

The additional investigations consist in:

• SCPTu - Seismic Piezocone Penetrometer with measurement of pore water pressure, extended over 30 m deep to the berm.

• CPTu - Piezocone Penetrometer with pore water pressure measurement, extended 30 m deep to the top of the embankment.

- • Wire line core drilling with drawing of 10 undisturbed samples; extended 35 m deep to berm of the embankment.
- • Seismic MASW HVSR
- • Laboratory tests including static geotechnical soil classification, Oedometer tests, Triaxial tests: consolidated drained (TxCD) and unconsolidated undrained (TxUU);
- • Laboratory tests in the dynamic field by resonant column and torsional shear.

All investigations have been performed by Elletipi s.r.l. between July and September 2011 and supervised on site by the writer and STBR engineers. The results of these tests have been used to define the geotechnical model of the ground.

COMPATIBLE SPECTRA SELECTION

To select compatible response spectra it has been used specific software REXEL.

REXEL allows to define the design spectra according to the Eurocode 8, the new Italian Building Code or completely user-defined. Based on these spectra, the software allows to search for sets of 7 records compatible (recorded accelerograms scaled), in the average, with them. Records may also reflect the seismogenetic features of the sources (in terms of magnitude and epicentral distance), ground motion intensity measures, and soil conditions appropriate to the site. The datasets contained in REXEL are the European Strong-motion Database (ESD), the Italian Accelerometric Archive (ITACA).

All 7 selected records have been referred to category A subsurface (rock outcropping).

TIME-FREQUENCY ANALYSIS

An analysis has been conducted in the time-frequency domain to demonstrate the consistency between synthetic generated signals and real spectrum compatible signals. The analysis has been

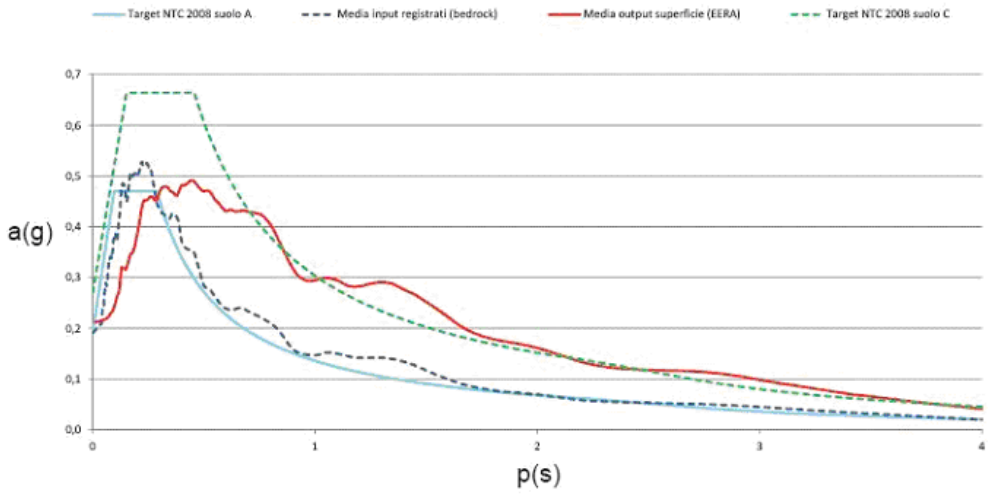

Figure 1 – response spectrum

done through MatLab function "s-transform". It results that synthetic signals are worse than real selected signals in terms of energetic distribution.

SEISMIC RESPONSE ANALYSIS

The seismic site-dependent analysis has been performed by EERA (Equivalent-linear Earthquake Response Analysis) software, which is based on SHAKE mathematical model. It has been chosen a one-dimensional modeling because the site doesn't present particularly complex conditions for what concerns the surface and buried morphology. EERA takes the follows input parameters:

- Number and thickness of layers
- soil physical characteristics of each layer
- shear stress (G/Gmax) and damping ratio (D%) for each type of soil
- input signal (accelerogram) based on the seismic reflector surface

The output consists in a new seismic signal and considers the modification of the signal that happens in the way between seismic source and surface.

Spectral site amplification factor has been found by comparing the average spectrum of output signals with the target spectrum.

$$Fa_{0.1-0.5} = \frac{si_{0.1-0.5}(output)}{si_{0.1-0.5}(input)} \quad ; \quad Fa_{0.5-1.5} = \frac{si_{0.5-1.5}(output)}{si_{0.5-1.5}(input)}$$

Figure 2 – Spectral amplification factor.

Figure 1 shows the comparison between average output spectra and target spectrum. It shows that target spectrum is more precautionary in range of periods between 0,1-0,5 sec and almost equal between 0,5-1,5 sec than average output spectrum.

	Fa (0,1-0,5)	Fa (0,5-1,5)
Soil A	0,96	2,23
Soil C	0,67	0,99

Tab 3 – Spectral amplification factors referred to two different categories of soil

CONCLUSIONS

The site doesn't lead particular amplification in terms of maximum acceleration, whereas there is a spectrum general towards strain to low frequencies. However the target spectrum on soil C is absolutely precautionary for safety.

Stability slopes analysis have been performed for two embankment's typical section considering different hydraulic conditions. Safety condition is verified in all studied situations. Soil liquefaction susceptibility is verified.

ACKNOWLEDGEMENTS

I'm grateful to Servizio Tecnico di Bacino Reno, my professor, and all the other people that helped me for this project.

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THE DIGITAL BACKBONE OF THE DATABASE OF INDIVIDUAL SEISMOGENIC SOURCES (DISS), VERSION 3

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KEY WORDS: Active tectonics, active fault, seismogenic source, seismic hazard, database, GIS, web application.

DISS RATIONALE

The Database of Individual Seismogenic Sources (DISS) is a large repository of geological, tectonic and active-fault data for Italy and surrounding areas. It was conceived in the late '90s and first published in 2000 on CD-ROM with limited circulation. Version 2, the first official version, was also released on CD-ROM (Valensise & Pantosti, 2001) and, after some additions and revisions became the main geological basis of the Italian seismic hazard map (Gruppo di Lavoro MPS04, 2004). After re-designing its structure and basic concepts, the DISS version 3 was first published online in 2005. The DISS is compiled based on field work and analytical elaborations by its authors and on a large amount of literature data (see Basili et al., 2008). Its data model has also been compared and made compatible with that of the USGS seismic hazard faults to facilitate data exchange and use of seismic hazard codes (Haller & Basili, 2011).

The DISS, version 3, stores two main categories of parameterized crustal fault sources: Individual Seismogenic Sources (ISS) and Composite Seismogenic Sources (CSS), both of which are considered able to release earthquakes of Mw 5.5 or larger. It also stores information about Debated Seismogenic Sources (DSS) which are crustal active faults that have been proposed in the literature as potential seismogenic sources but were not considered reliable enough to be included in the other two categories. In addition to crustal seismogenic sources, information about subduction zones in the Mediterranean area has recently been added to the database.

Considering that the primary purpose is to provide a seismogenic source model at regional scale, the database is usually populated by filling in or reviewing large regions at once (e.g. Burrato et al., 2008; Kastelic & Carafa, 2012; Vannoli et al., 2012). Substantial updates are expected to appear in the web approximately once a year. The latest public updates being version 3.1.1 for Italy and some surrounding areas (DISS Working Group, 2010) and its extension to the general Euro-Mediterranean area in the framework of the EU project SHARE (Figure 1).

INFORMATION TECHNOLOGY BEHIND THE DISS

The DISS system has a "back end" where the database content, its updates, and new developments are prepared and a "front end" where the database finalized content is made available to the public.

The back end is based on the Windows server 2008 operating system equipped with the desktop GIS MapInfo Professional 11. The database is managed through a dedicated MapBasic application that offers a number of tools in a friendly GUI. This part of the system is mainly devoted at putting together the building blocks of the database. These are (Basili et al., 2009):

- the main data tables with the parametric information of the four categories of seismogenic sources;
- the relational tables that link the above tables together and with other relevant information in the database;
- text and figures that augment the description of each database record;
- the associated references to scientific literature;
- vector data and raster maps taken from the literature or from public-domain databases that contain any useful information about seismogenic sources.

The front end is based on a High Availability (HA) cluster made up by two nodes. On a Linux operating system this type of cluster is based on Distributed Replicated Block Device (DRBD), i.e. a kernel module that provides a block device (or more) distributed on all nodes and thus accessible by all of them. Each block device is formed by a number of partitions residing on all machines of the cluster and thereby replicating all data. For this configuration the cluster uses both local and wide area networks. Our DRBD configuration is

composed by one active node and one passive node that are always synchronized by a dedicated network link. This job is carried out by the Heartbeat (2.0) application that in case of failure switches the master and slave units from one to another making the DRBD partitions available for access by all other applications.

The back end and the front end communicate through a dedicated graphic user interface basically devoted at uploading new files and modifying existing files.

The database is made available to the public in the internet through a dedicated MapServer-based web GIS application and a custom-made web application called CADMO (Create Access Delete Modify with Objects) that automatically develops web pages. This system provides operators with a complete set of data management tools and public users with visualization tools for consulting alphanumeric data, figures, comments and perform searches within the database. The DISS is fully accessible at http://diss.rm.ingv.it/diss/.

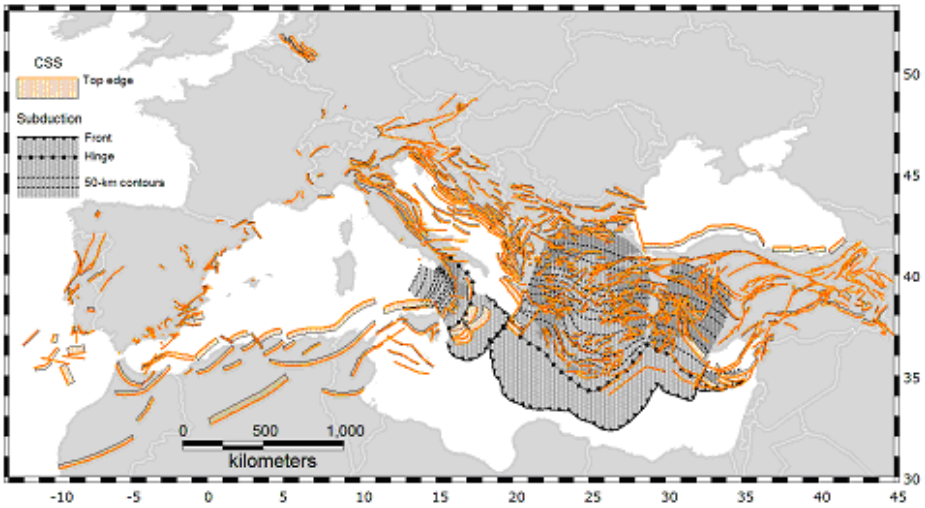

Figure 1 – Map view of the recently completed compilation of seismogenic sources for the EU project SHARE (http://diss.rm.ingv.it/share/; Basili et al., 2010).

ACKNOWLEDGEMENTS

The DISS is developed and maintained with the financial contribution of Istituto Nazionale di Geofisica e Vulcanologia and of several Italian and international projects.

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EVIDENCE OF THE MIRANDOLA ANTICLINE USING HVSR MEASUREMENTS

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KEY WORDS: Mirandola Anticline, structural high, Po Plain, passive seismic, HVSR, seismic microzonation, Quaternary, impedance contrast, colour-shaded grid.

The southwestern portion of the Municipality of Mirandola area (Province of Modena, Emilia-Romagna region, Italy) is interested by a buried structural high known as “Mirandola Anticline” (Burrato et al. 2003). In correspondence of this structure the continental and marine superficial deposits of Po Plain are particularly thin (figure 1).

104 passive seismic measurements (single station microtremor) were performed over the entire municipal area for the the seismic microzonation study of Mirandola (september 2011 – february 2012).

The comparison of HVSR (horizontal to vertical spectral ratio) curves (Castellaro et al. 2005) with the detailed geological sections made by Geological, Seismic and Soil Survey of Regione Emilia Romagna for the recent researches relating to potential geothermal reservoirs in the Mirandola subsoil (Martelli e Molinari 2008), shows an excellent correlation between the stratigraphic architecture of superficial units and the results of the passive seismic mesuraments (peak frequency and amplitude) (figure 1).

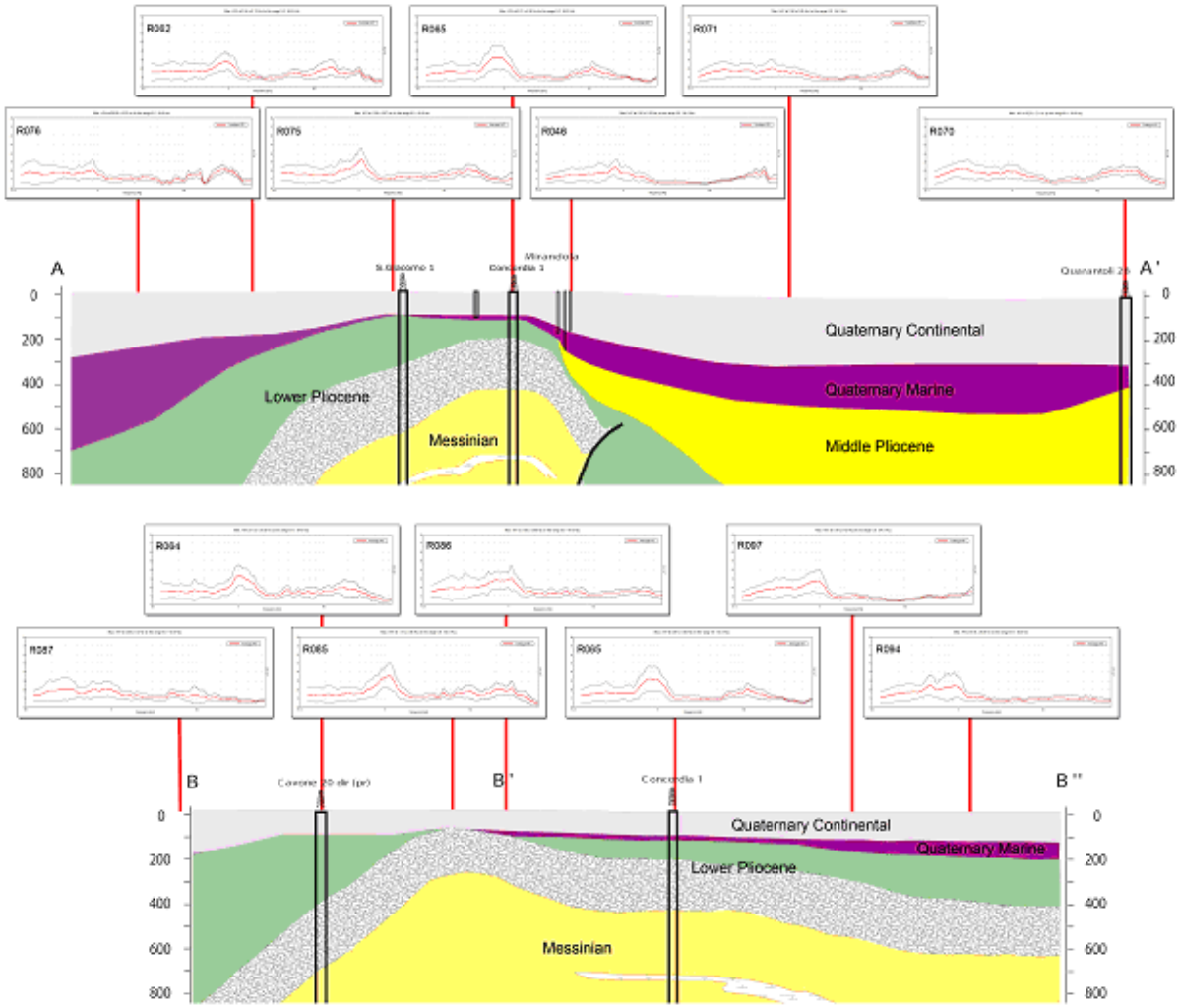

Figure 1 – HVSR curves and geological sections (traces in figure 2) made by Geological, Seismic and Soil Survey of Regione Emilia Romagna (Martelli e Molinari 2008) (vertical exaggeration 20x).

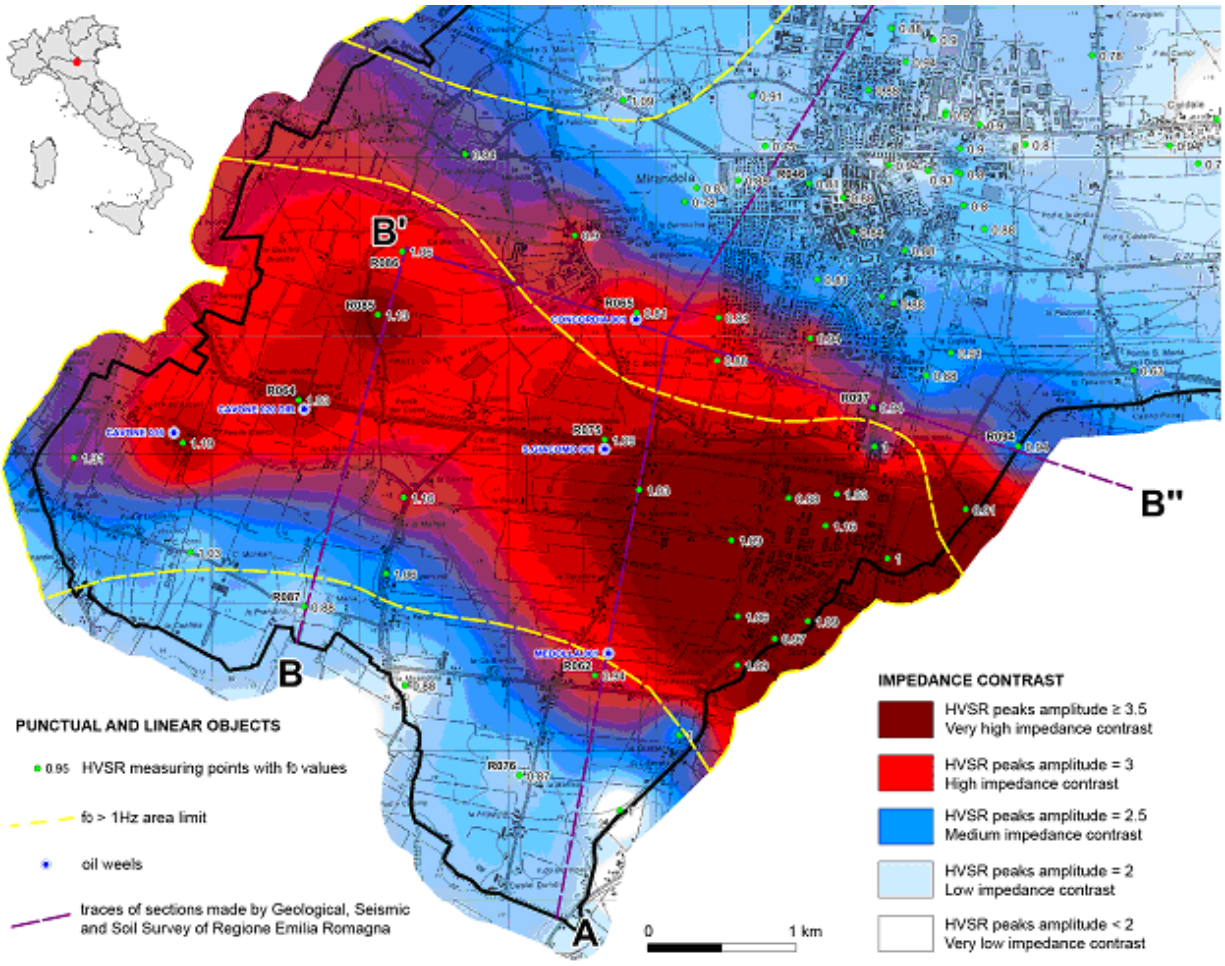

Figure 2 – Fundamental frequency map of the southwestern portion of the Municipaity of Mirandola area.

In the area of the structural high culmination, where Quaternary Continental deposits are thinned (80-90 meters only) and laid directly over Pliocene units, a very high impedance contrast, connected by an abrupt velocity increase, is detected: HVSR peaks are steep with *frequencies > 1 Hz and very high* amplitude (>3).

Where a very thin layer of Quaternary Marine deposits (only 20-30 meters) is interposed between thinned Quaternary Continental deposits and Pliocene units, a high impedance contrast connected by two very close velocity increases is detcted: HVSR peaks are wide with frequencies ~1 Hz and high amplitude (~3).

The fundamental frequency (f0) map (figure 2), required by the DGR 1051/2011 of Regione Emilia Romagna for the first level seismic microzonation, was then enhanced to highlight the results of HVSR measurements related with the structural high: in addition to the required f0 values for each single measuring point, a colour-shaded grid, related to HVSR peaks amplitude, has been added in background. This thematization, created with Inverse Distance Weighting (IDW) interpolation provided by the desktop GIS Mapinfo Professional, allows us to highlight how the HVSR measurements show with great precision the architecture of the more superficial stratigraphic units, in particular where they are thinned, due to the presence of the Mirandola Anticline (figure 2).

ACKNOWLEDGEMENTS

We are grateful to Luca Martelli (Geological, Seismic and Soil Survey of Regione Emilia Romagna) for his valuable and helpful suggestions.

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DISTRIBUTION POTENTIALLY TOXIC ELEMENTS IN SOILS DEVELOPED ON KARST IN CROATIA

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KEY WORDS: Potentially toxic elements, Geochemical mapping, Soil geochemistry; Statistical analyses; Land use/cover ; Multivariate analyses.

TITLE OF SECTION

Regional geochemical baselines in topsoil developed on karst in Croatia were determined for potentially toxic elements (PTE). The concentrations of PTE in the Croatian karst soils differ due to mineralogical composition but due to two different types of climates which influence pedogenesis (mountain and Mediterranean). In this study, the relationships between 25 geochemical variables in soils and various geologic, climate, soil type, and diverse land use types including grazing and agricultural lands, forested areas and the urban/ suburban centres with multivariate analyses following an investigation into their distribution based on a total of 1700 surface soil samples.

Total concentrations and aqua regia extracts were used to evaluate the extraction capacity of aqua regia for PTE, since this method for determination of PTE in soils is defined by Croatian environmental protocols. Soils were found to be mostly impacted on a regional scale by Pb, Cd, Zn, Hg and Se and locally Cu by agricultural activities. Heavy metals in this group appear more related to human activities including pollution. Some of the PTE (Pb, Cd, Zn, Se and Hg) correlate with the amount of annual rainfall which in mountain areas is > 2000 mm.

The distributions of Cr, Ni, Co, Mn, Mo, V and As are linked substantially to pedogenic processes and content of clay minerals, Fe-Mn oxides and possible bauxite influence. Within the karst of the Dalmatian region more than 2000 deposits of bauxite were located within a belt 150 km long and were mined during the second half of the 20th century. The bauxites are enriched Cr, V, As, Cd, Ni and Pb. The results of a geochemical topsoil mapping program (Halamić and Miko, 2009) which covered the whole Croatian karst region with almost 1700 sampling sites showed that the soils from the Dalmatian region had 30 to 50 % higher concentrations of these metals than other karst regions. As most of the underlying carbonate rocks contain low insoluble residua the chemistry of mineral dust from which the soils were formed originated from two sources during the LGM the Po and the Neretva river floodplains which were submerged during the Holocene sea level rise. These two different provenances give the distinct geochemical patterns. The high concentrations of Al, As, Co, Cu, Fe, La, Pb, Ni, Mn, Th, V, Cr, and Zn have higher mean values in soils transported (by wind) on carbonate bedrock from the Neretva floodplain during the LGM than those from the Po plain. These signatures in both geochemical provinces are influenced by various degrees by bauxite dust derived during mining activities.

Multivariate analysis were applied to reveal the influencing factors of altitude, climate, rock type, soil type and land use. Among these factors, land use was found to be the least important influencing factor for the geochemical variables studied except for forest soils.

ACKNOWLEDGEMENTS

This study is based on the results published in the “Geochemical Atlas of the Republic of Croatia” both produced under the project ‘‘The Basic Geochemical Map of Croatia’’ (181-1811096-1181) which is funded by The Ministry of Science, Education and Sports, Republic of Croatia. Their support is greatly appreciated. The authors would also like to express their gratitude to all who participated to the project in its various stages.

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Table 1. Statistical comparison of Croatian karst data set (this study) with continental-scale data sets.

This study					European data[a]			
Element	Mean	Max	Min	Median	Mean	Max	Min	Median
Al (wt%)	7.9	16.0	0.0	7.5	5.6	14.1	0.2	5.8
As (mg/kg)	7.9	106.0	1.0	6.0	11.6	282.0	0.3	7.0
Ba (mg/kg)	640	7610	28	601	399	1870	5	375
Ca (wt%)	1.81	8.07	0.05	1.56	2.53	34.07	0.02	0.66
Cd (mg/kg)	0.3	11.2	0.1	0.2	0.3	14.1	0.0	0.1
Co (mg/kg)	18	166	0.1	16	2	3	2	2
Cr (mg/kg)	119	5910	12	96	95	6234	2	60
Cu (mg/kg)	49	3088	5	37	17	256	1	13
Fe (wt%)	4.25	12.43	1.20	3.92	2.70	15.78	0.11	2.49
K (wt%)	1.25	3.67	0.07	1.23	1.67	5.09	0.02	1.59
La (mg/kg)	21	128	1	19	26	143	1	24
Mg (mg/kg)	1.19	14.26	0.13	1.03	0.71	14.85	0.00	0.46
Mn (mg/kg)	823	4430	48	752	624	6030	31	503
Mo (mg/kg)	0.988	10	0.05	0.71	0.943	21.3	0.05	0.62
Na (wt%)	1.36	4.27	0.04	1.45	0.86	3.30	0.03	0.59
Ni (mg/kg)	84	4955	6	50	37	2690	1	18
P (mg/kg)	619	4790	50	554	653	5770	48	559
Pb (mg/kg)	45	2354	1	23	33	970	5	23
S (mg/kg)	0.03	1.32	0.01	0.02				
Sc (mg/kg)	17.1	72.3	0.2	15.7	9.1	54	0.3	8.2
Sr (mg/kg)	245	1717	11	226	130	3125	2	89
Te (mg/kg)	0.1	1.1	0.1	0.1	0.0	0.9	0.01	0.03
Th (mg/kg)	7.4	145.6	0.2	6.0	8.2	75.9	0.3	7.2
Ti (wt%)	0.456	2.08	0.07	0.4	0.365	3.265	0.0126	0.343
U(mg/kg)	2.1	11.4	0.1	1.8	2.4	53.2	0.2	2.0
V(mg/kg)	149	490	35	135	68	537	3	60
Zn (mg/kg)	102	3350	18	88	68	2904	2	52

Data in bold with shading are median values that are approximately a factor of two higher in the Karst soil data set than in the European data set.
a Salminen et al. (2005).

THE GEMAS PROJECT: GEOCHEMISTRY OF EUROPEAN AGRICULTURAL AND GRAZING LAND SOILS.

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KEY WORDS: GEMAS; Geochemical atlas of Europe; grazing land; agricultural land; soils;

TITLE OF SECTION

The administration of REACH (Registration, Evaluation and Authorisation of Chemicals), the new European Chemicals Regulation adopted in December 2006, and the pending EU Soil Protection Directive, require additional knowledge about 'soil quality' at the European scale.

The geochemical atlas of agricultural and grazing land soils with the acronym GEMAS is a collaborative project of experts from national istitutions, Universities and the European Association of Metals (Eurometaux –www.eurometaux.eu).

The project will provide background values for a large variety of elements/parameters in agricultural and grazing land soil at the European scale.

During 2008 agricultural soils (Ap-horizon, 0-20 cm, regularly ploughed fields) and soils from land under permanent grass cover (grazing land soil, 0-10 cm) were collected at the European scale at an average sample density of 1 site / 2500 km2 (2211 samples of agricultural soil and 2118 samples of grazing land soil) according to an agreed field protocol (www.ngu.no/upload/Publikasjoner/Rapporter/2008/ 2008_038.pdf).

Following an aqua regia extraction concentrations of the elements Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn and Zr were determined.

The GEMAS project will deliver good quality and comparable exposure data of inorganic elements in agricultural and grazing land soil; in addition, soil properties, known to influence the bioavailability and toxicity of inorganic elements, will be determined on soil at the European scale. As inorganic elements occur naturally, industry dealing with natural resources requires this information to prove that it can produce its substances safely, which is a REACH requirement. In addition, the GEMAS project results will be useful to public health authorities, environmental policy makers and mineral exploration companies.

The results indicate that the chosen sample density of 1 site / 2500 km2 is sufficient to detect and document large scale processes determining element distribution at the European scale. The initial results indicate also that nature, geology and climate are the major driving forces for the mapped distribution of element patterns at the European scale.

Anthropogenic anomalies due to industry, agriculture, etc. occur on a more local scale. Many elements show substantially lower concentrations in the North European than in the South European soils.

CONTRIBUTION OF SOIL STUDIES TO GEOCHEMICAL MAPPING: THE PEDOGEOCHEMICAL MAP OF EMILIA-ROMAGNA PLAIN AT 1:250000 SCALE

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KEY WORDS: Genetic-functional soil unit; Geochemical mapping; Facies analysis; Alluvial, deltaic and coastal sediments; Emilia-Romagna plain.

ABSTRACT

Advances in sedimentological and soil research in Emilia-Romagna provide today the opportunity to examine distribution of pedogeochemical contents of selected elements within a mixed pedological and geological framework, through integration of geochemical data with detailed soil characterization. In this framework, the Pedogeochemical Map of Emilia-Romagna plain at 1:250000 scale, a joint project carried out between 2010 and 2012 by Geological and Soil Survey of Regione Emilia-Romagna and Bologna University, represents the first step toward a new type of geochemical map that can pragmatically be used by the regulatory bodies to deal with environmental protection issues.

Pedological and geochemical analyses of 702 soil samples from the Emilia-Romagna plain, collected within depths of 90-130 cm, enable precise identification of the pedogeochemical contents of selected heavy metals (Cr, Ni, Cu, Zn, Pb) as a function of soil characteristics and sediment dispersal pathways.

About fifteen genetical-functional soil units (UGFs), each bearing a distinctive connotation in terms of soil profile, alteration, grain size and sediment source, were defined on map and used as reference units for geochemical (metal) characterization. Accurate facies analysis allowed precise attribution of each UGF to specific depositional processes and sub-environments. Statistical analysis was performed through cluster analysis, frequency histograms, cumulative frequency curves, and box-and-whiskers plots. The Kolmogorov-Smirnov test was used to determine the type of data distribution. For dataset that did not follow a normal distribution, Box-Cox transformations were used.

Sediment provenance appears to be the major factor controlling natural spatial distribution of Cr and Ni within soils of the Emilia-Romagna plain. Sediment deriving from erosion of Alpine and Apenninic ultramafic complexes invariably shows high Cr and Ni values. This is reflected by the relatively high metal contents observed within genetic-functional soil units related to the abandoned Po Delta lobe and selected rivers (Po, Trebbia, Nure, Arda and Taro). By contrast, significantly lower Cr and Ni contents are recorded where the drainage basins are ophiolite-free (e.g., Romagna Apennines).

Spatial distribution of other metals does not reflect major differences in sediment provenance, but is instead primarily a function of changes in grain size (Zn) and degree of soil weathering (Cu). In particular, Zn is significantly enriched within fine-grained (floodplain) genetic-functional soil units (UGFs “A”), whereas it exhibits generally lower values within relatively coarser, channel-related deposits (UGFs “B”), and displays the lowest values within coarse-grained littoral sands (UGFs “C”). As for Zn, Cu is strongly depleted within coastal sandy soils (UGFs “C”), but also shows low values in highly altered soils, in response to leaching processes. The spatial distribution of Pb appears rather homogeneous across the study area.

In the Pedogeochemical Map, UGFs are grouped into four classes of metal concentration, centred on the threshold limit value for each metal. Darker shades denote background concentrations higher than maximum permitted levels, whereas lighter shades indicate lower natural metal contents.

A realistic view of the pollution status of the Emilia alluvial plain was obtained by matching the pedogeochemical contents measured at 90-130 cm depth against metal contents recorded in the corresponding 702 topsoil (20-30 cm) samples. Despite very high concentrations, locally exceeding the maximum values permitted by law, Ni and Cr did not show enrichments due to anthropogenic disturbance. In contrast, a diffuse (although moderate) soil contamination was observed for Cu and Pb throughout the alluvial plain.

In order to provide all necessary information to assess in an unequivocal way legislation limits and levels of concern for potentially toxic heavy metals, we used two combined analytical techniques on

the same samples: X-ray fluorescence (Bologna University laboratory) and aqua-regia inductive coupled plasma mass spectrometry (ICP-MS) determinations (Ravenna – ARPA laboratory). These comparative analyses confirmed the well established lower metal extraction using aqua regia digestion (60-95% of XRF determinations depending on the type of metal and soil).

This project (http://ambiente.regione.emilia-romagna.it/geologia/temi/metalli-pesanti/la-carta-pedogeochimica-di-cr-ni-zn-pb-cu-della-pianura-emiliano-romagnola-a-scala-1-250.000-2011)

shows that detailed soil studies constitute a priority for geochemical mapping of Quaternary deposits, and that identifying a geochemical signature for specific soil typological units and sedimentary facies is essential to obtain reliable information on natural metal distribution. An appropriate sampling strategy, including detailed soil characterization, is recommended to adequately represent the remarkable variability in terms of sediment provenance, grain size and soil alteration. Soil-oriented geochemical maps represent a new, more efficient alternative approach to conventional geochemical mapping based upon geostatistical methods alone. Specifically, through the use of genetic-functional soil mapping units the Pedogeochemical Map of the Emilia-Romagna plain constitutes a powerful tool to assess the anthropogenic impact on soils, which can be of use for legislative purposes and for planning strategies for environmental protection.

EUROPEAN AND NATIONAL REGULATORY FRAMEWORK ON CONTAMINATED SOIL MANAGEMENT.

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KEY WORDS: soil contamination, Soil Thematic Strategy, soil protection, soil threats.

Contaminated soil management is one of the major environmental problems for European countries. Recent data from the European Environmental Agency (EEA) show that soil contamination resulting from industrial and mining activities, waste storage, hydrocarbon leakage from tanks and lines of transport is one of the major threats to soil, with adverse effects on human health and ecosystems. The relevance of the problem at European level has resulted into the first Soil Thematic Strategy and then into the recent draft Soil framework directive, which is not yet approved, whose importance has recently been underlined by the enactment by the European Commission of a report on the implementation of the Soil Thematic Strategy. In the absence of a European framework, Italy has been among the first European countries to adopt regulatory tools to regulate the protection of soil from contamination and contaminated site management. This paper intends to compare the Italian legislation on contaminated sites, which has recently been modified by various regulatory interventions introducing simplified procedures and allowances for businesses, with the procedures adopted in other European countries. It thus intends to examine all its advantages and limitations and to put forward a few suggestions on how to improve its implementation, through an analysis of actions that have so far been implemented.

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ASSESSING BACKGROUND VALUES OF METALS AND METALLOIDS IN SOILS OF THE VENETO REGION

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KEY WORDS: soil, metals, metalloids, background values.

INTRODUCTION

Sustainable land management needs to be based on reliable data that allow to plan economic and social development. Soil is part of these necessary information as it is an essential component of environment, subject to increasing pressures that can lead to accumulation of metals.

In order to assess soil contamination by metals it is necessary to know natural content due to the composition of the minerals in parent material. Actually such concentrations, especially for some metals, can vary greatly depending on the material from which the soil has developed (Alloway, 1995; Kabata Pendias, 2001).

During soil field description throughout several years ARPAV, in addition to determining the basic characteristics of soil, necessary for their classification, has provided the measurement of the concentration of some metals and metalloids, with the aim of defining a basic information level for the regional territory.

This activity has been carried out since the first survey (1995) and subsequently in the implementation of the regional soil map at 1:250,000 scale (ARPAV, 2005) and of the soil maps at 1:50.000 scale of the provinces of Treviso (ARPAV, 2008), Venice (ARPAV, 2008) and Padua (ARPAV, 2012).

MATERIALS AND METHODS

Determination of metal background values in soil was carried out as specified by ISO 19258:2005 (Soil Quality - Guidance on the determination of background values).

According with it pedo-geochemical background content represents the concentration of elements generated by the characteristic features of pedogenesis, such as the composition and alteration of the rock and any subsequent movements in soil. Background content refers to the concentration of an element in a specific type of soil, located in an area or region, resulting from both natural, geological and pedological processes and including diffuse source inputs, such as atmospheric deposition and agricultural practices.

The choice of sampling sites was carried out following the “typological approach” of ISO 19258:2005, i.e. depending on the parent material, soil types and land use. Homogeneous areas were defined by parent material composition. For the plain, where soils have been formed from alluvial deposits (Fig. 1) areas were defined by means of the origin of the sediments from which the soil was formed, and these were called “depositional units”.

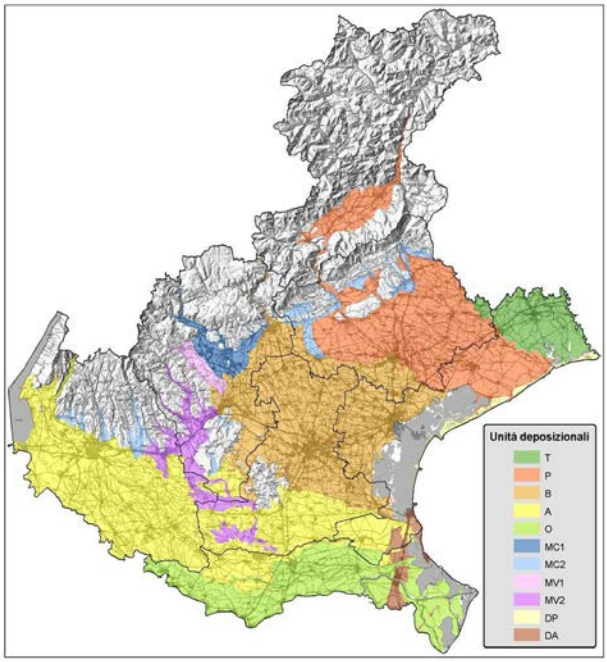

Figure 1: Depositional Units of the Plain: T= Tagliamento river deposit; P= Piave river deposit; B= Brenta river deposit; A= Adige river deposit; O= Po river deposit; MC1= Astico river fan; MC2= Prealpine rivers fan; MV1= Leogra-Timonchio rivers fan; MV2= Agno-Guà rivers fan; DP= north-eastern coastal deposit; DA= southern coastal deposit.

In the selection of the sampling sites also land use was taken into consideration, in order to consider only sites with agricultural use, taking care to avoid contaminated areas or sites too close to potential sources of pollutants or showing signs of human intervention.

Two sampling depth was chosen depending on

soil horizons: the first within upper horizon, up to a maximum depth of 40-50 cm and the second in the subsoil within the first soil horizon or layer below 70 cm, that usually excludes a possible anthropogenic contribution.

1954 samples were totally analyzed, of which 1119 surface and 835 deep. The analytical determinations were performed at the ARPAV Laboratories of Treviso, using official methods, on the size fraction less than 2 mm. Antimony, arsenic, beryllium, cadmium, cobalt, chromium, copper, mercury, nickel, lead, selenium, tin, vanadium, zinc, were determined in an aqua regia extractable fraction to measure the “pseudo-total” fraction.

Statistical analysis of data was worked out for each depositional unit. Some descriptive statistics were performed for each item, keeping separate values of the surface from deeper horizons; for each variable many parameters were determined mean, median, minimum, maximum, percentiles (5th, 25th, 75th, 90th and 95th), standard deviation, standard error, skewness and kurtosis, normality tests. Once outliers were removed, background value for each metal was determined by means of 95th percentile value within each depositional units. Background values were then compared to threshold limits for residential sites stated by Italian environmental code (D. Lgs. 152/2006)

RESULTS

In each of the 11 depositional units the final value for each metal and metalloid was determined taking the higher between the upper and lower horizon values (Tab. 1).

Table 1: Background values in depositional units of Veneto Region; in bold values exceding threshold limits of Italian law for residential sites.

Depositional Unit	Sb	As	Be	Cd	Co	Cr	Hg	Ni	Pb	Cu	Se	Sn	V	Zn
Tagliamento river deposit	nd	14	nd	0,62	12	67	0,09	42	33	44	nd	nd	nd	86
Piave river deposit	1,0	13	1,7	0,64	15	61	0,26	52	36	186	0,50	4,0	87	113
Brenta river deposit	2,4	45	2,3	0,95	16	64	0,67	38	54	110	0,31	7,8	96	144
Adige river deposit	1,5	50	1,4	1,17	20	141	0,32	125	46	79	1,00	3,7	89	155
Po river deposit	1,4	31	1,6	0,60	20	153	0,08	130	35	63	0,90	3,4	80	111
Antico river fan	2,0	21	2,1	0,66	23	83	0,31	64	61	103	0,40	4,4	203	137
Prealpine river fan	0,8	23	1,6	0,86	16	76	0,26	56	45	114	0,40	3,4	81	110
Lessinian Limonchio river fan	2,8	26	1,7	0,86	35	153	0,16	120	106	86	0,44	6,4	157	200
Agno-Guà river fan	1,6	41	1,5	0,59	51	190	0,10	161	56	66	0,72	2,9	146	164
North-eastern coastal dep.	0,8	12	0,2	0,25	5	19	0,85	8	51	58	0,10	5,7	20	67
Southern coastal dep.	1,2	23	0,9	0,25	14	89	0,13	83	56	54	0,68	5,8	61	181

For antimony, cadmium, mercury, lead and selenium no exceeding of threshold concentrations in any depositional units occurs.

In the Piave river unit high concentration of copper occurs due to the widespread cultivation of vineyards that requires repeated treatments with copper products for plant protection. Arsenic, beryllium, cobalt, chromium, nickel, vanadium and zinc exceed the threshold concentration in many units, involving a significant area within the region.

In all the depositional units of the Veneto region a particular situation is pointed out for tin which everywhere has background values above threshold limit, with maximum values of more than 7 times higher than the limit in Brenta river unit. Anyway, the tin threshold limit stated by the Italian environmental code for residential sites has revealed inadequate if compared to the background values.

The unit with the highest number of background values exceeding the threshold limits is the Agno-Guà river fan, who receive alluvial deposits from the alteration of basalts, in which concentration of zinc, nickel, chromium, cobalt, arsenic, tin and vanadium is significantly higher than in sedimentary rocks (Alloway, 1995; Kabata Pendias, 2001).

Po, Adige and Brenta river units show many background values exceeding the limits, Piave river unit, only for copper and tin, while in the Tagliamento river unit no exceeding occurs (although data are not available for tin, beryllium, and vanadium).

ACKNOWLEDGEMENTS

We are grateful to ARPAV Laboratories, Soil Analysis Unit.

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ASSESSMENT AND SPATIAL PREDICTION OF SOIL DIFFUSE CONTAMINATION BY INORGANIC POLLUTANTS IN THE PROVINCE OF TURIN – NORTHERN ITALY

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KEY WORDS: soil, diffuse contamination, heavy metals, rare earth elements, enrichment factors, regression kriging.

INTRODUCTION

Soil pollution from diffuse sources is recognized as one of the soil threats by the EU Soil Thematic Strategy [(1)]. This is especially true in regions with a high population density and strong industrialization, where land is intensely used.

The aim of the present work was:

- to give an appraisal of the degree of soil diffuse contamination in a large Italian Province
- to apply and verify the appropriateness of tools developed to establish background values and evaluate the intensity of contamination.
- to improve the fine-resolution maps of diffuse contamination with regression kriging technique (RK)

To do this, the effect of different land uses was investigated, contaminant background concentrations were determined, and Enrichment factor (Ef) were calculated for 11 trace elements and 13 rare earth elements (REEs).

MATERIALS AND METHODS

The soil sampling scheme was based on a 9×9 km grid covering the whole province of Torino (48 stations - 6851 km^2), on a 3×3 km grid located in the periurban zone of the city of Torino (24 stations - 858 km^2) and on 29 representative stations in the green areas of Torino city, for a total of 101 monitoring sites.

Land uses sampled were natural (n), agricultural (a), periurban (p) and urban (u).

Samples were taken from the topsoil and the subsoil layers. Overall 202 samples were analyzed for general soil properties, pseudo-total metal contents (Al, As, Co, Cr, Cu, Ni, Pb, Sb, Sn, V and Zn - aqua regia - microwave digestion) and REEs (Ce, Dy, Er, Eu, Gd, Ho, La, Nd, Pr, Sm Tm Y, and Yb) were analysed with an ICP-MS Agilent, 7500CE.

Background values for the contaminants were calculated following the ISO Guidance [(2)].

Calculation of Ef is based on the normalization of analytical data against "conservative" reference elements (in this study Al) applying the eq (1) [(3)]:

$$(1) \qquad Ef = (X_c / R_c)/(X_{vf} / R_{vf})$$

where X_c are the the considered element, R_c are the reference element selected in the topsoil of each monitoring site, X_{vf} are the background values of the considered element and R_{vf} is the conservative element calculated for the entire study area. The sum of Ef for all elements examined represents the total contamination factor (CF).

Overall 25 Landscape metrics for both urban and road network were calculated at the intersection of 1.5x1.5 km regular grid within 9x9 km sampling network, using FRAGSTATS 1.0. As a cartographic base Land Cover Piemonte Map - 2009, GRID format 10 m was used.

RK is a hybrid spatial interpolation, that combines a regression of the dependent variable on auxiliary variables ($\hat{m}\,\hat{m}_{s0}$), with simple kriging of the regression residuals ($\hat{e}\,\hat{e}_{S0}$) using eq 2 [(4)]:

$$\hat{z}(s_0) = \hat{m}(s_0) + \hat{e}(s_0) = \sum_{k=0}^{p} \hat{\beta}_k \cdot q_k(s_0) + \sum_{i=1}^{n} \lambda_i(s_0) \cdot e(s_i)$$

where $\beta_k\beta_k$ are estimated drift model coefficients, λ_i are kriging weights determined by the spatial dependence structure of the residual and $e(s_i)$ is the residual at location s_i.

Data were statistically handled and spatialized using R software with GSTAT, sp and rgdal packages (www.r-project.org).

RESULTS

The combined use of Pearson correlation, cluster analysis and principal component analysis revealed group of contaminants suggesting their common origin. The first group, of main anthropogenic origin, included Cu, Pb, Sb, Sn, and Zn, a second group included elements of main natural origin such as As, Co, Cr, Ni, and V, a third group comprised the REEs.

In Figure 1 boxplots of Ef are presented divided by elements and land uses.

Statistical analysis reveal similar degree of contamination for two groups of contaminants.

Cu, Pb, Sb, Sn and Zn presented average and background values always below Italian legislative

limits for green areas; however Ef presented values above 1 for these elements, suggesting a main anthropic origin (traffic, heating systems, industrial activities). The degree of contamination for these elements was low in agricultural and natural soils but became relevant in periurban and urban ones, showing surface enrichment.

As, Co, Cr, Ni, V and REEs presented average and background values often above Italian limits. Ef for these elements were however often below or close to 1, excluding an anthropic origin. In particular Cr, Ni and Co are related to the presence of ultramaphic rocks outcrops, which are abundant in the soils of the Province, causing a high background value [5].

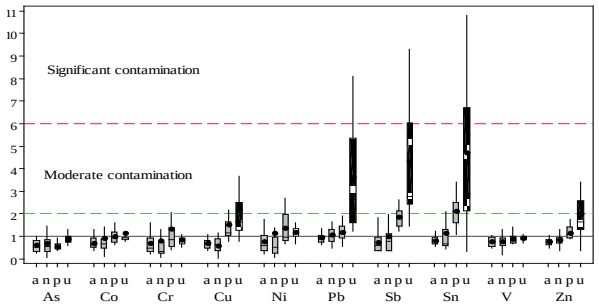

Figure 1 Enrichment factors (Ef) divided by agricultural (a), natural (n), periurban (p) and urban (u) soils.

Step-wise regression identifies Percentage of urban class area (CA%_u), Edge density of urban class (ED_u) and Edge density of road class (ED_r) as the "best" sub-set of auxiliary predictors for CF through the eq (3) (R^2 = 82%) used to fit the target variables map ($\mathbf{m}_{S0}$):

(3) $$CF = 3.2 + 0.7\ ED_u + 0.2\ CA\%_u - 0.1\ ED_r$$

Residuals ($\mathbf{e}_{S0}$) were interpolated with exponential variogram.

The analysis of the final map obtained with RK (Figure 2), represent areas with greater detail, for a better practical use of the results aimed at identifying homogeneous areas and a number of contamination hotspots, hardly detectable with ordinary kriging.

CONCLUSIONS

The combined use of selected statistical tools and algorithms revealed to be effective in the description of the presence and the intensity of diffuse contamination in soils of an Italian Province. Of key importance is to calculate natural background values, which are needed for the calculation of Ef. Results shown regroupments of contaminants according to their dominant origin (natural or anthropogenic) and enrichment of periurban and urban soils with some of the elements investigated. REEs were found to derive from parent material, not representing evidence of contamination.

The use of appropriately selected urban landscape metrics, was found to be a valuable tool to detect the reciprocal relationships between soil diffuse pollution and human activity.

The good fit of linear regression with selected landscape metrics as auxiliary variables confirms the appropriateness of the CF to express the cumulative effect of contaminants arising from diffuse contamination and allows the use of RK technique to predict its spatial structure.

Regression kriging, using CF as target variable and urban landscape metrics as auxiliary variables, has proven useful instrument to improve prediction efficiency in spatialization of diffuse contamination at large scale.

The results obtained provide useful guidance to improve the quality of assessment and spatial prediction of diffuse contamination.

Data provided may constitute an important dataset of the soil environmental quality on a large scale that can be used for the development of guidelines for soil management, the definition of local clean-up values and the implementation of risk assessment procedures.

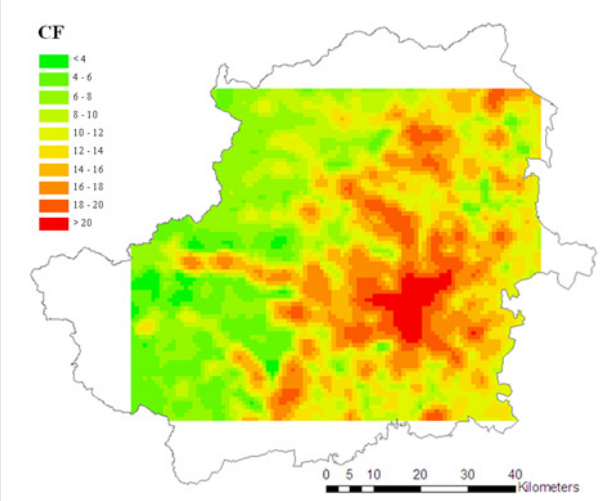

Figure 2: Province of Torino - Regression Kriging prediction map for Total contamination factor (CF).

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REGIONAL GEOCHEMICAL MAPPING OF TOPSOIL HEAVY METALS: A SCORPAN KRIGING APPROACH CONDITIONAL ON SOIL MAP DELINEATIONS AND LAND USE.

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KEY WORDS: Heavy metals; Pedogeochemical mapping; Scorpan Kriging; Soil unit; Land use

INTRODUCTION

According to the Italian Legislative Decree 152/06 of April 3rd, 2006, concerning the consolidated law governing environmental issues ("Testo Unico recante le Norme in Materia Ambientale"), the Contamination Threshold Value is defined as follows (art. 240, comma 1, letter b): "*threshold values are the values of contamination of environmental matrix above which the characterization and specific risk analysis of the contaminated site, as described in the Appendix 5 at part four of the present law, becomes necessary. In the event the potentially polluted site is located in an area where geogenic or anthropogenic factors are responsible for exceeding the threshold values for some parameters, the background content of these parameters is assumed as threshold*."

In the last decades the increase of industrial activities and the massive use of pesticides in agriculture, enhanced the risk of soil contamination by pollutants. Among these, heavy metals, due to their persistence, accumulate in soils possibly reaching concentrations above regulatory contamination thresholds. An accurate knowledge of the "usual" background content of metals in soils is then necessary to assess their contamination state. Aim of this work is to map the concentration of topsoil heavy metals using a Scorpan Kriging approach. The approach combines the trend of metals concentrations, as derived from the 1:50,000 soil map, with geostatistical modeling of the stochastic, locally varying but spatially correlated component. The trend component is described in terms of varying local means, calculated accounting for soil pedo-geochemical affinity and dominant land use.

MATERIALS AND METHODS

In the frame of soil survey carried out in Emilia Romagna (North Eastern Italy) most of the alluvial plain (about 12000 km^2) was investigated at the scale 1:50,000. The area, main agricultural area, covers slightly more than half of the region (12002 km^2), stretches south of the Po River and is delimited by the Apennines range in the south and by the Adriatic Sea in the east. The climate is temperate sub- continental, with an average annual temperature between 12 and 14°C and a mean annual precipitation ranging from 600 to 800 mm. Elevation ranges between -3 and 150 m a.m.s.l.

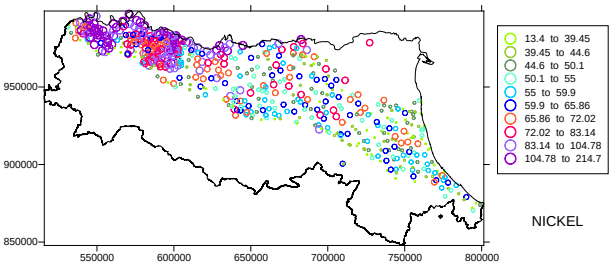

Figure 1 – Nickel sampling points and concentrations (the classes are the deciles of the observed distribution; values in mg kg^{-1}).

Metal	N	Mean	SD	Min	Median	90P	95P	Max
As	500	7.19	2.29	3.5	6.70	9.50	11.7	27.7
Cd	483	0.21	0.08	0.00	0.21	0.31	0.34	0.69
Cr	568	84.7	32.2	22.1	77.4	123.0	148.0	242.6
Cu	568	51.2	33.3	5.0	42.1	87.40	106.0	323.6
Ni	568	67.0	29.9	13.4	59.9	104.8	126.9	214.6
Pb	567	20.7	6.97	3.1	19.8	27.6	31.6	69.4
Sb	475	0.35	0.26	0.0	0.32	0.59	0.70	2.9
Sn	475	2.03	0.88	0.01	1.80	3.0	3.6	8.1
Zn	568	85.9	22.6	17.6	85.0	112.8	123.7	193.8

Table 1 – Heavy metals'descriptive statistics (mg Kg^{-1}).

The soils of the area, mainly on quaternary alluvial deposits, are characterized by a high degree of heterogeneity, ranging from coarse textured Arenosols to fine textured Vertisols, leached paleosols along the Apennine border, and soils characterized by the presence of organic horizons in the reclaimed areas of the Po delta. For a variable number (475-568) of representative sites (e.g. Nickel, Fig. 1), topsoil samples (20-30 cm) were analyzed for heavy metals. The pseudo-total contents of Cr, Pb, Zn, Cu, Ni, Sn, As, Sb and Cd were determined through acid extraction with aqua regia (UNI/EN 13346 method C) and detection by ICP (Inductive Coupled Plasma, EPA

6020). The upper limit of the "usual" background value defined for topsoil samples following the ISO international standards (ISO/DIS 19528). The descriptive statistics of the different metals are shown in Table 1. In order to take into account the non-stationarity of metal concentration, a simple kriging with varying local means (SKlm) approach was chosen (Goovaerts, 1997). This approach can be considered as one of the many spatialisation variants that have been termed as geostatistic-scorpan kriging by McBratney et al. (2003). The model is then partially deterministic and partially stochastic, and the locally varying mean can be estimated in various different ways. In this study, the locally varying means were calculated from the observations: these were divided into classes and mapped as categorical secondary information i.e. genetic functional soil unit - district combinations. The soil units were based upon: i) texture; ii) degree of weathering; iii) origin of parent material. This scheme led to 11 groups (Amorosi et al. 2011); these were further divided subgroups of using the nine agricultural districts of the plain a proxy of dominant land use. The geostatistical analysis followed the following steps:

- the available data in each of the nine districts were grouped in terms of soil units, and for each metal the local mean was computed and retained;
- the non-stationary local mean was subtracted from each observation to compute the residuals of each variable;
- a normal score transform was used to normalize the residuals assuming a Gaussian random function model;
- experimental variography of the transformed residuals was carried out computing the residual semivariograms;
- using the semivariogram models of the normalized residuals, these were simulated with simple kriging over a 1 km x 1 km regular grid and the corresponding local mean was added to the average (N = 1000) of the estimated residuals after being back-transformed;
- the final maps were prepared for each metal.

DISCUSSION AND CONCLUSIONS

The proposed methodology highlights for some metal the same trend described by the pedo-geochemical map of the natural background concentrations. In particular, topsoil Cr (Fig. 2) and Ni concentrations are due to the origin of soil parent materials and are higher in the province of Piacenza, Parma and Reggio Emilia where sediments are originated form catchments characterised by the presence of ophiolitic rocks. In this case land use does not affect metals distribution and their values are locally above the regulatory thresholds.

The distributions of Zn and Cu, on the other hand, are only in part explained in term of genetic-functional soil unit, with the coarser soils along the coastline showing the lower concentrations as compared to fine textured soils; nevertheless the higher contents which characterise the provinces of Reggio and Modena (and secondly Parma for Cu) are due to dominant land uses and management practices (vineyards, slurry applications); Cu values are always below the threshold, while Zn concentrations are locally above the threshold. Pb is uniformly distributed in agricultural soils regardless dominant land use and soil unit; it values is well below the regulatory threshold.

As, Cd and Sb have unclear distribution patterns, with extremely low concentrations; Sn, on the other hand, is systematically above the regulatory threshold in all the area, with higher concentrations in the provinces of Bologna (only in fine textured soils), Ravenna, Forlì-Cesena, Rimini and Ferrara, as far as the surveyed part is concerned. Sn is widely present is acaricides used in orchards and vineyards and in fungicides widely used in sugar beet and rice fields so that its abundance is likely to be due to dominant land use and management; further investigations are needed to confirm this evidence.

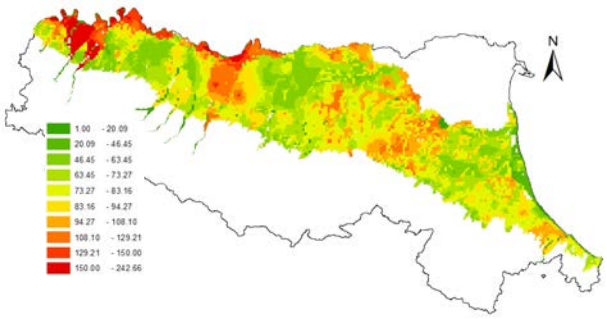

Figure 2 - Estimated Cr toposoil concentration (mg kg^{-1}).

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THEORETICAL ASSESSMENT ON THE EMILIA ROMAGNA PEDOGEOCHEMICAL MAP IN RELATION TO THE RISK ANALYSIS MODELS

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KEY WORDS: Site-specificity, Risk Assessment, Pedogeochemical map .

SESSION - REGIONAL GEOCHEMICAL MAPPING AND ENVIRONMENTAL APPLICATIONS

The technological and scientific world has recently focused on the new site-specific approach in the environmental field, mainly due to the complexity of the systems to be analysed. Given its highly conservative approach, the generalist "screening level" philosophy is not sufficiently manageable for specific case studies, often leading to situations that are very far from a minimum level of representativeness.

With reference to the content of heavy metals in soils the tabular approach is more easily applied and smoothly integrated into rules and regulations by the lawmaker, but it is not so easily manageable during the administrative – investigation phase, since it is at times very detached from the actual chemical soils characteristics.

The approach adopted by a few European countries with respect to these potential contaminants is to apply a "trigger value" at a national or regional scale, based on the background content (defined as the natural anthropogenic content) as a general screening and then apply the detailed operations and site-specific approaches.

The main tendency followed by the Italian regulatory framework is to define a natural background value outside the site, on which to assess the state of contamination of the site itself.

Polluted site management is one of the sectors that have more significantly developed site-specificity, thus giving rise to the so-called "Environmental Health Risk Assessment". The whole system concerned by contamination is actually parameterized during risk assessment, in order to extract all the necessary information. This leads to a certain number of analytical models and empirical formulas that consider a large amount of input data and provide a consequent range of output data.

Because of the intrinsic complexity of the risk analysis models, the variation of a single parameter could lead to substantial consequences within the system. The input data could basically belong to two categories: they could be taken from scientific literature (often already present in software as a default set), or they could be site-specific, actually measured on the field.

It is clear that the larger the amount of site-specific data within the input set, the greater the representativeness of the obtained results will be.

Since it is potentially impossible to obtain 100% data according to a site-specific approach (since the different parameters result from theoretical-empirical processing), it is often necessary to rely on default criteria also for theoretically measurable parameters. With regard to these parameters, it is necessary to apply the conservative principle at first; then, it is appropriate to assess how this set of data affects results, i.e. their sensitivity – in order to obtain a sufficiently representative output.

As far as Italy is concerned, its specific legislation in this field does not regulate procedures in detail. The guidelines issued by ISPRA, Institute for Environmental Protection and Research (Istituto Superiore per la Protezione e la Ricerca Ambientale), in collaboration with ISS, INAIL and ENEA, are the most relevant documents in this field.

Regarding the content of heavy metals in soils guidelines do not emvisage any national base values, but they identify a procedure to determine them, taking into account all the existing useful information.

The regional and local authorities, with different procedures and timing, are now beginning to develop projects and guidelines aimed to investigate and define distinctive environmental characteristics tailored to each individual region. Among these local bodies, the Emilia-Romagna Regional Authority is developing a specific project designed to characterize soils from a chemical-physical point of view starting from soil maps; it is thus possible to obtain all the data that outline the distinctive regional land characteristics to be used in the environmental assessment models. The experimental use of data deriving from these projects within the site-specific risk analysis points out how the representativeness conditions of the environmental system could change with respect to the framework resulting from the set of "default" national guidelines.

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NATURAL BACKGROUND CONCENTRATIONS OF METALS IN ALLUVIAL DEPOSITS IN THE VALLEY OF TRENTO (ITALY)

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KEY WORDS: mineralisation, natural background, sampling, chemical analysis, risk analysis

INTRODUCTION

A study were performed to find background concentrations of metals in accordance to the DM 471/1999, the first Italian regulation on contaminated sites. After detection of extremely high lead levels outside of a former industrial area (contaminated with tetra-ethyl lead) the presumption arose that the lead outside of that contaminated site do not only result from the industrial production. The objective of the study was to determine possible other sources of lead.

In addition to a broad geological and historical study, a comprehensive study to investigate the metal content in the surface zone was conducted. There were also performed analysis of eluates to obtain experimental values for a specific risk analysis.

The historic centre and its expansion towards the North was built on alluvial soils in "Val d'Adige", which were transported by rivers and creeks that drain mineralised lead compounds, coming predominantly originally from silver mining sites of the Middle Ages. The risk analysis showed that the possible negative health effects of lead compounds from "natural" or "historical" sources considerably lower than those from industrial production.

NATURAL BACKGROUND CONTENTS OF METALS

The presence of metals in the soils of an ancient urban area can result from many sources:

- disintegration of mineralised rocks
- by transport processes in rivers, glaciers and wind before the appearance of man
- transport processes in historical times, such as floods in the presence of construction, production activities, landfills, etc..
- anthropogenic fillings in historical times, in the absence of legal regulations for environmental protection, e.g. dumps of old mines
- diffuse spread of fall-out of dust during large-scale agricultural use

In some cases it was not easy to distinguish between natural background and anthropogenic influence in the tested areas. This fact was taken into account in the different phases of the investigation.

GEOLOGY AND MINERALISATIONS

The surveyed area covered two areas in the East of the city of Trento with different kinds of mineralisation:

- Basin of the river "Fersina" with hydrothermal mineralisations of mixed sulfides from lower Permian volcanic rocks and the location of old mines of Pergine (Middle Ages -16th century)
- Plateau "Monte Calisio" with argentiferous galena and barite syn-sedimentary diagenetic mineralisations in Werfen layers (lower Triassic) and old silver mines (Middle Ages -15th century).

The west part of the city of Trento is influenced by limestones and dolomite rocks, which has no significant content of heavy metals.

SAMPLING AND ANALYSES PROCEDURE

Sampling procedures for the alluvial deposits of the valley include:

- 80 core drillings with an average depth of 4 m
- locations of the sampling points were chosen on public land, with no specific contamination known
- sample collections of the filling layers separately from the natural ground
- 1 meter was chosen as reference unit of measurement for the samples
- separate sampling of cover soil (top 10 cm)
- collection of 350 samples for chemical analysis of antimony (Sb), silver (Ag), arsenic (As), barium (Ba), bismuth (Bi), cadmium (Cd), cobalt (Co), chromium (CR), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), lead (Pb), copper (Cu), selenium (Se), tin (Sn), vanadium (V), and zinc (Zn)
- analysis of the eluates of 11 of these samples with high metal content
- analysis of ambient air (outdoor and indoor dust) in the area downstream of "Monte Calisio", where measured values of lead in soil showed particularly high levels (max 5150 mg/kg)

SURVEY RESULTS

The survey confirm the geological study of three areas of different alluvial deposits in the valley of Trento:

- the area influenced by the Monte Calisio mineralisation (showing high contents of Pb, Ba, Ag)
- the area influenced by the basin mineralisation of the valley of Fersina (showing high contents of As, Ba, Hg, Pb and Zn)
- the valley area which is not affected by mineral deposits ("non-mineralised", showing no specific metal contents)

The analytical results compared with the limits of the table of the regulation DM 471/99 showed:

- concentration values of lead from natural background are considerably higher than those set by the two columns of DM 471/99 (A: residential use, B: industrial use). In fact, the area beneath Monte Calisio is used as residential area.
- concentration values of arsenic as a natural background of the alluvial cone of river Fersina are above the limits set by the DM 471/99 (A). In fact this area is used as residential area.
- concentration values of tin (Sn) from the natural background is frequently superior in every area, including the "non-mineralised" valley, to the low limits for residential areas.
- concentration values for Cd, Co, Hg, Cu and Zn are very close to the limits set by the DM 471/99 (A) with occasional exceedances specifically in the two areas influenced by mineralisation. For zinc the natural origin has clearly demonstrated. For copper it is not possible to exclude anthropogenic influence, especially in the "non-mineralised" valley. In this case the use in agriculture can be assumed.
- concentration values of Sb, Cr, Ni, and V are significantly below the limits set by the DM 471/99 (A).

All individual analyzes were tested statistically, even with "ProUCL". This program was designed from U.S.-EPA to determine significant levels of research campaigns for risk analysis.

Athough in Italy today, the DM 471/99 is hidden and replaced by the d.lgs n.152/2006, all facts discussed here remain valid, because the references have not changed.

With reference to the effects on water bodies the values of solubility of these metals in the soils elution experiments were performed and compared to the solubility that results from the distribution coefficient Kd of the databases recommended in the protocol of ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) differs considerably, for example:

	solubility	
	experimental [mg/l]	database [mg/l]
Pb	0,04 - 0,30	9580
As	0,01 – 0,02	441000

With reference to the dust in the atmosphere lead values measured outdoors were an order of magnitude lower than legal limits and those indoor negligible.

RISK ANALYSIS

The soils in the urbanised area beneath the hill Calisio are characterised by particularly high concentrations of lead. Therefore a risk analysis model according to the "Integrated Exposure Uptake Biokinetic Model for Lead in Children" (IEUBK - a model developed in the USA) was carried out to estimate the amount of lead in human blood transferred from soil, dust, air, food or objects. The result is not represented by a given value but from a distribution curve.

As result from this analysis the distribution of lead concentrations expected in the blood was well below the limits proposed by the model (10 µg/dl), as well as the percentage of cases that exceeded this limit: 3.9% (threshold: 5%).

The real risk was significantly lower than that of the conventional risk analysis (RBCA, Tier 2) prepared in accordance to the protocol of ISPRA. The differences in Kd values are caused from chemical species of the metals and their incorporation into the soil, eg grain sizes.

As result, the biological availability of natural lead was detected much lower than that of anthropogenic origin. Conventional models of risk analysis are not suitable for this particular case.

ACKNOWLEDGEMENTS

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Dall'emergenza delle bonifiche ad una gestione consapevole del territorio – Seminario internazionale Trento 3-4 luglio 2008.

THE GEOCHEMICAL ATLAS OF AGRICULTURAL AND GRAZING LAND SOILS OF ITALY

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KEY WORDS: GEMAS project; Geochemical atlas of Italy; agricultural soil; grazing land;

THE FRAMEWORK

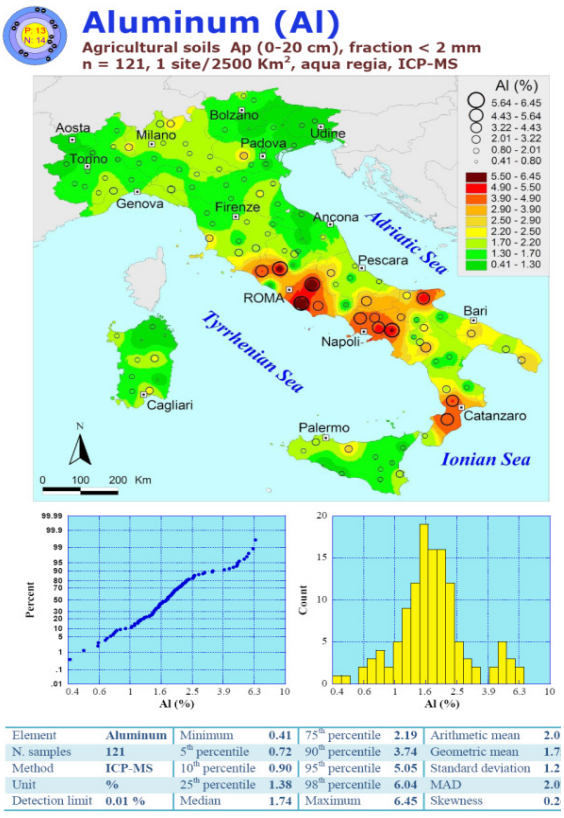
In the framework of the GEMAS project, aiming at characterizing the soils of rural areas of the whole Europe, 121 samples of agricultural soil (0-20 cm) and 121 samples of grazing land soil (0-10 cm) were collected in Italy at an average sample density of 1 site/2500 sqkm (Fig. 1).

MATERIALS AND METHODS

All samples were prepared in the same laboratory, where they were air dried, sieved to <2 mm using a nylon screen, homogenised and split into subsamples for analysis. For the production of comparable results, all samples were analysed for the same suite of determinants in the same laboratory.

By means of a GIS software, georeferenced data of the italian territory were used to produce the geochemical maps of all the analysed elements for both agricultural and grazing land soils. Specifically, for each element and sampling media a map reporting interpolated data and graduated dots was produced; univariate statistics and graphs were also associated to each map (Fig. 2).

Figure 1 – GEMAS sampling grid for the italian territory



Element	**Aluminum**	Minimum	**0.41**	75th percentile	**2.19**	Arithmetic mean	**2.0**
N. samples	**121**	5th percentile	**0.72**	90th percentile	**3.74**	Geometric mean	**1.7**
Method	**ICP-MS**	10th percentile	**0.90**	95th percentile	**5.05**	Standard deviation	**1.2**
Unit	**%**	25th percentile	**1.38**	98th percentile	**6.04**	MAD	**2.0**
Detection limit	**0.01 %**	Median	**1.74**	Maximum	**6.45**	Skewness	**0.2**

Figure 2 – Layout of the map reporting the spatial distribution of Al in the agricultural soils of Italy.

RESULTS AND HIGHLIGHTS

Distribution patterns of elements in soils were often comparable with the underlying geology although the sampling density was not so high.

As a matter of the fact, we report here the geochemical maps of some elements whose concentrations are often strongly related to the nature of the parent rocks.

ARSENIC

In agricultural soils the highest As content occurs

in Central Alps, in central Calabria and in volcanic areas near Rome and in Tuscany (Fig. 3).

In grazing land soils the high values occur in the Roman Volcanic Province, and on French and Swiss Alpine boundaries.

BERYLLUM

The highest values (> 6 mg/Kg) of Be have been registered south of Rome and in the Neapolitan Volcanic Province (Fig. 4).

These values are six times greater than the limit imposed by Italian law for residential/recreational areas. The median Be content in agricultural soils is 0.8 mg/Kg, ranging from <0.1 mg/Kg to 11.14 mg/Kg.

In grazing land soils the median value of Be is 0.92 mg/Kg, ranging from 0.15 mg/Kg to 9.5 mg/Kg. Both distribution maps show very similar pattern with low values (<1 mg/Kg) concentrated in north Italy, Sardinia and Sicily, and high concentration (>2 mg/Kg) occurring along the Roman and Neapolitan alkaline magmatic province. The high values in Apulia region might have an anthropogenic source.

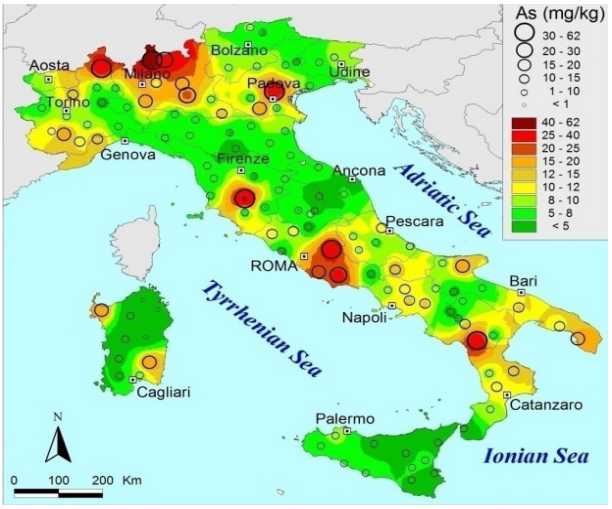


Figure 3 – Map of As in agricultural land soils of Italy.

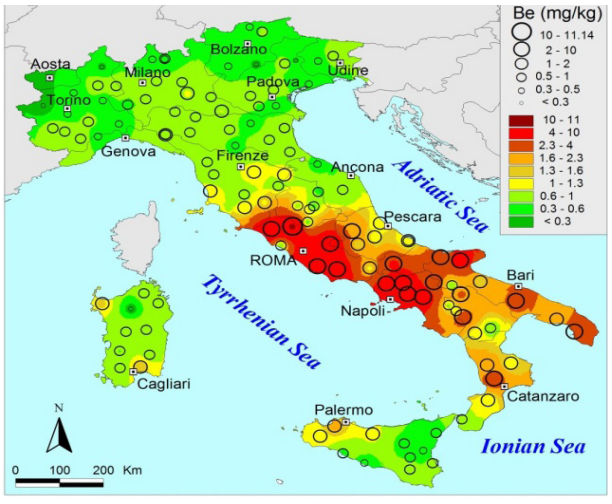


Figure 4 – Map of Be in agricultural land soils of Italy.

COBALT

In the agricultural soils map, the highest values of Co occur in Val d'Aosta, in the ophiolitic rocks of Liguria, in Tuscany, in western Sardinia, along the Roman alkaline Province and in Veneto, near Padova; these high concentrations can be explained by the presence of mafic and alkalic rocks (ophiolites, basalts, serpentinites).

The distribution of Co in grazing land soil map (Fig. 5), shows highest values in eastern Liguria, along the Roman alkaline Province and in central-southern Sardinia island.

Low Co values occur in north-east Italy and in some few areas of central and southern Apennine.

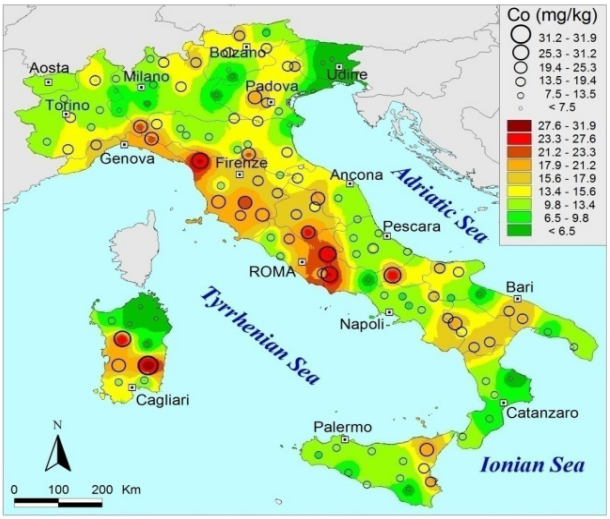


Figure 5 – Map of Co in grazing land soils of Italy.

URANIUM

High U contents (>4.5 mg/Kg) mainly occur over alkaline volcanic rocks of the Roman and Neapolitan Volcanic Province in both sampled media. Other U anomalous values are found over granites of northern Sardinia (Fig. 6).

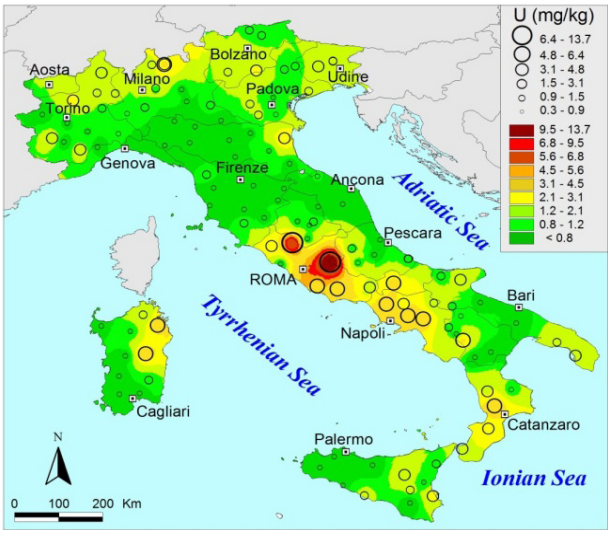


Figure 6 – Map of U in agricultural land soils of Italy.

GEMAS PROJECT – INTERESTING RESULTS FROM THE COMPARISON OF AQUA REGIA AND TOTAL ELEMENT CONCENTRATIONS IN EUROPEAN AGRICULTURAL SOIL

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KEY WORDS: Soil, geochemistry, aqua regia, XRF, Europe

INTRODUCTION

One key factor, when dealing with soil quality and soil critical values, is the choice of analytical methods to be used in a project. Aqua regia (AR) extraction is widely applied in the analysis of soil samples, because it combines practical advantages in laboratory routine with the environmental relevance of acid extraction results. It is effective on elements adsorbed on mineral surfaces, associated with carbonates, absorbed by iron and manganese oxides and organic matter and partially by silicate minerals, mainly clay minerals. Total concentrations obtained by X-ray fluorescence (XRF) spectrometry provide additional information on elements bound to silicates and other minerals that will not dissolve in AR. XRF results better portray bedrock geochemistry and directly reflect geology and pedogenic processes.

Results from both AR extraction and total XRF analyses from the GEMAS (GEochemical Mapping of Agricultural and grazing land Soils) project are compared. One of the aims of the GEMAS project is to produce soil geochemical data at the continental scale consistent with REACH directive (Registration, Evaluation and Authorisation of Chemicals) requirements (e.g., sampling depth, land use). The project involved the collection of samples from agricultural soil (Ap-samples) and from land under permanent grass cover at the continental scale, with a sample density of 1 site/2500 km^2. The strength of the project is that critical issues, such as standardisation of sampling procedures (EuroGeosurveys, 2008), sample preparation and analysis for a large suite of parameters were carried out in a single laboratory and under strict quality control (Reimann et al., 2009; 2011).

This work focuses on the comparison of total and acid-soluble element concentrations in the Ap-samples. The factors that control the changes in the ratio between AR and XRF analytical results are evaluated.

MATERIALS AND METHODS

Sampling was carried out in 2008. In total, 2211 agricultural soil (Ap) samples (0-20 cm, composite from five pits within an area of ~100 m^2) were collected from regularly ploughed agricultural fields, evenly spread over 33 European countries. Sample preparation was conducted at the central laboratory of the Geological Survey of the Slovak Republic (air dried, sieved through a 2 mm nylon screen, milled, homogenised and splitted). Aqua regia analyses were carried out at ACME Labs, and XRF determinations at the Federal Institute for Geosciences and Natural Resources, Germany.

RESULTS AND DISCUSSION

Element recovery by AR, compared to total XRF concentration (extractability) is very different. It ranges from <1% to practically 100% (% extractability in brackets) [Na (0.7), Zr (0.7), Ti (2.9), Nb (4.0), K (8.5), Ba (17.0), Sr (18.7), Rb (20.6), Al (21.6), Y (25.5), Cr (34.0), Th (36.0), V (39.9), Mg (54.7), Ca (61.0), Fe (71.8), Zn (74.4), Pb (77.3), Ni (78.9), Mn (79.9), P (82.9), Co (83.3)]. Extractability of chemical elements depends on several factors and their interplay. Mineralogy of parent material characterises the source, but other important factors, such as weathering history, climate, abundance of organic matter, soil pH, occurrence and abundance of Fe and Mn oxides and clay minerals, will affect the amount of metal extracted by AR. The high extractability observed for Fe and Mn confirm the efficiency of the AR digestion for their oxidised forms in soil, and affects the extractability of other transition elements (e.g., Co, Ni, Zn). The moderate extractability of Ca and Mg is related to the abundance of carbonate content in soils, completely extracted by AR.

As an example of the results, the map of K extractability (defined as the ratio K_{AR}/K_{XRF}) identifies clear spatial patterns, that are basically controlled by soil pH and clay content (Fig. 1). The Mediterranean area records the highest ratios in generally basic and clay rich soils. High extractability areas in France and UK are associated with chalk and limestone. Other areas with high extractability occur in Ukraine, while in Scandinavia relatively low values are recorded with exception of southern Finland, southern Sweden and coastal Norway.

Total element concentrations are not generally related to element recovery by AR, as verified by the K distribution map presented by Reimann et al. (in press). In contrast, soil pH, reflecting weathering intensity on soil minerals, appears to influence extractability. Under acidic conditions, most of the easily available elements were already leached from minerals, resulting in a low extractability that increases with increasing pH and is highest in the 7-8 pH range. Critical also is the clay content, which controls the extractability of many elements, providing higher extractability with increasing clay content, as depicted by the K ratio example shown in Figure 1.

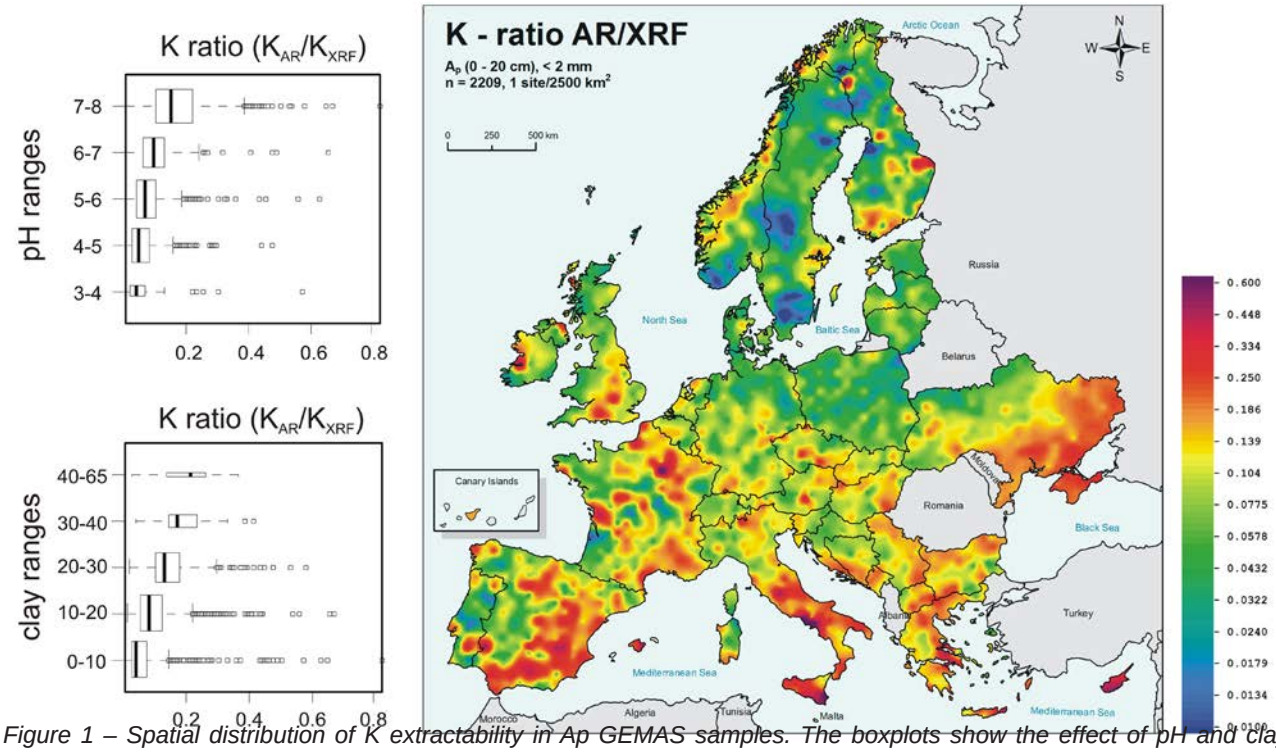

Figure 1 – Spatial distribution of K extractability in Ap GEMAS samples. The boxplots show the effect of pH and clay content on K extractability.

FINAL CONSIDERATIONS

The results illustrate that there exist significant differences in the aqua regia extractability of elements from soils. They further show that the extractability of an element is not constant, but is influenced by the bedrock material and weathering intensity of soil minerals, soil pH, soil organic matter and clay content. Consequently, soil risk assessments for elements or metals should be made using effects and exposure values, based on the same extraction method.

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A COMPARISON OF ANALYTICAL METHODS FOR THE DETERMINATION OF THE HEAVY METAL CONCENTRATION IN THE AGRICOLTURAL SOILS OF EMILIA ROMAGNA ALLUVIAL PLAIN"

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KEY WORDS: heavy metal, aqua regia extraction, X-ray fluorescence, Soil Typological Unit

REGIONAL GEOCHEMICAL MAPPING AND ITS ENVIRONMENTAL APPLICATION

The Decree 152/06 (article 240, paragraph 1, letter b) recommends the use of natural or natural-anthropogenic background value in derogation of the Threshold Limit Value "... *should the potentially contaminated site be located in an area affected by anthropogenic or natural phenomena exceeding one or more threshold concentrations of contamination, the latter are assumed to be equal to the existing background levels for all exceeding parameters*". The same Decree, in annex 2, Title V, in the section on chemical analysis of soils, states that "*chemical analyses shall be conducted by means of officially recognized methodologies, such as to ensure levels 10 times lower than the Threshold Limit Value."*

In the Pedogeochemical map of the Po valley in the Emilia-Romagna region genetic-functional soil units (UGFs) were identified at a 1:250.000 scale. The different types of regional soils (Soil Typological Unit) and pedogeochemical affinities were aggregated on the basis of the following diagnostic or discriminatory characters (Fig. 1):
- Soil characteristics (texture, degree of alteration);
- Sediment distribution and provenance areas.

In the UGFs characterization the description of the depositional environment is equally important. Each of the 11 UGFs defined in the area under consideration features specific geochemical and pedological characteristics.

MATERIALS AND METHODS

Sampling

In order to determine the natural background level, a 20-30 cm deep soil sampling was carried out by means of a "Eijkelkamp" (*mod. 01.11.SO, hand auger set for heterogeneous soils*) hand auger, equipped with a set of accessories to be used according to the different types of soil.

The sampling sites were identified in order to obtain a homogeneous distribution that would take into account the spatial distribution of different types of soils, watersheds and their geological characteristics (typological sampling). For each sampling site, the survey sheet was filled in, indicating the soil observations envisaged by the Emilia-Romagna Survey Manual in order to link observations to the types of soils present in the Emilia-Romagna soil database.

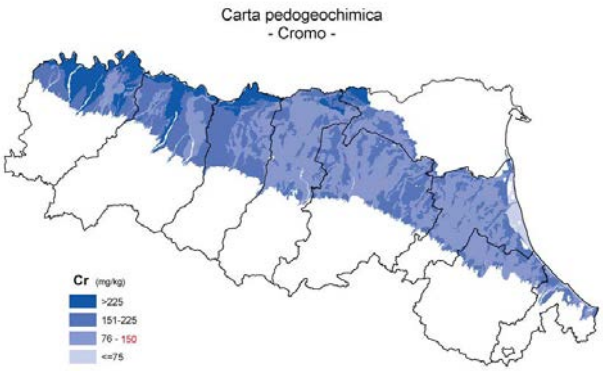

Figure 1 – Chromium pedogeochemical map

ANALYTICAL METHODS

The following analytical methods have been used for the determination of Cr, Cu, Zn, Pb, Ni present in the soil: X-Ray Fluorescence Spectrometry (XRF) and aqua regia attack according to the UNI / EN 13346 method (Method C. Close-system microwave assisted extraction in accordance with microwave oven mineralization - method of XI.I DM13/09/99) and ICP-MS (Mass Spectroscopy) reading according to the EPA 6020 method for all samples. The former method, which determines the total content, is regularly used in geochemistry surveys / studies for the genetic characterization of rocks and soils and it allows the drafting of related maps; the latter, determining the pseudo-total

content, is mainly used for the evaluation of the mobile portion of metal within the soil matrix

DATA PROCESSING

The data sets obtained by means of the two analytical methods have been subjected to statistical analyses performed separately for the purpose of analyzing the geochemical data distribution and detecting the presence of outliers (foreign elements) within each UGFs. UGFs with at least 10 analytical data were taken into account, since this value was considered sufficient for an adequate statistical analysis.

DISCUSSION AND CONCLUSIONS

In general, the XRF method, which envisages a minimal sample handling, is highly replicable and it allows to accurately identify the elements and metals bonded to the alumosilicate fraction with concentrations greater than approximately 20 mg/kg. It is however affected by the presence of significant amounts of carbonates (particularly relevant in the soil of the Emilia Romagna plain) and it becomes less reliable in the event in which the heavy metals are bound to an amorphous component generally associated with organic materials and materials of anthropogenic origin. On the contrary, the aqua regia treatment and ICP-MS reading determines only in part the contents of those elements relating to the alumosilicate fraction, but it is capable of destroying the amorphous matrix and it is not affected by the presence of carbonates. Since the method envisages a greater sample processing, it proves to be less repeatable than XRF, but it is more sensitive and therefore able to accurately determine even lower than mg/kg concentrations. The above-mentioned methodological approach has allowed us to compare data sets obtained by means of these two different analytical methods for each metal and to estimate the mobile metal percentage in aqua regia compared to the total content determined by XRF also in relation to geochemical and pedological differences typical of the genetic-functional soil units (UGFs) that have been identified. Hence, concentration values are more or less discordant in relation to the metal, its concentration and the soil characteristics

Code	Soils
A1	Soils with fine texture, with low or moderate degree of alterationt
A2	Soils with medium fine texture, with a high degree of alteration
A3	Soils with fine texture, with low or moderate degree of alteration
A4	Soils with fine texture, with low or moderate degree of alteration
B1	Soils with moderately fine to moderately coarse texture, locally with skeleton, with a low or moderate degree of alteration
B2	Soils with moderately fine to moderately coarse texture, locally with skeleton, with a low or moderate degree of alteration
B3	Soils with moderately fine to moderately coarse texture, locally with skeleton, with a low or moderate degree of alteration
B4	Soils with medium to moderately coarse texture, with low or moderate degree of alteration
B5	Soils with medium to moderately coarse texture, with frequent skeleton, with a low or moderate degree of alteration
C1	Soils with coarse texture, with a low degree of alteration
C2	Soils with coarse texture, with a low degree of alteration

Figure 2 – Genetic-functional soil units (UGFs)

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THE ACERRA-MARIGLIANO CONURBATION: THE GEOCHEMICAL BASELINE MAPPING OF THE NORTH-EASTERN SECTOR OF THE NAPLES METROPOLITAN AREA.

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KEY WORDS: Acerra-Marigliano, Urban geochemistry, Incinerator, Harmful metals, Dioxins, Furans, Pesticides.

INTRODUCTION

The URGE (Urban Geochemistry) project has as the main objective the production of the geochemical maps of 12 European urban areas using a shared sampling and analytical procedure. The use of a common protocol will allow both the characterization of the environmental conditions of several cities in Europe and the comparability of results obtained for a city with the others obtained across Europe.

In the framework of the URGE project the north-eastern sector of the Naples metropolitan area (Italy), namely the Acerra-Pomigliano-Marigliano area, has undergone a geochemical characterization based on topsoil sampling (145 samples over an area of about 100 sq km) (Figure 1).

This area has been selected on the basis of previous regional studies (Albanese et al., 2007; Cicchella et al., 2005; De Vivo et al., 2006) and because of the presence of some historical industrial settlements on it.

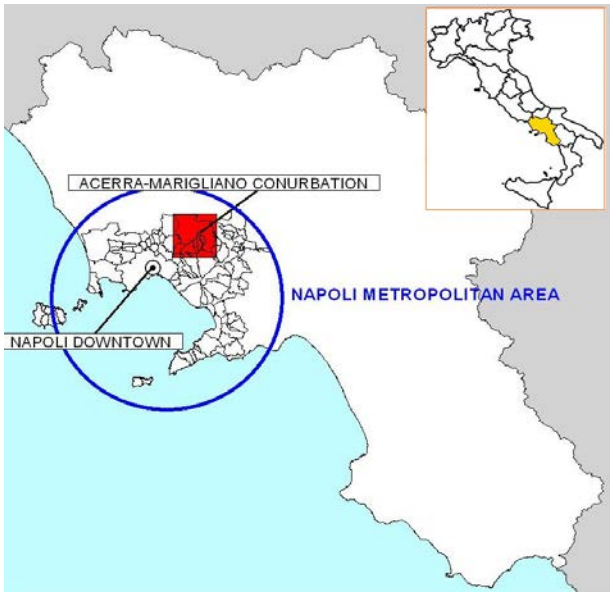

Figure 1 – The Acerra-Marigliano area

THE STUDY AREA

The Acerra-Marigliano conurbation includes 6 municipalities (Acerra, Pomigliano D'Arco, Castello di Cisterna, Brusciano, Mariglianella and Marigliano). The total population is about 160,000 and the average population density is about 1600 inhabitants/sqkm.

Considering the total extension of the urbanised areas (18-20 sqkm) the average population density could be corrected to 6-7000 inhabitants /sqkm.

Soils of the area are mostly originated by the pedogenenesis of the original pyroclastics produced by the Mt. Somma-Vesuvius volcano on the south-western side of the study area.

In the area (between Acerra and Pomigliano D'Arco) a branch of the italian automotive industries FIAT is present.

The factory came into activity in the early 70's and nowadays it has about 6000 employees .

In the northern sector of the Acerra municipal territory another industrial settlement is present (The ASI consortium). The settlement covers a total area of 2.601.000 sqm mostly occupied by the Montefibre factory.

Since the beginning of 80's, the Montefribre factory produces polyester fibers and it is accused of being one of the main culprits of pollution of soil and groundwater in the area.

Furthermore, close to the ASI-Montefibre area and in the middle of the crops in 2009 an incinerator for urban waste treatmant has been inaugurated and started to burn non-differentiated waste coming from every part of the Napoli metropolitan area. The waste were accumulated during the Campania region worldwide notorius waste crises (2004, 2008-2009) (Figure 2).

Epidemiological studies demostrated that the rate of cancer mortality in the Acerra area (better known as "Triangle of death") are higher of the regional average value although the higher rate has been mostly relate to the presence of many illegal waste disposal which have been contaminating soils and waters for decades.

Figure 2 – The Acerra incinerator

MATERIALS AND METHODS

The main objective of the study is to define the local geochemical baselines both for 53 elements (among which the toxic ones) and for some organic compounds, including Dioxins, Furans and Pesticides. Furthermore, the study aims to support epidemiological researches and to establishing a record of the actual environmental conditions to evaluate in the future the impact of the incinerator on both territory and public health.

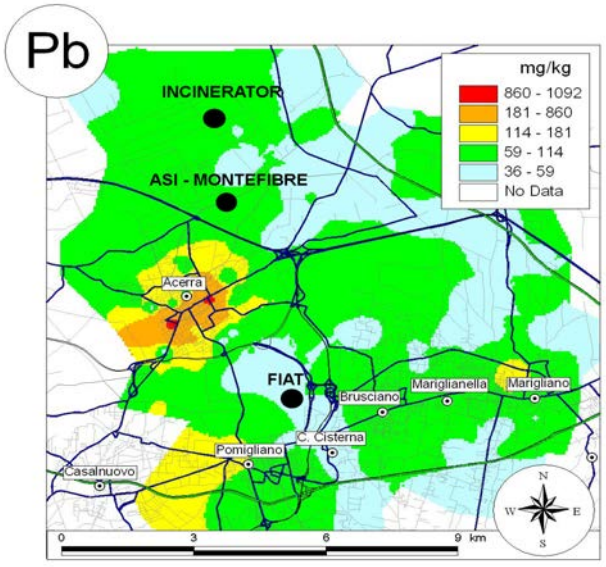

Figure 3 – Pb geochemical map

PRELIMINARY RESULTS

First results show that the most urbanized areas of the Acerra-Marigliano conurbation are characterized by concentrations of the highest values of Pb, Zn and V, often exceeding the intervention limits established for the residential land use by the Italian law (D.Lgs. 152/2006) (Figure 3).

Agricultural soils, in the surroundings of the urbanized areas, are enriched in Cu, Co, Cd, Be and Ni, and the probable presence of illegal waste disposals in the area should be considered as a potential source for them.

In the area where the incinerator has been built Cr, Se, Hg, Cu, Cd and Sb baselines are generally higher than in the rest of the territory (Figure 4).

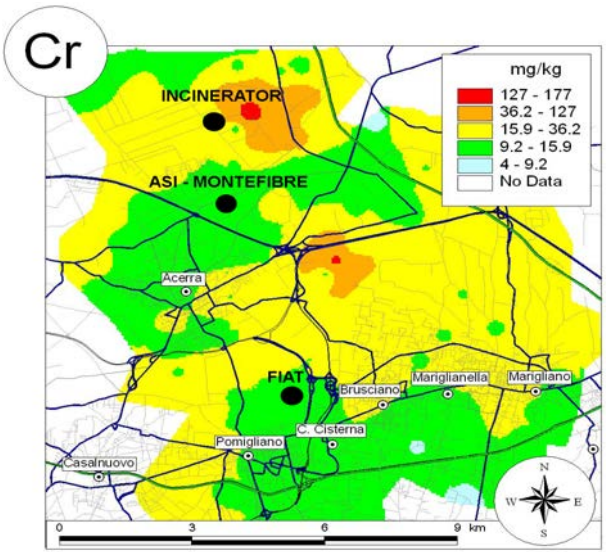

Figure 4 – Cr geochemical map

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SPATIAL DISTRIBUTION OF BACKGROUND AND ANOMALOUS POPULATION OF CHROME IN STREAM SEDIMENTS ON TUSCAN-EMILIAN APENNINES BASED ON THRESHOLDS DEFINED FROM CONTINUOUS AND DISCRETE CATCHMENT BASIN SURFACE OF THE CR DATA.

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KEY WORDS: GIS, catchment basins, concentration-area fractal method, stream sediment sampling.

INTRODUCTION

The environmental geochemical mapping is a valid tool for land monitoring. The knowledge of the distribution, diffusion and concentration of chemical elements provides important information about economic and/or environmental problems concerning agriculture, discovery of mineral resources and their exploitation, waste disposal, water supply, irrigation, animal health, soil utilization, epidemiological surveys, industrial pollution (De Vivo B et al, 2004; Plant et al, 2001).

Defining background and anomaly is a fundamental issue in exploration geochemistry. The choice of methods used for delineation of geochemical anomalies depends on the distribution pattern of data sets. Since the spatial distributions of element concentration in stream sediments often tend to a multifractal pattern, they should be treated with the fractal concept of scale-invariance (Li C et al, 2003).

In the analysis of exploration geochemical data to recognize significant anomalies, it can be useful to consider that geochemical landscapes have spatial variability, geometrical properties and scale-invariant characteristics. The concentration-area fractal method, developed originally by Cheng et al. (1994), takes into account such attributes of geochemical landscapes therefore it is appropriate for geochemical data analysis.

A geochemical landscape obtained by GIS-based application of the concentration-area method can be represented in two ways (Carranza E.J.M., 2009):

- Continuous field modelling of stream sediment geochemical data; in this case mapping of spatial extents of anomalous areas vaguely suggests the plausible source catchments of anomalous stream sediment samples.
- Discrete field modelling of stream sediment geochemical landscapes, by attributing measured or derived geochemical variables to their sample catchment basins; in this case the analysis suggests more clearly the plausible source catchments of anomalous stream sediment samples.
- In the representation of a map geochemistry is important to determine which technique to use in order to find the best correlation between concentration of the chemical elements and spatial distribution.

STUDY AREA

The study area is located in the southeast portion of Emilia Romagna region (central Italy) and covers about 2950 km^2. During five years, the department of Earth and Environmental-Geological Sciences (Alma Mater Studiorum-Bologna) collected 543 stream sediment samples for the purpose of compiling some environmental geochemical maps concerning the concentration and the spatial distribution of 35 chemical elements (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, P, L, Sc, V, Cr, Co, Ni, Cu, Zn, Ga, As, Rb, Sr, Y, Zr, Nb, Ba, La, Ce, Pb, Th, S). In Fig.1 is represented the geochemical distribution of Cr data.

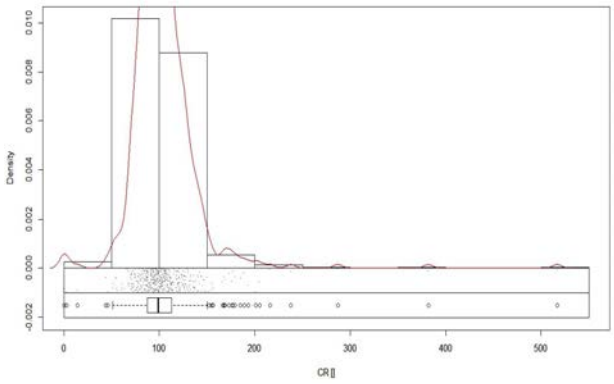

Figure 1 – Histogram and EDA grafic of Cr.

Morphologically the study area is made up by

the Apennine mountains oriented roughly NW–SE: these are crossed transversely by ten rivers drainage basins: Idice, Sillaro, Santerno, Senio, Lamone, Marzeno, Rabbi, Ronco, Savio e Marecchia.

The Apennine chain consists of a pile of nappes formed during the Miocene, overthrusting towards N–NE, and it is structured in several blocks in contact with one another along tectonic discontinuities. Lithologies consist mostly of sedimentary rocks, spanning from the Triassic to the recent age. The sedimentary rocks include: stratigraphic Mesozoic units, made up of calcareous-marly and marly-arenaceous-pelitic turbidites, detrital and organogenic limestones, marly limestones, marls, pelites, sands and conglomerates(Geological Survey of Italy, 2011).

Industrial activities are developed mostly around the main cities (Imola,Forlì,Faenza and Cesena) of area, whereas in the other portions of the territory agricultural activities prevail. No economic mineral deposits occur

Stream sediment sampling was carried out following two criteria: a random sampling with a density of one sample per 5 km^2 and a sampling for each catchment basin. In the second case, basins were preliminary extracted by DEM. All the stream sediments samples were sieved, and the < 180 µm fraction was retained for ICP-MS analysis.

For the compilation of such environmental maps it is critical to separate background from anomaly values, because, as explained previously, the recognition of background levels is critical for establishing the intervention limits of inorganic elements. The geochemical data have been analyzed by means of a GIS (Cheng et al, 2001).

The paper reports the results obtained by the multifractal IDW interpolation and by the spatial and spectral analysis (S–A) method to separate background and anomaly values for Cr. Interpolated values are represented in two ways: continuous field modelling of geochemical landscapes and discrete field modelling of geochemical landscapes (Fig.2 a-b).

The comparison of these representation shows how the second model having the best correlation between the concentration of Cr and their spatial distribution

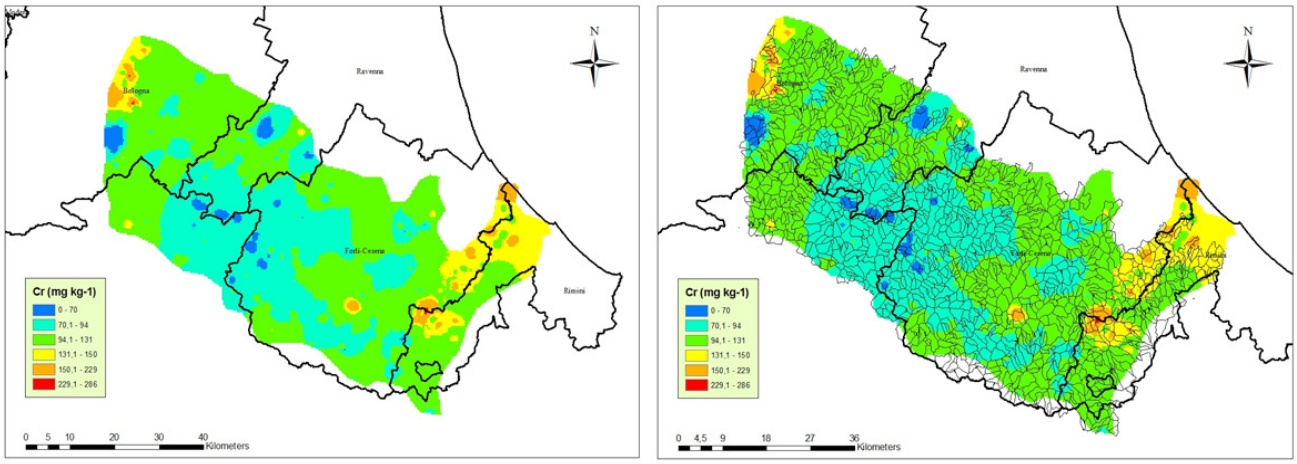

Figure 2 a-b. Continuous field modelling (a) and discrete field modelling (b) of geochemical landscapes.

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GEOCHEMICAL CHARACTERIZATION OF SEDIMENTS FROM COASTAL WETLANDS IN PO RIVER DELTA AREA.

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KEY WORDS: sediments, wetlands, geochemistry, heavy metals, Po River Delta area. .

INTRODUCTION

Coastal wetlands are transitional environments that can accumulate temporarily or permanently, many contaminants and nutrients carried by rivers to the sea. Wetlands often represent areas of high natural value but can be occasionally affected by strong anthropogenic pressure (e.p. industry, fishing, hunting and tourism). Pollutants, and in particular the metals, are not necessarily permanently connected to the sediment, but, once absorbed, can be mobilized from chemical or biological agents within the sedimentary layer or returned to the water column (Salomons and Forstner, 1984). The purpose of this study was to evaluate the presence of potentially toxic elements and metals in sediments of four coastal wetlands in the area of Po River delta. In order to evaluate metal enrichments, the results were compared with data from some continuously cored boreholes drilled in the surrounding area (Curzi et al., 2006; Dinelli et al., 2007; Amorosi et al., 2008).

MATERIALS AND METHODS

A total of 29 samples of surface sediments were collected from four coastal wetlands of the northern Adriatic sea that represent areas with different history and human pressure (Fig.1): Pialassa Baiona (Ravenna), close to a large town and an important industrial settlement; Valli di Comacchio (Ferrara), Valle Bertuzzi (Ferrara) and Valli di Rosolina (Rovigo), basically used for extensive fishing and hunting. Samples were sieved and washed with distilled water to eliminate any excess of sodium and the remains of animals and plants. After several days of sedimentation the deposited material were oven dried at 60°C to complete dryness, and homogenized in an agate mortar. An aliquot of pulverized sample was subjected to analysis by x¬ray fluorescence (XRF) for the determination of the major elements (Si, Ti, Al, Fe, Mg, Mn, Ca, Na, K and P conventionally expressed as weight percent oxides) and some trace elements (Sc, V, Cr, Co, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb, Ba, La, Ce, Pb, Th, S, Br, Mo) at the Department of Earth Sciences of the University of Bologna. Another sample split was sent to ACME Labs in Vancouver (Canada) for analysis by ICP-MS, after acqua regia dissolution (AR). By this technique were analyzed 53 elements (Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In , K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti , Tl, U, V, W, Y, Zn, Zr).

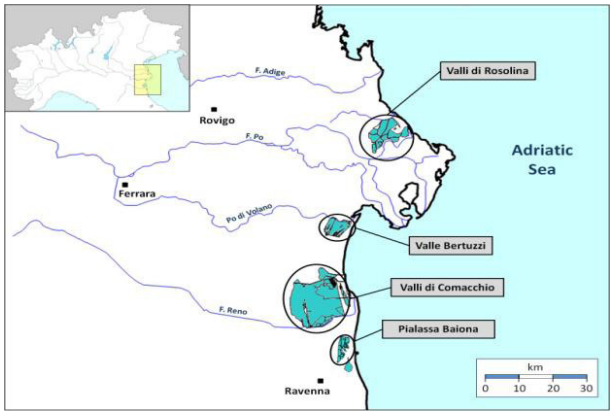

Figure 1 – Localization of the four areas studied in Po River Delta area.

RESULTS AND DISCUSSION

Enrichment ratios are shown in Figure 2. Among XRF data (fig.2A), Pb shows an enrichment ratio much greater than 1 for the majority of the samples, except those from Pialassa Baiona (blue diamonds). This site has the highest enrichment ratios for Cu and Zn. Regarding AR data (Fig. 2B), the Pb distribution is more homogeneous, with levels relatively similar to the background value. But, there are important sistematic enrichment for Cd and Sn, and Sb to a lesser extent. Observing the overall distribution of Pb, Pialassa Baiona shows the lowest values (16.4-30.4 mg/kg). The other areas show much higher levels, with values above 75 mg/kg in Valle Bertuzzi. These high concentrations may be partly due to intensive hunting practiced in these wetlands, which involves the release of large quantities of Pb in the form of lead shot. This fact could also explain the presence of Sb, which is a minor component of shots.

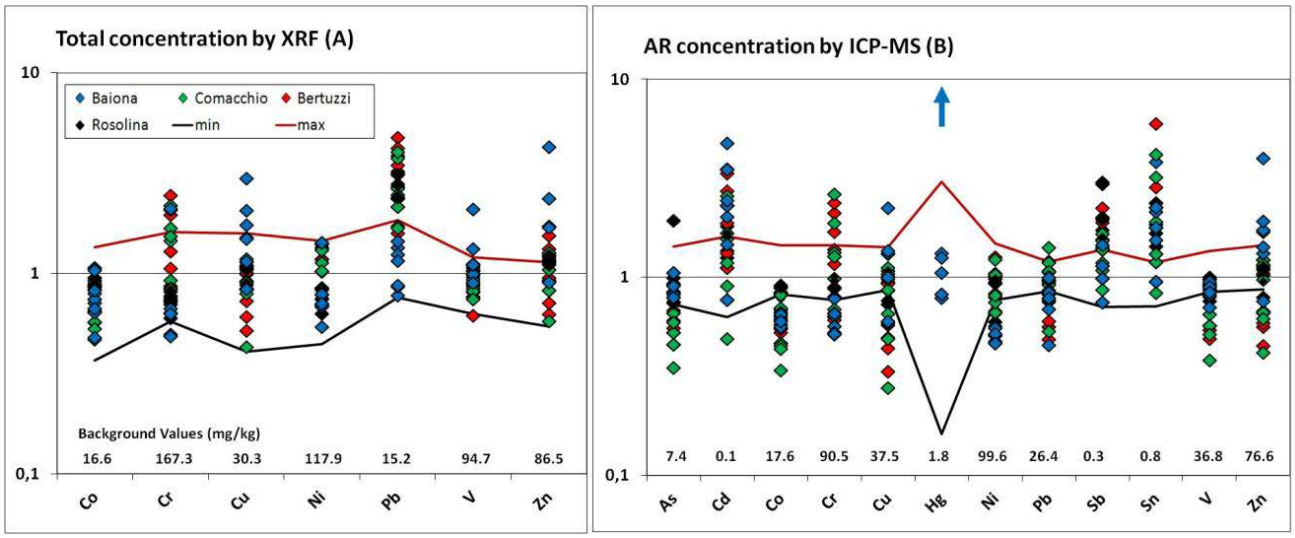

Figure 2 – Ratio between obtained value and background values derived from geological surveys carried out in the vicinity of the sites investigated.

Regarding Cd, although the enrichment ratio is relatively high for many samples, only the Cd levels in sediments from Pialassa Baiona is slightly higher than the normative standard (0.3 mg/kg) fixed by D.Lgs 152/2006. But, all values obtained in the present study are below the average value of 1.5 mg/kg referred in literature for this site (Matteucci et al., 2005). Particularly relevant are the concentrations of Hg found in Pialassa Baiona, with values that reach up to 2500 µg/kg. In Figure 2B enrichment ratios relative to Comacchio, Bertuzzi and Rosolina are not shown, as all less than 0.1, while the blue arrow indicates the presence of a value exceeding 10 for Pialassa Baiona. The Hg levels in this site are extremely higher than the quality standard of 300 µg/kg. These results confirm the very high levels of anthropogenically derived Hg reported in the literature for this area (Trombini et.al, 2003).

CONCLUSIONS

Hg results confirm the known Hg contamination of Pialassa Baiona. This site also shows high concentrations of other metals such as Cd, Cu and Zn which may in part arise from industrial settlement close to this wetland. The high concentrations of Pb in the study area, except in Pialassa Baiona, generate a particular concern. The source of these levels of Pb is not clear, but it is not possible to exclude a significant input due to hunting practiced in the three areas. However, in literature, there are not many geochemical data on the presence of metals in sediments for these areas, with the exception of Pialassa Baiona.

ACKNOWLEDGEMENTS

We are grateful to the ‘Settore attività produttive e politiche comunitarie’ division of the Province of Ravenna and the Institute for Environmental Protection and Research (ISPRA) for the financial support.Special thanks are due to “Corpo forestale dello Stato -Uff. Territoriale per la Biodiversità (Punta Marina -RA)” and to private owners that have allowed access to the areas and the sampling.

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CONSTRUCTION OF A GEOCHEMICAL ATLAS OF SARDINIA (ITALY)

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KEY WORDS: geochemistry, human health, territory monitoring, Sardinia

ABSTRACT

A good knowledge of a given territory under the geochemical viewpoint is to-day a priority, not only for recognising the perturbations more or less intensely induced by human activity in the environment, but also because the substratum original chemical composition itself may have important implications on life quality, thus a great influence on human health.

The environmental geochemical study of the entire territory of Sardinia has been performed through the analytical data from stream sediment samples. Several samples of this kind were collected during a series of important geochemical campaigns that in the past involved broad areas of the regional territory; the coverage of the whole island has been completed recently by a staff of the DIGITA, Cagliari University. After this completion, a minimum density of 1 sample / 5 sqkm has been reached.

A stream-sediment-type sampling, which is widely used for mineral prospecting, has the advantage of effectively representing the overall geochemical print of a wide portion of territory such as a stream basin; thus this methodology, that requires a comparatively small number of samples, is ideal for a first-phase environmental geochemical characterisation at acceptable cost.

In this first part of our study seventeen elements (As, Be, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Se, Sn, Th, Tl, U, V, Zn) are considered; through statistical treatment, for each element the formational threshold values have been determined; the different geological formations have been defined by plotting a lithological map based on the overall bibliography on the geology of Sardinia; only the formations covered by a sufficient set of data for a correct statistical treatment have been here distinctly considered, while the others have been often joined with formations of the same age and lithologically similar. Since a possible future use of these data concerns health aspects, linked with the different municipalities of the island, the sampling units include one or more municipality territories, and have been defined on the basis of the already said lithological aspects along with the sampling density and the total sample number; in this way a sufficient number of data for acceptable statistical treatment has been reached for almost all the considered elements in all the units, along with a rather good lithological homogeneity

Once the main statistical parameters were defined in this way, the limits of the different anomaly classes (possible, probable, and certain) were fixed, and anomaly maps were produced for each element.

The results of this work undoubtedly have a high significance and especially a high utility, not only for determining the limits of potential risk areas, to be submitted to detail sampling (stream sample thickening, soils, and waters), but also to define the natural concentration thresholds, to be adopted as reference values for characterisation in each unity, and possibly in each municipality, for a possily necessary intervention programme at every scale.

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REGIONAL GEOCHEMICAL BASELINE MAPPING FOR ENVIRONMENTAL MANAGEMENT USING TOP SOIL IN CAUVERY BASIN, TAMILNADU, INDIA

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KEY WORDS: Regional, geochemical, mapping, Cauvery Basin, Tamilnadu, India, Environmental management

SECTION: REGIONAL GEOCHEMICAL MAPPING

ABSTRACT:

Geochemical baseline studies were initiated by National Geophysical Research Institute (NGRI), Hyderabad in India to provide high quality baseline data for a wide range of environmental applications. Studies were carried out in Cauvery River Basin in Tamilnadu, Southern India. Geochemical baselines are required to present the state of earth's surface environment against which any future changes due to anthropogenic pollution can be measured.

Top soil samples were collected in the close grid pattern of 1x1 sq. kilometers. Fieldwork was carried out as per the guidelines mentioned in the "Green Book" prepared by Geological Survey of Finland. All the samples were processed at NGRI and were analyzed by X-ray fluorescence spectrometer. Geochemical maps were prepared by using SURFER software. Distribution map of lead is presented below. After completing these studies, samples were collected for the entire Tamilnadu state as per the global norms and distribution maps were prepared for 20 elements. Maps for Cauvery basin and Tamilnadu State are presented in this paper along with their environmental impacts. The data will be very useful to the policy makers for planning the new industrial areas, land use, agriculture etc.

The hot spots for the toxic metals can be seen at a glance for the entire state, which will help in taking suitable remedial measures. Initial results show that the distribution pattern of soil samples are related to the geochemical variation of large lithological units and contamination, reflecting industrial areas, residential and regions of intensive agriculture in Tamilnadu.

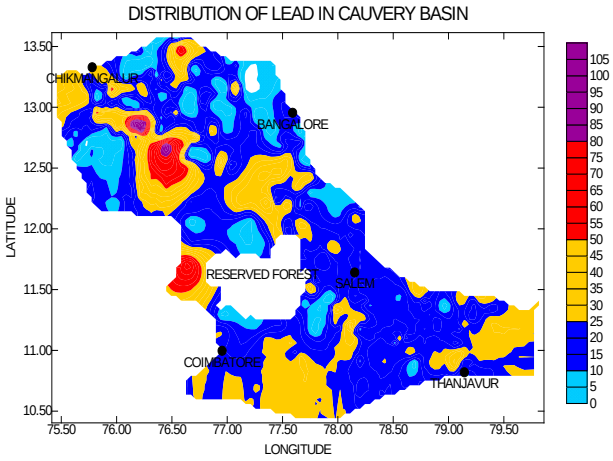

Figure 1: Distribution map of lead in Cauvery Basin

THE GIS-AIDED COLOUR COMPOSITE MAPS OF THE NAPLES METROPOLITAN AREA (ITALY).

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KEY WORDS: Naples; Urban geochemistry; Heavy metals; Color-composite maps;

INTRODUCTION

To highlight the possible relationships existing between environmentally important groups of elements in the metropolitan area of Naples an image processing technique (colour composite) has been applied to the element distribution maps previously presented by Cicchella et al. (2005) and De Vivo et al. (2006).

These images define and distinguish the spatial distribution of contamination sources, not well-defined in previous studies, and integrate information on elements, which can be considered indicative of anthropogenic or geogenic sources.

SAMPLING AND ANALYSIS

Soil samples (n=982) were collected in the metropolitan area with a grid of 0.5 km x 0.5 km in the more urbanized areas and a grid of 1.5 km x 1.5 km in the suburban areas.

Each sample is a composite of five subsamples collected from the corners and the centre of a 10 sqm site, in accordance with internationally adopted methods. Approximately 3 kg of soil was collected with a spade from 0 to 15 cm and stored in inert plastic bags.

All samples were air dried at a temperature below 35 °C to prevent the volatilization of Hg and sieved to collect 30 g of the <100 mesh fraction (150 mm) for chemical analysis.

Analyses were carried out at Acme Analytical Laboratories Ltd (Vancouver, Canada), accredited under ISO 9002, by inductively coupled plasma (ICP) mass spectrometry (MS) and ICP atomic emission spectrometry techniques using Acme's Group 1F-MS package (modified aqua regia digestion) for Ag, Al, As, Au, B, Ba, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, Hg, K, La, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Sc, Se, Sr, Te, Th, Ti, Tl, U, V, W and Zn.

COLOR COMPOSITE MAPS

The colour composite method is a widely used mapping

technique in satellite imagery, and it also has a long history of use for geochemical regional mapping in countries, such as the United Kingdom and Italy. Basically, it is based on the RGB additive colour model in which red, green and blue (defined as primary colours) are added together to reproduce an array of colours.

Usually in computing processes, intensity values of each primary colour are stored as integer numbers in the range 0 to 255 (8-bit representation), encoding 256 distinct values.

In order to generate a colour composite map using geochemical data, a group of three elemental interpolated grids is selected. Each grid is reclassified using a 256-interval scale and values ranging from 0 to 255 are associated with each interval in an ascending order (the interval representing the lower concentrations assumes the 0 value and the interval representing the higher concentrations assumes the 255 value).

On this basis, by means of the tool colour composite provided by the software ArcGIS, each reclassified grid of the considered group of elements is treated as a monochromatic colour map (one for each primary colour), and they are added together to generate a unique colour composite map in which the value of each pixel represents a triplet of colour (R, G, B), and each value of the triplet represents the influence of the associated element related to the others.

For example, if in a colour composite map a pixel has the colour white (coordinates 255, 255, 255), it has to be interpreted as a portion of territory where all three original interpolated grids were characterized by the highest concentration values of the related chemical elements.

In this study we will discuss the following composite maps:

- Pb–Cu–Zn
- Pt–Sb–Pb
- K–As–Na
- Mn–Co–Fe
- Ag–Hg–Au
- K–U–Th.

CONCLUSIONS

Further studies of geochemical data from detailed sampling of soils in the Naples metropolitan area using different methods, such as the production of colour composite maps, has resulted in a greater understanding of the relationship between groups of elements, and the distinction of the spatial distribution of contamination sources not evident in the previous studies (Albanese et al., 2007; De Vivo et al., 2006).

For the Naples metropolitan area, by using colour composite maps some elements can be clearly used as indicators of anthropogenic or geogenic sources. Element associations that have particular significance in the Naples metropolitan area are:

1. Pb–Cu–Zn, which is explained by elements exclusively introduced into the environment by anthropogenic activities;
2. Pt–Sb–Pb, the higher concentrations of this group occur mainly in the urbanized city centre areas subject to heavy motor-vehicle traffic;
3. K–As–Na, which is useful to differentiate clearly the soils developed on the Mt Somma-Vesuvius volcanic products, as opposed to those that developed on Campi Flegrei volcanic products;
4. Mn–Co–Fe, which divides the Naples metropolitan area into two sectors: the eastern one, which contains high values mostly for Fe and Co related to high basicity of the Vesuvian volcanics, and the western one, which contains lower values in correspondence with Campi Flegrei;
5. Ag–Hg–Au, the composite map of which highlights mostly an anthropogenic source of the contamination in the urban areas;
6. K–U–Th and 40K–238U–232Th, their composite maps distinguish quite clearly the soils developed on the Mt Somma-Vesuvius, in contrast with those developed on Campi Flegrei volcanic products.

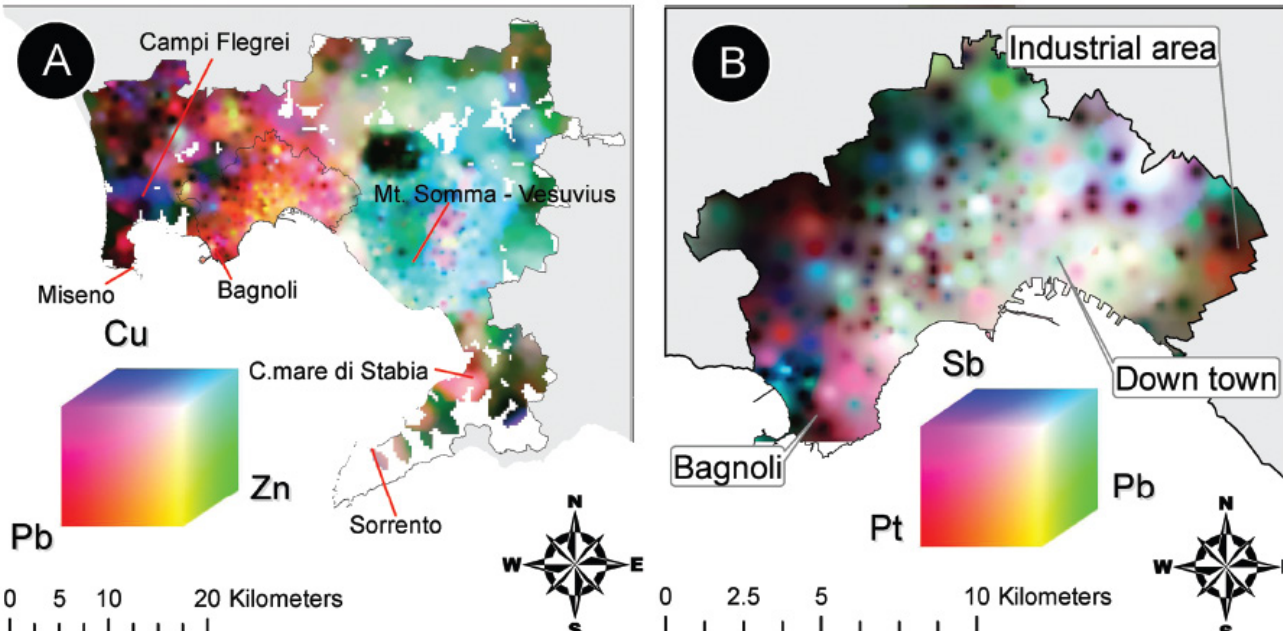

Figure 1 – Colour composite maps: A) Pb–Cu–Zn map for the Napoli metropolitan area; B)Pt-Sb-Pb map for the Napoli urban area.

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THE GEOGENIC NATURE OF SOME HARMFUL ELEMENT ANOMALIES IN THE CENTRAL SECTOR OF PELORITANI MOUNTAINS (SICILY, ITALY).

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KEY WORDS: Peloritani Mountains, Sicily,soil, Pb ratio ,heavy metals.

INTRODUCTION

The Peloritani Mountains, in the NE Sicily, are characterized by a large presence of sulphide and sulphosalt mineralizations.

This part of the Sicilian territory is characterized by the presence of rivers, called "fiumare" which represent a natural resource for the local rural economy (De Vivo et al, 1999).

This scientific work is focused on the content of some heavy and toxic metals in the topsoil samples (n=122) collected in the central part of Peloritani Mountains (Sicily), in the territories of Alì, Fiumedinisi and Mandanici (over an area of about 200 sqkm). The concentrations of 53 elements have been determined in the collected samples and geochemical maps have been created to show spatial distribution patterns of elements.

Furthermore soil and rock samples, mineralized by galena, have been collected along 3 soil profiles (1m depth) to determine Pb isotopic ratios.

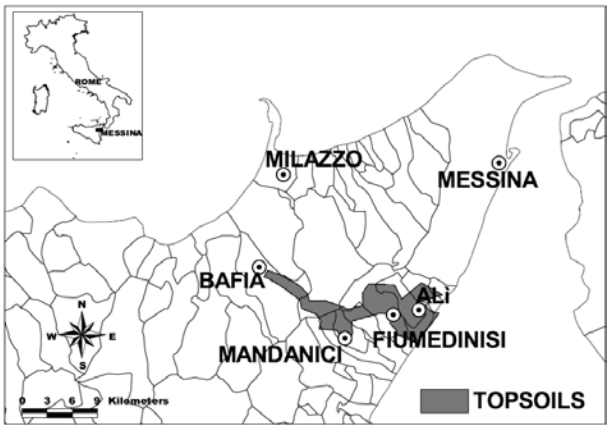

Figure 1 – Study area.

GEOLOGIC SETTING

The Peloritani Mts. geology is made up by a series of south-vergent crystalline nappes which are overtrusting the underlying Apenninic-Maghrebian sedimentary units along the transpressive Longi-Taormina lineament (Bonardi et al. 1976a, b).

In according with new studies on Peloritani Mts. (Messina and Macaione, 2010), the thrust belt is made by nine metamorphic units. The Units are Aspromonte, Mela, Piraino, Mandanici, Alì, Fondachelli, San Marco d'Alunzio, Longi-Taormina e Capo Sant'Andrea units.

THE MINES OF FIUMEDINISI AND ALI' TERRITORIES

The Peloritani Mts. territory is an key area for searching of the ore body deposits. An example was a regional geological investigation on rocks and stream sediments carried out in 1986 to 1991 years by Eni (Ente Nazionale Idrocarburi) for searching the tungsten and gold (De Vivo et al, 1993). The foreign dominations that came in Sicily, in the past time, mined the natural richness of sulphide ore body present in the lithotypes of this part of Peloritani. The mines located in the territory of Fiumedinisi and Alì were opened for extracting of metals as Pb, As, Zn, Cd and Sb, and the compeer Ag and Au were mined (Saccà et al, 2003).

In Val Pomia and Val Carbone, near the village of Bafia, a good concentration of Au in chalcopyrite and arsenopyrite mineralization (Saccà et al, 2003) was also found.

The mineral wealth of As, Sb, Zn, Cu and Pb present in the lithotypes of the units, may be explained by assuming a primary tectonic strata-bound genesis of the ore minerals, followed first by fragmentation and later by mobilization processes, occurred during regional metamorphism of Variscan age (Triscari, Saccà , 1982).

MATERIALS AND METHODS

Samples collected during the first phase of sampling activity (n=122) were dried by means of infrared light with limiting the maximum temperature at 37°C, and sieved retaining the 100 mesh fraction (150 µm) for analysis. Analyses were carried out at Acme Analytical Laboratories Ltd (Vancouver, Canada), by ICP-MS using Acme's Group 1F-MS package (modified aqua regia digestion) for 53 elements including Pb. The precision and accuracy of analysis are always in the range of 20%.

The Pb isotopic composition on topsoils (collected from soil profiles) and on rock samples from Fiumedinisi and Alì area have been determined, after a step-leaching procedure, using a Finnigan-Mat 262 Mass Spectrometer (Ayuso et al., 2003) at the US Geological Survey (Reston, VA, USA) and the ratios obtained were corrected for mass fractionation relative to the NIST- SRM981 standard (Ayuso et al., 2005).

CONCLUSIONS

In accordance with a regional study carried out by De Vivo et al. (1999) on stream sediments collected across the Peloritani area, the results of the present study show that Pb, As and Zn are mostly concentrated between the villages of Fiumendinisi and Alì. As a matter of the fact, high contents of Pb (>1600 mg/kg) in Mandanici and high contents of As (>700 mg/kg) in Fiumedinisi territories have been detected.

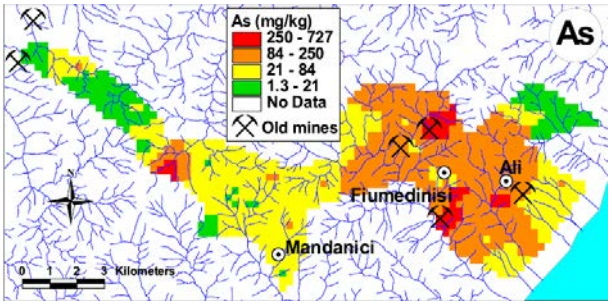

Figure 2 – Geochemical map of As

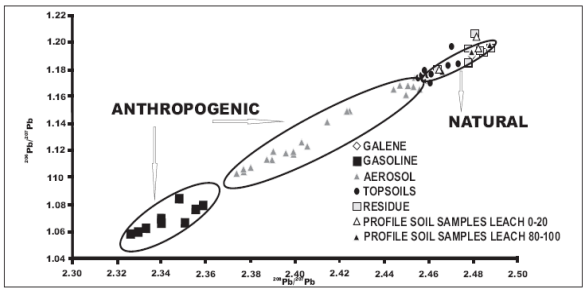

Figure 3 - Rappresentation of isotopic ratios of Pb for leach and residue of galene, topsoils and profile soil samples

The isotopic ratios of Pb ($^{206}Pb/^{207}Pb$ versus $^{208}Pb/^{207}Pb$), have been used to discriminate between the anthropic and the geological origin of harmful elements in topsoils and vertical profiles. The leached fraction of topsoils and profile have geogenic contamination mostly related to the presence of sulphide and sulphosalt minerals.

A factor score analysis shows that the Ag, As, Sb, Pb, Cd, Zn, Hg, Ni can be associated in a unique factor since they clearly marks the areas where old mines were present in these territories.

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WEATHERING OF VOLCANIC BASIC ROCKS IN NORTH OF IRAN AND RELATED DEVELOPED SOILS

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KEY WORDS:weathering,mafic minerals,alteration

INTRODUCTION

The chemical and mineralogical composition of rocks are regarded as the most important factor for developing soils in different areas. The petrographical and mineralogical studies have been combined to decipher the water and rock interactions that play so important role in defining the properties of the soil . The aim of this research is surveying the geochemical and mineralogical characteristics of basic volcanic rocks in the south of Marzanabad (north of Iran) and its influence on the characteristics of soils on the studied area.

DISCUSSION

Alborz mountain range is one of the structural zones of Iran that is the part of northern margin of the Alpine-Himalayan orogenic belt. The study area is located in the northern part of Alborz structural zone that is called Central Alborz. CA (Central Alborz) is limited in the west and east by border lines of Caspian Sea (Fig. 1). It is include sedimentary rocks of Paleozoic to Quaternary, a wide range of volcanic rocks of Paleozoic to Quaternary and some outcrops of metamorphic rocks in the northern border line. The study area locates in the northern part of Central Alborz zone. In Fig.1 the study area within the Central Alborz zone could be seen.

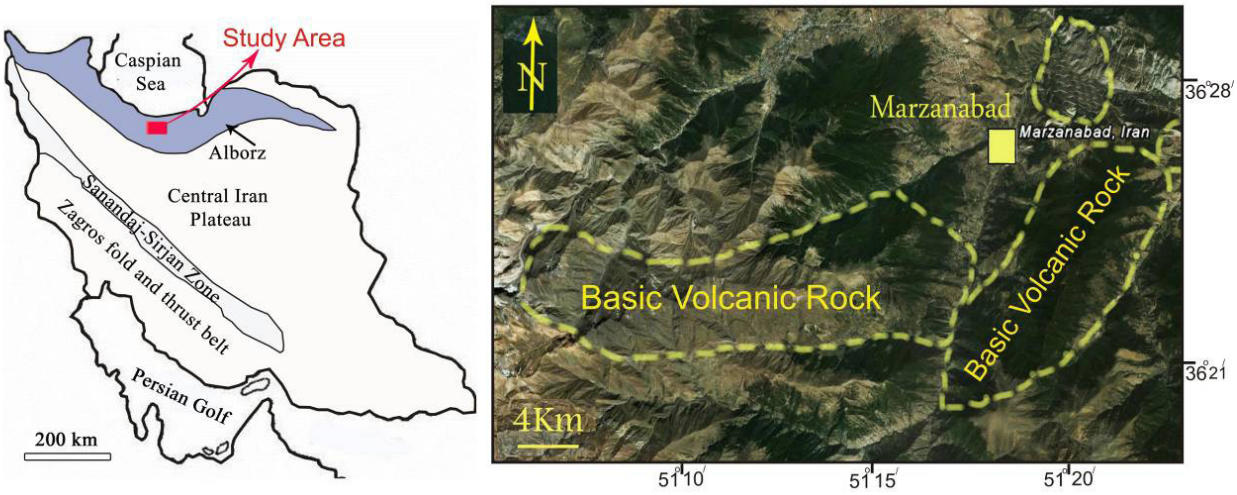

Figure 1 – location of the study area.

In this area sediments include a full line of deposits that are attributed to the Precambrian, Paleozoic and Mesozoic era. The studied exposed igneous rocks are attributed to the Cretaceous time (based on 1:250000 Amol geological map) (Vahdati Daneshmand, 1991, 2001).

With the weathering of different types of rocks, soils could be developed. Soils that are developed from the basic volcanic rocks have more clay and silt minerals that those are developed from the intermediate and acidic rocks (Abbas Nejad, 2005). Because of high amount of feldspar minerals and lack of quartz in basic rocks, they weathered more and so much easier than other type of rocks, so the soils that are developed from them will be so fertile and suitable for agricultural activities. In Fig. 2, thin section photos of basic volcanic rocks are presented. It could be seen that in these basaltic rocks, minerals such as plagioclase are converted and altered to clay minerals and calcite. This kind of alteration could be seen in phenocrysts and also in the mesostas of basaltic rocks. On the other hand the basic volcanic rocks have large amount of mafic minerals like olivine and pyroxene. Commonly soils that are developed from the weathering of basic volcanic rocks are fertile and suitable for agricultural activities but if weathering is developed in mafic minerals of these rocks, could cause to release elements such as Ni, Co and Cr.

The main source for marinating the transitional

elements like Ni and Co in basic volcanic rocks is the mafic minerals because the ionic radius of theses elements is similar to the elements like Fe and Mg. So when these minerals are altered, Co and Ni could be entered in to the soil. With the entrance of these elements to the soil the fertility of soil could be decreased. So the soil could be not suitable and proper for agricultural activities. In Fig. 3 the weathering of olivine minerals is shown that they are converted to oxides in a so wide range.

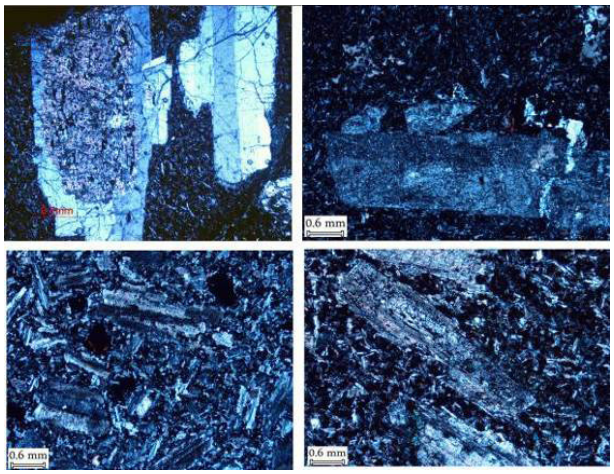

Figure 2 – alteration of feldspar minerals to clay minerals and calcite in the basic volcanic rocks of the study area.

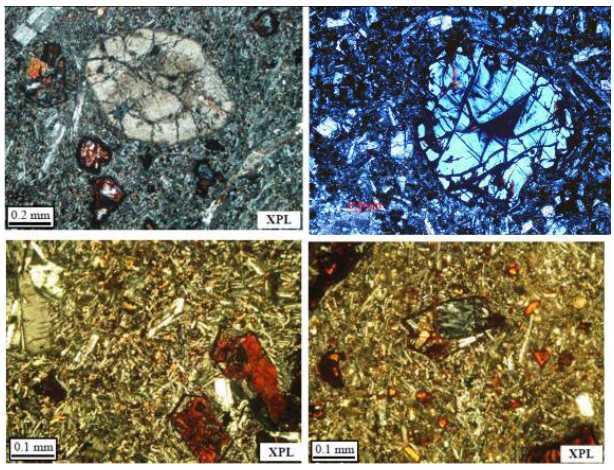

Figure 3 – alteration of mafic minerals to oxides serpentinite and cholorite in the basic volcanic rocks of the study area.

Elements like Co, Ni and Cr were determined by X-ray fluorescence spectrometry (XRF) for 26 samples of basic rocks. As it could be seen in the the frequency histogram of Fig. 4 , the amount of Ni and Co elements are high in these basic rocks. The average value of Ni is 60 ppm and Co is near to 50 ppm. These values are much more bigger than values in intemedite and acidic rocks. The high Cr content in the soil is related to the sepentine and chlorite alteration of mafic minerals (Caillaud et al. 2009), whereas the high resistance to weathering of spinels and the low mobility of Cr+3 can lead to its residual accumulation in pedogenesis of mafic rocks. Regard to high amount of Cr in these rocks (average 130 ppm) (Fig.4) and occuring the alteration of serpentinization and chloritization in them (Fig.3), it could also be possible to release Cr in to the soil.

CONCLUSION

Regard to the high humidity of weather in north of Iran and the high capacity of occurring the weathering process in the basic volcanic rocks in this area, we expect that due to the large amount of alteration in minerals specially mafic minerals like olivine and pyroxene that they are converted to oxides, serpentinite and cholorite, high quantity of Co, Ni and Cr released to the soil of the studied area. The high amount of the elements like Ni, Co and Cr could cause to reduce the fertility of soil. So we suggest that it is necessary to survey the precise amount of theses metals and mapping the geochemical characteristics of soil in this area for identifying the possibility of future agricultural activities.

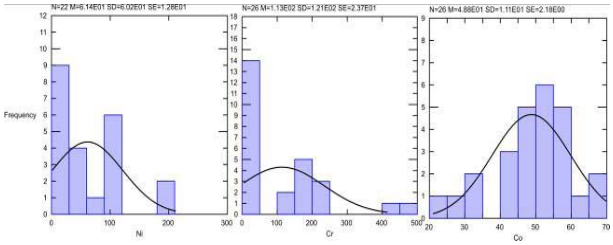

Figure 4 – frequency histogram of Ni, Co and Cr elements in the basic volcanic rocks of the study area.

ACKNOWLEDGEMENTS

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PETROLOGICAL AND GEOCHEMICAL CONSTRAINTS ON THE EVOLUTION OF LATE PAN-AFRICAN BAKRIYA POST-OROGENIC RING COMPLEX, CENTRAL EASTERN DESERT, EGYPT

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KEY WORDS: Egypt, Bakriya ring complex, post-orogenic, geochemistry, fractional crystallization

INTRODUCTION

A striking feature of the African continent is the occurrence of spectacular arrays of alkaline ring complexes. Emplacement of the ring complexes in NE Africa (Egypt, Sudan and Ethiopia) is mainly controlled by faults and shear zones and took place during an extended period of time span between closing of island arc activity at the end of the Pan-African orogeny and opening of the Red Sea Rift (650-30 Ma; Vail 1989).

Several hundreds of the post-orogenic and/or anorogenic ring complexes were emplaced in an intracontinental setting within the Arabian-Nubian Shield (ANS) (Frisch & Abdel-Rahman 1999). In the Egyptian part of the Nubian Shield, the ring complexes are mainly clustered in the southern Eastern Desert.

The Bakriya ring complex (BRC), aligned along an ENE and WNW transform faults in the central Eastern Desert of Egypt, is one of the least studied ring complexes in Egypt. The size of the BRC is relatively small compared with other complexes in the Nubian Shield of Egypt and contains a limited spectrum of rock types: diorite, syenogranite and alkali feldspar granite.

GEOLOGICAL AND STRUCTURAL SETTING

The location of BRC at the junction between the ENE transform faults and the NNW deep-seated tectonic zones (Bowden 1985) indicates the location of the province on pull-apart opening zones of structural weakness (Giret & Lameyre 1985) related to post-orogenic environment (El-Sayed et al. 1999). The rounded BRC, emplaced into late orogenic, calc-alkaline younger granitoids, consists of diorite in the middle part, outer alkaline syenogranite and central subsolvus alkali feldspar granite (Fig. 1). The three rock types are veined by pure quartz, quartzo-feldspathic and fluorite pegmatites. The outer syenogranite forms a raised semicircular ridge relative to the older inner diorite rocks. Fluorite mineralization occurs either as stockworks of rather pure fluorite veinlets near the marginal zones of cupola or otherwise as sets of larger veins of diluted fluorite ore filling structural zones.

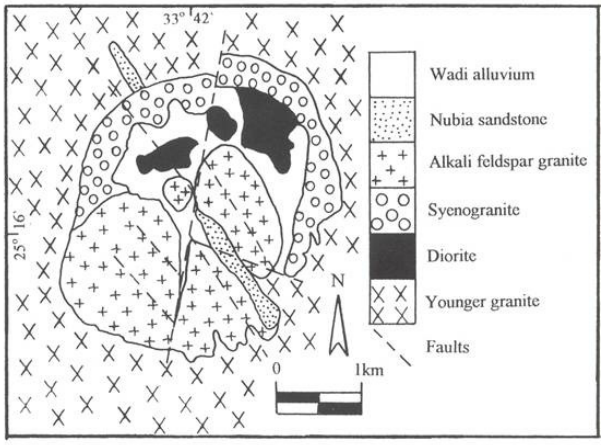

Figure 1 – A geological map of the Bakriya ring complex (BRC), central Eastern Desert, Egypt.

GEOCHEMISTRY

The diorite rocks of the BRC are metaluminous and exhibit geochemical features of calc-alkaline magmatism. The syenogranite and alkali feldspar granite exhibit alkaline and peralkaline affinity, respectively. The patterns of the different rocks all tend to have higher concentration of large ion lithophile elements (LILE) relative to high field strength elements (HFSE). The spiderdiagrams of the diorite and syenogranite are characterised by slight negative Ta-Nb, P and Ti anomalies. The spiderdiagram of the alkali feldspar granite, on the other hand, shows more significant negative P and Ti anomalies in addition to a strong negative Ba anomaly and absence of Ta-Nb anomaly. The fractionated REE patterns of the diorite-syenogranite suite have LREE-enrichment patterns {$(La/Sm)_n$ = 3.1 and 4.2, on average, respectively} with slightly flat HREE segment {$(Gd/Lu)_n$ = 0.69 and 0.77, on average, respectively}. The REE patterns of both diorite and syenogranite are characterised by slight negative Eu anomalies (Eu/Eu* = 0.8 and 0.78, on average, respectively). The REE patterns of the

alkali feldspar granite suite, on the other hand, are characterised by enrichment in HREE {$(Gd/Lu)_n$ = 0.04-0.29} and strong negative Eu anomalies (Eu/Eu* = 0.13-0.32) indicating a significant role of plagioclase fractional crystallization.

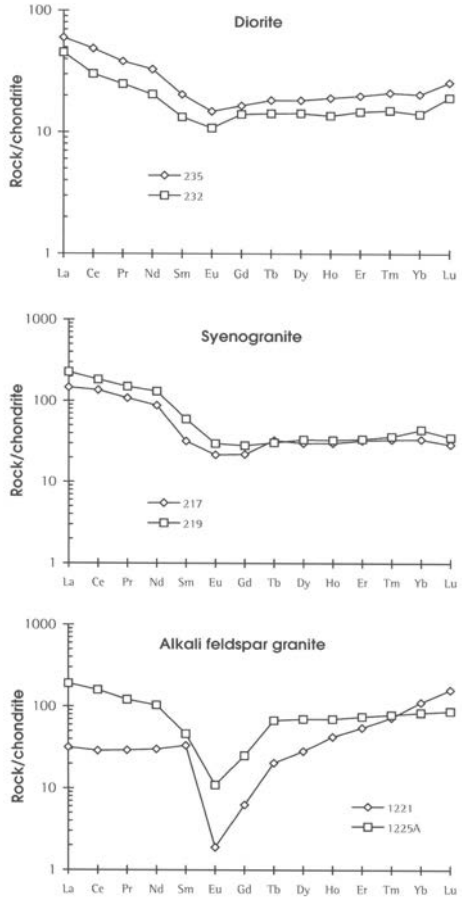

Figure 2 – Chondrite-normalized REE patterns for the diorite rocks, syenogranite and alkali feldspar granite from the Bakriya ring complex (BRC).

PETROGENESIS

The mineralogical composition of the rock types of the BRC indicate their crystallization under variable water pressures suggesting their emplacement at different levels within the Earth's crust. Field relationships and element patterns of the rocks of the Bakriya ring complex reveal an evolution in two suites, namely: a diorite-syenogranite suite and alkali feldspar granite suite, both with several pulses of emplacement. Fractional crystallization has played an important role in the evolution of the diorite-syenogranite suite. The chemical variation of the diorite-syenogranite suite is likely to be attributed to plagioclase, K-feldspar, biotite, hornblende, apatite and titano-magnetite fractionation. The geochemical data suggest that the alkali feldspar granite has evolved by means of fractional crystallization through removal of K-feldspar, biotite, plagioclase, together with some accessories such as apatite and Fe-Ti oxide phases. From the HREE-enrichment in some samples of alkali feldspar granite it may be suggested that fluorine-complexes played some role during its evolution.

EMPLACEMENT OF THE BRC

The diorite rocks dips inwards whereas the syenogranite dips outwards. In the former case the central plug must have pushed up, while in the latter case it sunk during the cauldron subsidence, occupying the space formed by sinking a block into the magma chamber. Hence, the formation of these concentric intrusion units indicates that the crustal forces operating were decreasing by reduction in water pressure through migration of water and volatile constituents in the enveloping rocks.

The formation of the complex started with the intrusion and development of the diorite rocks. A mantle-derived basaltic magma was emplaced at a lower to middle crustal level and fractionated to give an evolved diorite liquid. During the first eruption, the dioritic melt migrates into shallower crustal levels where it solidified as diorite. Ongoing magma supply into the magma chamber, accompanied by further fractional crystallization, the intrusion of the syenogranitic liquid resulted in the formation of a system of radial and ring fractures. The overall trends of major, trace, REE patterns and some element ratios suggest that diorite-syenogranite suite formed by individual magma pulses that have undergone internal differentiation but that overall differentiation did not take place in situ, but in a reservoir at greater crustal depth. Cauldron subsidence along fault system resulted in the development of a central wadi. The evolved granitic liquid ascended to shallower depths along the reactivated fracture system in the form of alkali feldspar granite. Differentiation, ascent and emplacement of the magma pulses probably occurred within a narrow time span.

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DATABASE GENERATION METHOD FOR GEOLOGICAL CHART INFORMATION ON EXAMPLE OF ORE DEPOSITS OF TIEN-SHAN.

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KEY WORDS:Tien-Shan, metallogenic features, computer database.

Tien-Shan is characterized with complicate geological structure, peculiarities of tectonic developments, magmatism and metallogeny. Many scientists have investigated ore deposits geology of this region. According to features of development, age of folding, types of mineral deposits and magmatism peculiarities most of them divide Tien Shan into three geotectonic districts: The Northern, The Median and the Southern. The boundaries between them are regional deep folds Nikolaev Structure Line, Nurata-South-Ferghana Fault, etc.

Characteristic metallogenic features of formations are remained rather stable in various geotectonic zones. This is indicated of certain connections between mineral composition of rocks - on the one hand, and mineralization type - on the other hand. At study ore of deposits geological, geophysical, geochemical and other kinds of maps are applied.

The processes of accumulation, storage, analysis and interpretation of various information have great value in geological science and practice. This determines the necessity of modern computer means of information processing in order to increase efficiency. GIS technologies are such modern means. In terms of data capacity, geological maps (geological, geophysical, geochemical) are unique. Apparently, the fact that a geological map could not be entered in its original form into a computer and analyzed with sufficient detail, the view of the difficulties associated with the loss of information in its computerized analysis has been defined. GIS technologies allow to enter into a computer a map practically without loss of the information and to construct computer database of geologic information. The emergence of GIS technologies and the possibility to create with their help a computer mapping database of geological, geophysical, geochemical information is an important achievement in the problem of visualization of maps to geologist.

The transformation of the geological map information for computer analysis is implemented in two phases:

1) automated data input in the computer and the creation of the computer database of the geologic map (computer versions of maps);

2) a map digitization, i.e. its reduction to an aspect "installations-signs". The proposed method of creating a digital version of geological maps of different content does not depend on scale and map specialization (geological, geophysical geochemical, structural, etc.). It depends on the formal properties of the maps. The maps used in geological studies according to the formal properties of maps are divided into the following types:

1) areal - some parts of maps, within which there are some factors (stratigraphy, lithology, igneous features);

2) linear - structural elements map (faults, dikes in the small-scale maps, folds, the boundaries between geological bodies and others);

3) isolinear - fields in the form of isolines (a map of isodepths of the foundation, a magnetic field map, geochemical maps, etc.);

4) dot fields (ore load maps , measurements of items of bedding, etc.).

Step by step procedure performs the following steps:

1) The first step - creating the base map for digitizing;

2) The second phase - calibration;

3) The third stage - digitizing. A method of sampling varies depending on the nature of the information displayed on a map: areal, isolinear, linear, dot and raster.

The computer analysis of the cartographical information is performed by two paths:

1) to use the traditional metallogenic analysis, i.e. make conclusions about the patterns of distribution of minerals with a visual overview of the different maps on the computer;

2) to use mathematical methods for analysis.

For this purpose it is supposed to compound from the constructed digital maps the basic processing object - matrixes "object-signs", i.e. maps digitization.

In Uzbekistan, the GIS system are mastered and applied for geological applications. Taking into account the specifics of geological, geophysical and geochemical maps GIS technologies are elaborated for input, accumulation, systematization and information processing from these maps. The atlases of geological features of ore deposits were compounded. At compounding of the atlases various cartographical methods on constructing of geologic, tectonic, structural, geochemical and geophysical maps were used which will be shown at the presentation of this work.

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS TO VISUALIZE CONTAMINATION OF INDIVIDUAL COMPONENTS OF ENVIRONMENT IN SURROUNDING OF BANSKÁ BYSTRICA, SLOVAKIA – CASE STUDY

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KEY WORDS: dump-field, contamination, heavy metals, technogenous sediments, soil, plants, erosion, water flow, visualisation, geographic information systems, risk

INTRODUCTION

The Ľubietová deposit near Banská Bystrica was exploited since the time of the Bronze Age and in the 16th and 17th centuries it was one of the most important and most extensively exploited Cu-mines of Europe. The Cu-ore was in the 18. century exported to more than 50 countries (Koděra et al. 1990).

The Cu mineralisation with Ag admixture is developed within 4 – 5 km long and 1.5 km wide range of N-S direction. There are three main ore-fields in the Ľubietová surrounding: Podlipa, Svätodušná and Kolba with admixture of Co/Ni-mineralisation. The Cu content in the ore ranged from 4 – 10 % and the Ag content was about 70 g.t-1 (Koděra et al., 1990). 25 thousand tons of Cu were exploited during last five centuries.

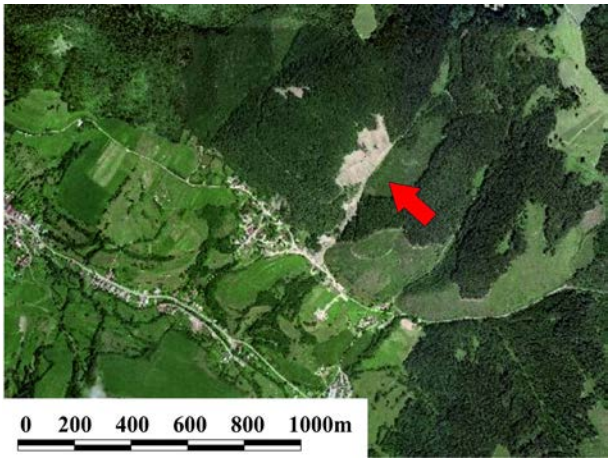

Figure 1 – The dump-field Podlipa in Ľubietová

The main dump-field Podlipa (fig. 1) represents about 2 km2 area and was exploited by 18 adits. The ore mineralisation is situated in the Ľubietová terrigene crystalline complex of Permian age which consists of greywackes, arcose schists and conglomerates. The main tectonic structures are of NE-SW direction, the main ore veins strike approximately E-W and N-S. Ore veins are 30 – 40 m thick. In the southern part of the ore-field was described also disseminated mineralisation.

The probably volcano-sedimentary mineralisation, genetically connected with the basic, intermediate and acid Permian volcanism, was mobilised by Hrončok granite intrusion during the Alpine (upper Cretaceous) orogene (Ebner et al., 2004). The vein mineralisation is characterised by a rather simple paragenesis which is represented by quartz, siderite, (± calcite and ankerite), chalcopyrite, Ag-bearing tetrahedrite, arsenopyrite, pyrite, barite and rare galena. In the well developed cementation zone the main Cu-minerals were cuprite and native copper. The deposit is famous also because of formation of wide range of rare secondary minerals as libethe-nite, langite, annabergite, aurichalcite, brochantite, azurite, cyanotrichite, erithrine, farmacosiderite, hemimorphite, evansite, cuprite, pseudomalachite, limonite, euchroite, chrysocol, malachite, olivenite, tirolite, copper etc. (Koděra et al. 1990).

Although the intensive mining activities were stopped during the 19th century (the last owner of the mine near Haliar locality Ernest Schtróbl finished the exploitation during the WWI on April 1915 because of the limited number of the miners) and only a few geological survey activities with negligible effect have been carried out here since, the area remains substantially affected.

EXPERIMENTAL

The technogenous sediment and soil samples from the dump-fields, surface water (stream water, drainage water) and groundwater were collected in order to characterize components of landscape

contamination. The reference site was selected by comparing territories loaded by heavy metals and non-contaminated natural environment (fig. 2). It was situated outside of geochemical anomalies of heavy metals and represent graywakes of Permian age similar to material at the dump-field. Samples of plant material were collected from the contaminated dumps.

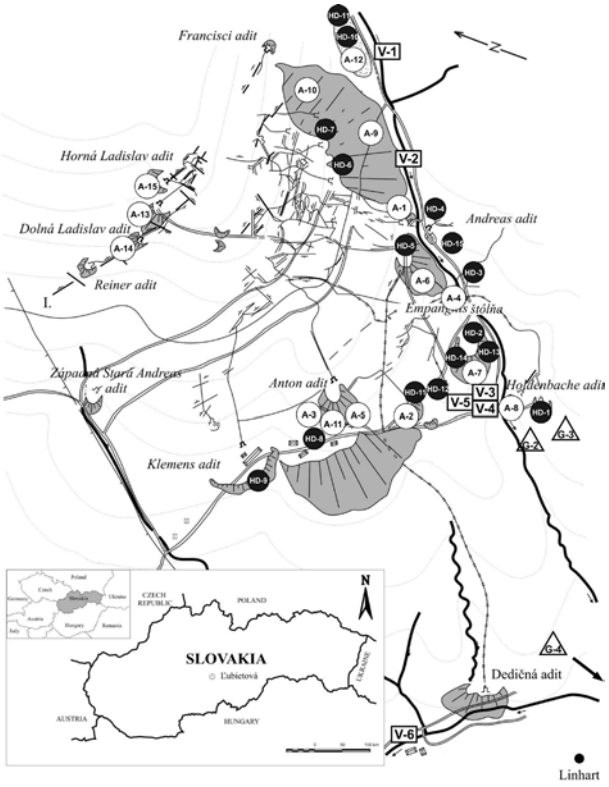

Figure 2 – The sampling sites at dump-field Podlipa

The samples of technogenous sediments from the dumps and soils were analysed by ICP-MS analysis at the ACME Analytical Laboratories (Vancouver, Canada).

The water samples were analyzed using AAS in the National Water Reference Laboratory for Slovakia at the Water Research Institute in Bratislava.

RESULTS

The dump-field sediments are influenced by heavy metals from the hydrothermal Cu-mineralisation. The main contaminants: Fe (up to 2,64 %), Cu (25 ppm - >10 %), Mn (34 - 1258 ppm), As (7 - 289 ppm), Pb (8 - 130 ppm), Co (5,1 - 96,3 ppm), Sb (7 – 62 ppm) and Ni (7,8 - 62,1 ppm) are accompanied also by U (up to 10 ppm) and Th (up to 35 ppm).

The heavy metal distribution in technogenous sediments of the dump-field is variable. The distribution of individual elements reflect the primary concentration in separate parts of the dump-field as well as their geochemical relations (figs. 2 - 5), first place their migration ability. In general we can distinguish at the dump-field three types of heavy metals: 1. group: Fe, As (fig. 3), Sb, Sn, Co, Ni, Cr, Ag, V, U, Th; 2. group: Cu, (fig. 4) Zn, Bi, Cd; 3. group: Pb (fig. 5).

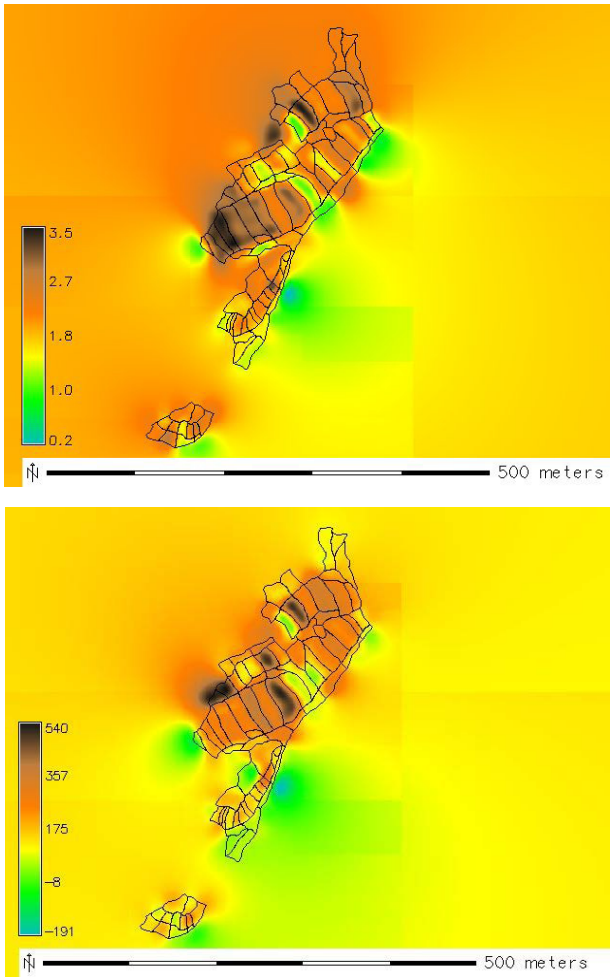

Figure 3 – Distribution of Fe and As at the dump-field Ľubietová (explanation to figs. 3 – 5: the numeric indexes represent the concentration of heavy metals in % or ppm)

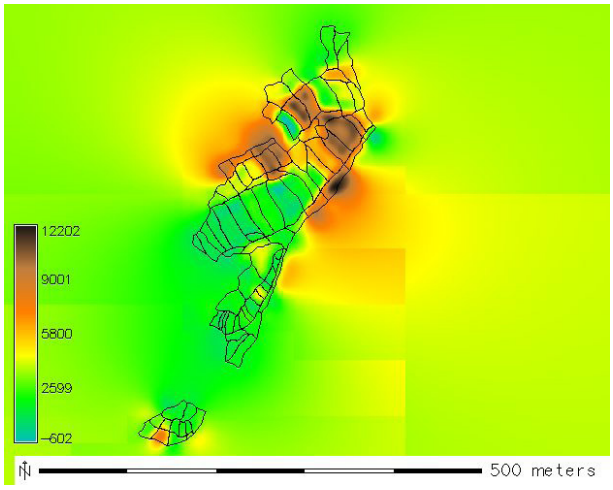

Figure 4 – Distribution of Cd at the dump-field Ľubietová

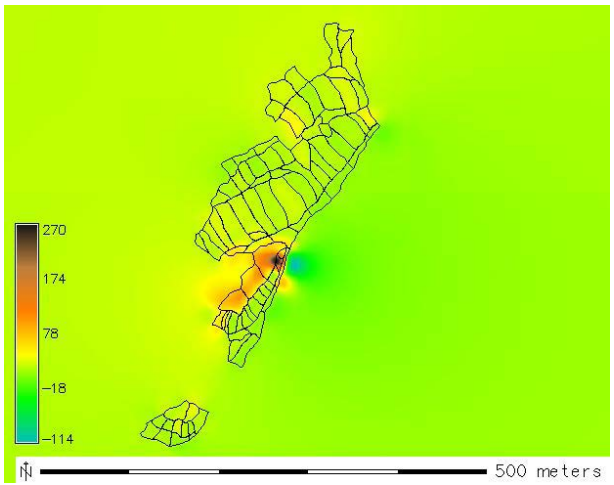

Figure 5 – Distribution of Pb at the dump-field Ľubietová

The surface water in the creek draining the valley along the dump-field is gradually contaminated by heavy metals from leached from the technogenous sediments of the mining dumps. The drainage water contains relatively high Cu (up to 2060 µg.l^{-1}), Fe (up to 584 µg.l^{-1}), Zn (up to 35 µg.l^{-1}) and sometimes also Co (up to 10 µg.l^{-1}) and Pb (up to 5 µg.l^{-1}) concentrations. The highest As concentration is 6.11 µg.l^{-1}.

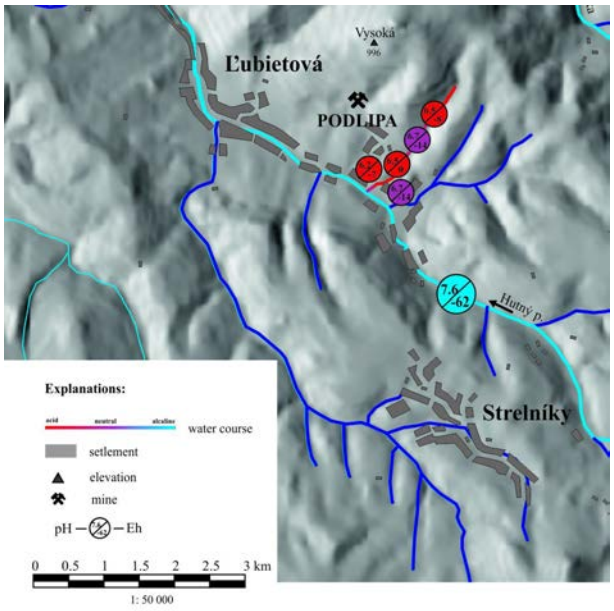

Figure 6 – Surrounding of Ľubietová. Water courses in the country near Podlipa dump-field

The heavy metal content in the water is in most cases higher during the dry period in comparison with the rainy period. The As content both in the surface (and drainage) as well as in the groundwater is not high (6.11 µg.l^{-1}). The presence of Acidithiobacteria or of sulphate reducing bacteria was not proved. The acidity both of the surface and groundwater is close to neutral pH (6.4 – 7.6; fig. 6).

The most contaminated is the mineral water from the spring Linhart (fig. 2). The total radioactivity is 6,498 Bq.l^{-1} and the Fe (380 µg.l^{-1}), Cu (181 µg.l^{-1}), Pb (1 µg.l^{-1}) and Cd (82.0 µg.l^{-1}) content exceed the Slovak decrees No. 296/2005, No 354/2006 Coll.

If distilled water is used in the measurment of paste or rinse pH of sediments or soils, its pH is usually around 5.3. The pH values less than 5.0 indicates that the sample contain net acidity at the time of analyse (Sobek, 1978).

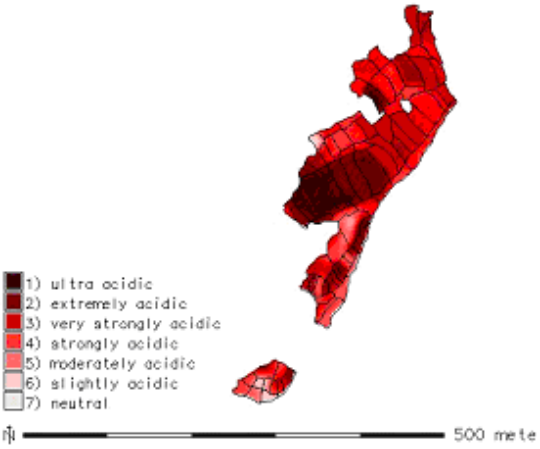

Figure 7 – Map of the sediments acidity in the central part of the dump-field

Values of paste pH between 5.0 and 10.0 can be considered near neutral at the time of the analysis. From viewpoint of this study only two samples (A-3, A-12, fig. 2) account acid values. It is interesting that one of this samples is the sample from the reference area. The reason of such a behaviour is the lack of the carbonates. The map of the soil and sediment acidity of the central part of Podlipa dump-field is presented at fig. 7.

The measuring of the pH paste in the samples using solution of 1M KCl give similar values. It means that only several few samples show markedly acid reaction.

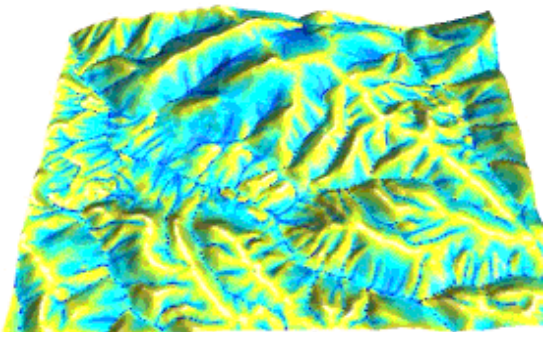

Figure 8 – Path of surface runoff

DISCUSSION

Heavy metal distribution at the investigated dump-fields at Ľubietová reflect the geochemical

behaviour of the elements, depend on their content, solubility, migration potential and sorption properties. The major sources of metals to the soil and technogenous sediments may be classified according to expected initial solubility of primary minerals (Cataldo and Wildung, 1978). Hydrolyzable metals (e.g., Ni, Cd) or metals forming insoluble precipitates with S or P on entering the soil in soluble forms may be expected to be rapidly insolubilized at the near neutral pH of most soils due to hydrolysis on dilution and subsequent precipitation on, or reaction with, particle surfaces. Certain elements (e.g., Fe) may also form precipitates with S or P (Routson and Wildung, 1969; Keeney and Wildung, 1972). The soil physicochemical parameters most important in influencing the solubility of metals include: solution composition (inorganic and organic solubles), Eh, and pH; type and density of charge on soil colloids; and reactive surface area (Keeney and Wildung, 1972).

The contamination is intimately connected with the surface and undersurface flow, which have together with the erosion dominant influence on the heavy metals migration and on their distribution in the country. These factors are controlled by rainfall, wind, slope inclination and solifluction (gravitation), by pH, Eh and also by vegetation.

The geographic information systems (GIS) enable to visualize environmental problems and connected risk-factors. The presented graphic work show visualization of space-data using GIS-tools implementation and web-services. It is focused on problem of flow-conditions, contain real (and potential) erosion modelling, study the contaminants diffusion supposition in studied area.

The acidity depend predominantly on the geochemical behaviour (weathering) of particular minerals (mainly pyrite).

CONCLUSIONS

The dump-field mining sediments are influenced by heavy metals from the hydrothermal Cu-mineralisation. The main contaminants: Cu, Fe, As, Sb and Zn are accompanied also by U and Th. The results for the irregular contamination of sediments by selected heavy metals are shown at fig. 3a, b.

The surface water (and drainage water) as well as the groundwater water are substantially contamined predominantly by Cu, Fe and As. Both the As content and its speciation don't pose acute risk (the highest arsenic content is only 0.6 ppm and it is present both in the form of As^{3+} as well as in form of less toxic As^{5+}). The only risk poses the spring of the mineral water Linhart because of the high radioactivity and high Fe, Cu, Cd and Pb contents. For this reason was the spring closed and it is not used for drinking.

The paste or rinse pH of sediments measured in distilled H_2O is ~ 5.3 and only very few samples account acid values (< 5.0). The measuring of the pH paste in the samples using solution of 1M KCl give similar values. It means that only several few samples show markedly acid reaction.

The surface water (and drainage water) as well as the groundwater water are substantially contamined predominantly by Cu, Fe and As. Both the As content and its speciation don't pose acute risk. The only risk poses the spring of the mineral water Linhart because of the high radioactivity and high Fe, Cu, Cd and Pb contents. For this reason was the spring closed and it is not used for drinking.

ACKNOWLEDGEMENTS

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RADIOMETRIC RISK MAPPING AND ASSESSMENT OF A URBAN ENVIRONMENT: THE PORTICI CASE STUDY (NAPOLI, ITALY).

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KEY WORDS: Radioactivity, Dose rate, Bequerel, Risk assessment.

INTRODUCTION

The objective of this study was to carry out a radioactivity survey on the whole territory of the village of Portici with the aim of assessing the radiometric risk to which the local population is exposed.

The territory of Portici, inside the Napoli metropolitan area and very close to the Mt. Somma-Vesuvius volcano, was divided by means of a regular grid in 61 square cells of 300 m x 300 m. 64 measurements were made: one for each cell plus 3 in the more crowded areas of the village (Via Leonardo da Vinci, Piazza S. Ciro, Piazzale Brunelleschi) (Fig. 1).

Furthermore, extra-measurements were also carried out on some street front-walls made up of volcanic material (blocks of Neapolitan Yellow Tuff and lava of Vesuvius) in order to estimate the radiological characteristics of these materials and to evaluate the contribution that they may have on the environmental dose rate.

MATERIAL AND METHODS

For the detection of radiation the AT6102 ATOMTEX spectrometer was used. This spectrometer has two radiation detectors installed inside: the Nal (Tl) and a Geiger-Muller detectors. The Nal (Tl) detector contains a highly sensitive crystal (with a size of 40 mm x 40 mm). It is used to investigate gamma radiation, research sources of radioactive contamination, measures the energy distribution of gamma radiation and identifies radionuclides. It also measures the dose rate of environmental gamma radiation.

In addition to the dose rate, the spectrometer is able to measure also the energy released by a radioactive (anthropic or natural) source within a measurement range of 50-3000 keV.

Focusing on the gamma radiation, at each measurement station we acquired:

- The emission spectrum
- the number of disintegrations per second emitted by the source (cps)
- The name of most active radionuclide at the measurement point
- The dose rates of the surrounding environment (Background) measured at an average vertical distance of 1.5 m from the ground.
- The dose rate at the ground, considered as the "radiating" source.

Furthermore, at each site the radiometric data were both georeferenced (latitude and longitude) by means of a GPS receiver and information about the nature of material paving the ground was annoted.

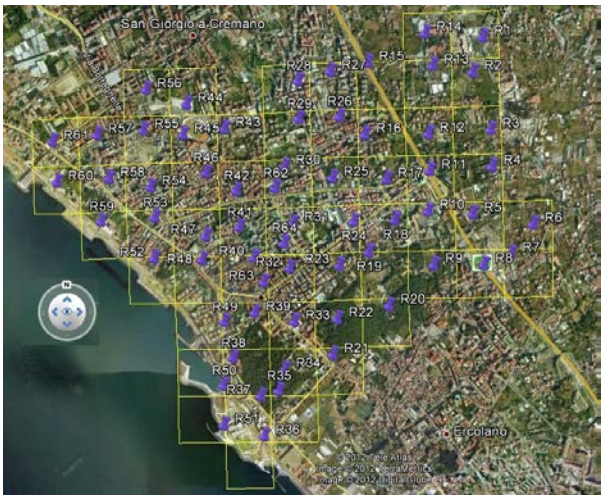

Figure 1 – Measurement site location map overlying the Google Earth® imagering of Portici.

RESULTS AND CONCLUSIONS

Data obtained by the radioactivity survey were elaborated by means of a GIS software to map the spatial distribution of total radioactivity (expressed as Bq) and of dose rate in the surrounding environment (Background) and at the ground (Expressed as µSv/hour or mSv/year).

Data were also spatially interpolated to generate a countinuous surface representing the spatial variation of energy (Fig. 2) and dose rates (Fig. 3 and 4).

Total radioactivity values measured across the village (Fig. 2) is generally in range with values generally measured in the whole vesuvian area (De Vivo et al, 2006).

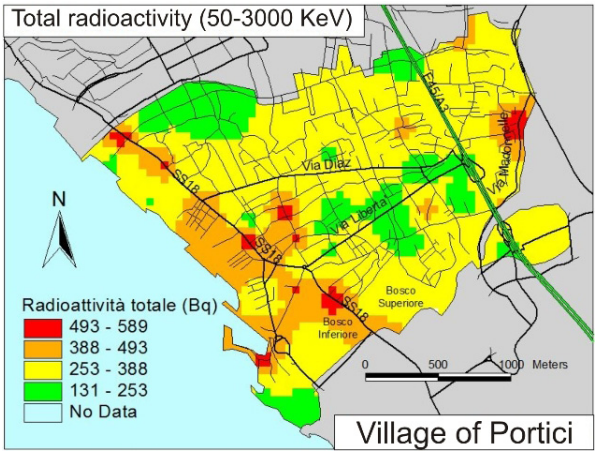

Figure 2 – Interpolated distribution of total radioactivity expressed as Bequerel (Bq).

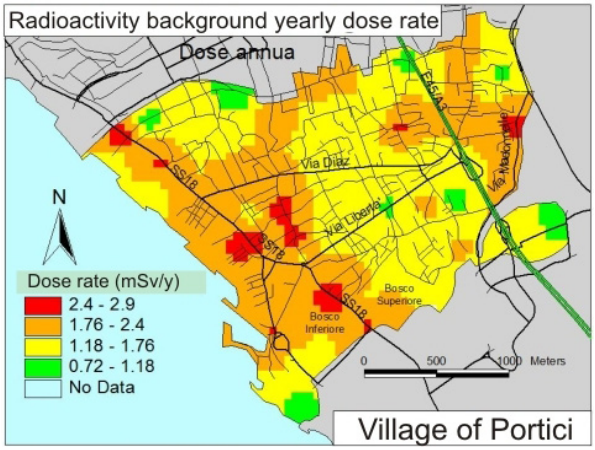

Figure 3 – Interpolated distribution of environmental (Background) radioactivity dose rates expressed a microsievert per year (mSv/y).

Background dose rates (Fig. 3) are generally below the threshold (2.4 mSv/a) established by Italian laws (D.Lgs. 230/95 and D.Lgs. 241/00) for humans (excluding exposed workers) except for some areas (along the SS18 road and in correspondence with the old downtown) where the presence of basaltic pavement could be considered as the main cause of the increase of the background dose rates up to 2.9 mSv/y.

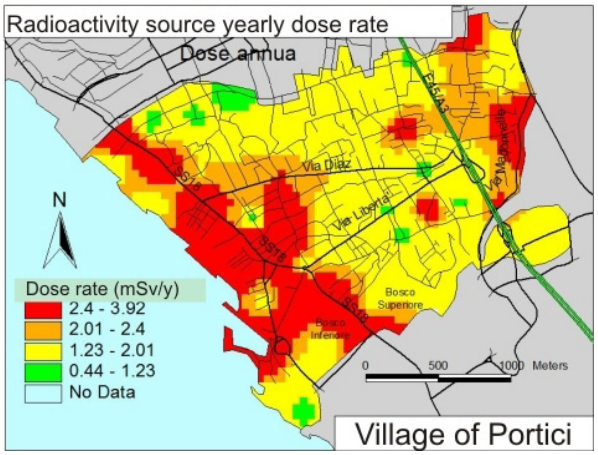

Figure 4 – Interpolated distribution of radioactivity dose rates at the ground (source) expressed on a yearly basis (mSv/y).

As expected, where pavement is mainly made of volcanic materials the dose rates at the ground (Fig. 4) is even more high. Values of dose rate at ground (source) overcome the 2.4 mSv/y threshold in correspondence with the whole route of the SS18 road and some densely populated areas of Portici.

In these areas, in some places, the dose rate is also higher than the 3.5 mS/y threshold (up to 3.92 mSv/y) which is considered definitively not acceptable for human health.

This condition, often ignored by local administrations, poses a serious risk specially for the safety of children which are more exposed to the radioactivity because of their stature and their natural inclination to play on the ground.

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THE RAMET PROJECT: A REGIONAL SURVEY ON HEAVY METALS CONTENT IN CULTIVATED SOILS FROM LOMBARDY

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KEY WORDS: heavy metals, soil, diffuse contamination, geochemical baselines, enrichment factors.

INTRODUCTION

Heavy metals in soils are always present at a background level of non-anthropic origin, their input in soils being related to weathering of parent rocks and pedogenesis. In the last decades, the natural content has been exceeded by the human input[1]. Currently, according to the EEA[2], contamination by heavy metals is one of the more relevant soil contamination problems from diffuse sources.

The Lombardy plain is characterised both by intensive agriculture and by a strong anthropic pressure exerted by industrial and urban settlements. The RAMET Project, which was completed by ERSAF and the University of Pavia in 2006[3], aims at investigating diffuse pollution in cultivated soils, at quantifying the input and the sustainability of agricultural practices, and at providing a sound basis for long term monitoring of the soil quality, according to EU indications.

MATERIALS AND METHODS

Approximately 1000 soil profiles were selected from the ERSAF collection, created in the last decades for the elaboration of the pedological map (1:50.000), in order to homogeneously cover the plain and the foothill areas of Lombardy. Heavy metals analyses (Cd, Cu, Ni, Pb, Zn and Mn) were conducted by aqua regia digestion and Atomic Absorption Spectrometry on two samples per soil profile, one representative of the A horizon (1456 samples), and the second (981 samples) corresponding approximately to a depth of 100 cm (generally belonging to a B or C horizon).

RESULTS AND DISCUSSION

The heavy metal concentration values were statistically treated in order to examine their variance. All metals show a log-normal distribution, both in the top and in the deep layer. Generally it is assumed that the upper layer contains most of the anthropic input, while the underlying layer essentially represents the lithogenic input with minor anthropic contamination. In our case, the top layer is often enriched in heavy metals, as indicated by a shift in the mode. Cu and Zn show an almost double mean concentration in the top layer compared to that in the deep layer, and Pb is about three times more enriched. The heavy metal concentration ratio between the upper layer and the underlying layer (Top Enrichment Factor or TEF) in soil profiles may be helpful in understanding the origin of the heavy metals content. A natural pedogenetic enrichment is unlikely to produce TEF values exceeding 2, while higher values point at an important anthropic input from the top. This strongly suggests, for Cu, Zn and Pb, an anthropic contribution. On the contrary, Mn and Ni display about the same content in the top and in the deep layer, likely indicating a mostly natural origin and distribution in the soil profiles [6].

Results were compared with the threshold values indicated by the Italian legislation (D.L. 152/06), both for residential and for industrial land use, the exceeding of which requires the establishment of a risk analysis procedure. It is generally observed that for residential land use, less than 5% of the analysed samples exceed these limits, with the exception of Pb. Very few soil samples are presently not in line for an industrial land use. On the contrary, numerous soils cannot be used for sewage sludge disposal due to their high Ni and Cd content, both in the top and in the deep layer. These results show that agricultural soils in Lombardy are generally not heavily impacted by heavy metal contamination.

Distribution maps were compiled for all metals, subdividing the metal content in content in classes according to both the natural variability and the regulatory limits[3]. As an example, the Pb distribution map clearly evidences that high concentrations are commonly found in northern part of Lombardy and around the main cities. Pb is strongly enriched in the top layer and anomalous concentrations readily disappear in the deep layer, pointing at an important anthropic input. In the literature the main input of Pb to the environment is the atmospheric deposition

of industrial emissions and road traffic. Indeed, northern Lombardy is one of the most important Italian industrial districts, where numerous smelters and steel production plants are located. In addition, the Torino-Venezia highway and the ring road of Milan are the main regional traffic axes, supporting exceedingly high road traffic since the 1970's. A similar Pb enrichment in the top soil is detected in the neighbouring Piedmont region[7,8] and attributed to the same pollution sources.

Spatial interpolation of the concentration data was performed using the geostatistical tool in Arcmap. This data treatment must be carefully considered in its predictive character. The presence of soil contaminants, indeed, is generally limited to the area where the contamination has occurred and cannot be readily extrapolated to the adjacent areas. On the other hand, this representation may evidence areas where anomalous values can more frequently be found. In addition, in the case of diffuse pollution due atmospheric deposition or peculiar land use districts, distribution maps can provide information about the origin of the contamination and the extension of potentially affected areas. As an example, the geostatistical map obtained by ordinary kriging performed over the Cu concentration in the top layer evidences a strong enrichment around the main cities (Milano, Bergamo and Brescia), in the eastern sector of the Oltrepo region (Pavia province), and in the plain sector of the Mantova province. Also in this case, the anomalous contents are not detected in the deep layer. In addition, the Cu content is strongly correlated to the Zn and Cd content, and the distribution maps for those elements are very similar.

These observations confirm a dominantly anthropic origin for Cu and associated metals. Among the areas where the anomalous contents are more frequently observed, only the southern ones are closely related to agricultural inputs. Indeed, the Oltrepo region is one of the most important vine growing areas in Italy, and the Cu input is due to the long-lasting use of Cu-based pesticides. This has already been evidenced both in Lombardy[6] and in neighbouring regions[7,8], and is a well known problem also in other European countries[9]. In the Mantova plain, Cu and Zn enrichment can be attributed to the long lasting agricultural use of manure[10] and sewage sludge[11].

CONCLUSIONS

Results indicate that, in cultivated soils from Lombardy, heavy metals contents are generally well below the regulatory limits, with the exception of Cu in vineyard soils. A strong enrichment in the top soil for Cd, Cu, Pb and Zn is observed, especially south of Milan and other urban areas, which can be attributed to an anthropic input. In these areas, the contribution of industrial and vehicular emissions is dominant. On the other hand, the Ni content often exceeds regulatory standards for sewage sludge disposal, but its association with Mn and its distribution with depth point to a natural origin.

The study highlights that, although an input from agricultural activities certainly exists, especially in vineyards and intensively cultivated areas, it is largely exceeded at the regional scale by the input due to industrial pollution and road traffic.

The results of this study are published in a report[3] and are collected in a database aiming to serve as a basis for long term monitoring of cultivated soil quality.

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COPPER ACCUMULATION IN VINEYARDS SOILS OF LOMBARDY AND ITS TRANSFER TO SURFACE AND GROUND WATER - A SURVEY IN OLTREPÒ PAVESE.

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KEY WORDS: soil, heavy metals, Cu-based pesticides, sequential extractions.

INTRODUCTION

The Plain of Lombardy is characterised both by intensive agriculture and by large industrial and urban settlements. The RAMET project aims to quantify the contribution of agricultural practices to diffuse pollution in cultivated soils. A regional investigation on contamination by heavy metals (HMs) was conducted on about 1000 soil profiles [1]. To validate the conclusions obtained in the regional investigation, we selected areas that correspond to the main agricultural land uses of Lombardy to conduct detailed investigations. Among these areas, the Versa Valley, in the Oltrepò region, one of the most important vine-growing areas in Italy, was selected to evaluate Cu accumulation in soils and its potential transfer to surface and groundwater.

MATERIALS AND METHODS

The Oltrepò area is a hilly area. Soils are mainly Calcaric- Cambisols, occasionally showing vertic features. Soils are fine textured (>30% clay), with alkaline pH, carbonate content around 15-25%, medium-high cation exchange capacity, and topsoil organic carbon ranging from 0.5 to 1.1%.

We excavated five soil profiles, in which soil was sampled at regular intervals of 20 cm. Soil samples were air-dried, crushed and sieved at 2mm, and analysed for the determination of the main physico-chemical parameters. Methods conformed to officially approved national procedures[2] and to ISO protocols[3]. HM analyses (Cd, Cu, Ni, Pb, Zn and Mn) were conducted by aqua regia digestion on 3-5 g of sieved soil, crushed to 0.5 mm[2]. Solutions were analysed by Atomic Absorption Spectrometry. Accuracy and precision were tested with repeated analyses of certified reference materials (CMR7001-CMR7004), within a 10% error range.

Sequential extractions were performed to establish the Cu chemical forms and the mineral phases responsible for adsorption and retention in soils, following the improved BCR procedure[4].

The Versa River suspended sediment was sampled during flood events in spring and autumn. Water samples were decanted, filtered and weighted to determine the amount of suspended solids per liter of water. Mineralogical and geochemical analyses were performed with the same analytical techniques used for soil samples. Dissolved Cu in groundwater was analysed in samples form some private wells in the Versa Valley; additional data are available from groundwater monitoring studies conducted by the Pavia Province, especially in the Po Plain sector.

RESULTS

HM depth profiles (Figure 1) evidence Cu strong enrichment in the top 40-60 cm, with values sometimes reaching exceptionally high levels (> 400 ppm) that substantially exceed regulatory limits for residential land use (120 ppm). The natural Cu concentration of these soils is lower than 40 ppm, as shown by layers at about 80 cm depth. Cu is associated with ubiquitous enrichment in Zn (up to 176 ppm in top soil with a deep layer concentration of about 80 ppm) and in Pb (up to 30 ppm in top soil compared with 5-10 ppm in the deep layer); sometimes Cd too is enriched in the top layer (up to 2 ppm with deep layer contents of about 1.2 ppm), as is Mn (although this metals displays high local variability in both layers).

The Cu input is due to the long-lasting use of Cu-based pesticides. Cu is associated with Zn and Cd, which are present as impurities in these pesticides. Dedicated profiles also showed topsoil enrichment both in Pb, which is possibly related to this metal's use as a stabiliser when pesticides are applied with helicopters, and in Mn, which is liberally added to control other pests. HMs are strongly retained in the top layer, since soils are rich in clay and display an alkaline pH. This association of this type of contamination to agricultural practices has already been evidenced, both in Lombardy[5]

and in neighbouring regions [6], and is a well-known problem in other European countries too[7].

Sequential extractions (Figure 2) indicate that Cu is strongly bound to soil minerals. More than 70% is only mobilised with a strong acid attack. Soil OC is responsible for the retention of approximately 20% in the top layer, while carbonates and Fe-Ox or Mn-Ox play a minor role.

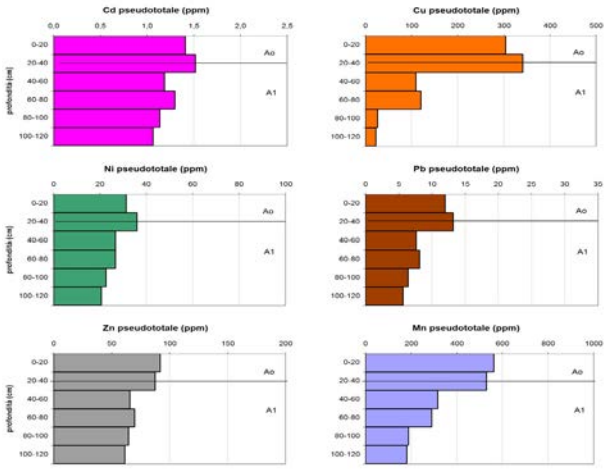

Figure 1: HMs concentrations with depth in a soil profile excavated in vineyard soils of the Oltrepò area.

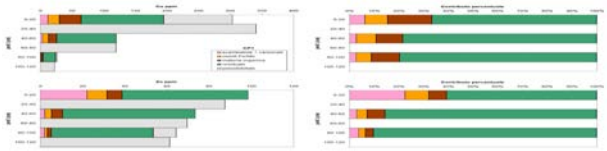

Figure 2: Cu speciation obtained by sequential extraction procedures.

During meteoric events, soil erosion is very active in the area, due to high acclivity and low soil permeability, and soil particles are transported to the rivers. The suspended sediment in the Versa River shows a mineralogical composition mainly constituted by carbonates (30%) and clay minerals (22%), corresponding to that of soils from the lower Versa Valley, but enriched in the finer grained minerals. Pseudototal Cu concentrations in solid transport are of the same order of magnitude as those detected in the top soils.

Cu concentrations in groundwater from the Versa Valley range from 25 to 70 ppb, while natural background values are in the range of 3-5 ppb. Concentrations higher than 10 ppb are also observed in groundwater from the Po Plain area bordering the Apennine range, between Casteggio and Stradella. Although below drinking water limits, groundwater Cu contents indicate a transfer to the aquatic environment. Since the aquifer located in the Plain sector is mainly recharged by infiltration of Apennine river water through the alluvial deposits at the Valley outlet, it is likely that the Cu transfer to groundwater is operated by infiltrating river waters.

CONCLUSIONS

In vineyard soils, Cu accumulation occurs in the top soil layer. Agricultural practices in hilly areas may enhance the natural soil erosion processes and run-off may transfer the contamination to the surface water network during flood events. While in soils Cu is strongly bound to minerals and scarcely bioavailable, during erosion and transport the finer particles are favoured. Therefore it is likely that, in surface water, the Cu bioavailability is enhanced. A Cu concentration higher than background values is evidenced in groundwater from the Versa Valley and in the phreatic aquifer of the Po Plain sector, the latter being recharged by surface water through the alluvial deposits at the valley outlets.

High Cu and Zn accumulation in vineyard soils stresses the urgent need to reduce the input of these HMs by changing the composition of pesticides[8], and cost effective approaches to remediation (e.g. phytoremediation) tested [9].

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GEOCHEMICAL CHARACTERISTICS OF THE GRANITOID COMPLEX OF BOROUJERD, NORTH-WEST OF IRAN, FROM THE POINT OF BENEFICIATION

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Keywords: Boroujerd , REE,I-type granite, continental arc.

MINING AND NATURAL AGGREGATES RESOURCES

ABSTRACT:

The study area is located in north-west of Iran closed to Boroujerd belongs to the Sanandaj-Sirjan Zone (SSZ) in the north-western of Iran. It is elongated and parallel to the prevailing schistosity in the metamorphic rocks by the trend of NW–SE and consists of quartz diorites, granodiorites, monzogranites and acidic dikes (aplites and pegmatites). This Complex is of sub-alkaline affinity; belong to the high-K calc-alkaline series, metaluminous to weakly peraluminous, and display features typical of I-type granites.

Trace and rare-earth elements distribution patterns for the Astaneh granitoid rocks indicate a distinctive depletion with respect to primitive mantle in Nb, Eu, Sr, Ba, P and Ti relative to other trace elements and a greater enrichment in LILE compared to HFSE. These geochemical characteristics suggest that these rocks derived from a crustal source.

The granitoid Astaneh has geochemical characteristics typical of arc intrusives and plot as volcanic arc granites on various discriminant diagrams. This granitoid is typical representatives of a volcanic arc environment, spatially related to an active continental margin. Probably, it is the result of the subduction of Neo- Tethyan oceanic crust below the Iranian microcontinent. All available data are compatible with the idea that these rocks represent the products of convergent margin processes during the Mesozoic.

INTRODUCTION

The tectonic history of the Tethyan region has been studied by many authors [4],[10],[2],among others. From Late Precambrian until Late Paleozoic time, southeastern Turkey, Central Iran, central Afghanistan, southern Pamir and Arabia were part of Gondwana, separated from the Eurasian plate by the Hercynian Ocean called Paleotethys. In the Middle to Late Triassic, during the closure of the Paleotethys in the north, rifting in the continental plate along the Zagros thrust zone occurred which resulted in the opening of a new ocean called Neotethys. During Triassic–Jurassic time with the closure of Paleotethys, the oceanic crust of the Neotethys started to subduct beneath the Eurasian plate. This led to an Early Cimmerian metamorphic event, recorded in the southwest Sanandaj-Sirjan Zone [4],[7] associated with Upper Triassic emplacement of intrusive bodies [9] within this zone. Finally, closure of Neotethys and collision of Arabia and Central Iran took place during the Neogene time [4]

The Sanandaj-Sirjan Zone, which is the host of the Boroujerd granitoid complex, has a length of 1500 km and a width up to 200 km from northwest to southeast of Iran. and separates the stable Central Iran block, from the Afro-Arabian plate .

The Boroujerd complex is a NW-SE trending body covering an area of 600 km2, approximately 40 km in length and 6 Km in width, which lies between 33° 38’ - 34° N and between 48° 45’- 49° 20’ E(Fig.1).The Astaneh area is characterised by the predominance of metamorphic rocks of Jurassic age [3] and the presence of the Boroujerd huge granitoid complex.

The Boroujerd Granitoid Complex is made of three units including quartz diorite, granodiorite and monzogranite [1] The geochemical characteristics, mineralogy and petrography of these rocks are comparable with the typical I-type granites. The Complex belongs to metaluminous to slightly peraluminous, a high-K calk-alkaline series, and displays geochemical characteristics typical of volcanic arc granites related to an active continental margin. This conclusion is in good agreement with the general model of Shahabpour[11]which assumed that the Sanandaj-Sirjan calc-alkaline magmatic arc formed over a high angle subducting

oceanic slab in the Neotethyan subduction zone during Late Triassic to Late Cretaceous time .

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NDSKIS – A WEB BASED KNOWLEDGE MANAGEMENT SYSTEM FOR MARINE SCIENCES AND INTEGRATED COASTAL ZONE MANAGEMENT

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KEY WORDS: Knowledge Management, Marine Science, Coastal Zone Management, Wiki, WebGIS, SDI, Open Source

BACKGROUND

In the modern scientific community web portals are an important tool for the access to data and information on spatial distributed features and environmental conditions. Many research and development projects focus on the development of systems dealing with a sophisticated assess to the huge amount of data in the field of integrated marine and coastal zone management. So far it is mainly the transfer of metadata and geospatial data via map services as required by the European Union (EC, 2007). Official data collected and provided by public authorities for example are linked to observation sites and conservation areas or environmental conditions. Thus, a transfer of knowledge about used methods and used software, or intermediate analysing results, for example from measurements of monitoring networks which can be processed with different geo-statistical methods, is lacking.

Scholars use existing data and generate new knowledge about different methods, but they also develop tools such as plugins for existing software. Methods and data are mainly made available through various different media. This causes losses of information and knowledge, for example of preliminary results from analyses that may be of interest for other scientists (Roosmann et al., 2011). Web portals such as the portalU or the North and Baltic Sea Coastal Information System (NOKIS) are systems that have been developed for the storage of and requests for metadata on coastal information according to ISO 19115/19119 standards (Kohlus et al., 2006). The MDI-DE is an infrastructure that provides services to set up access to metadata but also the data itself. This is especially a problem in the marine science, as data can be used in a hundred of different formats, where the spatial relation is of less importance than the temporal reference (Kazakos et al., 2006). Whether and how data is accessible, depends on the decisions of the providing institution.

OBJECTIVES

The NdsKIS is a web portal that focuses on three objectives. One goal is the establishment of a knowledge management that allows the expansion of project-specific information in a broader context. Goal of the system is to provide access to knowledge that can be beneficial for various user groups. It is also a goal to manage the information that already exist in heterogeneous form (data, methods and software) in order to make it interoperable useful. The third goal is to connect knowledge by linking information inside the NdsKIS to allow access to complementary knowledge on specific topics.

Existing platforms provide more or less expert system for the professional staff of marine science oriented institutions but have limited accessibilities for “simple” users. Data located via metadata often are not for free and no regulations on how to access the data itself are given. How and in which form the data provided by services according to standards of the OGC and INSPIRE will be accessed is still unknown or depends on the providing institution.

The NdsKIS is rather similar to a wiki and offers a free and direct access to information about projects, methods used for very specific questions, (geo) data produced and software products. Authentications are necessary only for the users that provide information and media; all the rest have free access.

CONCEPT AND METHODS

The information on methods, developed software products and (geo)data is included into the NdsKIS by the users. They enter information into one of the categories *data*, *methods* or *software;* data to share has to be uploaded. The information can be arranged according to the topic groups (a) Climate & climate change, b) coasts & coastal protection, c) fishing & aquaculture, d) environmental protection, e) shipping, f) offshore industry, g) risk & accident management, h) marine planning & ICZM). The workflow of the handover (Fig. 1) demands a short abstract of a project that has to be entered at the beginning. This abstract will inform other users

about the context of the following information on methods, data or software. Then the categories can be filled with an unlimited number of records. The user has to enter a general introduction followed by detailed information about the software, data or methods as well as support information. With the last step the upload accomplishes the submission.

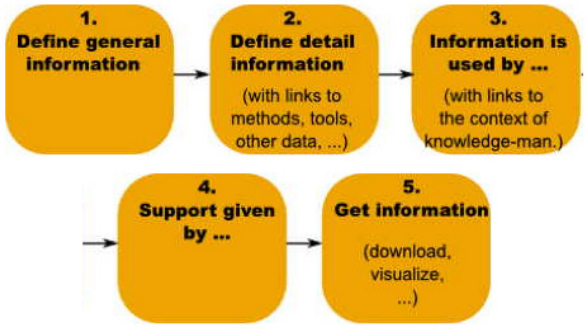

Figure 1 – Workflow of information entry.

To ensure a general quality of the contributions, selected experts are responsible for the thematic groups, being able to administer the respective inputs and to manipulate them.

The NdsKIS also contains the GeoCMS HotSpot which is implemented into the backend to provide the integration of scientific geo data in a standardised way and to make them available via metadata and Web Map Services (WMS). This allows the integration into existing SDIs and simplifies the query for specific spatial data, such as a map or metadata. On the other hand, there are also Web Processing Services that can be utilised via HotSpot to process spatial data and analysis by standardised methods (Aden, 2011). Another part of the concept is the use of open source software. This concerns both the production of the platform as well as the processing and presentation of selected resources such as geospatial data.

In order to realise the NdsKIS, the Open Source Content Management System CMS made simple (CMSms) was used. This Software is developed in PHP and can be used with the database management system PostgreSQL and MySQL. CMSms is a modular designed system that supports the integration and installation of specifically programmed modules and user-defined tags. A number of modules such as “Frontend User” and “Custom Content” can be used for administration of information and access rights issues. The backend consists of the database management system PostgreSQL with PostGIS for handling spatial data, the UMN MapServer installed for providing WMS, GeoNetworks for managing metadata and GRASS GIS for the use and delivery of Web Processing Services.

CONCLUSIONS

NdsKIS is a social software enabling users to examine knowledge and information about a specific locality, discuss it and pass it on in a form adjusted for specific groups of users. The system also supports the idea of Integrated Environmental Modelling (IEM).The goal of IEM is the interpolation of information on local ecosystem behaviour and the extrapolation and transfer of results to other locations or to different scenarios (Kraft, 2011).

Various data and method descriptions of different projects will be included into the NdsKIS now. In the next steps experts have to be addressed which should be responsible for the topic groups. They should have a look at the contents of the submissions of other users.

The marine sciences need systems like the NdsKIS to share specialised knowledge about methods and generated data of the marine environment with standardised methods.

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PREDICTION OF SURFACE SUBSIDENCE DISPLACEMENT IN URBAN AREAS OF DONBASS ON THE BASIS OF THE SPECIAL-PURPOSE GEOINFORMATION SYSTEM

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KEY WORDS: geoinformation systems, geological structures, surface subsidence displacement and deformations.

INTRODUCTION

Experience accumulated worldwide shows that for solution of the problem to control conditions of unstable rock mass it is advisable to employ geoinformation systems (GIS). The article gives a case study for employing geoinformation system GeoMark to predict surface subsidence displacement in urban areas of Donbass.

PROBLEM FORMULATION

Donetsk region (Donbass) is characterized not only by high population density but also by the factor that coal mining operations are being conducted directly under the territories of Donetsk City and other inhabited localities. These operations have a number of negative impacts. Underground mining of coal seams results in disturbance of steady state of rocks and their movement which are manifested in the occurrence of areas of ground subsidence (see Fig. 1). Some points move non-uniformly in consequence of which vertical (bending, curvature) and horizontal (stretching, squeezing) deformations as well as cracking, benches, sinkholes occur. As a result, structures located in mining-affected zones are under loads and are being damaged. The impacts of repeated underground mining can range from ground water level rising to underflooding of basements and natural pollution.

EMPLOYMENT OF GIS GEOMARK

In order to compute ground surface movement and deformation, to evaluate degree of impact of this factor on conditions of buildings and structures UkrNIMI Institute uses GIS GeoMark of its own making that enables:

- to generate 3D models of surface relief, coal seams, tectonic faults, mine workings and other geological and man-made objects of mine fields and open pit mines;
- to predict or calculate state, composition and properties of rock mass in any point of the Earth's slice within mine field;
- to calculate and analyze variations of different parameters in depth of rock mass obtained on the basis of *in situ* geological, geophysical, geochemical observations and other types of observations.

The idea implemented in our GIS is that computation of surface subsidence displacement and deformation is made on the basis of 2-D and 3-D models of rock structures and mine takes where mining is in process.

Algorithm for computing ground surface deformations is supported by the regulatory document [2] worked out in UkrNIMI Institute, NAS of Ukraine.

The boundaries of mine subsidence impact on the surface are determined by reference to the shape of mine goaf, taking into account angles of rock occurrence and movement. Direction and speed of coal winning are of no importance in the computations. The obtained subsidence and deformation data related to old mine works are being summed with subsidence and deformation data related to new mining.

The results of computations are displayed at the layout that makes possible to find buildings and structures located in mine subsidence zones (see Fig. 2). Hazardous situation is being analyzed for each of the found objects with the aim to determine hazardous deformations induced by ground movement.

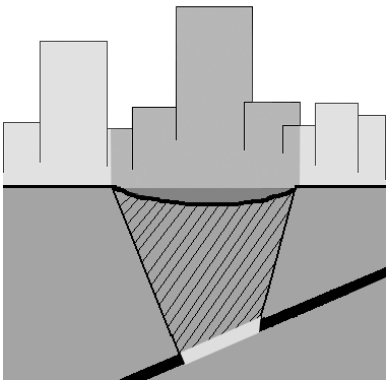

Figure 1 – Schematic representation of the impact of coal winning on ground surface condition.

Computation algorithms are based on the procedure for prediction of estimated and possible surface displacements and deformations [2] that is used in the following mining-geological conditions:

- Monoclinal folding of rocks because of the absence of discontinuities in the zone of effect of mine workings.
- Series of pitching seams in the Central part of the Donetsk Coal Basin.
- Existence in the zone of effect of mine working of discontinuities that do not alter the nature of displacement and that increase magnitude of displacements and deformations no more than by a factor of 1.3.

Of essential importance are several features of geoinformation system GeoMark in making computations: firstly, a three-dimensional representation of topology and geometrical description of natural, geologic and industrial objects, secondly, employment of specialized object classification. Mine and surface models must include all types of mine workings, shafts, wells and holes, hazardous zones, geology, lithology and so on. Besides, mining plans represent those surface objects that can be affected by mining: industrial buildings and structures, rivers, ponds, railways, transport roads, power lines, pipelines and others. As a result, even models of small mines contain up to 20,000 – 25,000 objects and more. In cases of large mines the number of objects that can be employed in solving such problems is up to 70,000. And the number of objects for the largest mine in Ukraine (A. F. Zasyadko Coal Mine) exceeds 300,000. This information needs classification and analysis. The GIS allows using different classifications for objects, properties and parameters being developed in the various branches of science and industry.

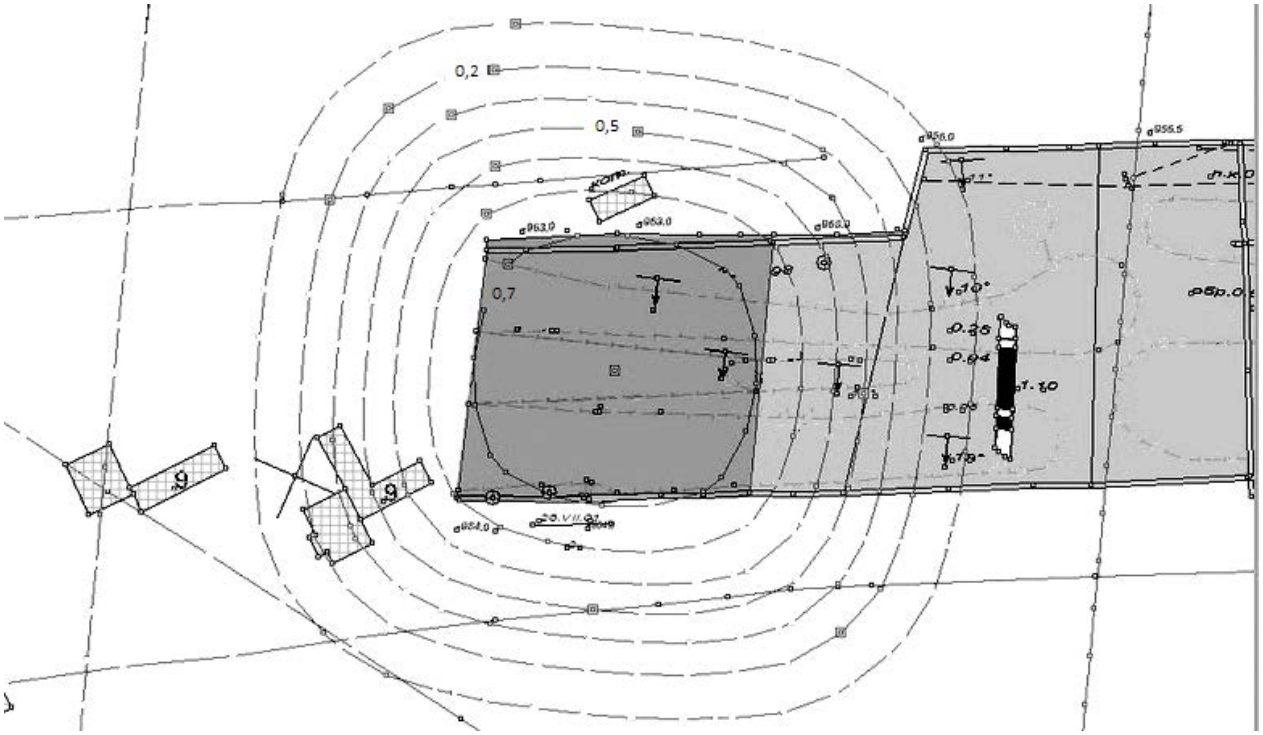

Figure 2 – An example of computation of surface prediction deformations near a housing estate of Donetsk under which a longwall is being mined. A fragment of integrated electronic plan for A. A. Skochinsky Coal Mine is shown which was obtained as a result of operation of geoinformation system GeoMark. Layout of longwall, surface buildings and structures and isolines for values of predicted deformations are shown.

ACKNOWLEDGEMENTS

We are grateful to Tatyana Skopich for her assistance in preparing and translating this article.

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FROM TRADITION TO IT - BUILDING A GEOGRAPHIC INFORMATION SYSTEM OF THE EUROPEAN QUATERNARY GEOLOGY (IQUAME)

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KEY WORDS: Quaternary geology, GIS, map, Europe

The Quaternary period is an essential part of geology: it consists is the uppermost layer of the geological subsurface and thus is in strong demand for many uses: it provides sand and gravel for builders, contains groundwater resources, supplies building ground for houses, streets, landfills, industrial plants and there are many uses more. It is also an interesting part of geology as it is the youngest geological period and includes the time when human life started to exist and large parts not only of Europe were covered with an immense glaciers.

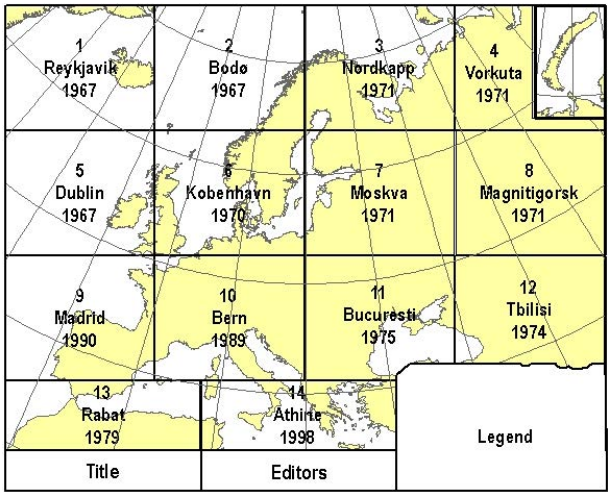

Figure 1 – The 14 map sheets of the IQUAME 2500 paper edition (BGR & UNESCO, 1995)

Thus, in 1932 at the 2nd Congress of the International Union for Quaternary Research (INQUA) held in St. Petersburg, the idea was discussed to represent the main Quaternary features for the entire of Europe on a map. In 1995, finally, the first edition of the International Quaternary Map of Europe in the scale 1 : 2500 000 scale was completed in 14 map sheets as a work of international cooperation (Figure 1). It was compiled by the Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources, BGR) with strong international participation and in close cooperation with INQUA. The traditional paper map was jointly published by the BGR and UNESCO. For the International Year for the Planet Earth (IYPE) a second paper edition on only one map sheet was produced with a generalized legend and a reduced scale: 1 : 5 Million (Figure 2)). This map was presented at the 33. International Geological Congress in Oslo, together with its twin map, the International Hydrogeological Map of Europe, also reduced in scale (BGR & UNESCO, 2008) and Geological Congress

With the development of Information Technology (IT) in the last third of our last century some factors that constrained our predecessors do not longer any longer. Modern computing systems (databases, Geoinformation systems, the Internet) allow us to store, retrieve, combine and present far more information and knowledge about an area than we could ever display on a 2-dimensional piece of paper. Following that development BGR started the IQUAME 2500 project to rework and digitize the paper map and to build a modern Quaternary Geological Information System (IQUAME GIS) of Europe. The aims are that users will be able to retrieve, combine and use spatial information on the Quaternary geology of Europe without any issues and discrepancies at political boundaries.

At the XVIII INQUA congress in Bern 2011 the initiating Workshop for the IQUAME 2500 took place. 14 participants from 12 countries in Europe participated and declared their willingness to contribute concrete data of their country and/ or to work in the scientific advisory group. The group agreed that the IQUAME GIS must contain information about:

- Lithology
- Age (according to the 2011 ISC Chart) as mandatory with the option to add regional stratigraphic subdivisions
- Genesis (possibly also from international IUGS-CGI vocabulary and/or from the former IQUAME
- Glaciation maxima,
- Loess coverage, and other details.

The Quaternary information will be made compatible with the requirements of the EC INSPIRE Directive (2007) and combined with the GIS of the 1: 5 Million International (pre-Quaternary) Geological Map of Europe and Adjacent Areas (IGME 5000, Asch, 2005) so that the information of both layers can be combined, selected and cross-referenced (Figure 2).

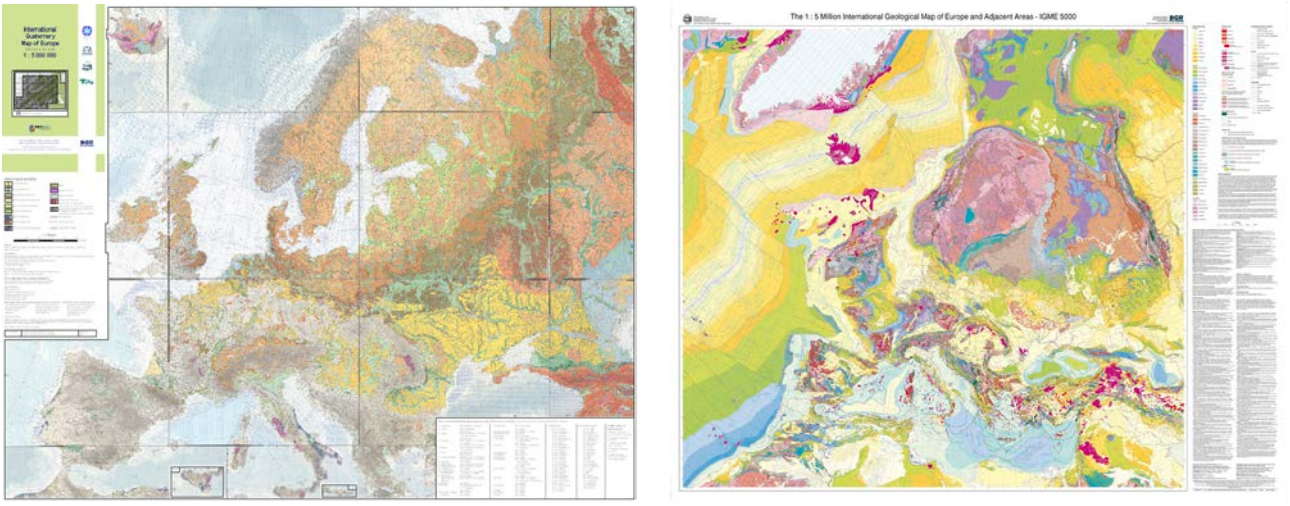

Figure 2 – International Quaternary Map of Europe, reduced to the scale 1 : 5 Million, BGR, 2008 (left) and the1 : 5 Million International Geological Map of Europe and Adjacent Areas (right).

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THE GEOMAGNETIC MAPPING OF THE ROMANIAN TERRITORY IN THE CONTEXT OF THE WDMAM PROJECT

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KEY WORDS: large-scale composite maps, geomagnetic anomaly, secular variation, space-time consistency, Romania.

GENERAL CONSIDERATIONS

The World Digital Magnetic Anomaly Map (WDMAM) project (e.g. Korhonen et al, 2007) represents a challenging initiative to synthesize the huge amount of near-surface geomagnetic observations in attempt to build up a global geomagnetic model with a superior resolution to models provided by satellite data.

The project found the Romanian scientific community incompletely prepared. Two national geomagnetic maps (ground and airborne) of Romania were available at the time, but none could satisfy the WDMAM requirements.

THE ROMANIAN GROUND VERTICAL COMPONENT GEOMAGNETIC MAP (GVCGM)

It seems that former versions of the WDMAM over the Romanian territory had used a magnetic dataset as derived from the GVCGM. The GVCGM (Airinei et al., 1983) represents a compilation of vertical component geomagnetic observations extracted from various ground magnetic surveys conducted by prospecting teams during about 30 years. But, as it has been demonstrated (Besutiu, Besutiu, 1994; Besutiu, 1999), this map has some major shortcomings.

1) **Poor data coverage**. Overall, the observations were conducted along the access ways (e.g. roads, paths) providing insufficient detail. Location of data points along the deep valleys in high magnetic topography may also distort the images obtained. That is the case in the East Carpathians Neogene Volcanism, where the ground map reveals negative anomalies while airborne conducted survey pointed out geomagnetic highs.

2) **Time inconsistency**. In the absence of a geomagnetic reference network, significant distortions due to the secular variation (SV) influence were revealed.

3) **The inappropriate geomagnetic reference model**. The use of a local geomagnetic reference model based on second order polynomial expression) did not allow taking into consideration the altitude of the data points. That generated, among the others, an artificial regional geomagnetic anomaly low over the Carpathians (the highest topography) due to the extraction of on overestimated reference field.

THE AIRBORNE GEOMAGNETIC SURVEY

More appropriate conditions for the integration within WDMAM project have been offered by the geomagnetic dataset provided by the regional airborne geomagnetic survey. During the time-span 1962-1968 a special team of the Romanian exploration company "PROSPECTIUNI S.A." performed an airborne survey providing a much better coverage than ground observations. Survey lines were systematically conducted at 1000 m or 500 m apart within flight panels of constant altitude ranging between 300 m and 2900 m above the sea level. Technical limitations did not allow at the time the achievement of a space-time consistent geomagnetic model for the whole territory. In fact, for about 40 years, the national airborne geomagnetic map looked like a puzzle of hundreds of small maps, each corresponding to a flight panel performed at a specific geomagnetic epoch and flight altitude. Besides as in the case of the GVCGM, a local model of the geomagnetic reference field (neglecting both the survey epoch and the observations altitude) had been employed for computing the geomagnetic anomaly.

The DYGEF project was especially run for providing space-time consistency to the previously obtained airborne geomagnetic data. As one of the main problems was the time inconsistency in the previous data, a special geomagnetic reference network covering the whole territory was designed and achieved in order to provide a consistent set of data to which all previous observations to be referred to. After reaching time consistency, space consistency was provided through the upward continuation of the geomagnetic anomaly as obtained in each flight panel to 3000 m (that is slightly above the highest altitude of the magnetic surveys).

THE ROMANIAN CONTRIBUTION TO WDMAM

Folowing the achievement of the above-mentioned space-time consistent model, a geomagnetic grid of total intensity scalar of the geomagnetic field for Romanian territory valid for 2007.5 epoch at 3000 m altitude has been provided to WDMAM project in order to replace

the dataset derived from GVCGM. By comparing this contribution to the previous one some certain improvements have been revealed, among which mention should be made to the following aspects: providing space-time integration to magnetic anomaly within the global context by using IGRF 11 / WMM 10 model; (ii) overall increase of the geomagnetic anomaly within high altitude areas by computing the reference field at the flight elevation; (iii) more accurate outlining of anomalies especially over magnetic topography through an appropriate data coverage (e.g. see how negative effects over Neogene volcanics in East Carpathians vanished).

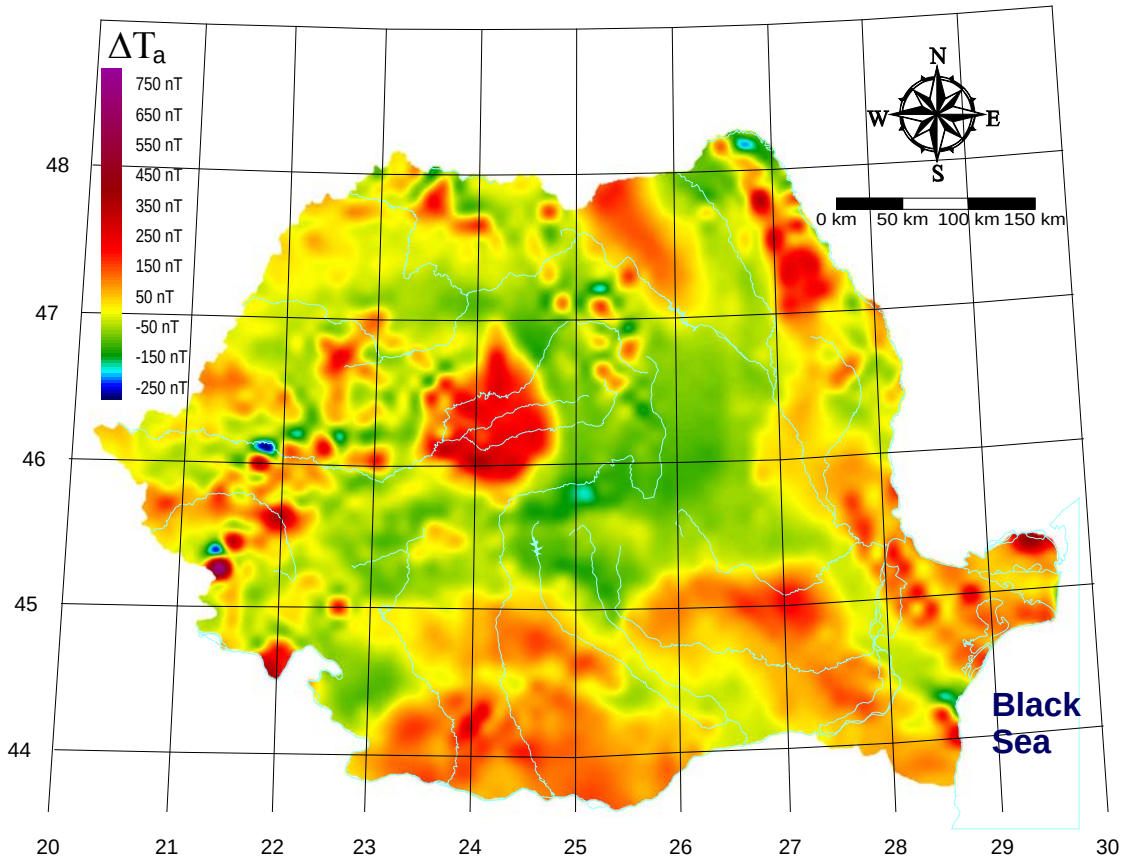

Figure 1 – The total intesity scalar geomagnetic anomaly over the Romanian territory at the 3000 m altitude for the geomagnetic epoch 2007,5. Stereographic projection: STEREO 1970. Height reference system: Black Sea 1975. Geomagnetic reference field model: WMM-10. Grid cell size: 10 km x 10 km

CONCLUDING REMARKS

A space-time consistent geomagnetic model for the Romanian territory based on the re-processing of the previously gathered data was obtained, and a homogeneous dataset valid for the geomagnetic epoch 2007.5 and the flight altitude of 3000 m above the sea level has been released as a Romanian contribution to the WDMAM project. Therefore, some artefacts present within former WDMAM version over Romania due to the inconsistencies in the inappropriate dataset the project had benefitted may be removed.

ACKNOWLEDGEMENTS

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NEW GIS-TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT AND NATURE FRIENDLY MINING

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KEY WORDS: geology, forecast of mineral deposits, geoinformatics, integrated analysis of heterogeneous data, GIS, GRID-technologies

INTRODUCTION

Strategy of the sustainable development includes providing efficient nature-friendly policy of exploitation of resources meeting social standards and maintaining ecological balance. So, one of the main factors of it's realization is environmental monitoring of exploration and exploitation of mineral, energy and other natural resources.

The primary tasks of environmental monitoring is data gathering, storage and processing for estimation of current ecological situation, forecast of possible negative changes in it and operative information support of decision-making processes. Character features of environmental monitoring are heterogeneity of forms and digital formats of the source data, large volumes of the processing information, lack of mathematics describing studied natural and technogenic processes. Successful solution of these problems can be obtained only by combination of all tools of information technologies: Relational Database Management System (RDBMS), Geographical Information Systems (GIS), Internet-based distributed computing framework, analytical procedures including mathematical and heuristic algorithms.

Laboratory of Geoinformatics, VNIIgeosystem, has accumulated wide experience in development of methods, techniques, and solutions for information and analytical support of the geological, ecological and nature-use studies. Our studies are focused on elaboration of methodology and original algorithms of integrated analysis of the data about studied processes of objects, and development of intellectual user interfaces providing the each stages of the process - from data acquisition, georeferencing, data integrity and quality assurance, through multi-level analysis to pre-print of hard-copies of published maps or decision-making support systems for mineral exploitation and environmental protection management. We would like to present our techniques and home-brewed software packages for nature-use problems.

SUPPORTING OF GEOLOGICAL STUDIES

Software package GIS INTEGRO is successful used for geological studies: forecast of mineral deposits, 3D modeling and economical evaluation of reserves, processing and interpretation of geophysical data, problems geological cartography.

GIS INTEGRO includes GIS-viewer and editor for digital mapping with support of the main vector and raster formats, wide set of algorithms and rich tools for analytical processing of geo-data from all sensing levels of the Earth:

interpolation and extrapolation procedures

structure, texture and morphological analysis of grids and images

data quality analysis

pattern recognition and zoning by a set of spatial characteristics

3D modelling

Combining the components of GIS INTEGRO under subjective user interface we develop software packages for different environmental researches:

INTEGRO-GEOPHYSICS for processing and interpretation of geophysical data allows for computer support of geophysical data processing based on integration and complex analysis of geophysical data along regional profiles, potential fields and additional geological information for studied area.

INTEGRO-FORECAST provides automatisation of prognostic tasks for all stages of geological exploration of mineral resources: identification of perspective areas, division of these areas by genetic types of minerals, ranking by perspective ness, economical evaluation of reserves.

INTEGRO-GEOLOGY provides computer-aided compilation and updating of geological maps with the use of map generalisation techniques. The implementation is based on the integration and analysis of large-scale geological maps compiled by different authors, field geological surveys, geophysical, and remote sensing data.

INTEGRO-RESERVES EVALUATION-GST provides computer support of reconstruction block solid-based models based on prospecting data. Technology realizes new approach to the problems of 3-D modelling, evaluation and monitoring of reserves, mine design and economic tasks.

Presented modules are joined as application-specific program packages under GIS INTEGRO (reg. number № 2003610063). Today further development of analytical functions and interfaces of the system are planned. One of the most interest directions of these works is adaptation of the system to the distributed processing and data storage with the use of GRID technologies. Such approach is very actual for nature-use problems because their solution requires operative processing of large volumes of heterogeneous information. The studies in this field are started in collaboration with International University of Dubna.

TOOLS FOR DATA STORAGE AND MANAGEMENT

Vast volumes of source information used for solving of environmental tasks requires of development of the tools for storage, systematization and operative analysis of the monitoring data. At the framework of this problem we developed original software platform allowing for quick and effective construction of multi-tier computer information and analytical systems (IAS). The presented platform provides full visual design of client applications without any coding and powers of modern relational databases. Such approach allows to minimize time, financial and professional resources during developing the programme systems.

The key features of the platform are as follows:

- complete visual approach to the client applications design without the need of the writing of the program code
- common approach to the creating of the client desktop and web applications
- advanced tools for the aggregation, processing and analysis of the heterogeneous data
- open architecture for the integration between IAS Constructor and the third-party applications, extendable plug-ins support
- spatial data built-in support and integration with the third-party geoinformation systems (GIS)

The platform was successful used for development of applied information and analytical systems in different fields of nature-use management, such as:

- monitoring of the groundwater state and account of resources and reserves for federal and territorial levels;
- monitoring of licensing of mineral deposits exploration and mining;
- monitoring of oil and gas fields exploration and exploitation.

SITUATION MANAGEMENT SYSTEMS

The most important component of information support of decision-making in nature-use tasks is developing of systems of situational management representing a complex of specially organized workplaces for personal and collective analytical work of the head or group of heads. The primary goal of such system is support of decisions acceptance on the basis of visualization and the profound analytical processing of the information about studied object. Because most of the nature use processes and activities are spatially located, the geographical information systems become the important part of the situation management. The GIS provides not only visualisation of geographically registered data and related spatial analysis functions, but also acts as the command envelope controlling operation and interaction of other subsystems.

For computer implementation of such approach we developed Multi-purpose Geoinformation Server (MGS). The system includes three main blocks: metadata manager, Internet-GIS with rich tool-set for quality presentation of the spatial data and geo-modelling subsystem for analytical processing of multi-level sensored information. We developed MGS with the heavy emphasis on the international geospatial processing standards (ISO, OGC, CGI) and the free and open-source software.

With the use MGS tools we realized several projects for different management levels: governmental organization, local municipalities, mining companies. The most interest application of MGS for nature-use problems is Situation Centre of Ministry of Natural Resources of Russian Federation. Integrating different sources data centre collects operative information about emergence events in nature-use management. Daily chronicle of emergencies is public on the web-site of the Ministry with localization on the situation map for identification of geographical objects in proximity of this point and detailed information about the each emergence.

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THE WEB-GIS PORTAL IN THE GEOLOGICAL SURVEY OF ITALY AS A PREVENTION TOOL, AND KNOWLEDGE OF THE AREA

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KEY WORDS: standard, metadata, geoportal

The Geological Survey of Italy has realized the SGI Portal in order to disseminate the data and geological maps, available at *http://sgi.isprambiente.com/geoportal*.

A series of web tools are available to provide to the different users (beginners and experts) the data stored in multiple databases created by the Survey.

The web tools allow easy and complete access to geological data and metadata and to geothematic maps, that constitute the basemap for knowledge of territorial phenomena, according to the INSPIRE directive.

The set of web tools has been elaborated for users of different level (i.e. useful knowledge of web-based gis, google-map or web-GIS applications dedicated for specific topics such as landslides or subsidence phenomena), up to the "GeoMapViewer" consultation (figure 1), with which you can build query and make overlay.

The technological growth increased the need of *specific web 'geo-viewer' to satisfy the several graphical interfaces, to share geographic information and analysis tools.*

In particular the Portal is firstly a standard metadata catalog (descriptive documents of databases, web services and consulting data visualization, web-GIS applications and related documents such as reports, surveys, projects, static maps, dictionaries and other).

After *a first version of the GeoMapViewer using technology flex (Adobe flash builder), it was necessary to prepare a new version for two main reasons: to provide an application more easier to use and more tools, including the analysis, on the bases of extensive feedback from users.*

The GeoMapViewer is made with Adobe Flash technology 4.5, using specific libraries of ESRI flex in version 2.4.

On this platform has been performed a specific development for making available to the user the data contents organized to thematic widget, in order to provide advanced query tools, and for giving the opportunity to the user to load external data.

The new viewer also displays the data into some thematic domains, in order to facilitate the consulting and researching.

Moreover, recently, the great deal of data available to the user was further increased from a selection of raster hydrogeological maps of the Italian area. All of the data available in the Portal and in the viewer represent an important element in support of knowledge of the environmental phenomena and a useful tool for the professional and the citizen.

Figure 1. GeoMapViewer version 2. It represents the integrated tool for displaying all data in the Geological Survey of Italy.

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EUROGEOSOURCE, CLOUD TECHNOLOGY BRINGS DISTRIBUTED WEB GIS SYSTEMS TO ANDROID

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KEY WORDS: cloud computing, data harmonisation, distributed web system, INSPIRE, mineral resources, energy resources.

INTRODUCTION

A central problem Europe is facing today is to secure its energy and non-energetic minerals supply. EU authorities currently compile their long-term policies regarding the need for oil, gas and minerals, including estimates of the required import, from national reports contributed by the member countries. These reports contain only generalized information regarding reserves and production forecasts for a country as a whole and do not allow a fast response to crisis situations and significantly reduce the accuracy of the long-term planning of the geo-energy supply of Europe. Furthermore the way the data is available; users can not query the data interactively, or combine it with their own spatial datasets for more complex analysis.

To address this issue the EuroGeoSource (EGS) project is building a multilingual web GIS system that will allow users to identify access, use and reuse aggregated geographical information on geo energy and mineral resources provided by geological surveys from at least ten countries in Europe. The system will enable services for the registration of data sets from different countries, the visualization and overlay of the information layers obtained from distributed sources, spatial analysis, and so on.

This paper will focus on the INSPIRE compliant data model and the technical design of the system.

HARMONISED DATA MODEL

The set of key attributes is grouped in general data of the site, data of location, administrative data, economic data and additional data (see figure 1). Attributes specific to mineral resources are labelled (M) to energy resources (E) and to both (M&E). Not all attributes are available and or accessible for each country. The data are mapped to the INSPIRE data specifications for the themes geology, minerals, energy and administrative units, leaving twenty-one attributes that could not be mapped. The mapping showed that the connection between the different data themes and the rationale within each theme in INSPIRE is not yet optimal, resulting in multiple references our redundancy when entering data. These insights is reported to the INSPIRE thematic working groups in detail to improve the final versions (3.0) of the data specifications.

GENERAL DATA OF SITE	DATA OF LOCATION	ADMINISTRATIVE DATA
INSPIRE ID of site (M&E)	Coordinates: longitude, latitude (M&E)	licence ID (M&E)
local ID (M&E)	depth below surface (M&E)	type of licence (M&E)
Name of site (M&E)	water depth (M&E)	Name of licencee / operator (M&E)
Name of site (M&E)	geographical location (M&E)	Duration of licence (M&E)
Type of resource (M&E)	Country name (M&E)	Areal extent of licence (M&E)
Year of discovery (M&E)		
status of site (M&E)		
References (M&E)		
Remarks (M&E)		
ECONOMIC DATA	**ADDITIONAL DATA**	**ADDITIONAL DATA**
Classification (M&E)	Geological characteristics regional / of field (M&E)	Main type of field (E)
in situ ore / substance reserves (M&E)	Age of host rock / Reservoir rock age (M&E)	Status (E)
Production (M)	Host Rock type / Reservoir rock type (M&E)	Nr of oil producing wells (E)
Period of Production (M)	mineral deposit type (M)	Nr of gas producing wells (E)
Dimension of the deposit (M)	primary comodities (M)	Nr of gas injecting wells (E)
mining method (M)	secondary comodities (M)	Nr of oil/gas producing wells (E)
Oil Initially in Place (E)	main ore minerals / substance (M)	Nr of water injecting wells (E)
Gas Initially in Place (E)	secondary ore minerals / substance (M)	Nr of water/gas injecting wells (E)
Cumulative oil production (E)		Nr of CO2 injecting wells (E)
Cumulative gas production (E)	hydrothermal alteration (M)	Nr of producing/injecting wells (E)
Cumulative water production (E)	morphology of the deposit (M)	Areal extent of field delimitation (E)
Cumulative gas injection (E)	regional deposit structure (M)	Reservoir depth (E)
Cumulative water injection (E)	dating method of mineralisation (M)	Production strategy (E)
Remaining Oil reserves (E)	age of mineralisation (M)	Installations (E)
Remaning Gas reserves (E)		
Year of reporting (E)		

Figure 1 – Attributes in harmonsed data model for mineral resources (M), energy resources (E) or both (M&E).

In order to distribute and portray the data two service types are installed at each geological survey. One service for filtering and requesting the data itself (Web Feature Service, WFS) and one for portraying the information as a geographical map (Web Mapping service, WMS). Furthermore translation services will be implemented to translate

the geological and user interface terms to different languages. The services are based on open standards from the OpenGeospatial Consortium and the INSPIRE specifications, but additionally also on standards such as Rest and GeoJSON.

CLOUD COMPUTING

Although the data originates from services and databases installed at the different participating Geological Surveys, cloud computing is used to fulfil basic (non-)functional requirements (c.f. figure 2). Typical non-functional requirements are the performance, availability and scalability. A user of the system may search for occurrences of commodities throughout Europe, e.g. to explore the possibilities to mine rare earth materials. In case all information is available on distributed servers, such a query will have to be executed at every geological survey, resulting in a high risk of low performance. Therefore the data is stored centralised to act as an optimised search index. It also reduces the risk of having actually inaccurate results if local services are down or unreachable.

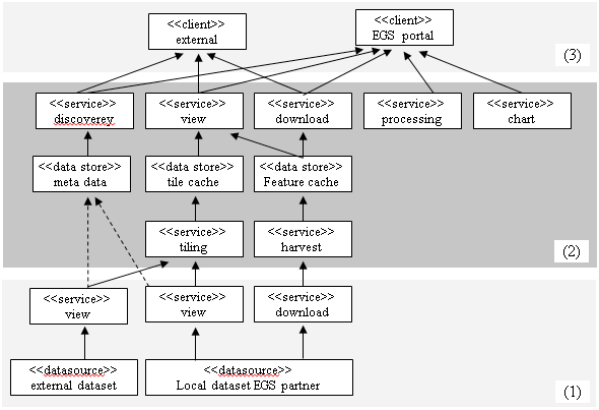

Figure 2 – EGS architecture with (1) data/service provider, (2) central EGS implemented in the cloud and (3) service consumer.

The system also uses cloud computing to compute so called tiles of the WMS services. A typical WMS setup is only able to support a very limited number of concurrent users and requests per second as it creates a map per request. Therefore using a WMS often results in poor usability if many users are accessing the system or if the system is over-requesting the individual WMS. In EGS the creation and caching of tiles is implemented in the cloud (Amazon Elastic Web) giving flexibility to the resources needed to pre-create the tiles and have a dynamic storage size for the tiles. Also the system is automatically scalable if the number of users and requests rises (expected or unexpectedly).

Another reason to (pre-) create and store tiles in the cloud is because other existing map services are used (e.g.OneGeology Europe) that only support the geographical coordinate system ERTS89. While this coordinate system is very useful for exchanging information, it is a very poor coordinate system for portraying geographical maps. EGS uses Spherical Mercator, a projected coordinate system also used by e.g. Google. This leads to much better looking maps. The transformation from maps based on geographical coordinates to tiles based on projected coordinates, is done using cloud computing, as well as the subsequent storing (caching) of the tiles.

The implementation of the EGS system in the cloud ensures satisfactory performance of the system, even for an ANDROID client operating on a 3G network.

PORTAL FUNCTIONALITY

Typically a web portal using spatial information is only visualising the information, either graphically in a map or showing the attribute information per geographical object in a table or pop-up screen. However, contrary to other systems in the case of EGS the emphasis lays not only on making data available, but also on the questions which must be answered by the system and the data. These have been elaborated in use cases and prototypes which have been discussed again with the (potential) users.

This has lead to a user interface where a user can easily “ask” a question that get answered in different ways suiting his needs, including automatically calculated diagrams with aggregated information. The diagrams can quickly show where (in what country) the most potentially rich areas are, what the most common deposit types are, etc. The diagrams are also interacting so a user could quickly zoom to Portugal by clicking in the diagram if he sees there are a lot of potential occurrences there.

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SATELLITE MAPPING AND STRUCTURAL ANALYSIS OF THE SUB E-W DEXTRAL SHEAR ZONE THROUGH TWO EXAMPLES IN THE BAS DRAÂ DOMAIN (WESTERN ANTI-ATLAS, MOROCCO)

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KEY WORDS: Landsat image, Structural mapping, Dextral Shear zone, Bas Draâ inlier, Western Anti-Atlas.

GEOLOGICAL SETTING

The Anti-Atlas Palaeozoic fold belt is the southern orogenic front of Moroccan Variscan domain, thus its foreland as external. This area is part of the peri-Atlantic Variscan belt resulting from the collision between Gondwana and Laurentia during the late Palaeozoic (Hassenforder, 1987; Simanacas et al., 2009). This collision, the so-called the variscan major event (Eovarisque, 300-290 Ma), is characterized in the Anti-Alas cover by the thick-skinned fashion (Burkhard et al., 2006). Many dextral shear zones N70-90° trending, has been indicating in the Western and Eastern part of the Anti-Atlas Variscan belt (Faik et al., 2002, Baider, 2005; Almeida and Dias, 2010).

The study domain is located in the western Anti-Atlas, along the eastern side of the Bas Draâ inlier (figure1). The lithostratigraphic column this area shows (Choubert, 1956; Soulaimani, 1998; Belfoul, 2005):

- The Palaeoproterozoic basement formed by metasedimentary rocks host a range of mainly granitic intrusions;
- The late Neoproterozoic thick sequence of volcanic and related sedimentary rocks;
- The Palaeozoic cover unconformably overlies the Precambrian basement, range from Cambrian to Upper Carboniferous, formed by sandstone and siltstone with some thick carbonate successions deposited in shallow marine.

METHODOLOGY AND GOALS

The cartography of the Bas Draâ Palaeozoic sequence consists on the analysis of Landsat TM5 image and geological maps (BGS, 2001g, 2001h), associated with Google Earth data (figure 1).

This work aims to cartography the lithosratigraphical series and to interpret tectonic structures in order to characterize the Shear Zone in the Eastern par of the inlier.

These operations of treatments were performed on software Erdas Imagine 9.1 for Landsat image. The final results are compiled in the Geographic Information System “software ArcGis 10.”

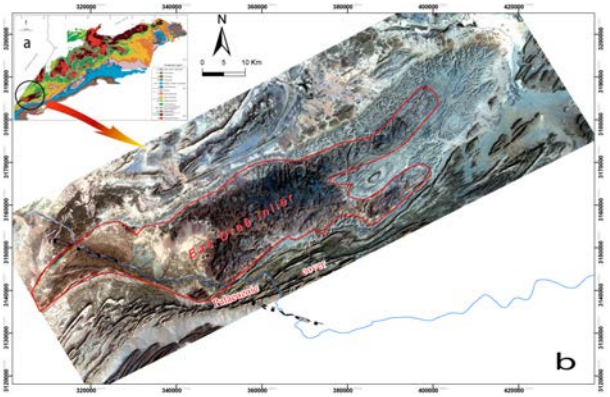

Figure 1 – Location of the Bas Draâ area in the south western Anti-Atlas (a), and Landsat TM5 image of the Bas Draâ inlier (b).

GEOMETRIC ANALYSIS

The Lithological map (map tele-analytical), extracted from the satellite cartography of the Bas Draa area show an homogeneous continuity of the Palaeozoic cover series. On the basis of sedimentary observations in the Southwestern and the Northeastern parts of the inlier, show a thick Palaeozoic sequence. On the other hand, near the south basement-cover boundary is characterized by thin Cambrian and Ordovician series. The undeformed Jbel Ouarkziz monocline (carboniferous ridge) shows, from North to South, a sigmoid appearance virgation (figure 2).

STRUCTURAL GEOMETRIC AND ANALYSIS

The Variscan shortening of the sedimentary cover generate a mega-folding structures NNE to NE-trending, in which axis ESE – dumping.

The Ordovician fold axis, in the south limit of the inlier, acquires a rotation from NNE to E-W trending.

In addition, the arrangement of the Devonian fold appearance “en echelon” is the expression of the dextral shear zone (figure 2).

A detail cartography and structural analysis in the Tiglite area permits to determine a minor ductile shear zone. This shear zone generates a deflection of folds NE-SW trend for a sub-equatorial trend (N70°).

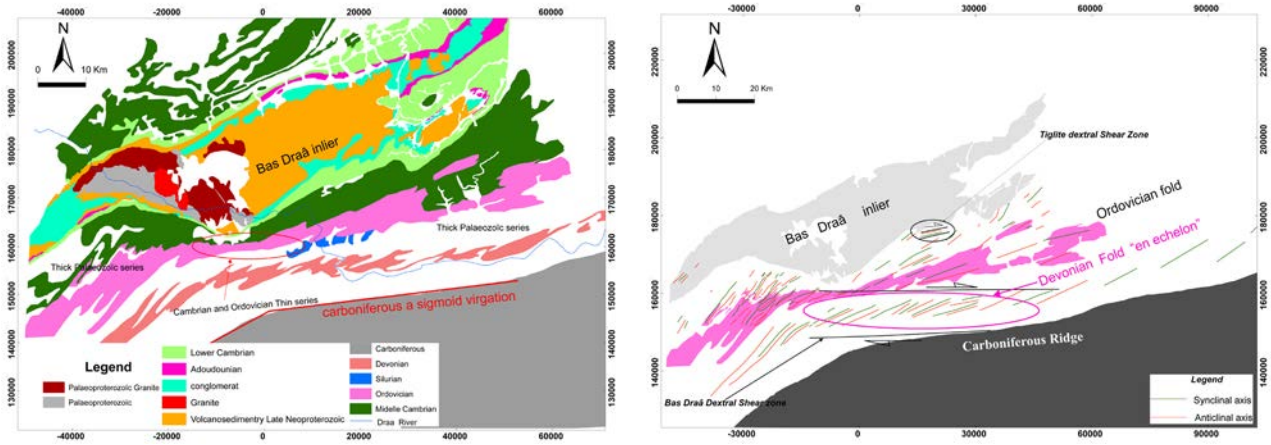

Figure 2 – The classification results from Landsat TM5 image(in the left) structural geometrie and analysis (in the right).

CONCLUSION AND DISCUSSION

This study investigated the lithologic mapping and structural analysis in the eastern part of the Bas Draâ area. Results of this mapping allows to substantiate two dextral shear zones, the minor Tiglite shear zone (TSZ), and the main Bas Draâ shear zone (BDSZ). These interpretations are according to the Cambrian and Ordovician thinning series, the deflection of folds axis in south limit of the inlier and in the Tiglite area, and the geometric orientation of the Carboniferous ridge. The right lateral sense of these shear zones is deduced from the arrangement of Devonian fold for the BDSZ and from structural analysis in the TSZ.

Hassenforder, 1987 and Weijrmars, 1993, have proposed this interpretation. Other authors (Belfoul, 2005; Soulaimane, 1998; Michard et al., 2010a) share this view, but the position of the shear zone is not in the south boundary Basement-cover.

Establish correlations with similar shear zones in other Varicsan out crop (Tata shear zone, Atlas south shear zone and Rabat-Tifelt shear zone) leads to considerate the Variscan deformation age at late Carboniferous.

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EFFMIS: AN INTERREG IV PROJECT DEVOTED TO THE FOREST FIRE MANAGEMENT

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KEY WORDS: wildfire, detection, risk index, prediction, prevention, good practices.

INTRODUZIONE

EFFMIS is a Capitalisation project coming under the INTERREG IVC Programme and is co-financed by the European Regional Development Fund. EFFMIS stands for European Forest Fire Monitoring using Information Systems and aims to answer the need for integrated regional action on monitoring forests in order to early detect and effectively manage forest fires. The objective of the project is to exchange experiences and good practices (GPs) about regional policies, methods and systems being used for the protection of this natural resource. EFFMIS will also pool good practices on the exploitation of information systems in the assessment of the damage in burnt areas and in the efficient management and monitoring of regeneration efforts.

The project will capitalize on the experiences of participating regions to help bridge the gap between more and less developed regions and to allow them to respond more efficiently to the Lisbon and Gothenburg agendas on issues related to environmental sustainability. EFFMIS will guide the participating regions from exchange of practices to concrete actions by orchestrating true inter-regional knowledge transfer.

The ultimate goal of the EFFMIS project is to develop regional action plans that will specifically describe how each participating region can enhance the use of information systems to protect its natural resources against fire and how it can align its regional or national policies with EU legislation related to forest fires. To achieve this goal the project will use tested tools and methodologies to bring the transfer of good practices from the stronger standing regions to the weaker ones – namely site visits, taking stock of existing situations (environmental, meteorological, geographical) as well as potentials, piloting actions, outlining good practice catalogues and proposing concrete actions. The project will also integrate the implementation of targeted dissemination actions in key areas of forest fire detection and management and will expand and maximize impact to further regions within Europe. EFFMIS also primarily deals with the process of forest monitoring and early detection systems to increase each regions' readiness to respond in the most prompt and efficient manner.

OBJECTIVES

EFFMIS attempts to mitigate these negative effects of forest fires while taking into consideration the different "fire environment" in each of the participating countries. The term "fire environment" is used for factors affecting the occurrence and intensity of forest fires, such as topography, weather (precipitation and humidity, temperature and winds) and forest type.

In this scope the main issues addressed by EFFMIS are:

Early detection and visualization of fire propagation;

Forecasting of danger zones based on "fire environment" analysis;

Risk assessment during panic evacuation;

Optimal spatial distribution of service vehicles;

Fire suppression services routing;

Rule-based knowledge representation and scenario management;

Post-fire impact assessment.

EFFMIS will identify the special conditions (topography, weather and forest type) in each partner's region, will gather partners' GPs, will analyze them and will examine how these GPs could be transferred in regional Action Plans. Consequently, the project has the following specific sub objectives:

a) Leverage effects in usage of IS for forest fires detection and management through joint learning and actions:

- transfer previously identified GPs increasing the capacity of responsible for forests monitoring authorities and research institutes;
- raise awareness on potential tools for increasing the effectiveness of relevant IS at regional level

through a GP mainstreaming guide based on project experience;
- enable constant flow of knowledge transfer between European regions;
- establish a methodology of adaptation of GPs to the individualities of each region.
- b) Effective and efficient management of structural funds:
- improve the management of structural funds with regards for environmental sustainability through the transfer and exchange on GPs;
- promote the involvement of regional stakeholders in forest protection actions and interregional cooperation.

c) Contribution to cohesion in Europe:
- - help bridge the gap between more and less advanced regions in EU.

This paper is devoted to illustrate the needs of the individual European countries with reference to wild fires management and the most effective good practices for reducing the impact of these events.

GOOD PRACTICES

The good practices presented by the partners are evaluated on the base of a series of parameters

The process of evaluating the Good Practices (GPs) presented by EFFMIS partners will constitute the basis on which a transparent decision making process will be built, which will eventually lead to the development of country/region specific action plans for the transfer of suitable practices between participating regions.

A number of Good Practices have been assembled by the Partnership for the exchange of experience and expertise on regional policies, methods and systems being used for the protection of forests from fire risks.

Partners have assembled a set of about 30 Practices from participating regions and have provided brief descriptions of those practices based on a unified template. Partners have also provided additional information through presentations and other informative material.

This pool of GPs will be the target of the exchange process that will be taking place throughout the project between participating regions. Ultimate goal of this process will be the delivery of a 9 regional action plans that will specifically describe how each participating region can enhance/adopt the use of information systems to protect its natural forest resources against fire and how it can align its regional or national policies with EU legislation related to forest fires. The development of the foreseen action plans will be based on a transparent and efficient evaluation process of these GPs and a correlation with the particular needs in each participating region. Under the scope of this detailed evaluation process, each presented GP will be 'decomposed to its elements (See Fig. 1). This procedure practically corresponds to an analysis of the particular services that each GP provides through a sub-system or application. Particular details will be analyzed to provide adequate information to regional/national teams during the process of selecting which GPs best suit the needs and particularities of their region.

Each partner presenting a GP will be responsible to respond based on a standard decomposition matrix, providing information on each GP and outlining specific details that define the GP or special characteristics that make it stand out. This step will lead to the creation of a detailed evaluation sheet per GP. By the end of this process a full Evaluation Matrix will be created which will present an aggregated view of the services/ elements provided by each GP offered.

Based on this aggregated evaluation matrix and the detailed evaluation sheet per GP, participating regions will be able to work transparently on their GP selection process that will take into consideration the needs, priorities and resources in each country/ region in order to formulate a feasible and effective action plan.

CONCLUSIONS

The proposed forest fires devoted good practices foreseen the utilization of the recently developed technologies comprising ground and satellite based observation systems, new approaches at the prevention and prediction phases based, primarily, on the increase of the integration of information coming from different sources as well as the nature and amount of collected and applied data.

The success of the project will be measured by means of the its capability to disseminate the good practices among the European region by means of the formulation of regional action plans and by increasing the increasing awareness about the usefulness of new technologies in the fight against forest fires.

ACKNOWLEDGEMENTS

The EFFMIS project has been funded by ERDF in the framework of the INTERREG IVC initiative.

THE ASSESSMENT AND GIS MODELING OF BASIC INDICES OF LANDSCAPE_ ECOLOGICAL ANALYSIS (A CASE STUDY OF SYUNIK MARZ, ARMENIA)

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KEY WORDS: GIS, landscape-ecological, modeling, potential .

INTRODUCTION

Regional landscape-ecological studies have acquired a special topicality as efficient environmental conservation and rational use of natural and resource potential is a major prerequisite to sustainable development (Francoise & Acques 2003, Мельник 2006, Плохих 2007). Such studies are underpinned by collection, systematization and consequent arrangement of information on environmental components. Such an opportunity is provided by geographic information systems (GIS) (Мкртчян 2006).

MATERIALS AND METHODS

In mountain regions similar to Syunik marz (province) landscape-ecological problems are sharply manifested. The diversity of the region's natural conditions and high sensibility of natural-territorial complexes to man-made intervention is seen in their poor and unstable ecological state.

As a software while preparing a landscape-ecological GIS, we employed GIS package ArcGIS 9.2, with expansion moduli 3D Analyst 1.0, Spatial Analyst 2.0 (ESRI Inc.) and ERDAS Imagine 9.1.

A landscape-ecological analysis of Syunik marz was performed based on 4 underlying parameters:

- Assessing ecological potential of mountain landscapes
- Assessing ecological stability of mountain landscapes
- Assessing ecological load of mountain landscapes
- Assessing ecological tension of mountain landscapes

The values of basic parameters of the landscape-ecological analysis were calculated as sums of respective indices expressed in scores and multiplied by their significance reflecting coefficients. Conversion of natural unit measurement indices to a single score system is implemented through division of natural value (minimal to maximal) segment into a quantity of equal-size segments (Горелов 2000), corresponding to the quantity of single-scale scores. To obtain compatible collation units by different indices, a single score scale was assumed (1-5). Then produced were chains of significance of diagnostic indices (from most to less significant) in a complex index. According to the methods (Коломыц 1998) the sum of all weight factors of one complex index does not exceed a unit. In agreement with that rule, a formula was derived of calculation of basic indices of landscape-ecological analysis (ecological potential, stability, load and tension):

$M_{int} = K_1*(F_1)+ K_2*(F_2)+ K_3*(F_3)+.... +K_n*(F_n)$,

where M_{int}- is an integral assessment of basic indices of landscape-ecological analysis; $F_1...F_n$ –values of under-consideration indices in scores; n – the number of factors; $K_1..K_n$ – corresponding weight factors.

RESULTS

Subsequently, those factors were integrated by "Model Builder" in ArcGIS 9.2 applying "Weighted Sum" functions (Figs.1,2,3,4). The produced maps enabled us to assess general landscape-ecological conditions of Syunik marz.

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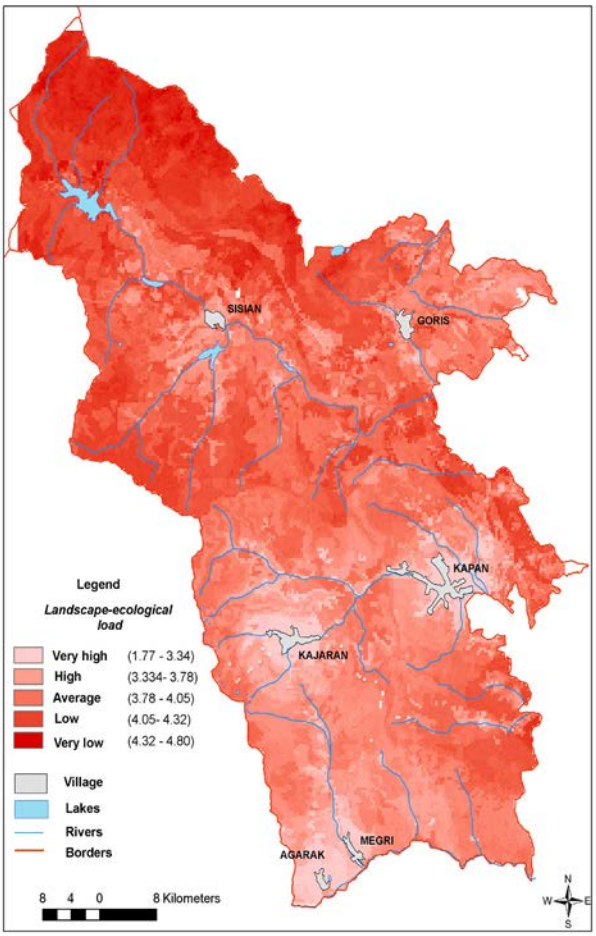

Figure 1 – A map of landscape-ecological load.

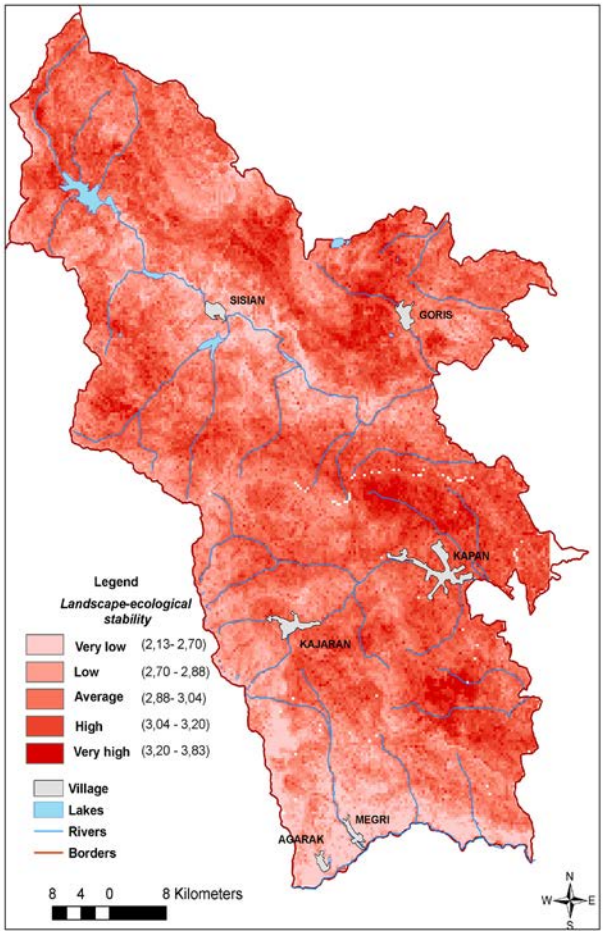

Figure 2 – A map of landscape-ecological stability.

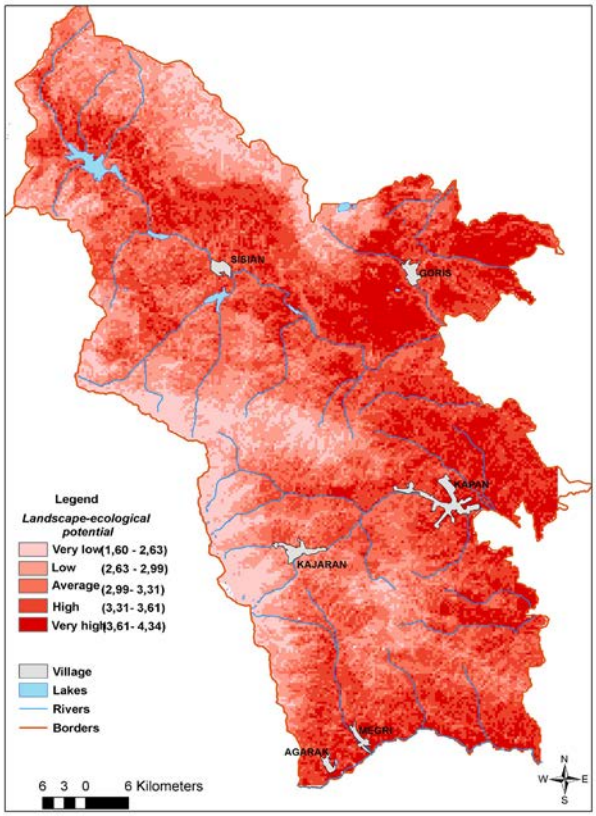

Figure 3 – A map of landscape-ecological potential .

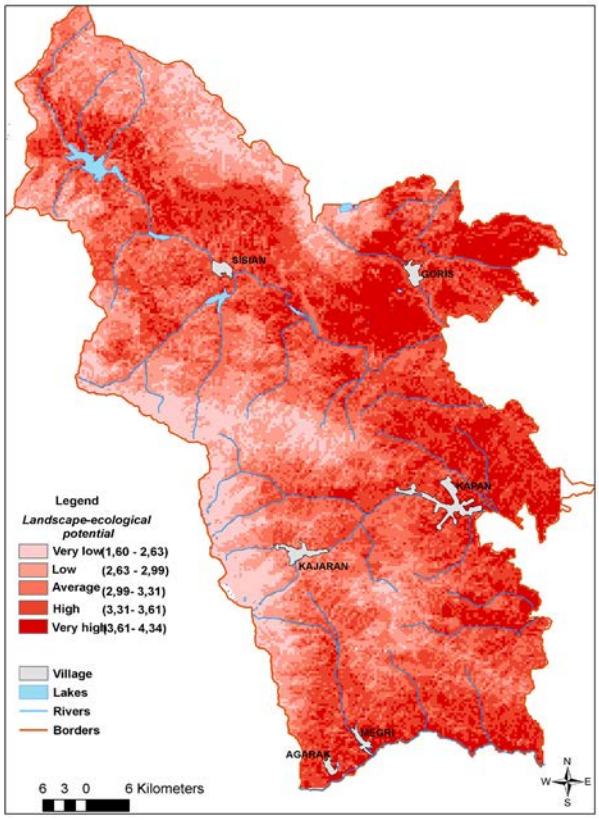

Figure 4 – A map of landscape-ecological tension.

INTERACTIVE WEB DATA DELIVERY SYSTEM - PROVIDING OPEN AND FREE ACCESS TO IRELAND'S MARINE DATA VIA THE INTERNET.
BRIDGING THE GAP BETWEEN SCIENTIFIC EXPLORATION AND PRACTICAL DATA APPLICATIONS.

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KEY WORDS: Data, Download, Web, Delivery, System, Marine, Ireland, INFOMAR, GSI

DATA ACCESS

In February 2007 the Irish government launched the initiative to provide open and free access to all Geological Survey of Ireland (GSI) data. Exploration, academic and corporate demand for marine geoscientific data has driven the creation of hydrographic data products such as high resolution digital elevation models of the Irish seabed.

The data has been generated from the Irish National Seabed Survey (INSS) & Integrated Mapping for the Sustainable Development of Ireland's Marine Resources (INFOMAR) projects. Together these Irish projects constitute one of the world's largest marine mapping programmes.

Vast amounts of seabed data are generated annually and currently, there is in excess of 1.5 TerraBytes available for download, via the web, on the GSI's Interactive Web Data Delivery System (IWDDS). There are over 1,100 registered users who have completed over 50,000 downloads in excess of 2,000GB of digital data. Data can be accessed, viewed and downloaded in a variety of manners.

- Websites: www.gsi.ie and www.infomar.ie
- Interactive Web Data Delivery System (IWDDS) https://jetstream.gsi.ie/iwdds/
- Webmapping Viewers
- Web Map Services (WMS)
- Metadata

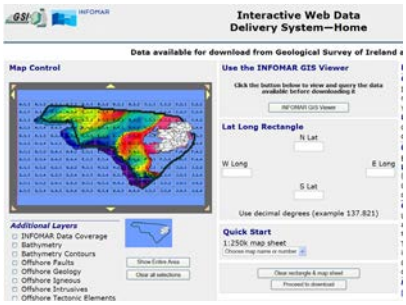


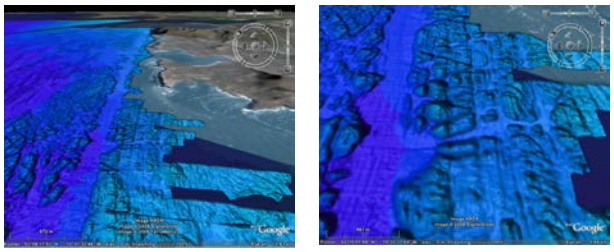
Figure 1 – Interactive Web Data Delivery System

DATA PRODUCTS

Data products are provided in a number of key formats compatible with open source and proprietory software such as ASCII (xyz), ArcGIS Grid & shapefile, ER Mapper Grid(.ers), Olex, Fledermaus (.scene), GeoTiff and Google (.kml & .kmz).

INFOMAR provides data in a wide variety of formats to suit all users from the general public to experienced GIS users.

- Bathymetry Maps (pdf and geotiff)
- Bathymetry Data (xyz, ArcGIS grid, .ers, .kmz, .scene)
- Backscatter Maps (pdf and geotiff)
- Backscatter Data (xyz, .ers grid & .kmz)
- Gravity Data (xyz, ArcGIS grid & .ers grid)
- Groundtruthing & sample Locations(.xls & .shp)
- Lidar Maps (pdf and geotiff)
- Lidar Data(xyz, ArcGIS grid, .ers, .kmz, .scene)
- Magnetic Data (xyz, ArcGIS grid & .ers grid)
- Shaded Relief Maps (pdf , geotiff & .kmz)
- Seabed Classification Maps (pdf and geotiff)
- Seabed Classification Data (xyz, ArcGIS grid & .kmz)
- Shipwreck Information (pdf , xls, kml & .shp)
- Sound Velocity Profiles (.xls & .shp)
- Survey Areas & tracklines (.shp)
- Reports (pdf, .doc & .xls)



New Discoveries. Trench-like feature, dubbed the “Brendan Trench”, a Seabed expression of a major geological fault zone.

Figure 2 – Google .kmz format

DATA APPLICATIONS

INFOMAR is a programme which is data-rich. Survey operations are delivering vast amounts of high quality data of interest to industry and academia alike, yet unless the data is made easily available to all end users, then there is a danger that the survey becomes a data-gathering exercise alone.

- Transport / Shipping
- Environment
- Coastal Zone Management
- Heritage
- Fisheries
- Resource Management
- Aggregates
- Fish Spawning Grounds
- Wind & wave energy sites
- Marine Leisure
- Spatial planning tools

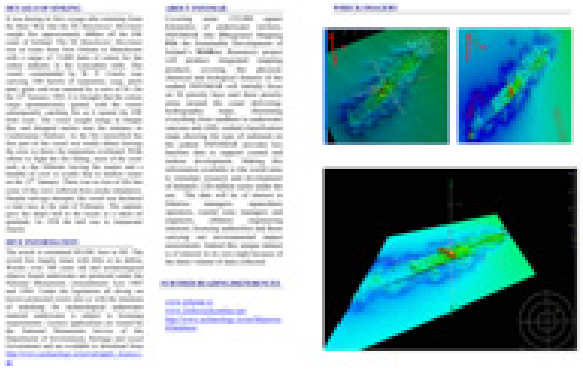


Figure 3 – Shipwreck Information Sheet

TECHNOLOGY AND SOFTWARE

A variety of software packages and technological solutions, both propriety and opensource are used to enable the download of INFOMAR’s digital data. The IWDDS website was developed by Intrepid Geophysics of Australia. The data download site also links up to INFOMAR’s Webmapping sites. To our knowledge, this system is one of only a very small group of systems available throughout the world where free web access to a data-store of this extent is available.

- ESRI ArcIMS 9.2 & Moximedia IMF
- ESRI ArcGIS Server 10
- Intrepid Geophysics JetStream software
- GeoNetwork
- OpenLayers

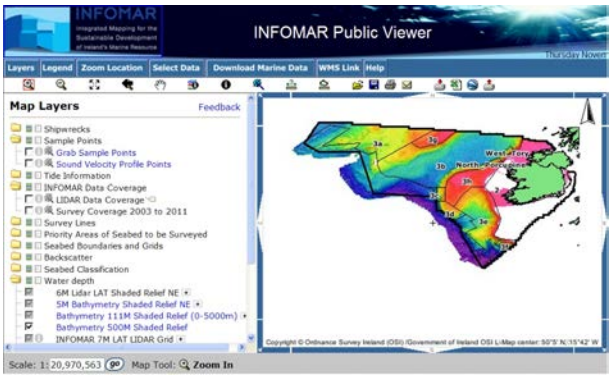


Figure 4 – INFOMAR Webmapping Viewer

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http://geos2.marine.ie/infomar/
Web Map Services (WMS)
http://spatial.dcenr.gov.ie/wmsconnector/com.esri.wms.Esrimap/INFOMAR?
http://geos2.marine.ie/ArcGIS/services/Infomar/Bathy_BroadScale/MapServer/WMSServer
http://geos2.marine.ie/ArcGIS/services/Infomar/Bathy_FineScale/MapServer/WMSServer
http://geos2.marine.ie/ArcGIS/services/Infomar/SeabedClassification/MapServer/WMSServer
http://geos2.marine.ie/ArcGIS/services/Infomar/ShadedRelief_FM/MapServer/WMSServerr
http://geos2.marine.ie/ArcGIS/services/Infomar/Backscatter/MapServer/WMSServer
Metadata
http://www.dcenr.gov.ie/Spatial+Data/DCENR+Metadata.htm

GEOÍNDEX: A PUBLIC DATA DISSEMINATION SERVICE FROM THE INSTITUT GEOLÒGIC DE CATALUNYA (IGC)

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KEY WORDS: public information service, geological WMS,

INTRODUCTION

Through the Law 19/2005 of the Catalan Parliament, the Catalan Government created the Geological Institute as an instrument to contribute to the availability of basic and updated geological, pedological and geothematic information. The Law relates the activity of the Geological Institute to "the research, advice and production of information relative to the ground and the subsoil, which constitute essential tools to promote the several policies, both public and private, that have their operative axes in the ground and the subsoil, and also to establish the necessary preventive or corrective measures for situations of risk.

The new Institut takes over the previous existing Geological Survey created in 1979. From the legacy of years of working, the Institut has accumulated large amount of geological information and data collections in hard copy or electronic formats. To improve information and data management and due to inherent difficulty on creating a corporative GIS, the efforts were focused on a progressive migration guided by the needs of technical users as priority criteria.

Besides the IT breaking out into information management and dissemination, the IGC is fully committed in facilitating public access to geothematic information and data.

GEOÍNDEX: A PUBLIC SERVICE

The Decree 168/2009 passed by Catalan Government implemented various aspects of the creational Law of the IGC. It creates diverse legal instruments to help the Institut in carrying out its business. Among the instruments created by the Decree is the Documentation Centre and Geologic Archive (CEDAG). The CEDAG is divided in turn into the *Geoteca* and *Geoindex*.

The Geoteca is the legal IGC instrument for compiling, cataloging and working in custody, conservation and preservation of documents (books, maps, …) coming from daily work of IGC or from other sources, and geologic and pedologic samples (soil, drilling cores, water, …).

The Geoíndex is created to collecting and disseminating information and geothematic data that has been previously incorporated into the IGC databases and they are available in digital format.

Both Geoteca and Geoíndex have been created as public services to improve the geological knowledge for preserving the natural heritage and for helping decision makers to take the best possible solution.

WHAT DOES GEOINDEX OFFER?

Geoíndex allows users to search, view, and request for information about groups of data sets through available web map services (WMS).

To make a friendlier interface, the IGC offers labeled as GEOÍNDEX into its website, thematic viewers to query information from implemented WMS (Figure 1). The Geoíndex viewers provide visual query to geospatial metadata. These viewers are built using Java, JavaScript and HTML technology and they are based on OpenLayers, jSON and jQuery libraries.

Geoindex viewers include basic functions that enable search and display of information based on geographic location and connection with other internal or external WMS via URL. Users can request for information from the viewers and they will receive them in few days. Currently it is not possible to directly download data online.

Geoíndex is operational since December 2011 and on February 2012 are available through the IGC web site (www.igc.cat) the following viewers.

- Geological maps: Geologic map of Catalonia, at a resolution equivalent to 1:250.000 and 1:50.000 scales.
- Ground deformations: Vertical deformation obtained by leveling land surveying, GPS and radar differential interferometry.
- Geothermics: Deep and shallow geothermal regime maps and models.
- Geoworks: State of the work of geothematic mapping programs.
- Snowpack information and avalanches: Snow avalanche database of Catalonia (BDAC), existing protections and study areas

- Geological hazards: Danger zones evaluated from preliminary reports and map for the prevention of geological hazards
- Seismology: Seismic broad-band and accelerometer network and instrumental and macroseismic epicenters location
- Geotechnical surveys: Location of geotechnical surveys from public works projects, with code that contains the data report
- Geophysical techniques: Geophysical data acquisition surveys.

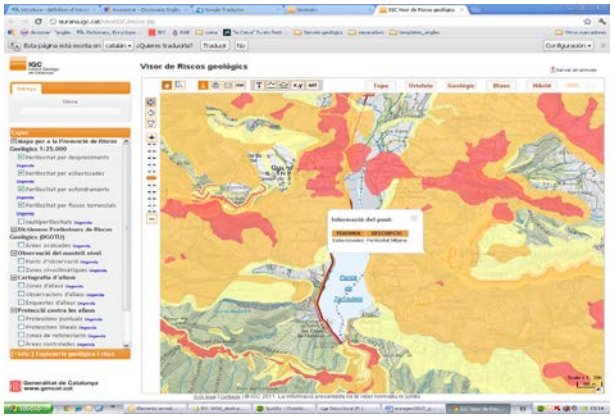

Figure 1: Geoindex screen capture. Geological hazards viewer.

Together with the implementation of WMS, data and service metadata have been incorporated to the Catalunya spatial data infrastructure (IDEC). So all the IGC WMS are available from its resources catalogue and consequently are standardized and are interoperable.

THE FUTURE OF GEOÍNDEX

Improving capacities and services served by Geoíndex viewers is an IGC background task. Soon online downloading data will be available through Web Feature Service (WFS) and more WMS will be implemented.

Geoíndex has the aim of becoming the main window for providing users with geological information and knowledge of Catalonia. Therefore, its content and technology upgrade is a priority of the Institut Geològic de Catalunya.

ACKNOWLEDGEMENTS

Authors want to thanks to the technical staff at IGC. Geoindex is built with a collective effort.

FROM ÉLITES TO COLLABORATION: TOWARDS A RESILIENT APPROACH TO NATURAL HAZARDS ANALYSIS & EMERGENCY MANAGEMENT

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KEY WORDS: Geolocation, data management, natural hazards, resilience, resilient information..
The presentation illustrates the background and the aim of the research project "Collaborative management of data for natural risk prevention and civil protection"[1] at the Doctoral School of Sciences and Innovative technologies of the University of Torino, Italy.

FROM PROTECTION TO RESILIENCE

It is acknowledged that major and minor disasters are a "reality" to cope with, as they are part of our environment. In the last 20 years the wider debate on disasters preparedness and relief operations underline that our culture should switch from "war" against hazards to "preparedness" in order to decrease the vulnerability of our societies [Wisner et al., 1994]. In this perspective the key word "resilience" fosters a wider cultural change that should drive the risk & emergency management towards a participatory dimension of all the key players: scientific communities experts, civil protection bodies, media, citizens, volunteers, civil society. The aim is to "develop a network between all civil protection actors and interested parties, including the private sector; increasing the knowledge of new prevention, preparedness and response technologies available on the market; and raise public awareness [3rd EU Civil Protection Forum -Bruxelles, 2009]. This could be interpreted as a call to switch from protection (passive behaviour) to resilience, increasing the user\citizens\local-bodies responsibility and proactive behaviour.

THE POST-GUTEMBERG REVOLUTION AS INNOVATIONDRIVER OF THE INFORMATION FLOW IN DISASTER CYCLE

The web 2.0 revolution is a twofold reality: technological and cultural. The widespread diffusion of web 2.0 technologies is changing the overall organisation of information production [Benkler, 2006] and depriving the institutionalised mediations models. The new actor in the information scene is the crowd and its talent in producing, disseminating, selecting and promoting information. Besides the validation and reliability implications, the "talent of the crowd" represents *in se* a dramatic innovation in the disaster scenario, to cope with. Moreover the technological development is having a huge impact on GIS and more generally on geographic disciplines. As a matter of fact information is becoming more and more "geolocation dependent" and this is witnessed by the " geographic phase" of social media. The "democratisation of GIS" [Butler, 2006], started with Google Earth, and mash-ups created by common people [Goodchild, 2007]

(e.g. Ushahidi platform) are now changing the whole background, with important consequences in risk prevention and emergency management. Key-words such as "crowdsourcing" and "crowdmapping", state that the worldwide citizens community is becoming a main player in the volunteered geographic information (VGI) production [Goodchild, 2007] during crisis and emergency events. This democratisation of the information, supported by the VTC (Volunteers Technical Communities) enhances that collaboration, enabled by web technology, could represent a radical change in the whole Disaster Cycle (fig. 1), that involves not only citizens but also scientific community, institutions, experts, relief bodies, media representatives.

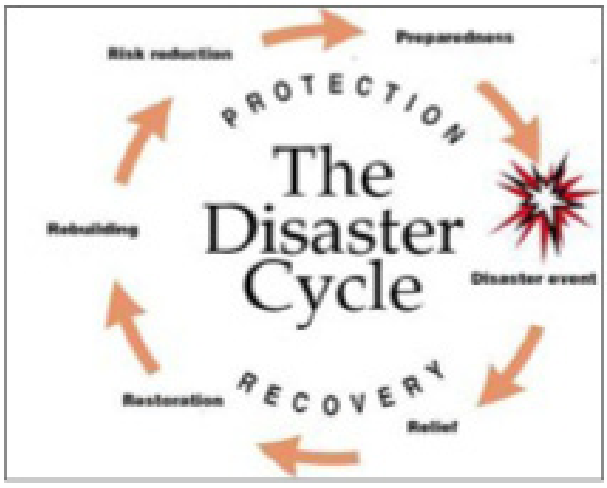

Figure 1 – The Disaster Cycle (What makes a disaster? by Ian Davis,- http://goo.gl/FK7Jq)

[1] *MIUR scholarship "Progetto Giovani" in the Research field "Sistemi di telecomunicazione innovativi a larga banda anche con impiego di satelliti per utenze differenziate in materia di sicurezza, prevenzione e intervento in caso di catastrofi naturali"*

In this perspective collaboration becomes not only a citizens approach, but also a challenge for scholars and practitioners. A collaboration trend whose aim is to produce, exchange, and share information in a world wide open and free environment, in the stream of Open Government and Open Data. Web & mobile access are enablers and channels for achieving:

- citizens engagement in preparedness, planning, early warning, relief, restore;
- faster relief with improved situational awareness;
- communication strategy both bottom/up and top/ down;
- resilience enhancement with local storytelling.

THE RESEARCH PROJECT: COLLABORATIVE MANAGEMENT OF DATA

The background of our project is the analysis of the Varazze flash flood event, April 10, 2010 (Lanfranco & Rapisardi, 2011).By taking into account the web 2.0 revolution and the international best practices, the Varazze case study outlined:

- To what extent web 2.0 mobile technologies and tools would have changed the scenario?
- How to develop a "resilient information" flow both bottom/up and top/down?
- How to manage the crowdsourced information in a risk and emergency management perspective?
- How to raise citizens and media awareness on information need during crisis and in the whole disaster cycle?

Later, on november 2011 another succession of flash floods struck both Tuscany and Liguria regions, resulting in a loss of lives and in extensive damages. Right after the disaster, citizens, social media and citizens ournalism platforms (e.g. youreporter.it) played a unique role in producing information and documenting the events. They became the main informations source fornational media (e.g.TV, radio, online newspaper) as this information was in real time and from the field. On the other end, the institutional information was slower, scattered, and had difficulties to get into the social stream.

THE FIRST STEP: BOTTOM/UP MASH-UPS

1. Crowdmapping -Actors involved: *Citizens – Media - Scientific Community*

A joint initiative set up by UNITO-Dep. of Earth Sciences and Gruppo Editoriale L'Espresso. A crowdmap,for study purposes only, to gather and classify damages through information reports, videos, and photos generated by citizens. The aim was to transform user generated information into volunteered geographical information (VGI). The involvement of a media national publishing group is two fold: wider coverage of the initiative, collaborative involvement of the editorial staff, in the gathering of information for scientific purposes. [http:// alluvione2011.crowdmap.com/main]

2. Geolocated photo sharing -*Actors involved: Project team - Relief Bodies*

The project team experimented the geolocated photo sharing in real time with the operational centre. [google+ photosharing tool and Picasa] This first test simulated a sharing approach to be developed between relief bodies and citizens or volunteers.

3. Geolocated assessment -Actors involved*: COC [Municipality Operational Centre], civil protection operatives and volunteers*

In order to exchange and share information the COC of Mulazzo set up a privately-shared google map to geolocate landslides and related damages. This map allowed different actors to "view" in distance the same information for supporting the decision making process.

THE NEXT STEP: RESILIENT INFORMATION

On the basis of this first test, the project will design and experiment a *Geosciences Information Stream*, enabled by web 2.0 app and tools, that involves in a continuum "users" and "contributors" of the disaster cycle. Particularly, starting from the November flash flood case studies, the research project will outline practices and web/mobile tools to set up a collaborative multilevel environment in order to improve and practice:

- the sharing of reliable and acknowledged geographical information, such as geological maps, hazard maps, enviromental status, weather forecast. Including the Open Data issue;
- the collaborative management of geodata stream from different sources for risk management and decision making;
- the raising awareness on natural hazard and emergency issues (preparedness) to better cope with risks.

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COMBINED ALLO- AND LITHOSTRATIGRAPHY AS A TOOL FOR QUATERNARY GEOLOGICAL MAPPING IN GLACIATED TERRAINS

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KEY WORDS: Allostratigraphy, lithostratigraphy, stratigraphic framework, Quaternary, glacial, sequence stratigraphy, mapping, stratigraphic database

ABSTRACT

Formal stratigraphic classification is a fundamental scientific tool for developing a regional knowledge of the geologic evolution of any period in the Earth's history. For the subfield of Quaternary geology, the selection of stratigraphic classification criteria is as important a paradigmal decision as was the adoption of sequence stratigraphy for petroleum geology in the 1980s.

The few currently existing national Quaternary stratigraphic frameworks are based on lithostratigraphy. As the true nature of the Quaternary depositional units especially in glaciated shield areas is often that they are arranged in unconformity-bounded, lithologically varying packages, allostratigraphy may be regarded as the most promising descriptive approach for stratigraphic classification. A classification based on the combined use of allostratigraphic and lithostratigraphic data should fit better for such areas, with alloformations as the fundamental units and lithostratigraphic units filling out the framework where appropriate. Lithostratigraphy is undoubtedly applicable, but it should be applied in a stricter manner than it has been used.

The combined use of allo- and lithostratigraphy provides a hierarchical classification system for glacigenic deposits and creates a basis for sequence stratigraphic interpretations. It supports detailed chronostratigraphic and diachronic work in order to improve our understanding of the complicated Quaternary couplings of astronomic forcing, climatic change and continental glacial dynamics that have determined the distribution and nature of glacial depositional and erosional products. The classification would also provide a hierarchical framework for glacigenic deposits, which could potentially support stratigraphic information systems, databases and digital spatial models more effectively than the traditional lithostratigraphic frameworks.

In the presentation practical recent field examples on the application of the combined use of allo- and lithostratigraphy in Finland are discussed.

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THE SOCIAL AND ECONOMIC BENEFITS AND IMPACTS OF GEOLOGICAL MAPS, DATA AND MODELS

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KEY WORDS: geology, maps, data, models, economic impacts, mobile technologies

TITLE OF SECTION

The British Geological Survey (BGS) began geological surveying in the British Isles in 1835, 177 years ago. So why are BGS geologists still involved in surveying work after so many years of effort?

The answer, of course, is that although the rocks remain the same the needs of our broad user community have changed very considerably. The identification of natural resource deposits (coal, minerals, oil and gas) is no longer the main focus of our systematic geological surveying programmes. However, our geological maps, data and models are invaluable in providing information and knowledge to support decision-making on major current issues and challenges such as the exploitaiton of unconventional energy sources (*e.g.* shale gas, underground coal gasification), the planning of major new infrastructure (*e.g.* high-speed rail networks), carbon capture and sequestration, management of groundwater resources, and of course geological hazards.

Not only has the focus of our geological surveying programme changed considerably, but the techniques we apply to the interpretation of geological data have changed enormously. In particular, during the past 15-20 years the digital revolution has fundamentally transformed our surveying methods, our spatial data and other outputs, and the methods we use to deliver them to our users.

Spatial data-sets derived from basic geological map outputs enable complex scientific data and information on themes such as geological hazard potential to be communicated meaningfully to members of the public who have little or no specialist knowledge. Such derived spatial data-sets have measurable economic and social benefits and impacts for a broad user base – everyone from the public to major private sector insurance companies. They enable, for example, a better understanding of hazard vulnerability within the public and the construction sector, the improved quantification of risk by the insurance industry, and a better understanding of the need for risk mitigation strategies in the wider community.

The BGS has used independent economic analysts to investigate and quantify the economic and social benefits of some spatial data-sets derived from its national geological map outputs. Some of the key findings of these studies will be described.

Equipped with both the data and the expertise, geological surveys and agencies are ideally placed to respond to many of today's environmental and societal challenges and pressures. But how successful has our community been in responding to the opportunities? Some have responded in very innovative ways, while others perhaps have yet to respond to the opportunities to deliver societal benefits to their user communities. There remain great opportunities for surveys and agencies to respond positively and to demonstrate real societal impacts and benefits, and even – in these times of economic austerity - to contribute to economic growth and recovery.

Across the geological community there is a clear trend towards modelling the subsurface in three dimensions. Understanding natural processes through time within the framework of a 3D geological model, and quantifying the uncertainties inherent in those process models, is the route to time series models (4D) with quantified uncertainties (5D). The need for tightly-constrained 3D litho-tectonic models to underpin natural resource exploitation is obvious. However, the broader societal impacts that 3D, 4D and 5D models can create are only beginning to become clear, and at the heart of this issue is the challenge of communicating complex science to the lay-user.

An exploration of these issues, and of the innovative ways of delivering geological maps, data and models, presents some important indicators for the future strategic direction of the geological community.

This communication was presented in the special session "Geological cartography in Italy and in Europe: perspectives and opportunities"

THE GIS BASED ANALYSIS AND THE TERRITORIAL MANAGEMENT

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KEY WORDS: Map; GIS; Landscape; Territory; Knowledge; Elba Island;

THE GIS MULTI-SCALE ANALYSIS

The knowledge of the territory and the transmission of the knowledge is a necessity that still holds great importance and influence in the political and economic development of the contemporary society.

The physical, natural, social and economic sciences, have often a common factor: the "land", both as object of study and as a "landmark" for the research on phenomena and processes.

The recent development of GIS based mapping, optimized for the Web, has allowed an opening to the public until a few years ago unthinkable.

In the case of geological/ecological data bases, the Geographical Information Systems are the most complete tools, in terms of logical structure, versatility and upgradeability.

Referring to the thematic maps, the GIS offer all the prerogatives typically required by the use of such techniques: to provide a reliable tool, accurate and well-timed (both in terms of upgradability and speed of access). The structuring of the information becomes essential; this kind of technological approach allows the management of a simultaneous presence of data from different sources and on different scales, as well as the integration of interpretative and evaluative models, useful as decision support in the territo rial planning activities. Versatile and user-friendly (also referring to the traditional cartographic output) GIS keep track of the changes (both to the geometric and alphanumeric data) as well as of the access to geographic data base.

In the geological/ecological mapping projects, the multi-scale GIS feature allows the identification of homogeneous territorial units, to which is referred a set of information, following the more significant criteria at the selected scale of analysis.

Remote Sensing and semi-automatic image classification processes, supervised through field controls, represent the procedure followed in order to identify and map the homogeneous territorial areas. The "multi-scalarity" represent one of the most important peculiarity of the Geographical Information Systems. The set of polygons identified (at each scale of analysis) represents only one of several layers of information managed by the GIS. The combination of information extracted from the related data consistent with the geometric congruence of positioning, allows a wide range of territorial interpretations, available to the decision makers (or more generally to the end users) as applicable solutions.

Today, GIS are the logical choice for the structure of a database scheme, particularly referring to the geo-environmental ones. The tolerances are generally chosen according to the fairness to the different scales. The description of each polygon identified and mapped, is handled in two ways: a short description is stored in the polygon attribute table connected to the map, to be displayed by the built-in tools of the GIS; more detailed descriptions are stored and displayed by customized user interface within the same project, which includes links between maps at different scales

A CASE STUDY: THE ELBA ISLAND

A multi-scale Landscape analysis has been performed in the Elba Island (in the Tyrrhenian Sea). The territory has been analized at three different scales:

- 1:250.000 –physiographic unit
- 1:50.000 – Biotope (CORINE classification - EEA) (Carta della Natura project)
- 1:10.000 - Ecotope

In the most recent approach to geo-environmental analysis, the relationships between the components of landscape and environment are very close, as well as the physical and the biological phenomena. Environmental diversity can be considered the result of the integration between biodiversity and geodiversity: its conservation must take into account the integrated studies on geological heritage, habitats and ecosystems. The multi-scale analysis highlights the components of an area, allowing a complete recognition of the territory. In Particular, at a detailed scale, like the 1:10,000 scale, a

territorial analysis performed following the so-called Landscape approach, provides a readout of the environmental components that integrates the geo-morphological, lithological, biological/vegetational data. At this scale the environmental unit of reference, can be described as an “Ecotope”, following the interpretation given by Carl Troll (1950) “the smallest spatial object or component of a geographical landscape” applying to landscape ecology the former definition of Sir Arthur Tansley (1939): “the particular portion..., of the physical world that forms a home for the organisms which inhabit it”. The new experimental phase of the mapping projects, which integrate geological, morphological and ecological components, can be usefully applied to territorial planning and management. The concept of ecotope gives a *geographical-territorial* contextualization to an ecological-environmental study, containing the concept of “environmental diversity”, understood as the integration of geodiversity and biodiversity.

The aim to protect places of significant environmental interest, derives from the need to guarantee a conscious and enjoyable use of landscape in all its forms for future generations, activating an appropriate management of the environment by way of processes based on knowledge.

Figure 1 – Map of Physiographic Unit of Elba Island (Carta della Natura Project – ISPRA)

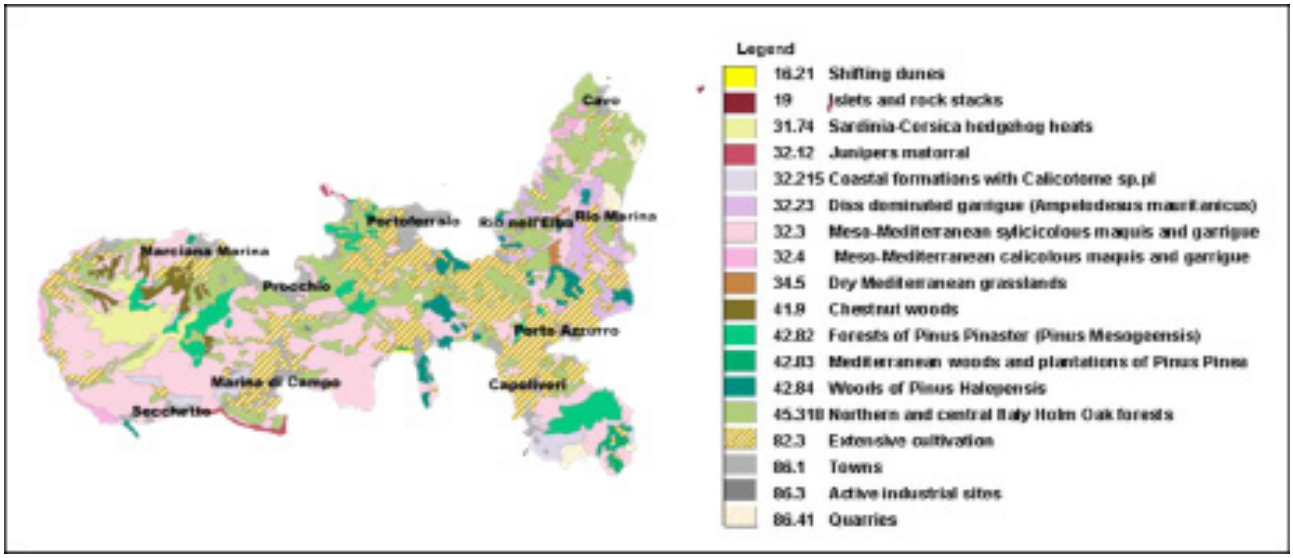

Figure 2 – Map of the habitat of Elba Island (Carta della Natura Project – ISPRA)

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MINES IDENTIFICATION BY REMOTE SENSING TECHNIQUES: FIRST RESULTS

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KEY WORDS: miniere, telerilevamento, spettroradiometria

INTRODUCTION

Mining is one of the industrial activities that may further damage, pollute or change the land. This involves the creation of unstable morphologies subjected to landslides and collapses (Di Gregorio et al., 1992), but mostly exogenic environmental exposure of large areas of mineralized rocks and treatment products, which produce important changes in the environmental chemistry. The most relevant impact is the leakage of toxic elements, mostly “heavy metal”, such as Cu, Pb, Zn, Cd, As, Cr and Ni. The sources of pollution are represented besides by mineralization exposed in underground, waste materials accumulated outside and/or by filling mines material. A prominent role is played by sludge flotation, originally deposited in basins: they contain high concentrations of heavy metals and their leaching by weathering causes severe pollution in mining areas. Remote sensing includes techniques that allow you to get information for a reality at a known distance from the sensor; this technique allows the knowledge of the different characteristics of the objects investigated by analyzing the information obtained from the spectrum of electromagnetic waves. The present work has as its primary objective to use remote sensing to detect abandoned mining areas of Sardinia and monitor the areas at highest risk for the environment. What is presented is the preliminary result of the test area of a larger project, still ongoing, involving the entire region of Sardinia.

AREA OF STUDY

The test areas, chosen for the project, belong to the mining district of Montevecchio - Ingurtosu - Gennamari (South-West Sardinia) and fall in the municipalities of Guspini and Arbus; in particular the Cantiere di Levante of Montevecchio known as “ Piccalinna basin “, flotation tailings basin, and watershed of the Rio Naracauli South-West of the village of Montevecchio, characterized by large amounts of materials from both the underground excavations and pre-enrichment and flotation plants.

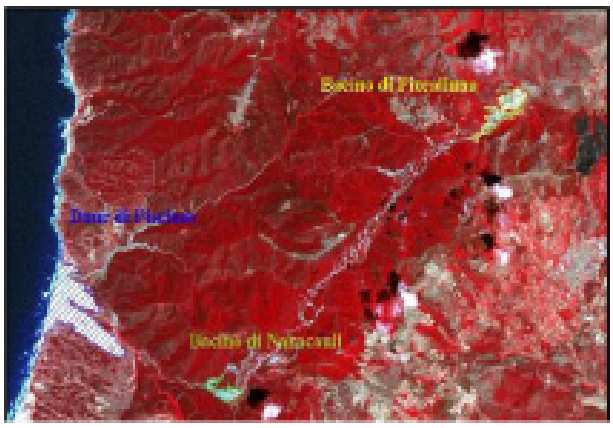

Figure 1 – Aree test

MATERIALS AND METHODS

The data used in this study are essentially of two types: Aster satellite imagery and ground reflectance data acquired by field spectroradiometer model Macam. The images of the sensor Aster have a spatial and spectral resolution useful in this kind of studies. The image used is the one acquired on July 29, 2000. The bands used in this paper are those of the visible, the close and mid infrared spectral ranges that are used in geological-mineralogical studies. The spectral range of VNIR, 0.520 to 0.860 microns (bands 1-3), allows the identification of minerals in which are present the transition metals particularly iron. The spectral range of SWIR, 1.656 to 2.400 microns (bands 4-9), allows the identification of minerals such as carbonates, sulfates, oxides and hydroxides. Aster Data were processed and subsequently classified by application of specific algorithms for this type of investigation. Therefore has been used the algorithm SAM Spectral Angle

Mapper and Spectral Hourglass Wizard, the latter is a procedure designed for the analysis of the data hyperspectral and multispectral (Kruse et al., 2000) and has been applied successfully also to the data Aster (Hubbard et al, 2003; Galvao et al., 2005). With the spectral signatures acquired in the countryside have been created "spectral libraries," which have been compared through the application of algorithms, with the USGS Mineral Spectral Library (splib04), a spectral library of known minerals obtained from readings laboratory. From this comparison it was possible to select the minerals, that from literature, it knows be present in the mining district of Montevecchio -Ingurtosu – Gennamari; in this way has been created the reference library, used in the subsequent stages of analysis for comparison of the spectral data acquired in the countryside with the given satellite.

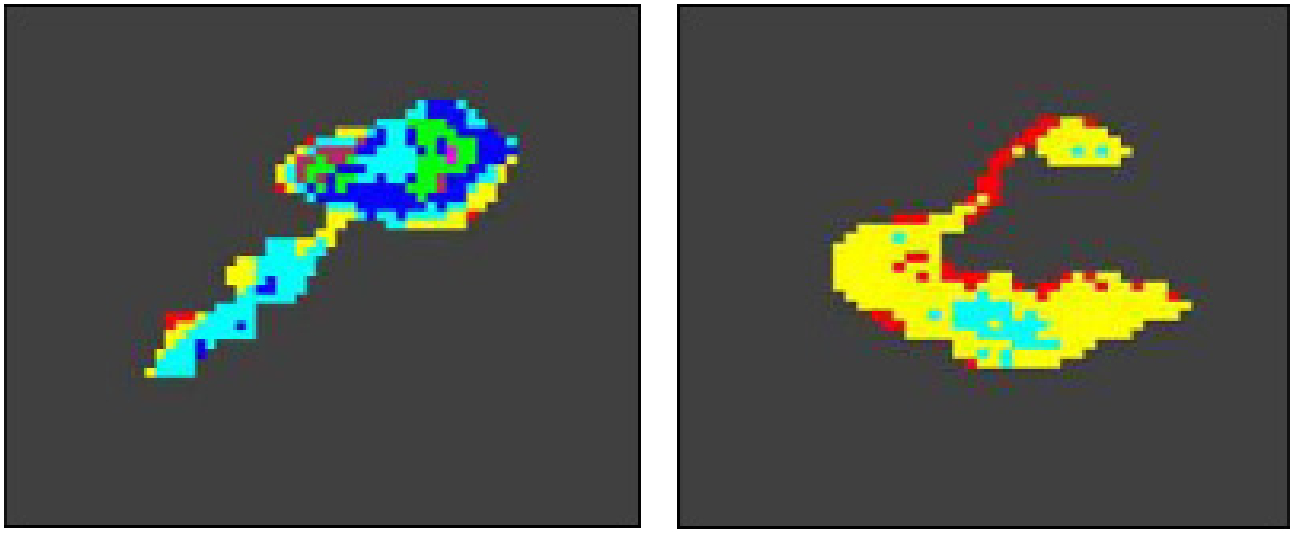

Figure 2 - Preliminary results of the ASTER SWIR image classification about the Piccalinna and Naracauli basins

RESULTS AND CONCLUSIONS

The first results are encouraging, as they allow a precise mapping of mining areas and the ability to recognize certain minerals that have a significant environmental importance, as the case of epsomite , $MgSO_4 \cdot 7H_2O$. This mineral has a very distinctive spectral signature, and often appears in spectral analysis. Its presence in the Montevecchio landfills, and in particular to Piccalinna, is well documented and characteristic (Da Pelo, 1998 and references). The epsomite from Montevecchio contains Zn often as vicarious of Mg, and presumably also contains Cd, so it is a mineral phase that affects a certain extent on the mobility of "heavy metals". Considering that it presents several cycles of formation/dissolution in response to varying environmental conditions, this mineral is an indicator of chemical changes in the landfills. In evaluating these results, we must keep in mind the limitations inherent in the determination of the spectral signature of a surface in a natural system, which is influenced by various factors on non-quantifiable, including the type of ground cover (in this case the substrates of landfills) , the conditions of acquisition of the data and the size distribution of the particles of the surfaces. However, the results obtained so far, encourage the continuation of the study undertaken in this project. Best results will be obtained with an increase of spectral riflettance data at ground, with high resolution satellite images (in acquisition), and a refinement of the analysis algorithms, all supported also by mineralogical and geochemical analysis. This will make it possible to have a complete mapping of abandoned mining areas in the area and their environmental status.

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PROCEDURE TO STANDARDIZE THE GEOLOGICAL INFORMATION STORED IN CARG GEODATABASE

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KEY WORDS: CARG Project, Geological database

INTRODUCTION

Geological Survey of Italy realizes by the CARG Project, funded since 1988, the new Geological Map of Italy at 1:50,000 scale. The first phase is almost concluded with the production of the 255 geological sheets (corresponding to 40% of the entire Italian territory).

The Project is carried out through the continuous collaboration between the Geological Survey of Italy (SGI) and territorial organizations, research institutions and universities. The SGI coordinate the achievement of geological sheets and, by the expertise of its technical staff and the "Coordinating Committees for homogeneous geological areas" support, guarantees the quality of geological sheets with technical and scientific testing.

CARG Project has the aim to obtain homogeneous and organized geological data; for this purpose Guidelines have been published which define the content and the standards for survey, data storage, print process and "Explanatory Notes" of the official geological and geothematic maps at scale 1:50,000. In particolar the Guideline - "Linee guida per l'informatizzazione e per l'allestimento per la stampa dalla banca dati (Quaderno Serie III Volumi 6-12 Carta Geologica d'Italia – scala 1:50,000)"- establishes logical model of the database.

The database of the single sheet, compliant with legislation through technical tests, are now 150 of which 117 have been published on the website of SGI.

STANDARDIZATION PROCEEDINGS OF CARG GEOLOGICAL DATABASE

During the loading phase of each database in the General Geodatabase, it has found the presence of further heterogeneity between adjacent sheets that were undetectable previously, due to different times and authors, which emphasized the need for further standardization process to eliminate inconsistencies observed.

In order to standardize the information stored in general Geodatabase the information content of individual databases were analyzed in detail to establish the criteria and the procedure to be applied to geographical areas larger than single sheet.

It is shown that the process of homogenization is mainly concerned with the geological units present in the sheets; sometimes in adjacent sheets abbreviations of geological units are not aligned, for which it has been possible to rectify the field concerning the coding of litho-stratigraphic units.

Another phase of work involved the analysis of tabular data in order to identify any gaps and inconsistencies as stated in the Guidelines referred to above, in order to continue the work of standardization and integration of missing information.

We must also bear in mind that the same Guidelines has undergone a process of integration and updating, for which it has been necessary to a realignment of databases set up for the first.

The work plan derived from this study allowed us to focus on the following aspects:

- the correction of codes present in the tables relating to geological units sometimes incorrectly completed or imprecise
- the standardization of codes for the Quaternary deposits in accordance with the Guidelines
- the integration and review of the content of field 'LEGENDA'
- the inclusion of the missing information in some required fields
- the revision and integration of the data in the field "COLORE" on the basis of codes published on SGI's Chromatic Handbook to use these codes to obtain a better visualization of geological CARG Database elements, similar to the printed map.

The process of revision and correction, which involves a considerable amount of data, aims to improve the current archive with more correct and consistent information and provides, as most immediate result, a clearer representation of the information contained in it, and especially a good basis for all future processing and queries required for a spatial analysis

THE GEOLOGICAL MAP OF PALEOPROTEROZOIC TIREK TERRANE (WESTERN HOGGAR, ALGERIA), 1:200.000.

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KEY WORDS: Remote-sensing - Cartography – Geochronology - Paleoproterozoic - Pan-African - Hoggar.

INTRODUCTION

The Hoggar (South Algeria) is composed of an amalgamation of Archean, lower Paleoproterozoic and juvenile terranes during the Pan-African orogeny, between 750 and 550 Ma (Black et al., 1994).

In this work we present a geological map at 1:200,000, integrated into a GIS, of the central part of Tirek terrane (Western Hoggar), one of the least known of the Hoggar. For this work, combined with several field missions, the image processing satelitales Landsat 7 ETM + (Colour composites, principal component analysis, band ratios, directional filters, etc ...) was essential. New geochronological (U-Pb, LA-ICP-MS) and petrological datas were also included.

REMOTE-SENSING AND CARTOGRAPHY

The image processing ETM + Landsat 7 was a very great contribution. Thus, the map of the foliation trajectories and major accidents was obtained by directional filtering while the nature of the different lithology are mapped through false color composites, the principal component analysis and band ratios. Associated with the field work, the result is a map where there were from West to East:

- A NS mylonitic broadband, corresponding at megashear zone,
- A block of a few hundred meters consists of a training gabbros and ultramafic rocks.;
- One large sub-meridien compartment where the foliation is generally NS, however, disturbed by mega-folds. It consists of migmatitic orthogneiss, dated at 1965 ± 18 Ma (this study), surmounted by metasediments composed of quartzites associated with metapelites and aluminous shales. Two generations of migmatitic orthogneiss intersect this base: alkaline pink migmatitic orthogneisses sills, dated at 1810 ± 38 Ma (this study) and calco-alkalin gray migmatitic orthogneisses with contours more diffuse, dated at 663 ± 4 Ma (this study).
- Then a compartment in the same direction slightly deformed. It occupies the largest space and corresponds to a dioritic-granodioritic batholiths. It is cut by small granitic and dolerite dykes. It is attributed to Panafrican (Caby, 2003).
- Finally, further east, a Pharusian (late Panafrican) low metamorphic volcano-sedimentary formation.

Figure 1 Principal component 1 obtained on the bands of 7,5,4,3,2 and 1 of Landsat 7 ETM + image.

CONCLUSION

This study shows that treatment of Landsat 7 ETM+ can be extremely effective in the Precambrian geological mapping of areas located in arid desert where the methodology is associated with a parallel bibliographic and field work as a tool for reference, checking and validation. This gives us, for the Hoggar, where few maps were published despite an area of 500,000 km2, very promising perspectives for more efficient geological mapping: both in quality and in realization time.

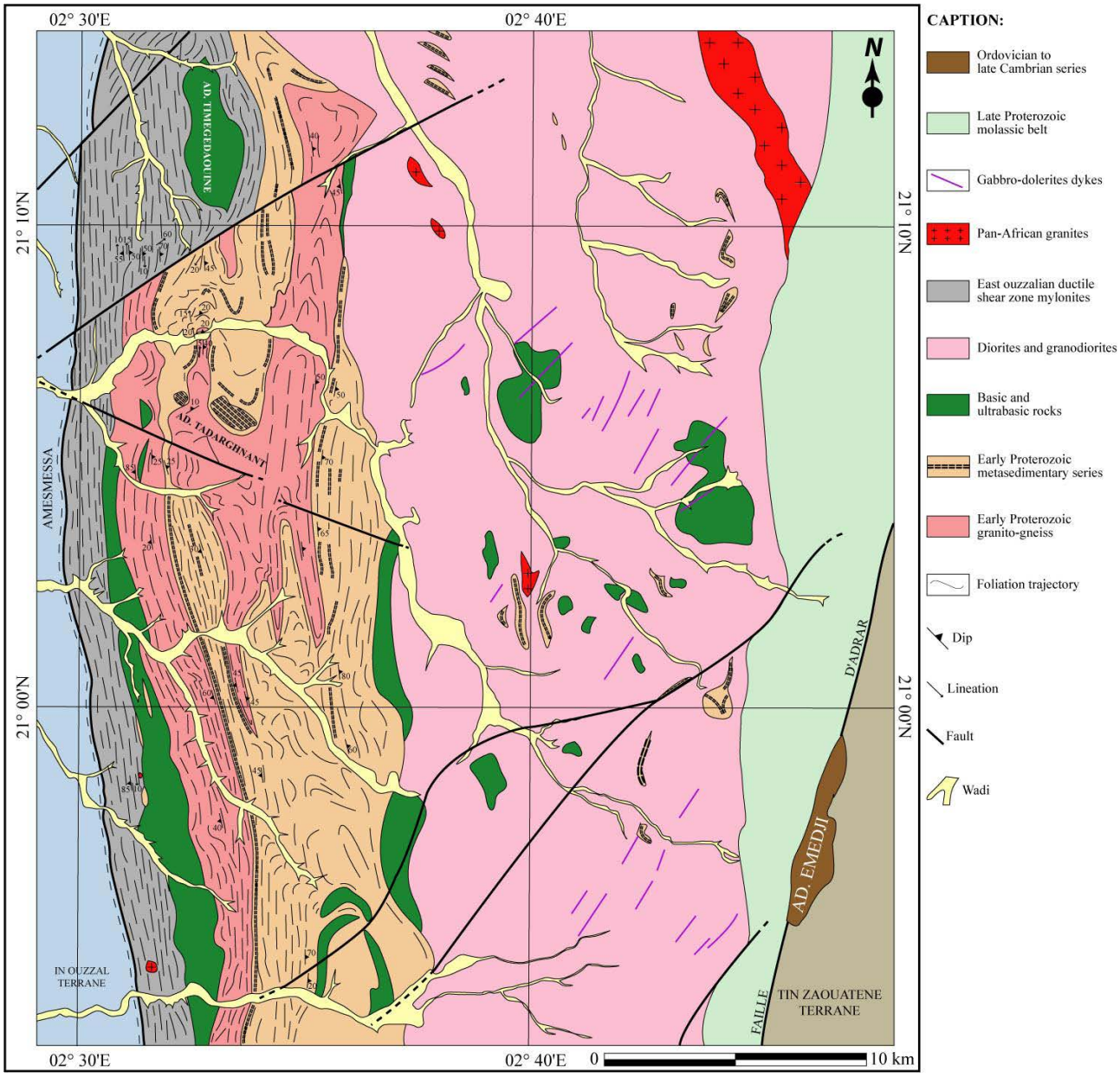

Figure 2 – Geological and structural map of Tirek showing the foliation trajectory and the lithologic diversity.

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GEOLOGICAL CARTOGRAPHY OF THE MARCHE REGIONE AT 10.000 SCALE

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KEY WORDS: CARG Project, geological map, database

GEOLOGICAL MAP OF MARCHE REGION

The geological map of the Marche Region at 1:10.000 scale, currently available for consultation, covers an area of 6576 km^2, equivalent to more than 2/3 of the region. It is the end result from the implementation of two projects: the first, called the "CARta Geologica nazionale" (CARG), was launched in 1993 as a result of funding from the National Geological Survey (now ISPRA) and co-financed by the Marche Region, while the second (what we call DOCUP 5B) was activated from the Marche Region following the earthquake of 1997 with european financing. Soon geological coverage of the region will also be integrated with the coastal areas (and a part of sea) detected by a third project, also made an agreement with the National Geological Survey, concluded in 2011. Its maps will be made available as soon as possible.

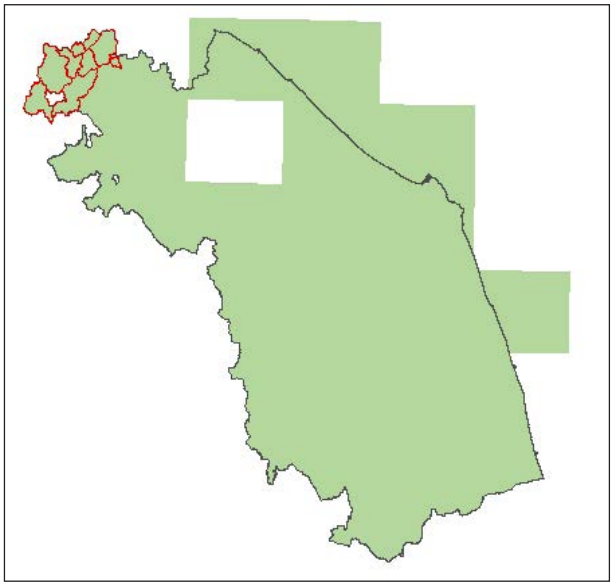
A fourth project, enteraly financed from the Marche Region, interests the south of Marche. Its maps will be made available as soon as possible.

Subsequently the completion of the first two projects, in order to attain a homogeneous and organized product, the Marche Region launched a new work to unify the results of the two works and to transfer of geological information from the old base map (topographic map derived from land coverage in 1978) to the new C.T.R. (Regional Map, realized in 1999-2001).

This new project, is based on the controls and testing of matches between the geological map, of course, without repeating the geological survey and then based on a general control of database .

The result is a geological "*unicum*", structured as a unique area where are elements of structural geology, geological boundaries distinguished by the criterion of lithostratigraphy (Geological formation, Member and lithofacies), quaternary deposits classified according to the criterion of UBSU (Supersynthem and synthem). For some types of information, presented in CARG projects or DOCUP 5B, was verified the inability to guarantee the geometric correctness in the transition between the old and the new base maps (inherently incoherent with each other), and for this reason were not so reported some type of areal and linear geomorphological elements such as quarries, cones, the edges of the landslide scarp, the edges of river terrace.

Imminently the geological "*unicum*" will be integrated with the third and fourth project in order to cover the entire regional territory except for an area where ISPRA is working.



The wealth of geological information, created by the Marche Region over the past two decades, represents a basic knowledge of the physical characteristics of the area critical for the proper use of natural resources and wants to be an important tool for planning medium to large sized scale, design works and the prediction and prevention of natural hazards.

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SUBSIDENCE MONITORING AT REGIONAL SCALE IN EMILIA-ROMAGNA REGION

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KEY WORDS: subsidence, levelling, GPS, SAR.

INTRODUCTION

In the last decade has been assisted to a considerable development in the techniques used for the monitoring vertical movements of the soil. This paper illustrates the methodologies used to monitor land subsidence at regional scale since 1999 in Emilia-Romagna region, whose lowland is subjected to vertical movements due both to natural and anthropogenic subsidence. The first one, mainly due to the geological context, consists on few mm/year variable velocity rates from area to area. The second cause of movements is related to anthropogenic activities, especially since the 50s of the twentieth century. This latter is mainly due to the over-consumption of fluids from the subsurface, and generally it shows velocity rates much higher with respect to natural subsidence. The phenomenon was initially monitored by different Institutions, but in limited geographic areas and without providing a monitoring plan consistent on a regional scale. These initiatives, though useful at the local level, have revealed, on larger portions of territory, overlaps, inconsistencies and gaps [1].

In order to overcome these problems ARPA Emilia Romagna (Regional Agency for Environmental Prevention in Emilia-Romagna Region), on behalf of the Emilia-Romagna Region and in collaboration with the Department DISTART (now DICAM Dept) of the University of Bologna, established a network composed by 2300 levelling benchmarks, connected to 60 GPS marker points, covering the whole regional part of the Po Valley. Both networks were measured for the first time in 1999; the measurement of the GPS network was repeated in 2002. In 2005-2007, the geometric knowledge of the regional subsidence phenomenon was updated through the integration of data obtained by two techniques: high precision spirit levelling through the surveying of a subnet of the regional network (about 50% of the whole network, composed of more than 1000 benchmarks), and radar interferometry analysis with the PSInSAR™ technology, covering the whole plain territory of the region, about 11,000 km^2 [2], [4]. This technique exploits long temporal series of satellite radar data, acquired over the same area of interest at different times, to identify “natural radar targets” that return stable radar reflections over time back to the satellite, where very precise displacement information can be retrieved [5], [6].

The PSInSAR™ analysis carried out, focused on two distinct periods: the first time interval 1992-2000 refers to the processing of data from ERS1 and ERS2 ESA satellites, while the second one, concerning the time interval 2002-2006, refers to the processing of data from Envisat (ESA) and Radarsat (Canadian Space Agency) satellites.

In 2011, Arpa on behalf of the Emilia-Romagna Region and in collaboration with the DICAM Dept. estabished the first phase of a new survey of the ground vertical movements over the Po Valley part of the region through an analysis based on the SqueeSAR™ technique, the latest evolution of PSInSAR™ technology [7], realised using radar images acquired by the satellite Radarsat, in the period 2006-2011 and controlled by 17 permanent GPS stations homogeneusly distributed in the area of investigation.

THE 2011 SURVEY

The analysis carried out with the interferometric technique SqueeSAR™ has allowed the comprehensive coverage (about 13,200 km^2) of the entire flat area of Emilia-Romagna, with about 318,600 measured points. In particular for each point has been determined the rate of vertical movement of the ground in the period January 2006 - May 2011 and the displacements time series. Enlarging the time span of the dataset and thank to the introduction of the new SqueeSAR™ technique, the density of the measured points has increased dramatically (more than 50%) with respect to the previous process, especially outside of urban areas. In parallel, the acquired data from 17 permanent

GPS stations (Figure 1) were processed through a time-series analysis in order to calibrate and verify the SqueeSAR™analysis, defining an "absolute" velocity datum with respect to the International Terrestrial Reference Frame. Thus, for the first time, in the study of land subsidence in the Emilia-Romagna, has been overcame the concept of an *a priori* fixed reference point within a geodetic network, historically assumed stable, on the basis of generic considerations about the structural stability of the geological context of the area not really verified experimentally.

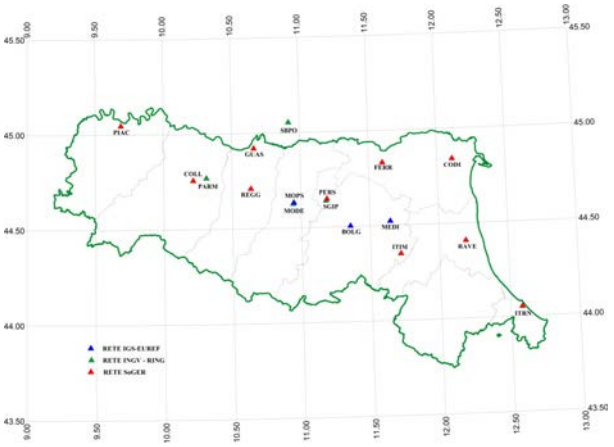

Figure 1 - Positions of the GPS permanent stations.

The techniques of Space Geodesy for the global positioning allow to determine independently from classical topographic measurements the ground displacement where the GPS station is fixed (vertical and horizontal components). In this way the continuous GPS, becomes a landmark of which are accurately measured its "absolute" movements over time.

The calibration work and the final validation [3] of the interferometric results is ongoing and it will end in 2012 with the production of an updated map of the vertical rates of the ground in the period 2006-2011. A preliminary result is shown in Figure 2, where the histograms represent vertical ground movement rates in 2006-2011 period, derived by 17 GPS stations processing.

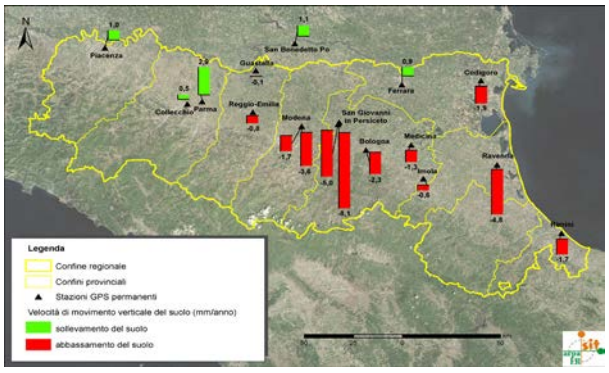

Figure 2 - Vertical movement rates (mm/y) in 2006-11 period for the analysed GPS permanent stations.

CONCLUSION

In 2011, Arpa Emilia Romagna on behalf of the Emilia-Romagna Region and in collaboration with the DICAM Dept has released the first phase of an updating work about the geometrical knowledge of subsidence over the lowland of the Region. A radar interferometric satellite analysis was made using SqueeSAR™ analysis of Radarsat images over an area of about 13,200 km^2. The radar data come with the analysis of 17 permanent GPS stations located in the same area. Therefore a second phase of work is ongoing, involving the calibration and verification of SqueeSAR™ data through the information acquired by GPS (in this study adopted instead of spirit leveling used in the previous analysis).This approach was chosen in order to fix the uncertainty related to the real stability of the reference point adopted in classical network analysis. The final results will be produced within 2012 through the realization of a new thematic map of land subsidence in the Emilia-Romagna part of the Po Valley in the period 2006-2011.

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AUTOMATED PRODUCTION OF GEOSCIENTIFIC MAP SERIES AT THE BAVARIAN ENVIRONMENT AGENCY

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KEY WORDS: GIS, cartography, map series, automatic map production, ArcGIS, KTS, map generator

INTRODUCTION

Since the beginning of the EU-Project "Information Offensive Shallow Geothermal Energy" in 2008, the Bavarian Environment Agency (LfU) has been collecting a huge amount of geoscientific data. A main goal of this project is to publish geoscientific base maps as downloadable PDFs. To reach this objective, the production of geoscientific map series like the General Soil Map of Bavaria 1:25.000 (UEBK25) needs to be optimized. Therefore the Geographic Information System ArcGIS 10 has been enhanced with a toolset to configure and automatically export map sheet line-oriented map series. This so-called "map generator" shall be introduced during this presentation.

AUTOMATION OF MAP SERIES

Each map sheet of a map series is generally based on a map template, which defines static and dynamic map elements (Fig. 1). While static map elements, like the title of a map series (e.g. "General Soil Map of Bavaria 1:25.000 ") do not change, dynamic map elements like map sheet name (e.g. Aham", "Frontenhausen") or map sheet number (e.g. "7440", "7441") change with each map sheet. Beside textual changes also spatial changes can occur, for example the extent of a map changing with each map sheet using the spatial information of a map sheet index. According to these examples the key to an optimized map series production lies in the automation of dynamic map elements.

The idea of an automated map series is not new. In ArcGIS 10 Desktop two ESRI tools for an automated map series production can be used: firstly the standard tool "Data Driven Pages", and second "MPS Atlas" as a component of ESRIs extension "Production Mapping", which provides additional features. Because neither "Data Driven Pages" or "MPS Atlas" fulfils our requirements an enhanced generic map generator was developed by GISCON based on their existing standard generator tool KTS, which is limited up to three Dataframes and offered restricted functionality.

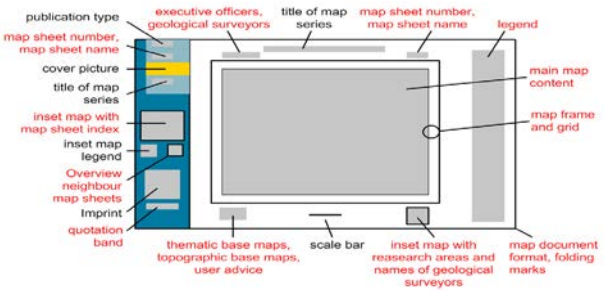

Figure 1 – Template of the "General Soil Map of Bavaria 1:25.000" (UEBK25) with static (black) and dynamic (red) map elements.

ARCGIS INTEGRATION AND ARCHITECTURE

The map generator is a further development of the standard software KTS[1] 2.0 of GISCON. KTS is designed to automate the production of Mapbooks or high quality map series in professional, cross-functional teams and cartographic departments. *Based on an Add-In concept it is fully integrated in the functional and GUI concept of ArcGIS 10 (Fig. 2). The map generator is based on ArcObjects technology and implemented as a modular architecture, which assures simple maintenance and update of tools and functions. The map generator runs on Windows XP, Windows 7 and supports German and English.*

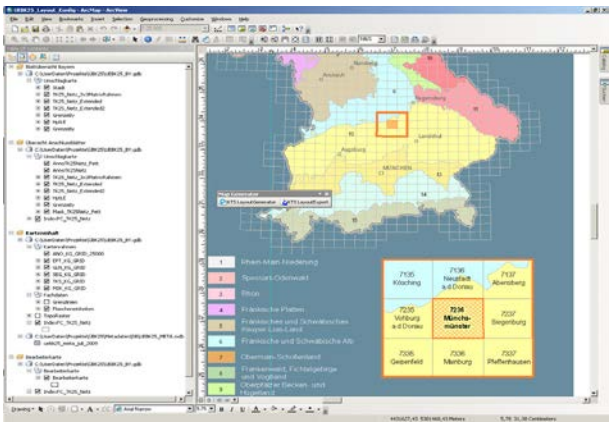

Figure 2 – ArcGIS Toolbar with "KTS LayoutGenerator" and "KTS LayoutExport" tool.

1 KTS is the german acronym for "KartenToolSet" meaning "Mapping ToolSet" or "Map Production ToolSet" in English.

WORKFLOW AND FUNCTIONALITY

When using the map generator the production workflow of a map series consists of two steps (Fig. 3):

1. Configuration
2. Map export

While the configuration of a map series requires cartographic knowledge and advanced ArcGIS Desktop skills the export of one or more map sheets is easy to apply. After the configuration it is possible to save the configuration parameters in a human readable and editable XML file. This XML file will later control the map export.

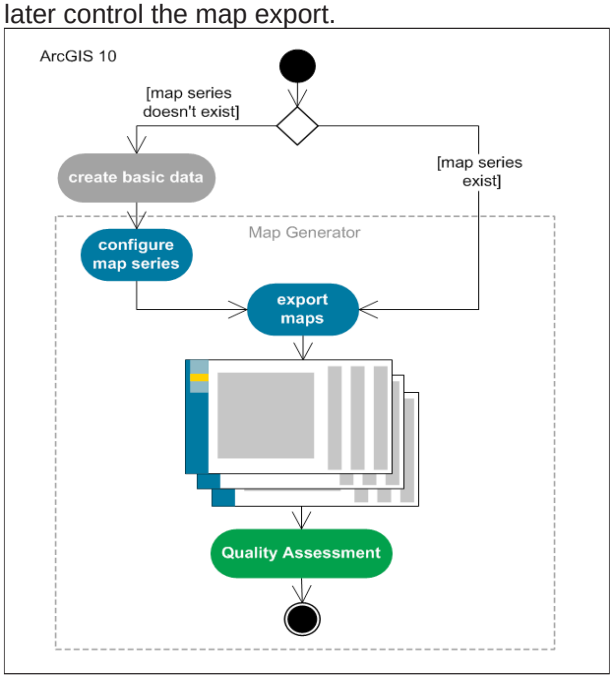

Figure 3 – Main activities of map series production using the map generator.

CONFIGURATION

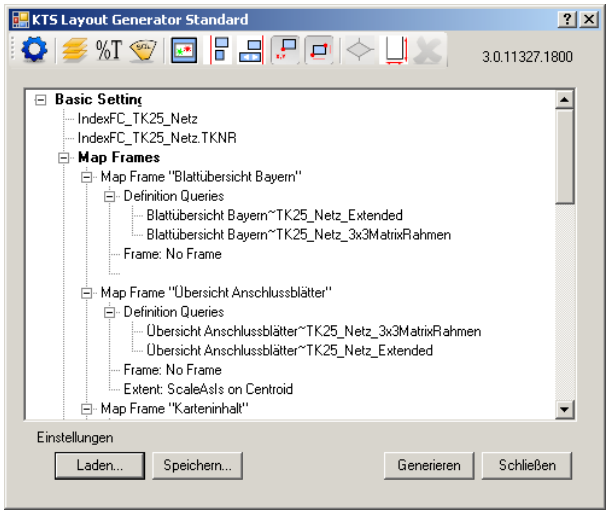

Figure 4 – KTS Layout Generator with an extract of the configured UEBK25.

The "KTS Layout Generator" provides tools and functions to configure dynamic map elements. The configuration starts with a style sheet MXD which represents the layout concept of a map series with all its static and dynamic map elements. Normally such an MXD shows a fictional sample map sheet. The user checks all dynamic elements defining their data sources, their map sheet driven behaviour, element rules and element dependencies. All configuration parameters are visualised in a tree structure (Fig. 4), which can be stored and reloaded as an XML file. After the configuration is done, all the settings will be generated and exported as a "Layout-XML-File", which contains the change instructions for all dynamic elements in each map sheet. The following settings or dynamic elements can be defined by the user:

Basic Settings

In the basic settings the user chooses an "Index Feature Class" and a unique map sheet name field. The combination of both is later used to identify and access individual sheets within the map series. Each feature belonging to the "Index Feature Class" represents the spatial extent of a map sheet. Its attributes represent marginal data or control attributes (e.g. rotation angles). In the case of UEBK25 the "Index Feature Class" is represented by the map sheet line system of the Topographic Map of Bavaria 1:25.000.

Dynamic Data Frames

The user can define any number of dynamic data frames for an automated map series. Within the UEBK25 the main map is represented by a dynamic data frame named "Main Map Content". This data frame changes its extent and its rotation angle while the scale of 1:25.000 remains the same. Furthermore it uses the clip to shape function using the "Index Feature Class" geometry.

Dynamic Texts

Dynamic text elements can be configured via text variables. Text variables can be defined within the layout generator and can be assigned to an attribute field in the defined "Index Feature Class" or any related tables or databases. The user can combine different text variables with each other or with system information (e.g. current date) or text constants. In the case of UEBK25 the map title and the map number will be changed with each map sheet (Fig. 5).

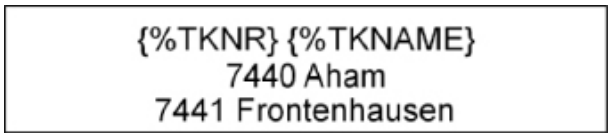

Figure 5 – Example for combined text variables taken from the UEBK25.

Dynamic Tables

In the configuration process the user has the

possibility to configure the number of columns, data connections and layout parameters for a dynamic table. The configuration can be saved in a separate XML file. The idea behind dynamic tables is, that the number of data records change with each map sheet. One use case for dynamic tables can be found in the “Hydrogeological Map of Bavaria 1:50.000” (HK50).

Dynamic Raster Graphics

For dynamic raster graphics the user can configure a dynamic access path. The dynamic element inside the path should be a unique parameter like the map sheet number or map sheet name. Thus it is possible to change the path with each map sheet and with it the corresponding raster graphic inside the MXD file. A common application could be the change of a cover picture with each map sheet.

Dynamic Map Frames

The user has the possibility to configure different map frame templates and their corresponding grids. These templates are especially prepared for the use at the LfU and the configuration can be saved separately in an XML file. After configuring a template the user can choose one map frame template per data frame in the dynamic data frame settings. Beside these templates it is also possible to use the ArcGIS standard grid tool. For the realization of the UEBK25 a map frame with a combination of Gauss-Krueger and geographic coordinates has been chosen.

Dynamic Legend

For a dynamic legend the user can configure its position, size, layout properties, distances, legend text elements including their data connections and symbols. The configuration can be saved separately as an XML file. The main goal of a dynamic legend is a context-sensitive representation for each map sheet. To realize a complex geoscientific legend like in the UEBK25 a structured database with all textual legend elements and a central symbol library is essential.

Dynamic Definition Query

For each feature layer the user can define a dynamic definition query. A dynamic definition query is a combination of a static SQL statement and a dynamic variable, which is represented by an attribute field of the “Index Feature Class”. With a dynamic definition query it is possible to change the SQL statement automatically with each map sheet. Within the UEBK25 a dynamic definition query is used to highlight the current map sheet in an inset map.

Dynamic Document Format

During the configuration the user has the possibility to configure the behaviour of a map document in interaction with its dynamic map elements. That means, if the legend in one UEBK25 map sheet is for example larger than in another, the document format needs to be enlarged. The user can define an enlargement interval, an element free border area and dynamic folding marks.

Layout Rules

With the help of unique element names the user can define different layout rules. These layout rules could comprise scale rules, position rules and minimum distances between two map elements. In the case of UEBK25 there is for example a relation between the dynamic text element “thematic base maps” and “topographic base maps”. If the textual content of the dynamic text element “thematic base maps” is extended, the text element “topographic base map” needs to be moved downwards maintaining a predefined distance.

MAP EXPORT

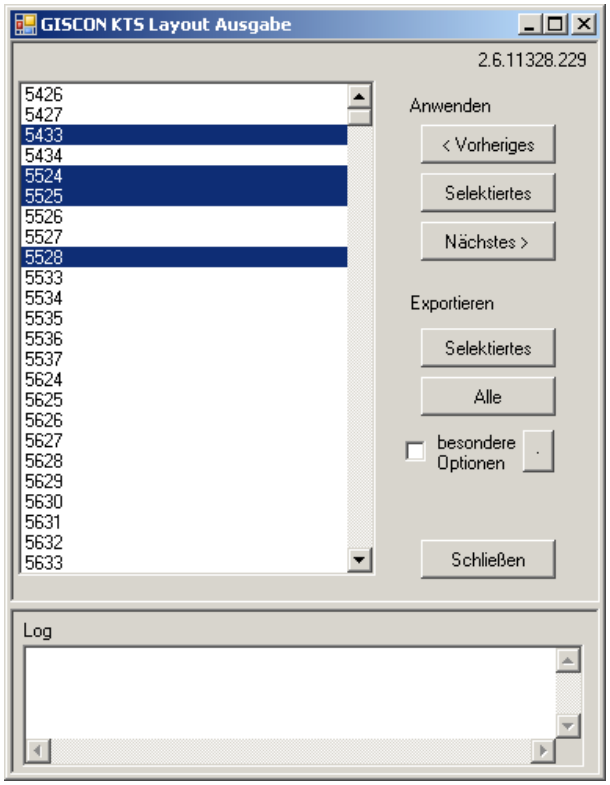

Figure 6 – Screenshot of the layout export tool with a selection of UEBK25 map sheets.

After loading the generated layout XML file to the “KTS Layout Export Tool” a list with all available map sheets will be shown (Fig. 6). Each map sheet is described in a part of the XML file, which defines all changes from one map sheet to another. With a double click on a map sheet number all changes will be executed and a preview of the selected map sheet will be shown in the MXD. Beside this preview function the user has the possibility to export one

or more maps in different output formats (e.g. z.B. PDF, JPEG, TIFF, GeoTIFF). These formats can be defined by default or individually using a configuration dialog. Additionally, the user has the option to edit or improve a single map sheet in a separate MXD.

CONCLUSION

What are the consequences after the introduction of the map generator at the LfU? First, a new level of cartographic quality has been introduced. That means beside high quality maps, which where made manually by cartographers, there exists a new type of automatically produced maps. Second, it means more conceptual cartographic work in cooperation with geoscientists and less work in the field of individual map sheet production. Third, because automation is always connected with a loss of cartographic quality, there has to be a well-balanced relationship between cartographic compromises and readability of a map. Fourth, the preparation and configuration of a complex map series takes time. But once configured it can be exported at any time in a standardized way. Fifth, the underlying generic concept of the map generator opens the possibility to realize thematic map series with all kinds of environmental topics beyond soil and geology.

The realization of the UEBK25 shows that different requirements for an automatic map production (e.g. geoscientific legend, metadata, symbol libraries etc.) already exist. The well-structured spatial and non-spatial data of the UEBK25 can be regarded as a good example for further map series.

NUMERICAL MAPPING USING GEOPHYSICAL AND GEOCHEMICAL DATA IN THE NE PART OF CENTRAL MOROCCAN MASSIF AND SUB-HORIZONTAL MIDDLE ATLAS FORMATIONS (AGOURAI AND EL HAJEB AREA)

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KEYWORDS: Mapping, Spectrometric data, Resistivity, Magnetism, Geological Structures, Middle Atlas, Central Massif, Morocco.

INTRODUCTION

The Techniques of numerical mapping based on the interpretation of geophysical and spectrometric data is applied in the NE part of the Central Moroccan Massif in order to study geological structures of this area and their relationship with the sub-horizontal mesozoic formations (Agourai and El Hajeb regions). So that a GIS database is prepared including all data required which permits to superimpose whole geological informations (Randrianasolo, 2009).

The data used in this study are treated with the Oasis Montaj program. They were already acquired during a program of measurements organized by Moroccan ministry of Energy and Mines. In order to use these techniques, we have to digitize data and to realize a database giving possibilities to compare numerical anomalies and geological maps of the region (Figure 1).

THORIUM (TH) SPECTROMETRIC DATA

The spectrometric map of the Thorium (Th) element traduces the gamma photons energy produced by outcrops during the disintegration of the Thorium (Denden, 2009).

The Th radiometric anomalies map is obtained after treatment of the systematic map of the Th gamma of the whole region (Figure 2). It consists of the digitization of about 9750 measurement points in order to obtain a numerical database which is analyzed with the Oasis Montaj software. The obtained results show NE-SW trending anomalies corresponding to the regional geological structures and permits to distinguish clearly the limit between the Paleozoic basement and the sub-horizontal Meso-Cenozoic cover of the Middle Atlas.

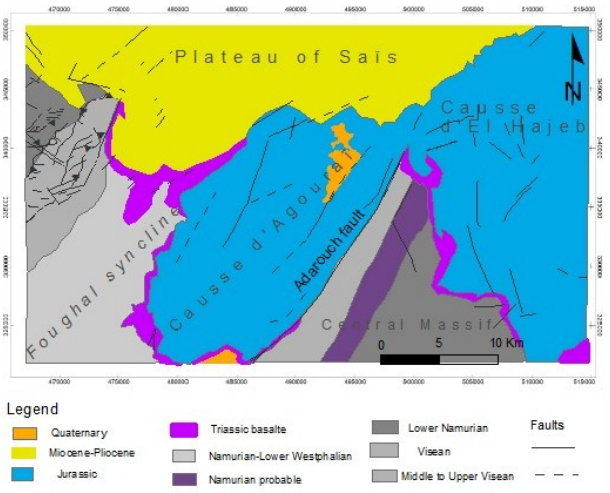

Figure 1 : Geological map of the study area

RESISTIVITY DATED 900HZ

The interpretation of the apparent resistivity data of a frequency 900 Hz shown in figure 3, obtained by the digitization of about 6790 measurement points, permits to characterize NE-SW trending structures of this region. The investigation depth is approximately 80m. The mapping is based on the variation of the values of resistivity of geological formations according to their lithology and facies. The variations of resistivity anomalies permit also to distinguish the limit between the folded paleozoic formations and the sub-horizontal meso-cenozoic cover.

MAGNETIC DATA

The digitization of magnetic measurements on which we based for the realization of the map of the magnetic anomalies, and which represents the natural variations of the terrestrial magnetic field, asks a creation of the data base by digitizing 9950 measurement points. The data are also treated with the Oasis Montaj program. The application of

filtering process permits to obtain the reduced to a pole map, and the upward continuation technique was applied to different elevation values in order to reveal the depth structures and formations. It also permits to detect the limit between the basement and the cover. Magnetic anomalies coincide with the succession of NE-SW trending structures corresponding to anticlines and synclines hercynid folds occurring in the whole Central Moroccan Meseta (Ben Abbou, 1990). In the Agourai region (Causse d'Agourai), anomalies are oriented NE-SW parallel to the NE-trending sub-vertical major fault of Adarouch separating Paleozoic and Mesozoic formations. Also in this region, Mesozoic formations show heterogenous magnetic responses, the northern side of the Agourai plateau (Causse d'Agourai) shows high magnetic susceptibility different of the southern part which shows average magnetic susceptibility.

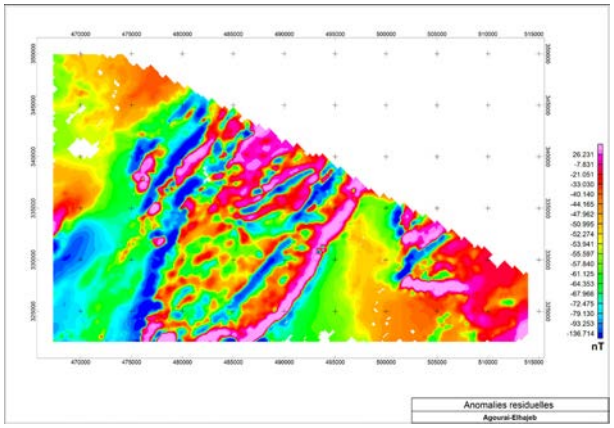

Figure 2 : Map of magnetic anomalies

DISCUSSION AND CONCLUSION

The processing and the analysis of geophysical and chemical (Th) data permit to have various anomalic zones according to different physical parameters of the main formations. The superimposition of these different maps allowed the realization of a synthetic map which relates the physical parameters of geological structures and different outcropping rocks. Thus the techniques used seem to be appropriate for indirect mapping of all geological features (formations, folds and faults structures, dykes and sills). So, it's possible to:

- Precise the limits between the paleozoic basement and the Meso-Cenozoic cover
- Determine various spectrometric and geophysics anomalies according to NE-SW direction compatible with the regional geological structures trends (folds and faults)
- Detect a NE-SW oriented system faults in the Mesozoic cover of the Middle Atlas (Agourai area) which seem to be the result of the reactivation of the basement faults

Thus, this strong correlation existing between the determined anomalies and the regional structures show that this numerical mapping could be used in other regions where access is difficult in order to put some corrections to various geological existing maps.

ACKNOWLEDGEMENTS

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VOLUNTEER INFORMATION CONTRIBUTION TO GLACIER MAPPING

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KEY WORDS: neogeography, participative mapping, glaciers.

CONTEXT OF THE RESEARCH

This paper deals with the introduction of volunteer information in the workflow of data collection, monitoring of changes, and related alerts as regards the glacier environment realm in Italian Alps. Usually such topics are addressed within institutional frameworks by the use of tools and practices that merely belongs to science, as geosciences and environmental engineering.

The revolutionary application features introduced by web 2.0, with the creation of collaborative networks and participative tools similar to social networks, has deeply changed the notion of geography itself and has brought a large number of neo-geographers to join the cartographic community.

Such innovative tools, which are still debated by the international scientific community as regards their growing potentials as well as their inherent drawbacks (Goodchild 2007), are the base for our study for the improvement (by both qualitative and quantitative point of view) of the information regarding Alpine glaciers.

The topic is of outstanding interest, since several studies recently are dealing with the glacier monitoring in a climate change and global warming perspective, in which small-medium glaciers represent optimal proxies of the Earth surface changes in energy and water budgets.

Results of such studies are sometimes extraordinary also for the public and when efficiently disseminated they obtain a good impact on public awareness and their behaves (UNEP 2009).

Hence there is a growing need of understanding the cryosphere and its phenomena, including Alpine glaciers; this understanding has as a basic element an intrinsically geographic element: the glacier. The glacier can be represented/modeled and measured in several different ways (qualitatively, quantitatively, as spatially and/or temporally distributed). Whatever the parameters used for glacier representation are, due to logistics and meteo-climatic issues, it is actual that the alpine glaciers are generally observed irregularly/occasionally and mainly by volunteers.

As a consequence, there are some problems of scarcity of reports as connected to the volunteer character of contributions, to the number/complexity of measurements to be collected, to the lack of funding.

Hence there is the need to: 1) improve the glaciological databases/collections (in terms of number of recordings and update frequencies); 2) enlarge the public engagement and the number of collaborators; 3) control the data quality while improving the awareness and knowledge of collaborators; 4) introduce such improvements with no additional charge.

Neo-geography tools seems to be able to address the mentioned issues, as well as contributing to innovation in the field by two points of view: 1) as regards methods: the involvement of volunteers in an organized network could create a positive feedback context for improving the collection protocols in parallel with the understanding of phenomena observed, in a bottom-up approach, facilitating the sharing of data and knowledge; 2) as regards technology: advance application scenarios by adapting existing technologies to specific use-cases and analysis of criticisms.

METHODS AND DEVELOPMENT

The first step of the study was devoted to the analysis of requirements in the context of glaciological information improvement: subjects traditionally involved with an institutional mandate together with potential new collaborators have been considered to finally draw out the network of actors involved besides the possible solutions for their better engagement.

In the Italian Alps the monitoring of glacier is performed by a network of different actors, who span from institutions of scientists or local authorities, to single volunteer operators (mainly hikers) who perform the annual observations in the field.

Volunteers collect measurements following different protocols, often established on a local basis, usually determined mainly to address the mountain environment constraints and often without a comprehensive experimental design.

This kind of present organization, even if

worthwhile for both activity and continuity (some historical recordings of glacier fluctuations covers up to 100 years), suffers from some limitations that ask for further improvements and that can be summarized as follows:

1. Quantity, quality and spatial/temporal frequency/representation of reports, often too scarce to properly describe the ongoing changes, especially in the last decade;
2. Poor harmonization level of data formats and information contents on a national/international level;
3. Lack of enabling strategies to open and enlarge the community to several potential members, either as contributors, or as users of information

Therefore the challenges to be addressed by the introduction of new approaches are to cope and exploit the traditional background of the volunteers, inserting it in a defined and well designed workflow, that can be shared at a regional/national level, that is operational and productive by the data collection point of view, but that it is also agreeable and rewarding for the contributors.

After the objectives have been stated and the requirements of the application been analyzed, an architecture has been designed and implemented (figure 1).

Figure 1 – Proposed architecture

As regards the implementation choice, it has been focused on the selection of communication interfaces suitable for the specific aims and targets, while assessing the solutions in terms of pros and cons.

Proposed tools are chosen from the Open and Free technological assets, to deal with the sharing data/knowledge and to avoid additional charges, taking advantage of the web 2.0 application features to collect and manage contributions coming from web users.

The Ushahidi platform has been chosen as a first implementation framework to test the collection and visualization of information from volunteer contributions. This mapping application has proven to be easy of use, efficient in the report management together with open and dynamic access to updated maps and useful for the case study at hand.

CONCLUSIONS

Observation of glaciers is a key issue in global monitoring and climate change. In this framework the Italian alpine glaciers are generally observed irregularly (occasionally) and mainly by volunteers by the use of heterogeneous protocols, and without a comprehensive observation scheme. The resulting problems – mainly the scarcity of reports, connected both to the volunteer character of contributions, and to the complexity of measurements to be collected - have been analysed in terms of actors involved and requirements and addressed with actions expressly designed in a web architecture outline.

The project is still at its early stage, anyway some first considerations can be drawn as response to the main criticism of the use case, i.e. that the neo-geography tool helped in:

- Starting-up a reporting platform shared by different groups of local volunteers
- Increasing number and frequency of reports
- Monitoring of reporting by the administrator and evaluation processes performed by the volunteers involved
- Rewarding of contributors and positive feedback for content improvement
- Enlarging of the community
- Disseminating and sharing data and knowledge to a wider public

A SWOT analysis performed on these first outcomes has helped to reveal the good solutions and the potential constraints of the project, in order to boost the former and limit the latter.

The experimental results give indications as regards future harmonizing actions as well as strategic operations in the field of glacier monitoring.

ACKNOWLEDGEMENTS

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GEOGRAPHICAL INFORMATION SYSTEM FOR THE DEVELOPMENT OF "LIMITONE DEI GRECI" GEOSITES IN BRINDISI AREA (APULIA, ITALY).

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KEY WORDS: GIS, geosite, cultural heritage, Apulia.

ABSTRACT

The idea of using a Geographical Information System to catalogue geosites that are located along the line of "Limitone dei Greci" has been carried out in a way that the characteristics of the geosites can be soon underlined .

GIS finality is to trace a course that shows the geomorphologic , hydrographic, archaeological and landscape characteristics of territory.

With the name "Limitone dei Greci" we mean a separation zone between two different geologic compositions that were crossed in Plio-pleistocene Age by a part of coast, which is remarked nowadays by a roads net from the city of Oria to the cross of the public road Mesagne – San Pancrazio Salentino.

The two geologic compositions are on two different height levels so they are parted by a scarp which was created by the erosion of Plio-pleistocene sea.

From the city of Oria moving to East there is a series of descending hills that are made of the sand of some ancient coast dune that stand on clay and sand deposits of the Pliocenic sea.

There are ancient stream inlets, the canal of Pezza dell'Abate and the canal of Crepacore, in which rain waters flow, sources phenomenon, fossil outcrops.

For the presence of many territorial resources, this area presents settlements from the Palaeolithic to Prehistoric and protohistoric, but above all in Roman and Medieval Age the roads course that connected Oria with Otranto developed.

Finally, in this GIS proper electronic tabs will be arranged and converted in special formats to be dynamically linked to artifacts and to the vector themes that are analysis objects. These tabs, beyond their natural, landscape and morphologic characteristics, offer important technical data and results to imagine first and consequently to program an ordered and efficient recovering plan for these geosites.

Figure 1 – The geologic map of Salento Peninsula (Apulia): the research area is pointed with an oval line.

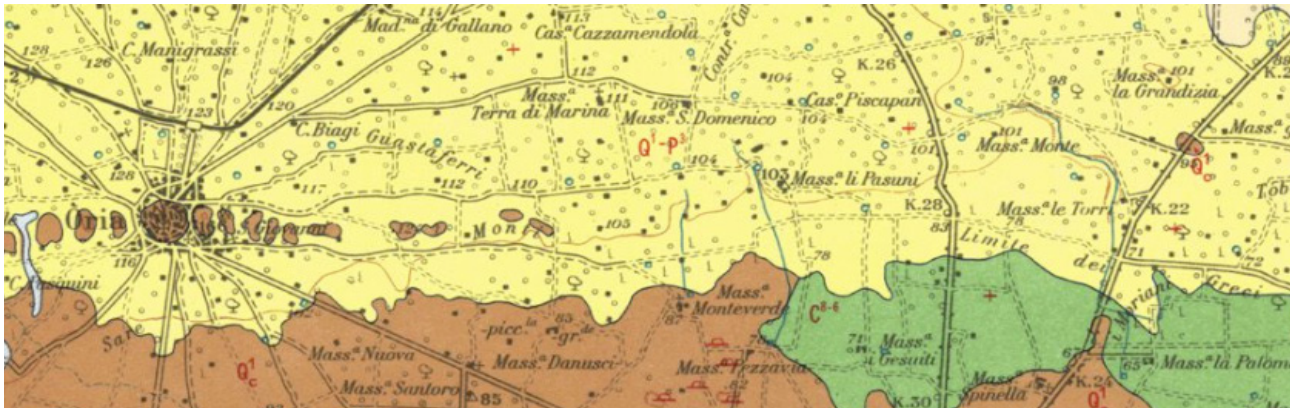

Figure 2 - The geologic map of the research area that develops among clay and sand (in yellow) and calcarenitic (in brown) and calcareous (in green).

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APPLICATION OF GEOSTATISTICS AND GIS TOOLS FOR THE INDIVIDUATION OF FLOODED ZONES DURING EXTREME RAINFALL EVENTS IN THE URBAN AREA OF ROME

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KEY WORDS: Urban flooding, ArcHydro tools, sinks, ordinary kriging.

INTRODUCTION

It is generally acknowledged that urban flooding linked to extreme rainfall events are a combination of overland flow, sewer surcharging and watercourse overloading (Ellis et al., 2009). During the last 5 years, the urban area of Rome has been affected by a rising number of extreme rainfall events causing flooding of shops, basements, subway stations and places of historical heritage.

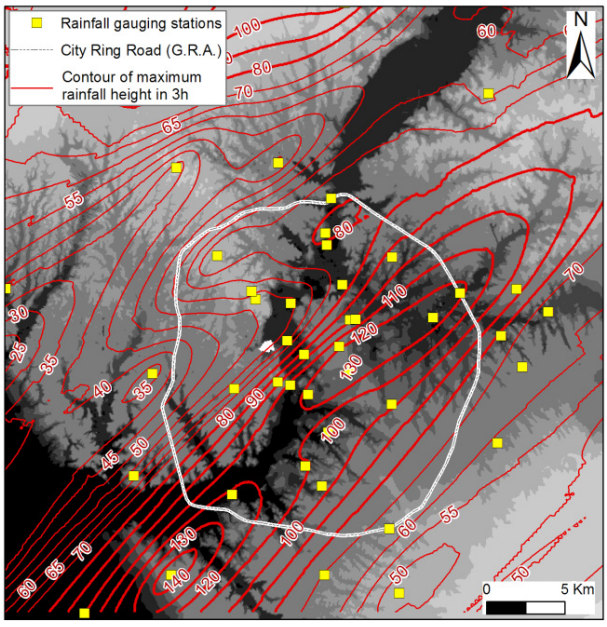

Figure 1 – Digital Terrain Model of the study area; contours are referred to the rainfall height (mm) during the event of 20 October 2011.

Two people died, during the event of 28 October 2008 in the Monterotondo municipality (northern of Rome), and during the event of 20 October 2011 in the city of Rome respectively; for this last event the cost of the damages led by the flooding is estimated between 4 and 10 mln of Euros. This study has been conducted within the 4-year UrbiSIT project between the Civil Protection Department and the CNR-IGAG (Institute for Environmental geology and Geoengineering of the National Research Council) and is aimed to develop tools and guidelines for geohazard evaluation in urban areas. This work describes a procedure aimed to furnish a useful tool for urban stormwater management by detecting areas of maximum flooding risk and, thus, provide information to the local administrations for planning emergency interventions.

METHODOLOGY

The analysis of possible critical situations of flooding was performed by the overlay of topography and rainfall data of extreme events, assuming a complete absence of urban drainage (i.e., sewers). The “extreme” events are defined as those with rainfall height exceeding 40, 60, 70, 80 mm in 30 minutes, 1, 2 and 3 hours respectively. Data from 44 rain gauges were acquired, belonging to the gauging station network of Istituto Idrografico e Mareografico della Regione Lazio - Idrographic and Maereographic Institute of Latium Region – Arsial, Regional Agency for development and innovation of agriculture in Latium Region and the Aeronautica Militare; data were interpolated by means of ordinary kriging (OK) algorithm in order to produce grid maps of maximum rain height after 30 minutes, 1, 2, and 3 hours (Figure 1). The analysis of experimental variograms highlights an anisotropy of the distribution of maximum rain values in direction N 45° for the event of 20 October 2011 and N 70° for the event of 28 October 2008, respectively. The variogram models used in the OK algorithm show a range of spatial continuity along the maximum axes of anisotropy of 25 km for the event of 28 October 2008 and 35 km for the event of 20 October 2011.

The GIS analysis of the topography was

performed by means of the ArcHydro tools (ESRI, 2011) that uses a chain of functions to analyze the geometric characteristics of the terrain, deriving the catchments and the preferential flow paths.

These functions allow to detect flood vulnerable areas (sinks). The Digital Terrain Model (DTM) with resolution 20x20 m was used to obtain a "hydraulically" correct DTM by filling the pits having a drainage area smaller than a specified threshold area. Then, sinks and drainage areas feature classes were generated, and are characterized in the attribute table by their geometric parameters as area, volume, fill depth and associated drainage area.

An average rainfall value has been associated to each drainage area on the basis of the rainfall grid maps and joined to the sink feature class; this allowed the association of the maximum rainfall height to the maximum volume of the sinks. Knowing that 1 mm of rain is equal to 1 L (or 0.001 m^3) per square meter, the height of rain fallen over each drainage area was divided by the sink area to find the volume of water that can flow toward the sink. This procedure provided the volume of rain that can be collected by each sink after 30 minutes, 1, 2, 3 hours (Figure 2). By subtracting the volume of rain from the sink volume, it is possible to distinguish completely filled sinks from not entirely filled.

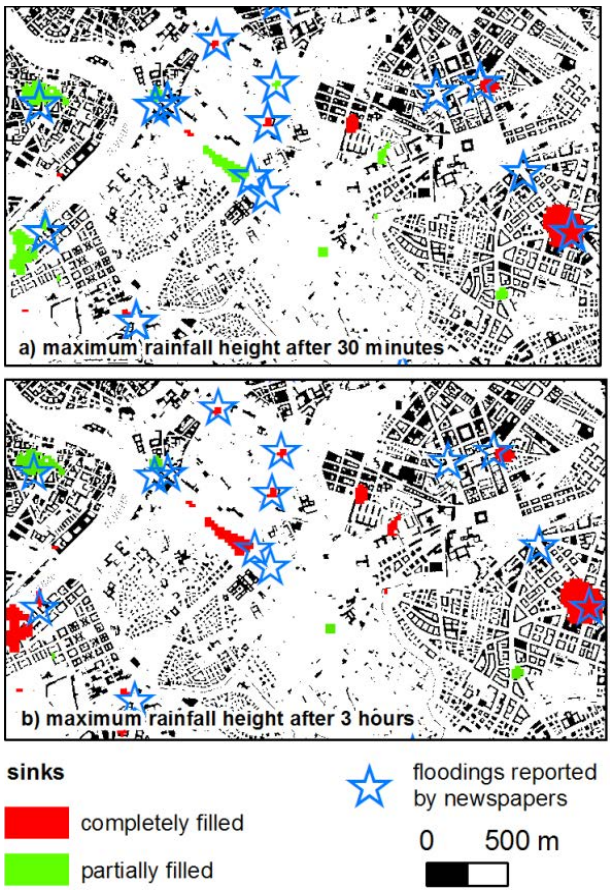

Figure 2 – Sinks filling after 30 minutes (a) and 3 hours (b) of rainfall for the event of 20 october 2011 and comparison with floodings reported by newspapers.

Obtained results are validated by using a back analysis in which calculated filled sinks have been compared with floodings reported by online newspapers in order to evaluate the predictive characteristics of the model. The model showed a good correspondence in the 40% of the completely filled sinks. Furthermore, a possible relationship between filled sinks and their distance from drainage and sewer network has been evaluated by a proximity analysis. Figure 3 shows that the majority of filled sinks after 3h is located within a distance of about 100m (61% of case cases from the drainage network and 40% of cases from the sewer network. This highlights that the zones with the highest susceptibility to flooding are located closed to the natural and anthropic drainage network.

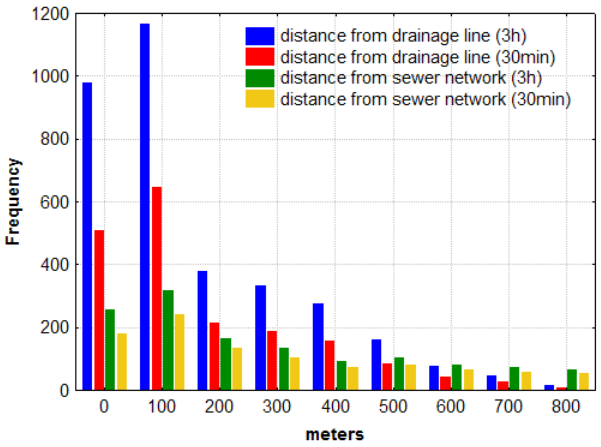

Fig. 3: proximity of completely filled sinks to the drainage and sewer network

CONCLUSIONS

The described procedure allows to quickly identify areas of maximum flooding susceptibility under the hypothesis that all the rainfall volume is not be drained by the sewer network. Results of model validation through back analysis show that some areas which are not supposed to be flooded in relation to their topography conformation, were flooded during extreme events: this can be related to structural inadequacy or lacking of sewer network maintenance.

It is important to remark that the reliability of the sink evaluation is strictly dependent on DTM resolution. Furthermore, and that the obtained results should be validated by using a wider dataset, for example by using the database of hourly emergency calls of firefighter (VV.FF.). Future work will involve the application of a geographical weighted regression to derive susceptibility models from the analysis of statistical relationships between the known flooded areas and a group of conditioning factors.

The described procedure is aimed to furnish a tool for urban stormwater management during emergency situations by detecting areas of maximum flooding risk and, thus, provide information for the

REMOTE-SENSING, CARTOGRAPHY AND TECTONIC EVOLUTION OF ARCHAEAN SERIES REWORKED AT PALEOPROTEROZOIC FROM AMESMESSA (IN OUZZAL PRECAMBRIAN TERRANE, WESTERN HOGGAR, ALGERIA).

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KEY WORDS: Remote-sensing - Cartography - Reworked Archaean - Paleoproterozoic - Pan-African - In Ouzzal Terrane - Hoggar.

GEOLOGICAL SETTING AND LITHOLOGY

The In Ouzzal terrane (Western Hoggar) is an example of Archaean crust remobilized by a very-high-temperature metamorphism during the Paleoproterozoic (2 Ga) (Haddoum et al., 1994). Structural geometry of the In Ouzzal terrane is characterized by closed structures trending NE-SW to ENE-WSW that correspond to domes of charnockitic orthogneiss. The supracrustal series are made up of metasediments and basic-ultrabasic rocks that occupy the basins located between these domes (Ouzegane et al., 2003). In the Amesmessa area the supracustal synforms and orthogneiss domes exhibit linear corridors near their contacts corresponding to shear zones. The structural features in the Amesmessa area, observed at the level of the base of the crust, argue in favour of a deformation taking place entirely under granulite-facies conditions during the Paleoproterozoic. These features are compatible with D_1 homogeneous horizontal shortening of overall NW-SE trend that accentuates the vertical stretching and flattening of old structures in the form of basins and domes. This shortening was accommodated by horizontal displacements along transpressive shear corridors.

During the Pan-African event, the brittle deformation affected the granulites which were retrogressed amphibolite and greenschists facies with the development of tremolite and chlorite, in the presence of fluids along shear zones corridors. Brittle deformations were concentrated in the southern boundary of In Ouzzal. An important NW-SE-trending dextral strike-slip pattern has been mapped along which we can see the Eburnean foliation F_1 overprinted. This period was also marked by ductile to brittle deformation along the eastern shear zone bordering the In Ouzzal terrane with steep fracture cleavage (NNW-SSE) and conjugate joint pattern. All these structural features are compatible with an ENE-WSW shortening in relation with the collision between the West African Craton and the Hoggar during the Pan-African orogeny.

REMOTE-SENSING AND CARTOGRAPHY

The IOT largely crops out in the rocky and sandy desert of western Hoggar. It is essentially a flat area with some reliefs composed of late granites, dyke networks or Palaeozoic volcanic rocks. The flat areas are particularly suitable for a radar study because: i) the sand cover is low if not absent over the bedrock; ii) the slope is generally gentle and the hydrographic network slightly expressed; iii) the structures are relatively obvious (folds, faults, veins, etc.); iv) the link between surface roughness and lithology is frequently close, for example in the case of BIF or marbles.

The main radar data used are those obtained with the ALOS-PALSAR sensor (L-band, quad-pol mode), the ALOS-SCANSAR sensor (large swath), the ERS-EMI sensor and the ENVISAT-ASAR sensor, both with the C-band. Results obtained using radar remote sensing have been also compared to the gravimetric and magnetic data acquired by the geophysical survey of the early 1970's. Complementary observations have been made using optical imagery (Figure 1).

The detailed mapping of some key areas checked in the field indicates extensive Archaean dome-and-basin patterns. The domes are made of charnockitic orthogneiss, whereas the basins are filled with marbles, BIF and mafic to ultramafic materials (Djemai, 2008). In certain parts, the supracustal synforms and orthogneiss domes exhibit linear corridors corresponding to shear zones. These shear zones are frequently formed in quartzites (Figure 2).

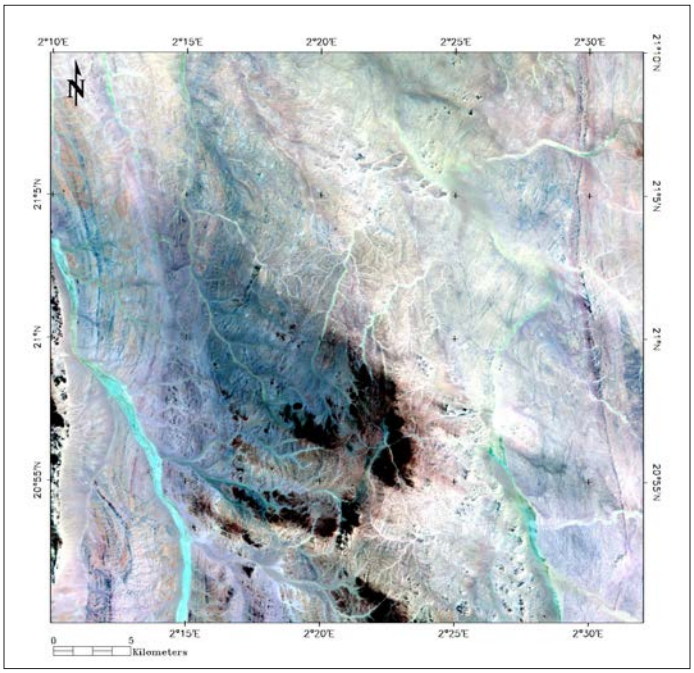

Figure 1 – Landsat 7 ETM+ image in RGB (7, 4, 2) (path: 194- Row: 045, 04 May 2003) of Amesmessa area.

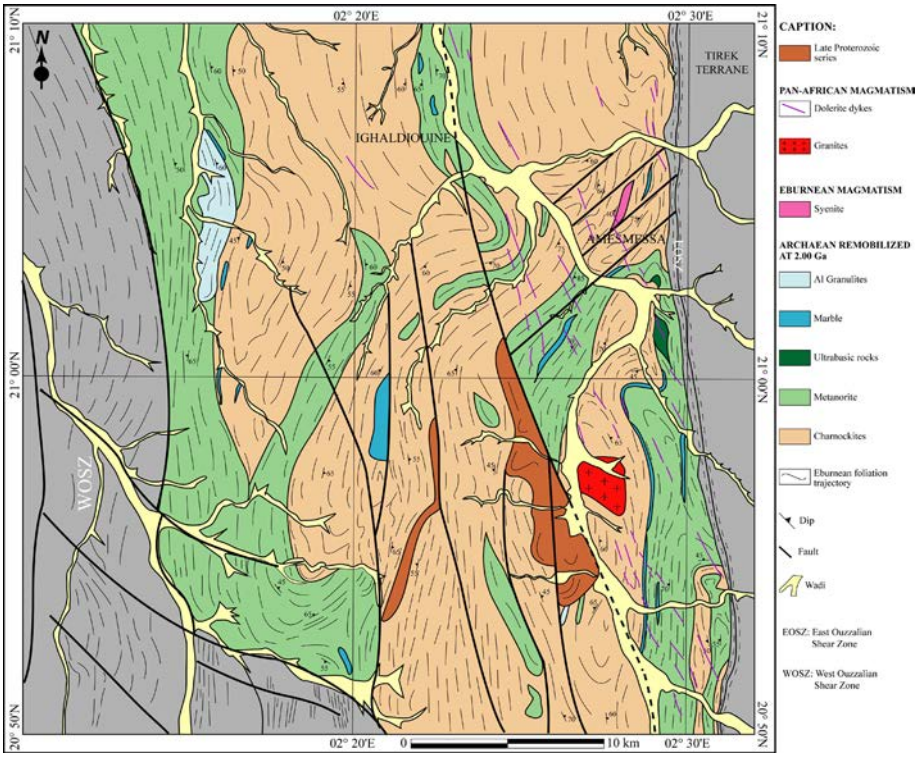

Figure 2 – Geological and structural map of Amesmessa area (Djemai, 2008) showing the foliation trajectory and the lithologic diversity.

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A SPATIAL PREDICTION MODELING SYSTEM FOR MINERAL POTENTIAL AND NATURAL HAZARD MAPPING

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KEY WORDS: spatial prediction, favourability, mineral potential, hazard assessment.

INTRODUCTION

During the past 40 years the need for national, regional and local institutions to anticipate the availability of resources has become increasingly more stringent. For this reason, a multitude of quantitative methods have been developed to construct resource potential maps of regions of interest. Similarly, hazard maps have been constructed for predicting the distribution of occurrences of landslides, floods and other hazardous events, particularly soon after disasters. Much of the work initially was restricted to the representation of known mineral occurrences or of past hazardous events, nevertheless, mathematical models were also developed to generate cartographies of the future that implied much greater social responsibility. Predictive spatial data analysis seeks to extract relationships between the occurrence of known discoveries and the distribution of mapping units within co-registered stacks of digital thematic maps. The combination of overlapping mapping units, hopefully, indicate the typical setting of the occurrences. Such spatial relationships within training areas, under assumptions of similarity of conditions in past and future periods, are used by mathematical models to infer future distributions within a study area.

MOTIVATION

Two main problems were encountered in the spatial modelling work of the past decades: (1) a constraining dependence on the specific design and processing capability of geographical information systems, GIS; and (2) in most applications a lack of cross-validation and uncertainty evaluation of the resulting maps of the future.

To overcome such problems and several additional ones, a mathematical framework of favourability function models had been developed (Chung and Fabbri, 1993) that led to programming a Spatial Prediction Modeling system, SPM, in later years (www.SpatialModels.com, Chung *et al.*, 2005, Fabbri *et al.*, 2004). SPM provides three fundamental modelling advantages. The first is that it is based on a clear multi-step procedure: (i) construction of mathematical proposition of future event occurrence based on supporting spatial evidence; (ii) generation of prediction maps via probability models applied to relate known event distribution with the integrated supporting evidence; (iii) validation/reliability evaluation of prediction results via blind-tests by partitioning the distribution of the known events and/or of the study sub-areas; and (iv) estimation of the probability of occurrence in a form usable for risk assessment or resource potential assessment under realistic assumptions and scenarios. A second advantage is the representation of predicted values in continuous functions for classification as maps and curves providing criteria to verify relative quality, support, uncertainty, robustness and comparability of results. A third advantage is the pipelining of spatial input for prediction modelling into iterative procedures for multiple analysis in a variety of cross-validation strategies.

APPLICATION EXAMPLE

Several models are provided in SPM based on: Fuzzy Sets, Likelihood Ratio, Logistic and Linear Regression, and Bayesian Probability. Input data in the form of raster images of size up to 5000 pixels x 5000 lines are commonly used that are imported as elementary raster format from a GIS. This enables the optimization of numerical processing with sufficient numerical accuracy, data configuration and computational speed.

Figure 1 shows and example of data flow for the prediction map of future occurrences. Figure 2a shows a gold deposit prediction map for the Red Lake area in north-western Ontario, Canada, generated by a logistic regression model. The 37 deposits are shown as circles. Figure 2b shows the cumulative prediction-rate curves obtained using different models from cross-validating prediction maps that used 36 gold deposit occurrences to

predict the 37th. Each prediction was iterated 37 times and the results were aggregated for each model into a prediction-rate curve. Table 1 shows the ranks in 1000* of the 37 occurrences for the 4 cross-validation sets.

CONCLUDING REMARKS

Apart from the processing convenience, the implied mathematical framework of favourability modelling in SPM assures that the analyses generate prediction results that are easily interpretable and transparent. Thus it represents an ideal tool available to institutions and researchers who are willing to commit to the responsibility of looking into the future with a concern for relative quality and associated uncertainty of spatial prediction modelling.

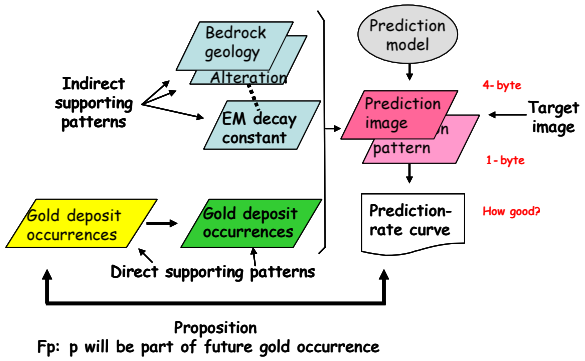

Figure 1 – Basic components in favorability modeling.

IID	lin	log	f15	f3	ID	lin	log	f15	F3
1	842	800	831	686	20	906	960	951	886
2	994	999	988	929	21	995	999	991	956
3	803	849	843	879	22	910	976	900	868
4	970	973	864	982	23	972	941	958	982
5	989	986	920	982	24	694	749	742	926
6	995	996	998	929	25	995	997	990	982
7	869	885	862	942	26	870	842	796	950
8	987	979	983	982	27	697	768	732	853
9	820	921	877	927	28	977	964	986	920
10	732	670	706	525	29	669	772	773	753
11	980	953	957	982	30	731	808	855	947
12	511	578	592	529	31	855	832	822	879
13	712	740	775	853	32	988	995	998	886
14	879	916	933	599	33	951	954	925	952
15	744	789	881	840	34	981	979	882	982
16	904	833	823	879	35	882	832	873	684
17	880	940	961	591	36	883	929	943	881
18	887	944	967	883	37	867	870	802	949
19	630	701	748	835					

Table 1 - Ranking of the 37 gold deposit occurrences in the Red Lake area, generated in 148 predictions. Linear and logistic, and fuzzy gamma operator, gamma 0.5, f15, maximum f3.

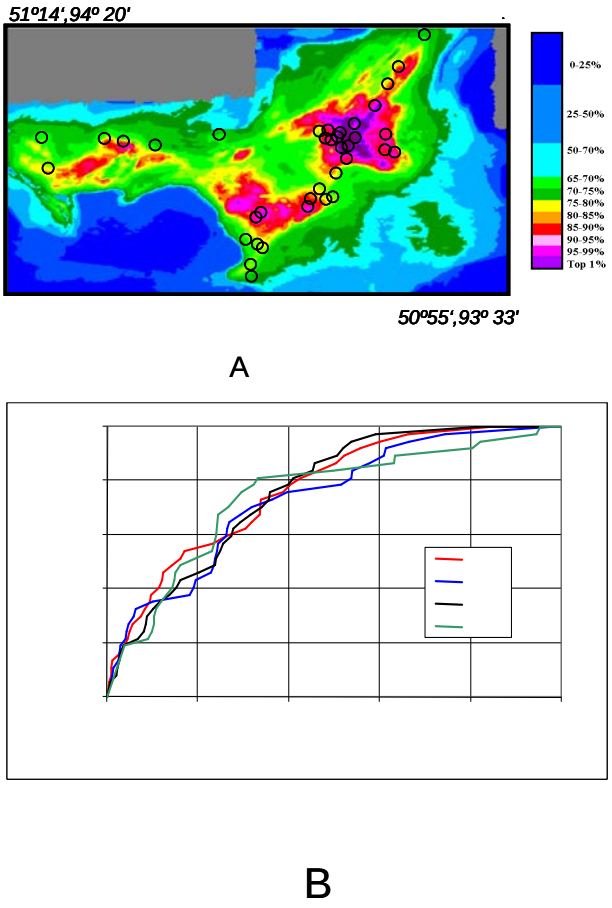

Figure 2 – Prediction map and prediction-rate curves.

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THE PRODUCTION OF GEOLOGICAL MAPS WITH ARCGIS 10 AT THE BAVARIAN ENVIRONMENT AGENCY

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KEY WORDS: cartography, geological map, geographic information system (GIS).

INTRODUCTION

The migration of the working process of the Geological Map 1:25.000 (GK25) from ArcInfo Workstation to ArcGIS has been finished in 2011. 9 of 11 printed GK25, which were published in the same year, were produced under ArcGIS 9.3 respectively 10.0. The high cartographic standard of the final product has been maintained also because of the use of Adobe Illustrator for pre-press.

DATA MODEL

Due to the necessity for a Single-User environment during the map making process, the File Geodatabase (FGDB) was chosen as the basis for the data model. Compared to the former ArcInfo coverage data model, the use of topology rules within the FGDB promises much higher error control possibilities and better error elimination already in the stage of data import and editing. Since the interdependence between the feature classes in the geological maps data structure is ambiguous there is no possibility however to use all the functional topology tools provided by ArcGIS.

Subtypes and Domains are not in use: The plausibility of the geological content of the data is already verified prior to the import into the FGDB. By using the expert mapping application GeoKart, the geologist has access to the geological legend already during the fieldwork process.

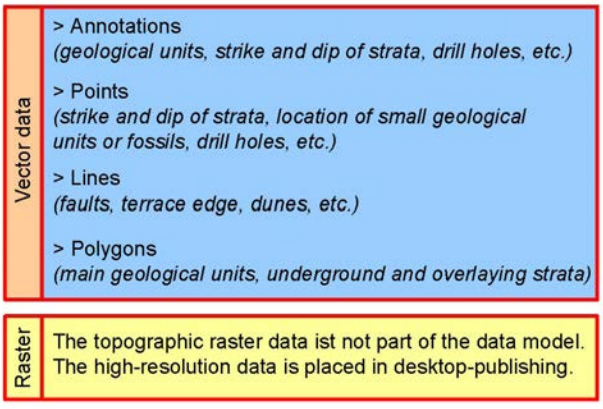

Figure 1 – Datastructure.

DATA IMPORT

The original data is composed mainly of GeoKart or ArcGIS projects, the data format here is shapefile. In rare cases coverage data from former ArcInfo map projects have to be imported to the FGDB.
Automated import routines with ArcGIS Model Builder are used were a homogeneous data structure is given.

AUTOMATED PROCESSING

Automated processes built up with ArcGIS methodes like ArcPy or Model Builder exist mainly for data import or consolidation. The current project at the LfU of developing an automated map generator will surely produce more impulses for further automation possibilities or the use of already built up tools, particularly for the legend generation.

CARTOGRAPHIC VISUALISATION

The direct conversion of ArcInfo workstation IGL-fonts to ArcGIS symbolisation is not supported. Using a font editor, the fill and point symbols of the geological map were recreated within a true type font. Using this font in combination with ArcGIS symbols, a new style library was set up in order to visualise the geoscientific features.
The cartographic symbolisation of a GK25 is reproduced for printing with the use of process colours (CMYK) in combination with spot colours. ArcGIS does not allow the use of spot colours. Therefore, the spot colours and their respective fraction are encoded within the style. Both process and spot colours are separated later during the pre-press in Adobe Illustrator.
The raster data has to be placed in Adobe Illustrator, too. Otherwise, the vector data laying underneath the raster data in ArcGIS is being rasterized. This results in enormous file sizes and the lack of vector data, which has to be edited for pre-press.

CARTOGRAPHIC IMPROVEMENT

Since the processes of data input and layout creation were separated within ArcInfo Workstation cartographic improvements were difficult.

With the introduction of the WYSIWYG principle

in ArcGIS, it is now possible to edit within the final layout, using the whole range of cartographic symbology and placement options. In addition, the use of representations within the ArcGIS project allows a better control of polygon, line and point symbolisation:

- Solution of cartographical conflicts, for example on faults (assumed faults always start with a gap)
- Manipulation of fill symbols in narrow or small geological units (single fill symbols can be moved by hand for improved readability)
- Point clouds of symbols like strike and dip of strata can be dissolved without manipulating the coordinates
-

There is still a large amount of manual work left for the cartographer, including the placement of annotations within the map or the creation of the map legend. Neither the main or interim headlines or the brackets for stratigraphy nor the partially complex legend solutions can be handled automatically with ArcGIS standard methods.

In future, the map generator should fulfil parts of these requirements.

OFFSET PRINTED MAP

As mentioned before, including process and spot colours is a major problem within the ArcGIS workflow. Because of limited, respectively missing pre-press options as well in ArcGIS 9.3 as in ArcGIS 10.0, the pre-press can only be handled by using Adobe Acrobat Distiller and Illustrator. The latter is used for the following tasks:

- Placement of CMYK raster data
- Deciphering of spot colours
- Overprinting settings
- Creation of colour separation file

But because of maps with large numbers of complex fill symbols in combination with raster transparency, Adobe Illustrator meets its technical limits. The export of PDF files of these maps is hardly possible.

WORKFLOW OVERVIEW

A summary of the current map making workflow of the GK25 is visualised in a simplified sketch (figure 2).

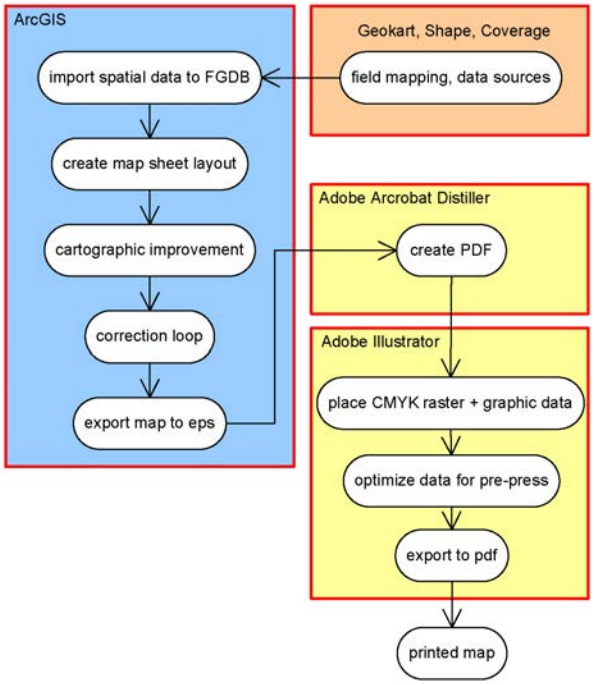

Figure 2 – Workflow of the GK25 production.

CONCLUSION

In 2011 ArcInfo Workstation was replaced in the process of map-making at the LfU with ArcGIS 10.0. There are clear advantages of this technological change:

- The changeover from an out-dated product like ArcInfo Workstation to further developed software for the Windows operating system provides opportunities for much easier retraining/training of the staff in the cartographic unit of the LfU and a better access to technical know-how of GIS service providers.
- The time for cartographic refinement of single maps sheets has clearly decreased. This can be attributed mainly to the WYSIWYG principle and the simplified use of automation processes.
- The interdisciplinary work has become much easier because of the use of common data formats which makes the exchange of data with other departments much easier.
-

Some of the expectations of the new workflow however have not been fulfilled. Mainly the lack of comprehensive tools for export and pre-press in ArcGIS causes additional effort by using desktop-publishing software. The more work has to be done outside ArcGIS, the more costly the corrections are if geological modifications arise during pre-press: After correcting the geometry, all the steps of desktop-publishing have to be done again.

Currently, there is a large amount of manual work, which successively will be decreased by using further automation tools.

For the GK25, a database-driven geological legend containing also the cartographic parameters of visualisation is planned for 2012. The database will also open up the opportunity to use different tools of the new map generator for the making of the GK25:

- Building up a basic layout with a prefabricated legend
- Automated placement of static and selected dynamic map elements
- With the technology currently available, an overall automation of the mapmaking process of the GK25 is not possible.

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STRATIGRAPHIC PRECISION AND CORRELATION IN THE DIGITAL AGE

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KEY WORDS: Stratigraphy, GSSPs, Terrestrial Laser Scanning, interactive open access digital resource.

IGCP 591 – DISP OBJECTIVES

Despite the widespread use of improved field instrumentation the basic premise of accuracy is still a factor governed by human error in observation and documentation with regard to sample position in a geological section. As high resolution stratigraphy reaches new levels of excellence across many sub-disciplines (bio, chemo and chronostratigraphy) for establishment of global standard zonation criteria (Ogg et al., 2008) it is crucial to future correlation studies that we document unambiguously the exact location of a sample. One centimetre of difference can incorporate thousands of years of time and a whole array of biotic/climatic/eustatic changes. In this respect it is essential that the measurement and sampling of geological sections are permanently recorded using a detailed visual representation for reference by future generations of researchers. This is part of the technological initiatives foreseen under UNESCO/IUGS IGCP Project *591 The Early to Middle Palaeozoic Revolution* under the *Digital Integrated Stratigraphy Project (DISP)* (www.igcp591.org).

METHODOLOGY - SECTION DIGITIZATION

A logical solution is the proposed digitization of geological sections using Terrestrial Laser Scanning (TLS) LiDAR, Real-Time Kinematic (RTK) GNSS, overlain digital photography, and GIS software, a technique developed by the University of Texas at Dallas (Aiken & Xu, 2003; Wang *et al*, in press: Xu *et al*, 2000) to produce a cm to mm-scale accurate digital version of a geological section.

DIGITAL STRATIGRAPHY RESOURCE

The systematic digitization of geological sections will provide an accurate and precise sampling grid for the detailed investigation of critical parts of the rock record. Once the digitized image of a geological section is incorporated within a database precise sampling point records may be inserted directly on the image by the user while in the field at that section by using a mobile device (i.e. tablet, smartphone) to access the web application. This precision in sample location will allow subsequent users to sample the same point for complementary studies now or in the future and will facilitate detailed precision correlation of the resulting scientific data with coeval digitized sections at a local, regional and global scale. These records will ensure that past sampling campaigns do not become obsolete when new techniques are developed at more refined scales.

The design of the open access interactive digital resource related to the 3D image of the section using an innovative tripartite transdisciplinary approach is the focus of an application for funding under the ERC IDEAS Program.

CASE STUDIES

The design test case is focused on the Silurian System, a critical interval in Earth History. The classic European Silurian sections (Gotland, Prague Basin, Carnic Alps, Brabant Massif, Brittany, Iberia etc.) will be scanned as a test case for input of key research data sample points for bio-chrono and chemostratigraphical studies with global correlation potential. These sampling campaigns will facilitate the design and development of the web application for transmission while in the field of accurately recorded sample positions and the end product database of the 3D images of those sections. The sections selected for scanning will represent diverse palaeocontinents and precise palaeogeographic settings during the Silurian. The digital scanning of six GSSPs for the Silurian (Aeronian, Telychian, Sheinwoodian, Homerian, Gorstian and Ludfordian Stages) in England /Wales was done in July 2011 within a pilot project funded by the the German Research Foundation (DFG Mu2352/2-1: refer to Munnecke *et al*., in press). Funding is now also being sought under the ERC IDEAS Program to

scan the remaining Palaeozoic GSSPs in Europe (8 sections located in Sweden, Czech Republic, Germany and France: Ordovician – Carboniferous). The digitized images and their related dataset once part of the interactive digital resource will become a reference documentation of the GSSP sections, both with regard to their conservation and for global correlation initiatives.

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ALBANIDES IN THE ENVIRONMENTAL GEOLOGICAL MAPS SERIE

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KEY WORDS: albanide, environmental, maps, complex types stady, maps

ABSTRACT

It comes to deal with a problem and needed too much practice, the regional framework, all Albanides, perhaps wider, nationwide, which has to do with all Working karacterization mapping geological make up date, to build a series of geological maps, with a view to reflect the latest scientific level contemporary, unifying them under the views and options, with the sole purpose, according to them we can have in management, research and management of all the territory and geological environment and beyond, it's natural that relates to, etc.

GOALS

To improve: a. Geological Map of Abanideve, 1:20000 scale (improved), b. Tectonic Map of Abanideve, 1:20000 scale (improved), c. Metalogenical Map of Abanide, 1:20000 scale (improved), d. Hydrogeological map of Abanideve, 1:20000 scale (improved), e. Geo-engineering Map of Albanide, scale 1:20000 (new). f. Geo-environmental Map of Abanide, scale 1:20000 (new). g. Geo-risc Map of Albanide, scale 1:20000 (improved), and throughout the Albanian territory, first as a sum of geological formations with a spatial setting, the dynamics of the above, can be fully controlled in the scientific view, already well characterized, such as composition, placement, background, age as potential resources, as waterbearing potential, potential as infrastructure, both potential and potential environmental risks of geological potential of natural whole, including those of the universal character of earthquakes, volcanoes, tsuname, etc.

However the data for these phenomena are meny years before, almost contemporaneous with man, which until recently were treated to separate and not in a context, in the geological environment, the natural environment as a whole, with all elements of infections. In geological terms, as such, observations on the types and forms of relief, on the basis of which new decoded geological formations on the surface, the surface and close observations of the geological-tectonic proper for characterization of geological formations based, according to potencuesit frame, which can be key infrastructural and community development in general. Well in this unity, according to these complex-type studies, we can outline the development corridors, we can determine the nature of human relationships can prevent risks, can ease the inevitable adversities. For example, according to these studies, orjentate the man where he can and should affect the nature, to take its resources to the benefit of providing the goods, without prejudice to the next and future generations of his own on.

EFECTS

Series of regional geological mapping, for all Albanides synthesized as a whole, gives a more complete information on the properties of the upper part of litosferës, expressed not only with words but with different figures and graphs, as most appropriate means to communicate with specialists of different fields, to the public. In this regard, study guides related work: the human use of the land surface by physical features and characteristics, especially for the expansion of urban space, to determine the factors that influence the safety and reliability of material losses and waste of all species in the rocks near the surface and in depth, with the rational use of land and underground, according to values that increasingly, the interpretation of links between geological units and the units near the surface of agricultural land, the determination of the occurrence and character of the aquifer depth near the surface, the geological setting of facilities for collection, disposal and waste landfill, in determining the resources of building materials, the determination of the geological-engineering characteristics of geologic units near the surface, etc. So all enclude graphic material, is part of a series of geological-environmental mapping and conceived as a record of the state of processes and dynamic environment, which in the above

performance, requires monitoring and supplements to mëtejshme. The givening in another form, all the material, the study result, it is generally understood as a realization of the problems and exposure to landscape, the soil and geological deposits containing resources in Albanides, in service of environmental management as a system to be understood and regulated by man. In this context, the environment (landscape, land, resources) is treated as the geo-lithological formation, genesis and age, ready to be used by other studies are detailed in service throughout the community for further growth of goods material, and in general the standard of living, enabling business strategy of sustainable development and efficient.

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TARGET ORIENTED EXPERT SYSTEMS OF GEOLOGICAL OBJECTS – THE PROBLEM CONCEPT AND RESULTS ACHIEVED

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KEY WORDS: expert systems, structural-lithological model, salt deposits, titanium-zirconium and gold placers.

INTRODUCTION

Nowadays in the area of geological activity management development a certain crisis of new ideas has taken place. This crisis is caused with contradiction between rapidly growing socio-economic challenges (supported with technological progress) and real state of informatic-analitical provision of pertinent managing actions. This contradiction is caused with low efficiency of traditional methods, basing upon usual modeling for objects and processes (even with a certain role of computer technologies). The contradiction overcoming is possible by means of introduction of target oriented expert systems (TOES) basing upon principles of target oriented complex modeling of geological medium on the basis of modern computer technologies with elements of artificial intellect. Fundamental reflection of this problem represents the target of the paper. This target comprises the following tasks: presentation of principles, methodology and methods of TOES directories, tasks, structures and contents: demonstration of results obtained; description of this scientific area development prospects.

METHODOLOGY AND METHODS

TOES of geological issues are aimed at solutions of practically significant problems characterized with high complicity, connected with multisided use of geological medium (minerals exploitation, underground construction etc.) and geological environment protection. From the methodological point of view the main tool for complex target oriented evaluation of a geological object selection has to be complex model, target oriented also (Khrushchov, Lobasov et al, 2010 etc.). This complex model comprises structural-lithological subordinate model, as a matrix one (Khrushchov, Lobasov, 2006) and a range of specific submodels (hydrogeological, geomechanic etc.). From the methodological point of view the development of a complex model is based upon a system approach (Karagodin, 1985 etc.): geological objects are distinguished as systems, being characterized with external and internal structure and passing stages of foundation and evolution and being in certain interrelation with neighbouring systems.

PRINCIPLES OF COMPLEX MODELS DEVELOPMENT

Complex model as a target oriented one has to reflect: 1 – certain specific interest – mineral resources, mining (exploitation, underground construction), ecological (geological environment protection, its remediation or their combination); 2 – aspects, being necessary for efficient realization of program actions (the latter are controlled by pertinent subordinate specific models). From the methodological point of view the procedure of subordinate models development reflects dynamic aspects of interactions interrelations and of systems or elements of their internal structures, i.e. processes. So, the joining of subordinate models, aimed at complex model compilation, represents a non-traditional task to significant increase of elements, factors and events (scenarios) as well as uncertain.

The results of a complex model compilation. The compilation of a complex target oriented model in fact represents the foundation of expert system. Such a model provides possibility to distinguish structural elements characterized with certain functional properties in the volume of an object massif (spread of minerals physic-mechanical properties barrier characteristics etc.) or processes which control changes of geological medium different functional properties (geomechanic, structural, matter, termodinamic etc. as well as underground waters

state). So, the possibilities mentioned provide a tool for informatic-analytical provision of R&D connected with resources, underground construction and ecological-geological problems.

The examples of development and implementation of target oriented digital models expert systems. Several examples of target oriented complex models and structural-lithological models, representing a basis for TOES compilation are demonstrated. In the area of mineral resources the following structural-lithological models are presented: Zlobychi Ti-Zr placer deposit. Kaniv promising area of gold bearing placer and Balka Shyroka gold deposit (weathering crust and placer with gold mineralization). The models have provided solution of the following tasks: regularities of ore bodies prognosis; automatic estimation of ore reserves; development of complex methodology for certain type of ore deposit prognosis etc. (Khrushchov, Geichenko, Lobasov et al, 2010).

In the area of ecological problems two geological objects are under consideration: Solotvino salt deposit and Kalush potassium salts deposit industrial area. Both are regarded as territories of ecological disasters. According to decisions of pertinent state programs special TOES basing upon complex ecological-mining-geological models compilation is in progress.

TYPISATION AND CONTENT OF TOES

Three conceptual directions of TOES are distinguished: 1 – mineral resources; 2 – underground construction; 3 – geological environment protection. The schemes of complex models related to this TOES groups are demonstrated.

CONCLUSIONS

From the point of view of traditional “classic” principles of expert systems the proposed principles of a complex target oriented model has a vulnerable point: the results of this model need final expert analysis and decisions making, i.e. in comparison with classic expert system definition it is not completed.

The subsequent task of our investigation is former “kibernetization” by means of complex modeling sophistication, formalization of knowledges base (with expert rules for geological tasks solution) and development of efficient mathematic apparatus for knowledge base processing.

TRAINING COURSE “GIS APPLICATIONS FOR ENVIRONMETAL MONITORING”

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KEY WORDS: natural and technogenic factors, ecological risks, geo-ecology, spatial modelling, integrated analysis, geoinformation systems.

INTRODUCTION

Ecological studies and monitoring of the environment in recent time are a required step in every scientific or industrial project. As such the experience in adequate representation of the real situation with mapped data, processing of instrumental observations, and analysis of the entire information is essential.

These studies are definitely based on geoinformatics which integrates geography, informatics, and ecology as well. The main focus of geoinformatical studies are spatial data, techniques and methods of its processing and representation for solution of practical problems, and also computer applications of geographical informations systems (GIS technologies).

For all this we present a training course “GIS applications for environmental monitoring”.

REVIEW INFORMATION

Our course provides for solution of information and analytical tasks as follows:

- monitoring of pollution of several components of environment (atmosphere, soil, underground and surface waters);
- complex evaluation of ecological status of natural eco-systems of a territory;
- prognosis of situation development in case of anthropogenic impacts.

Information block of the course is focused on acquiring scientific and methodological principles of computer-based modelling and processing of spatial data with utilisation of the modern technologies of geoinformatics.

The foundation of analytical studies on the subject is the method of spatial modelling of features/processes/situations with a complex of mapped data. In this approach a model is a hierarchical tree of endogenous and extraneous factors characterising the environment and pressures to it. These factors are characterised with a set of formalised spatial parameters with quantitative or graded values, and qualitative estimations. Calculation of objective function of the model includes integrated analysis of formalised parameters localised within the area under study.

Objectives of the course include:

- a brief introduction to the basics of geoinformatics: spatial data representation, methods of spatial analysis, review of modern geographical information systems;
- theoretical basics of solution of forecast and diagnostic problems: general schema of formulation and solution of a problem, formalisation of spatial representation of manifestations of analysed processes and features, methods of integration of estimations on heterogeneous data;
- introduction to the multi-purpose geo-information server (MGS) as an application platform for development of internet-GIS and spatial modelling systems;
- completion of a tutorial project on estimation of ecological state of a test region: discovery of related information sources, design of information database of the study (including metadata), development of a model of the situation or process, its calculation and interpretation.

After completion of the course students will be able to:

- formalise a problem related to ecological studies;
- determine spatial data needed for solution of the problem and discover related information sources;
- design the correct database for the study;
- develop a spatial model of the analysed situation;
- pre-process spatial data, calculate the model and interpret results.

BRIEF DESCRIPTION OF THE TUTORIAL

Objective – analysis of ecological situation within a test region.

Source data – mapped information on environment and anthropogenic impact, results of monitoring of several indicators of environmental conditions.

Methodology – assessing integrated evaluation of “trouble” situation in a test region based on spatial modelling techniques. A situation model is defined as an objective function on a set of factors representing properties of analysed environment, complex of disturbing and stabilising impacts to it. Factors is derived from a number of formalised spatial parameters with quantitative or graded values, and qualitative estimations. Calculation of the model

includes integrated estimation of manifestations of selected factors based on zonation techniques of their formalised parameters localised within the area under study.

Technological implementation is based on the multi-functional geo-information server (MGS) application platform which allows for development of Internet-GIS for diverse applications. MGS includes subsystems for management of spatial metadata and interaction with remote information systems, extended GIS tools on the level of desktop GIS applications. It was developed with heavy emphasis on many international, national, and corporate geospatial processing standards (ISO, OGC, CGI, etc.) and free and open-source software. Spatial modelling subsystem of MGS includes user interfaces and analytical modules for creation of a model of objects / processes / situations, fill it with related data and calculations for studies of the test region.

1st stage – formalisation of a problem and acquisition of data. At this stage analysis of the subject and area under study is performed, also of availability of data from various sources. The problem is formalised in the way of stating an objective function of the model, expected accuracy of processing result, and a set of source data for its completion. Information base of the study: design of a GIS project as an ordered set of digital or digitised map layers, representing the data significant for the solution of the problem.

2nd stage – design of the structure of the model. Structure of the model is represented with an hierarchical tree of target layers calculated from sub-targets and groups of factors. Each sub-target can be considered per se as an intermediate target of processing an with its own set of evaluation results grades. At the leaves of the model tree are the formalised characteristics of source factors which forms the criterion space of the model.

On this stage with the help of the interactive graphical user interface of the modelling subsystem students will define as follows:

- an hierarchical tree of factors and sub-targets;
- a system of evaluation gradations for ranking of groups of factors on each of hierarchical levels;
- processing function definitions for calculation of factors and their integrated characteristics;
- weights of factors representing their influence on a sub-target in the hierarchy.

3rd stage – filling and processing of the model. Filling of the model is a process of its completion with source data for the area under study. It implies linking of each factor of a model (or some of its sub-targets if only previously integrated data is available instead of source data) to data sources represented as layers of the GIS project designed on the 1st stage.

Calculation of the model – is performed in every sub-target with the use of assigned processing function definitions. For calculations based on source factors one can use as follows:

- single-dimensional relations of manifestation or absence of objects in a cell of the model grid, its value or rank;
- bi-dimensional relations characterising the planar position of the analysed factor : its density, direct or path distance, path costs;
- three-dimensional relations characterising formation of a surface: slopes, expositions, curvatures, etc.;
- statistical relations which aggregate characteristics of the analysed process in cell's neighbourhood usually within some focal or block window.

Calculation of the objective function of the model is made by sequential or parallel calculations of integrated evaluations of each of groups of factors within sub-targets. Methods used for each integrated calculation depend on the essence of the analysed process and the overall target of the study. They can include as follows:

- a statistic of a vector of factor values in the cell: minimum, maximum, mediane, unique value, etc.;
- a weighted sum of a vector of values;
- taxonomy with the method of k-means.

4th stage – analysis and interpretation of results

One of the most applicable techniques of interpretation of result is the criterion (range) evaluation of calculated integral values defined in a grades system pre-set in the model. After the model has been refined based on results of its first (test) calculation, its further completion and calculation can be accomplished automatically, its objective function being derived directly bypassing recursive chain of its sub-factors. This provides for dynamic assessment and forecasting of development of analysed situation in case of modification in values of source factors (Figure 3).

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MAP OF THE TECTONIC ROCKS FOR LAND MANAGEMENT: EXAMPLE IN THE ABRUZZO REGION (CENTRAL ITALY)

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KEY WORDS: tectonic rocks, maps, engineering geology, Abruzzo, Central Italy.

ABSTRACT

Tectonic rocks are a peculiar type of rock that lost their original structure and geotechnical properties, due to tectonic deformation and sliding along fault planes, and now are rock masses with variable mechanical properties.

Several classifications were defined in literature concerning tectonic and fault rocks (A.M. Killick 2003; N. H. Woodcock & K. Mort , 2008) and one of the most used is on textural base, form R.H.Sibson (1977) modified by Billi (2005).

Faults, fault rocks and tectonic rocks are very important concerning engineering geology and environment aspects because they control strictly local variations in the mechanical behaviour of rock masses involved in the deformation.

In this work a map of the tectonic rocks focused on land management is presented. The map is based on an integrated methodology incorporating geological, geomorphological, mineralogical and geothecnical analyses and particularly analysis of:

Geology according to several examples from international literature (Cembrano et alii, 2005; Faulkner et alii, 2008:

- lithology;
- fault planes slickensides, fault breccias and cataclasites;
- fault planes orientations
- relationships source rock/tectonic rock.

Structural Geomorphology:

- tectonic landforms;
- relationships between litho-structural features and landforms

Mineralogy:

- calcite gemination planes
- ground boundary migrations
- crystal morphology

Geothecnical:

- lab analysis of mechanical behaviour.

These analyses are carried on both in the field and in laboratory.

The map presented in this work is an example from the Aterno valley area within the Abruzzo Apennines. This area is characterized by fault homocline ridged on Meso-Cenozoic carbonate rocks and tectonic valleys and basins filled up by a variable thickness of quaternary continental deposits. The tectonic features of this area are still very active mostly due to NW-SE oriented normal faults that in recent times triggered the 2009 L'Aquila earthquake. So, this area is highly susceptible to show a variable distribution of tectonic rocks and a variable distribution of mechanical properties of rocks, otherwise defined simply as "geological bedrock".

The map of the tectonic rocks presented in this work allows to outline the distribution at local scale of the tectonic rock according to their specific geotechnical and mechanical behaviour. These data are basical for engineering purposes and can provide useful indication at land management stage, suggesting mitigation strategies for the effects of surface ruptures related to faults.

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GEOMORPHOLOGICAL AND GEOTHEMATIC MAPS: EXAMPLES APPLIED TO LANDSCAPE EVOLUTION, SLOPE INSTABILITIES, MEDICAL GEOLOGY AND GEOTOURISM

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KEY WORDS: morphotectonic maps, slope instabilities maps, geomedical maps, geotourism maps, Abruzzo, Central Italy.

INTRODUCTION

In this work several examples of geomorphological and geothematic maps are presented, realized in the Abruzzo region at different scales ranging form 1:15.000 to 1:50.000, within the research activities of the Laboratory of Tectonic Geomorphology and GIS, Department of Engineering and Geology, "G. d'Annunzio" University of Chieti-Pescara.

Several examples of Morphotectonic maps, Slope instabilities maps, Geomedical maps and Geotourist maps are presented. These maps are realized in the main morphostructural sectors of the Abruzzo Region: chain, piedmont area and coastal plain.

All the maps are based on the ISPRA (CARG Project) guidelines, eventually integrated and/or modified in order to be adapted to specific scopes and different scales of the maps. All the maps are realized within GIS environment.

MORPHOTECTONIC MAPS

The creation of Morphotectonic maps is based on drainage basin scale geomorphological analysis within GIS environment by means of: DEM- and map-based cartographic analysis, morphometry of orography and hydrography (raster and vector data 1:25,000 - 1:10,000 scale, 5m grid DEM), photogeology analysis (1:10,000 - 1:33,000 scale), Quaternary continental deposits, fluvial terraces and morphostructural field mapping (1:10,000 scale), morphotectonic profiles that couple landform, deposits and terraces.

The morphotectonic maps incorporates more main sections:

- orography and hydrography section;
- main morphotectonic map section;
- quaternary fluvial deposits and terraces section;
- longitudinal morphotectonic profile section.

The morphotectonic maps are realized in the Chain area (Marsica and Peligna region, Central Apennines, scale 1:50.000) and in the Piedmont-Coastal area (Aventino River basin – lower Sangro River area, SE Abruzzo scale 1:50.000; Osento River basin, SE Abruzzo, scale 1:30.000).

The maps presented in this work are the base for recognition of morphotectonic features at basin scale, detection of tectonic control on landscape, and reconstruction of paleo-landscapes. They provide a contribution to define the main phases of post orogenic landscape evolution of the piedmont area of the Apennines chain, resulting from the link of alternating morphotectonics and surface processes, due rock uplift processes, local tectonics and alternating slope and fluvial processes.

SLOPE INSTABILITIES MAPS

Slope instabilities maps are realized by geoscientist at different scales, with different methods and for different purposes (research or applied purposes; landslides mapping, soil erosion mapping, flood mapping, etc.). In this work, maps of the geomorphological instabilities, triggered by heavy rainfall events that affected the Coastal area Abruzzo Region in the last 5 years, are presented.

These maps are mainly based on aerial photo interpretation (taken after the rainfall events) and field geomorphological mapping carried on immediately after the rainfall events.

Particularly, the maps presented refers to the 1-2 March 2011 heavy rainfall event (up to ~200 mm/day) which affected the coastal slopes and the coastal hills of the northern Abruzzo. The main mapped landform are due to slope instabilities (earth flows, mud flows, gullies, areas affected by rill erosion) and flooding (flooded areas, crevasse splays).

These kind of maps are the base for flooding and slope instabilities hazard analysis and for the estimation of sediment volumes eroded during the events. This is particularly important for minor drainage basins of coastal slopes and coastal hills where erosion and hazard are frequently underestimated.

GEOMEDICAL MAPS

Geomedical maps are recently developed in many countries incorporating multiple land features: bedrock lithology, surface deposits, pedology, geochemistry, disease distribution and incidence etc.

In this work the first example of geomedical maps realized in the Abruzzo regionis presented. It is based on the comparison of geological data and epidemiological data in order to evaluate the disease risk induced by natural and anthropic sources in the main fluvial valleys of the piedmont area of the Abruzzo region.

GEOTOURIST MAPS

In the geotourist maps, geology and geomorphology are presented in an easy and educational way, as a base of a new way of reading landscape and tourism. Going back over a history wrote during millions of years, where books are rocks, pages are layers, words are fossils and ink ...is time.

In this work the first geotourist map in Abruzzo (southern chain piedmont area) realized in the Aventino - middle Sangro area is presented.

The map is reinterpreted from geological maps, distinguishing outcropping rocks as concern their surface expression into distinct geological landscapes. Limestone, marls, sandstones, clays, chalks, gypsum, gravels and landforms are presented as windows over a 200 million years history that today can be observed in a unique “breathtaking” landscapes rich of colours and suggestions, labelled with appealing names (i.e. the sliding rocks, the shining hills, the floating mountains). Symbols highlight the location of main geological and geomorphological features (i.e. national geosites, fossil sites, oil well, caves, glacial cirque remnants, and other geological interest areas). Finally, tourism facilities (offices, information centres, museums, trails, etc.) are added to the geological and geomorphological aspects in order to complete the geotourist map.

The backside of the map and the explanatory notes include text and figures explaining features and origin of different types of rocks and related landscapes.

CONCLUSION

This work is a contribution of data and examples to enhance the value of modern geomorphological and geothematic maps for several purposes such as: research activities concerning morphotectonics and landscape evolution, hazard and slope instabilities analysis, geomedical analysis, geotourism and enhancing geological and geomorphological heritage.

ACKNOWLEDGEMENTS

We are grateful to the Struttura Speciale di Supporto Sistema Informativo Regionale of Abruzzo Region (http://www.regione.abruzzo.it/xcartografia/) for providing the topographic data and aerial photos used for geological and geomorphological investigations and for geothematic maps.

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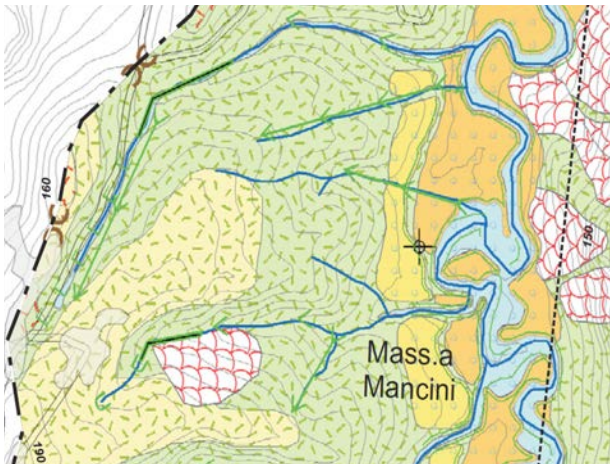

Figure 1 – Extract from the Morphotectonic map of the Osento river basin (Miccadei et alii, 2012).

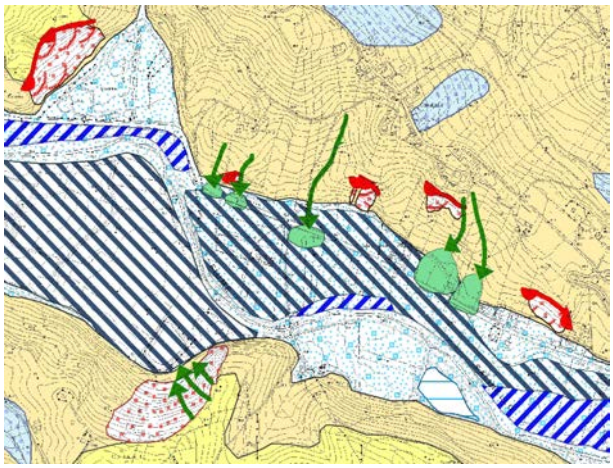

Figure 2 – Extract from the slope instabilities and floods triggered by the March 2011 heavy rainfall event.

GEOMORPHOLOGICAL MAP OF THE TREMITI ISLANDS (PUGLIA, SOUTHERN ADRIATIC SEA, ITALY), SCALE 1:15,000

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KEY WORDS: Geomorphological map, Quaternary continental deposits, scuba-dive geomorphological survey, Tremiti islands, central-southern Adriatic Sea.

INTRODUCTION

The Tremiti Islands lie in the central-southern Adriatic Sea, in northern Apulia, at about 20 km north from Gargano promontory coast. It includes San Domino, San Nicola, Capraia and Cretaccio islands, and La Vecchia rock; Pianosa island, also belonging to the archipelago, is 11 miles away from the main ones towards NE (Fig. 1). Being located around the centre of the Adriatic basin, and facing the junction between central and southern Apennines, the islands lie in a complex geological area, crucial for the study of Quaternary Adriatic basin evolution, strongly driven by eustatic processes and tectonics along well known regional faults (Fig. 1). The archipelago is the emerged part of one of the main structural highs within the Adriatic basin, well studied for erosional/depositional processes on the continental shelf due to Late Quaternary tectonics and eustatic sea-level changes.

METHODS

A detailed integrative geomorphological analysis in the Tremiti Islands (Puglia, Southern Adriatic Sea, Italy), on both the islands and the inner continental shelf around the islands (Miccadei et al., 2011a; Miccadei et al., 2011b), enabled the elaboration of a geomorphological map (1:15,000 scale) of above and below sea level areas (Miccadei et alii, 2012) by means of: 1) field Quaternary continental deposits and geomorphological survey supported by radiometric dating, 2) bathymetric analysis and 3) geomorphological analysis of side scan sonar survey, from coastline down to about 70 m b.s.l., 4) scuba-dive geomorphological survey.

The field mapping study was carried out by means of a geological survey of Quaternary continental deposits (1:5,000 scale), allowing for the construction of detailed lithostratigraphic logs for each island, and geomorphological survey (1: 5,000 scale, and 1:1,000 for the most significant areas). Field mapping was performed according to the guidelines of Geological Survey of Italy (APAT, 2007; ISPRA, 2009a), but upscaling the methods by means of detail outcrop analysis and logs. Dating of a calcrete and an aeolian deposit supported the morpho-lithostratigraphic correlation of the deposits among the different islands, together with landform studies.

Bathymetric analysis has been performed processing data from nautical cartography of Istituto Idrografico Militare (1:15,000 scale).

Bathymetric data allowed for plan geomorphological survey of an area of about 9 km^2, carried out by means of a side scan sonar records (1:5,000 scale).

Scuba-dive geomorphological mapping, up to a depth of ~50 m b.s.l., were carried out according to the guidelines of Geological Survey of Italy (DSTN, 2002; Monti et alii, 2003; APAT, 2007; ISPRA, 2009b) upscaled for a detail mapping by means of specific survey forms to be filled on site (Orru and Ulzega, 1987; D'Angelo et alii, 1996; Monti et alii, 2003). This allowed for a detailed direct observation of the inner continental shelf landforms (1:1,000 scale) and the observation of below sea-level cliff portion and caves, enabling side scan sonar calibration and improvement.

GEOMORPHOLOGICAL MAP

The Geomorphological map of the Tremiti Islands (Puglia, Southern Adriatic Sea, Italy), scale 1:15,000, incorporates three main sections:

- main geomorphological map and legend;
- geomorphological profiles and morphostratigraphic correlation of Quaternary continental deposits;
- geomorphological block diagrams.

The geomorphological map includes Quaternary deposits of islands and inner continental shelf areas lying on the Carbonate bedrock. The landforms mapped on the islands and on the inner continental shelf are due to different kind of conti-nental and marine geomorphological processes: slope gravity, fluvial, karst and marine; elements due to the biological activity are also included.

The geomorphological profiles allowed for the morphostratigraphic correlation of the inner

continental shelf features, with landforms and deposits of above sea level areas of the islands.

Finally, geomorphological block diagrams show a comprehensive view of the mapped features.

CONCLUSION

The study characterizes deposits and erosion surfaces of the Quaternary continental succession, outlining some new chronological constraints; main tectonic and geomorphological features, in surface and underwater area, are defined. The geomorphological and stratigraphical data analysis allowed the reconstruction of morphostratigraphic relationships between the islands; moreover, the correlation with tectonic features allowed for the recostruction of the morphotectonic setting.

This correlation has provided a contribution to the reconstruction of Late Quaternary landscape and geomorphological evolution, as the result of tectonics, sea-level fluctuations and marine, coastal, and continental geomorphological processes.

Finally, this kind of integrated geomorphological mapping is the base for the comprehension of the present coastal processes and a correct management of coastal areas and islands.

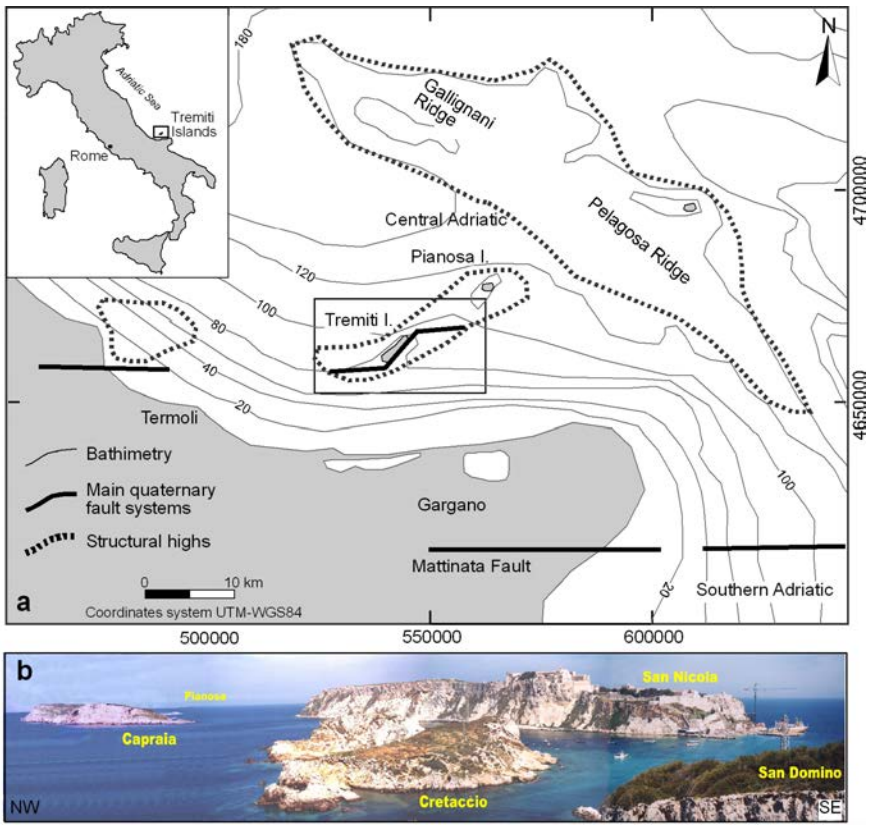

Figure 1. (a) Physiographic and geological scheme of North Garganic Adriatic sector (from Ridente and Trincardi, 2002). (b) Panorama of the islands from San Domino, from SW towards NE.

ACKNOWLEDGEMENTS

We are grateful to the Cartographic Office of the Puglia Region (http://www.sit.puglia.it), for providing the topographic data used for geomorphological investigations and mapping.

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AN INTEGRATED REGIONAL DATA MANAGEMENT CENTER (IRDMC) IN EMILIA ROMAGNA

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KEY WORDS: Sensors, Environmental monitoring, Real-time, Regional Network Infrastrucures, Data sharing.

THE PROJECT

A survey on the sensor networks deployed on the territory of Emilia Romagna has highlighted the presence of thousands of sensors with different purposes, different owners, not interoperable and not shared.

The Integrated Regional Data Management Center (IRDMG) aims the integration of all the sensors spread all over the territory of the Emilia-Romagna Region through two basic elements: a unified communication infrastructure, integrating regional fiber optic (Lepida) and mobile (ERretre) networks, and a unique center for data collection.

The presence of the two networks widely spread throughout the region is the proper opportunity to enable the monitoring of any area of the territory and the natural solution for homogeneous, safe and efficient transmission of the data collected by all the sensor networks.

The creation of IRDMC will provide the following advantages:

- to collect data from different sources, even those already existing;
- uniformly and contextually manage different types of data (piezometers and inclinometers to monitor landslides, hydrometers, rain gauges, temperature sensors for environmental monitoring, inductive loops for traffic monitoring, etc..)
- increase the quality and the update frequency of the territory information
- provide customized services to different users, both public and private
- share data among multiple agencies by reducing the duplication of resources
- ensure greater efficiency in service management

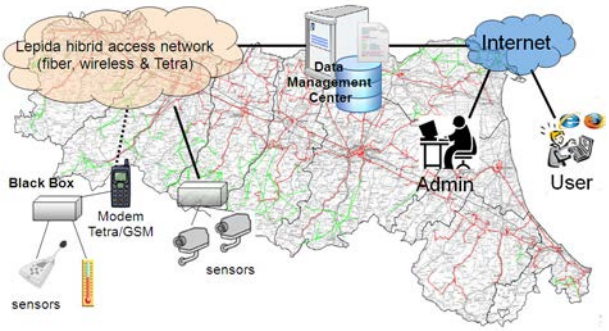

Figure 1 – An Integrated Regional Data Management Center

THE PLATFORM

The platform is designed to manage the acquisition and processing of **real time data**, in order to control potentially critical environmental phenomena and emergency situations through the configuration of alert and alarm thresholds which automatically detect critical conditions and trigger automatic alerting procedures (e-mail, SMS).

Furthermore, the platform allows to:

- access historical data related to time evolution of the physical phenomena monitored;
- perform retrospective statistical analysis of data, with emphasis on cross-correlation between different physical phenomena;
- enable proactive management of critical phenomena, with more awareness and coordination among all the different parties involved.

THE SPERIMENTATION: MONITORING OF HYDROGEOLOGICAL INSTABILITY

A test for integrated monitoring of a hydrological

instability in the Modena province has been started in collaboration with the Technical Service of the basins of the tributaries of the Po river (STBPO; Servizio Tecnico dei bacini degli affluenti del Po), with simultaneous data acquisition on the deformation and hydrostatic pressure on the sliding surface and their integration with the rainfall data derived from the monitoring network of the Regional Agency for Environment Protection in the Emilia-Romagna region (ARPA-ER; Agenzia Regionale Prevenzione e Ambiente dell'Emilia Romagna).

Detailed information about the landslide integrated monitoring

- active since june 2010 at the landslide of Fosso Moranda, in the municipality of Poligano (MO)
- consists of a 3rd party monitoring station including two bi-axial inclinometers (IN), a piezometer (PZ), and a gateway device, called BlackBox, connected to the ERretre radio network through a Tetra modem, which regularly sends the data measured in real time to the IRDMC
- DATALOGGER wakes up hourly to collect sensor measurements
- BlackBox repackages data into an appropriate protocol in order to send them, via MODEM TETRA, to the central storage server of IRDMC
- a personalized web interface allow access to data at any time

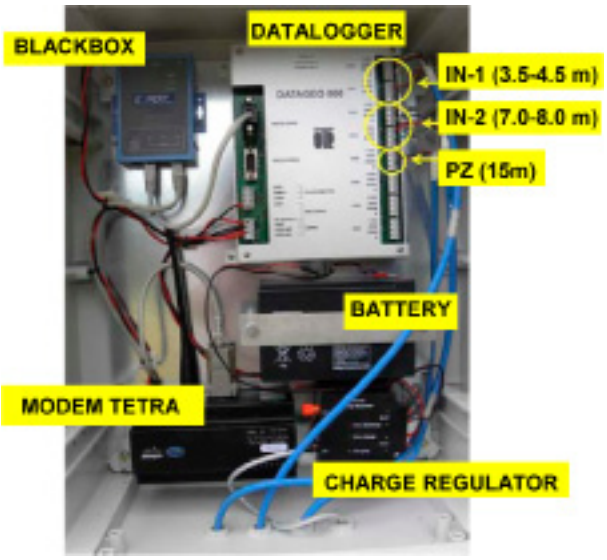

Figure 2 – The experiment monitoring of landslide at Fosso Moranda (MO); sensors consists of two inclinometer (IN) and one piezometer (PZ).

The integration in the same platform of multiple data having different origin allows the cross correlation of landslide movements and their potential triggering factors. The deployment of such monitoring systems might provide reliable and useful information in real time; thus, having relevant implications for Civil Protection agencies in the management of meteo-hydrological alerts.

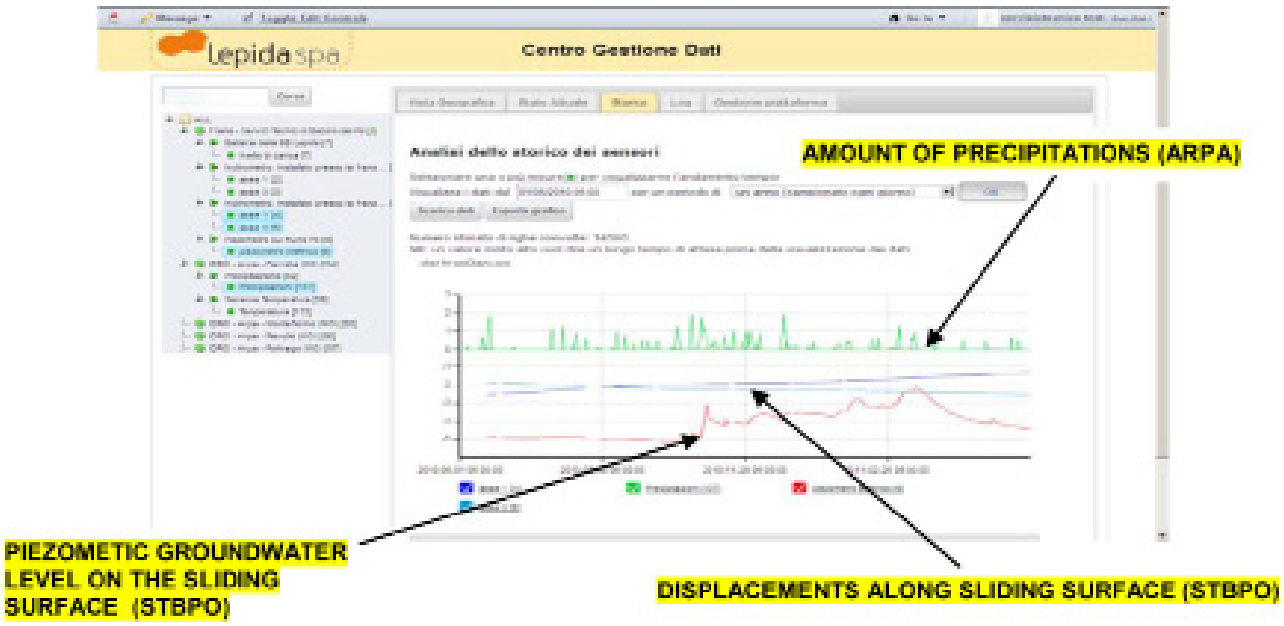

Figure 3 – Aggregation of data from different data sources: STBPO e ARPA

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GEOLOGICAL MAPS 1:50 000 OF ALBANIA SHEET 42-MALIQ(3176 III) AND SHEET 43-KORCA(3176 III)

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KEY WORDS???

Framework program of some European countries is the implementation of 1:50000 scale geological mapping, according to UTM geographic system. This initiative was undertaken for the territory of Albania. During 2010-11 we carried out the first geological maps in scale of 1:50 000, the sheet 42-Maliqi (Fig.2), and the sheet 43-Korca,geographic UTM system. To them are attached and their exploratory texts. According to UTM geographic system, the territory of Albania includes 56 topographic sheets, scale 1:50000 (Fig.1), which correspond to 56 geological maps, 2 of which have already been realized

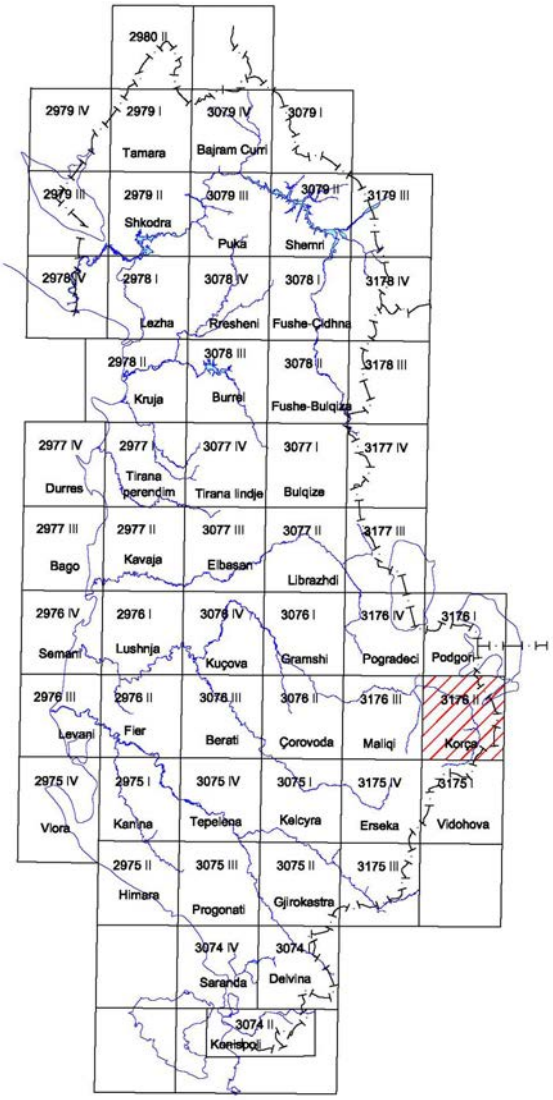

Fig1.Geological Maps 1:50 000 scale (Albania)

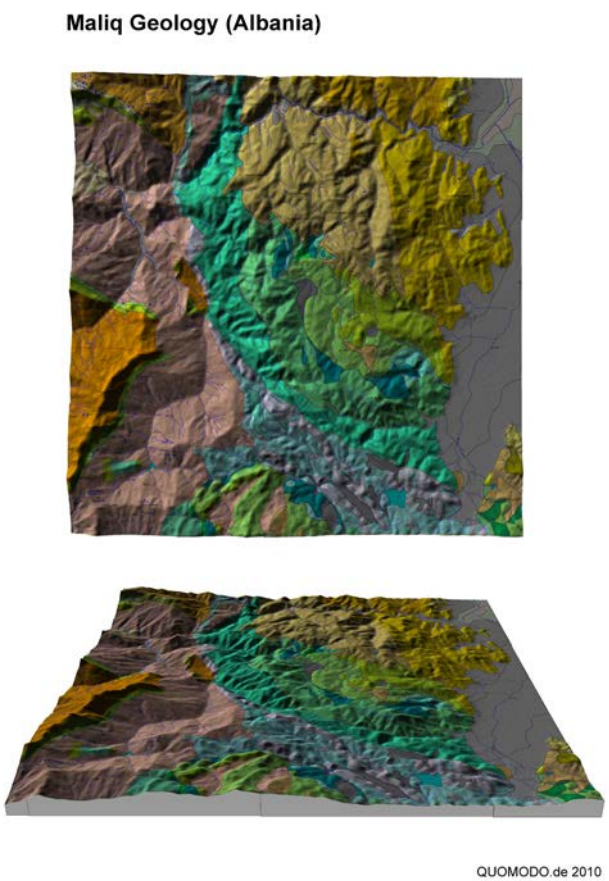

Fig2.Geological Maps 1:50 000 sheet 42-Maliqi

Each topographic sheet covers about 700km2, and in our study we provide data on the geological-geophysical feature of the region included into sheets 42-Maliq and 43-Korca, providing details for each type of rock in stratigraphic, petrographic, petrochemical and petrological aspects, their differences, similarities, placement position and relations between them. Also are provided geophysical data of magnetometeric properties and seismic activity occurred in areas of study as well as around it. Geologic maps were completed by performing correlation field observations, data processing, and the result was their publication accompanied with explanatory texts. The purpose of these maps is connection and coordination with geological maps of bordering areas, the Balkans and Europe.

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BASIC CONCEPTS FOR SURVEYING NATURAL CAVES

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KEY WORDS: cave entrance, survey point, 3D modelling, GIS.

ABSTRACT

Natural caves are voids formed by physical or chemical processes beneath the Earth surface. Worldwide, many caves are accessible to tourists, and represent an important economical income for some Regions. About 30 million people per year visit show-caves and these might probably represent to the most popular known geological sites, many of which are included in the UNESCO World Heritage list or in the GeoParks. Despite their popularity, caves are not so far considered geographical objects, and the standard procedures for a correct geographical informatisation are not available yet.

When its natural entrance is identified, a cave does belong to the Earth surface however does not to the conventional cartographic surface. This leads to the introduction of a three-dimensional component to the two-dimensional map representation of Earth surface.

As first, the identification of the linking point between a cave and the topographic surface is functional to the correct geographical registration of a cave entrance. Theoretically, a barycentric point of the polygon obtained by the intersection between the topographic surface and the volume of the cave should be identified. This point defines the starting position for the cave surveying.

From a geometric point of view, a cave represents a complex three-dimensional object that cannot be properly represented in a two-dimensional domain, i.e. plan views and/or vertical profiles.

A cave topographic survey usually consists of a complex line-plot organised in connecting nodes (survey points). A vertical cross section at each survey point provides the volumetric mapping of the cave. The cave volume is usually measured by four directions, left/right and up/down, normal to the line connecting two survey points. As these measures certainly make a simplified modelisation of the cave morphology, the total volume might be overestimated. For a more appropriate modelling of the cave geometry as well as a correct cross-section drawing, an overall eight measures should be acquired, adding a 45°left-up, right-up, right-down, left-down to the main four directions. This allows the speleologist to both properly represent and recognise the cave morphology.

A cave 3D model might therefore be produced by 9 points spatially referenced: 1 central point, corresponding to the *n*-survey point, and 8 points surrounding it, all encompasses in a vertical plane which renders an eight-vertex polygon, approximating the conduit cross section.

A correctly georeferenced and 3D modelled caves survey can be load into GIS-WebGIS platforms.

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COUPLING GROUND WATER MODELING AND GIS: A DECISION MAKING TOOL FOR GROUNDWATER MANAGEMENT TO SUPPORT AN IRRIGATION SYSTEM

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KEY WORDS: ground water modelling, GIS, tight coupling, decision making tool

ABSTRACT

The tool here described aims at integrating the results of monitoring activities on the evolution of groundwater levels with a groundwater flow model, in order to support decision making for the implementation of suitable management options. The tool has been developed in a GIS framework and is intended to be used by public administrators and local stakeholders.

INTRODUCTION

The use of mathematical models in hydrogeology is finalised at water resources management. The models should ideally be used directly by water managers, also if they haven't specific skills. For this reason a tool aimed to facilitate the decision making process for non-expert operators has been developed. Moreover it aims to fill the gap often existing between the big amount of monitoring data available and their functional use to solve specific problems. The tool is a GIS application in which data, models and user interfaces are integrated in the GIS environment in a "tight coupling" approach.

METHODOLOGY

The tool, called "MIGRI-GIS" (Monitoring and Groundwater Resources Integrated management in a GIS environment), is a "easy to use" decision support tool, able to individuate excessive water table fluctuations when they exceed defined thresholds. The latter task is carried out producing scenarios arising from different recharge conditions and/or management options, by means of a ground water flow model continuously updated with data coming from the monitoring network activities. The water managers are allowed to choose the most suitable management option by comparing the simulated scenario with a "an ideal target situation". The simulation results can be easily visualized in ArcGIS as maps, both in raster and in vector format

MIGRI-GIS enters in the spatial analysis of data, hence allows for the assessment of the water table current status, enhancing critical situation.

Additionally it permits to calculate the time evolution of the hydraulic heads through mathematical modelling.

The tool was developed in ArcGIS programming the ArcObjects with Visual Basic for Applications (VBA)(Burke, 2003). The numerical flow model was implemented with the finite differences code MODFLOW (McDonald and Harbough, 1988).

The conceptual scheme implemented for the tool is shown in Fig.1.

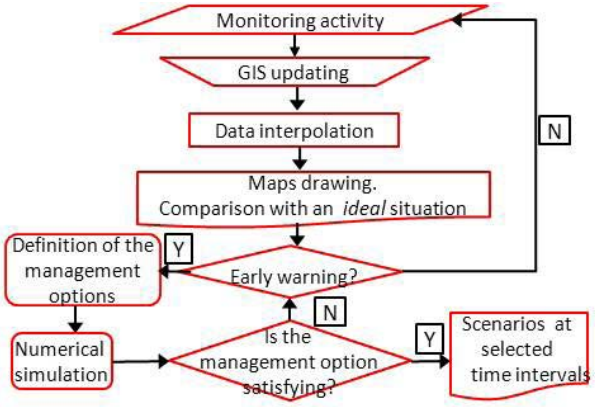

Figure 1 – Conceptual scheme of the MIGRI-GIS tool.

Data obtained from the monitoring activities are collected in a geo-referenced database and piezometric surfaces are created by means of interpolation techniques. Hence they are compared with an "ideal status" to highlight any critical situations, such as the excessive lowering of the water table. Should a critical situation appears, appropriate management options are defined and tested through numerical simulations of the heads evolution. Numeric simulations are run with different drivers (i.e. management options) until a suitable set of rules is found resulting in an appreciable mitigation of the enhanced critical issue. This model described above has been implemented by the architecture shown in Fig. 2.

The tool is designed with a "tight coupling" (Gurnell and Montgomery, 2000) between ArcGIS and Modflow and works entirely within ArcGIS by means of customized interfaces. The interactions between the two software is also allowed by codes

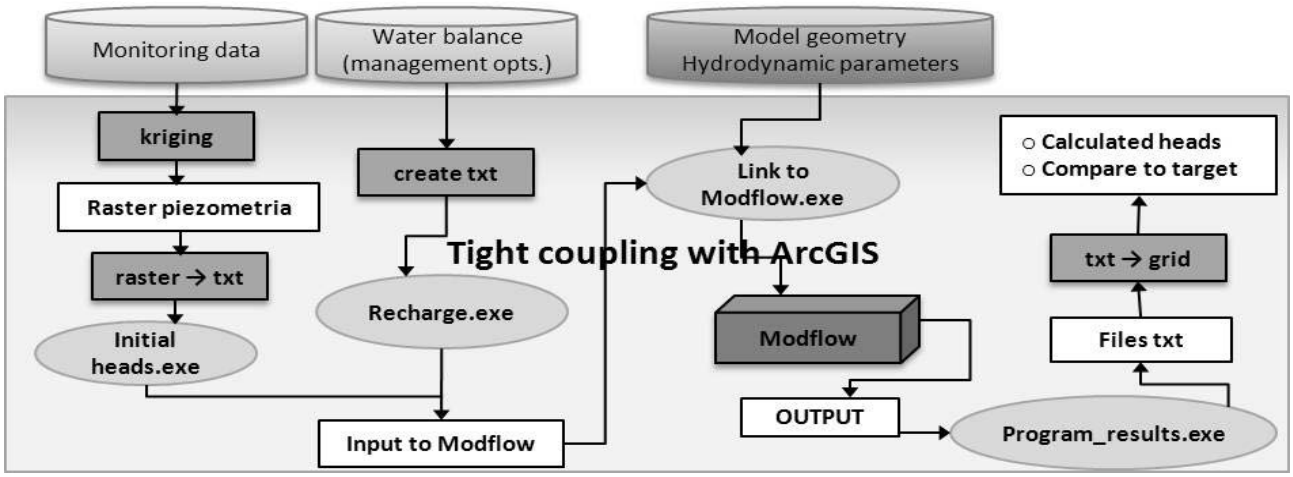

Figure 2 – Tool architecture.

developed *ad hoc* (written using Fortran90 language) able to generate the input to Modflow from text files generated by ArcGIS. Similarly, other codes read the Modflow output and return a format compatible with ArcGIS.

The tool is structured in four steps, which are here briefly described:

- STEP 1: **"Data interpolation"**; the objective is the creation of piezometric maps by interpolation of the measured piezometric heads using geo-statistical methods (kriging)
- STEP 2: **"Maps drawing and analysis"**; the objective is to visualize the maps interpolated in the previous step and to compare them with others representative of an "ideal" situation". Different types of visualization are possible (each map with its predefined and significant rendering): piezometric levels, water table depth, difference with respect to an "ideal" situation, representing the threshold that shouldn't be exceeded. In this way an early warning of local/ generalized critical situations can be defined. The difference between raster is calculated using *Map Algebra* techniques.
- STEP 3: **"Management Option Input running of the model"**; based on the results of the previous step, the user could wish to run the numerical flow model starting from the current situation in order to analyze the scenarios (at 3, 6, 9 and 12 months) arising from different management options. Simulations can be performed assigning as an input: the "initial conditions", represented by a piezometric map interpolated from the monitoring data at a certain period; the predicted volume of irrigation and the abstraction rates spatially distributed for the chosen scenario; the estimated irrigation return, as a percentage of the irrigation volume. The management options can be conveniently modified changing in time and space the irrigation and the abstraction rates; variations of the crop pattern or of the irrigation technique can be accounted for modifying the infiltration coefficients. The model has been implemented with a default assignment of the aquifer geometry, the hydrodynamic parameters (k, S) distribution and the boundary conditions, suitably calibrated outside the tool and which cannot be modified by the user. After introducing the inputs, the model can be run inside ArcGIS framework; the output format consists in ASCII file converted in GRID format to be visualized as a raster map into the GIS.
- STEP 4: **"Results visualization"**; the simulation results can be easily visualized in ArcMap, providing information on the suitability of the suggested management options. The outputs are piezometric raster maps representing the simulation results and vector maps for the contours drawn with an appropriate rendering previously defined.

CONCLUSION

A groundwater management tool which integrates in a dynamic way monitoring data with a numerical flow model within a GIS in order to provide a support to decision making has been carried out. The tool is addressed to water managers, who don't have specific skills both in hydrogeological modelling and GIS; for this reason the tool is thought as "closed box" in which the workflow is predefined, the parameters regarding the model calibration locked, while those related the monitoring data and the management options are flexible. Of course the effective value of the tool depends on ability of the user to implement the management choices suggested.

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AUTOMATED GIS DATA PROCESSING FOR THE DETECTION OF GROUND WATER ABSTRACTION SITES POSSIBLY INVOLVED IN AN ACCIDENTAL POLLUTION EVENT

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KEY WORDS: accidental pollution, water resources, GIS, automated procedure, decision support.

INTRODUCTION

In the framework of a collaboration between the Department of Civil Protection and the Water Research Institute of CNR a procedure for the emergency management of accidental pollution of ground waters occurrences has been developed (Fig. 1), in which a GIS tool allows for the immediate identification of the drinking water resources possibly involved. When an accidental pollution event happens, such as the overturning of a tanker, a key aspect is not often the lack of data but the ability to manage them optimally to obtain quick responses to support decision making. The GIS tool herein described aims to manage the phases immediately after an accidental contamination event, in order to provide support for prompt location of the target drinking water resources. Additionally the tool can facilitate the management of the available data for further modelling and analysis of the site. The tool is thought to be used also by non-expert personnel.

METHODOLOGY

The aim of this customized GIS tool is to automate data processing and analysis operations (Maguire et al., 2005) performed in sequence in order to obtain an immediate answer to alert the authorities for the resources that could be affected by the accidental event. In this phase the tool is able to manage the geographic analysis of the event, to identify the drinking water resources that may be involved and to query databases relating to them. After this preliminary step which must be very fast, the tool is able to support further analysis loading the informative layers available for the site map (hydrogeology, ground water vulnerability, hydrodynamic parameters, etc.) as well as the contaminant properties, and providing the relevant information to be used in transport models. All the operations are based on the spatial overlay of different thematic layers.

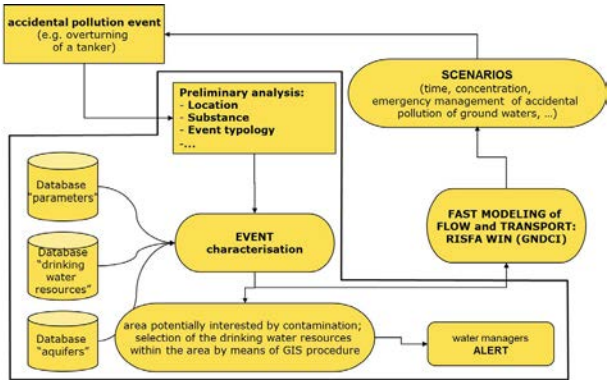

Figure 1 – schema of the procedure for the emergency management (the black box narrows the area interested by the GIS procedure)

The tool was firstly developed in ArcGIS 9.3.1 programming the ArcObjects with Visual Basic for Applications (VBA). The current version, developed in ArcGIS (version 10) in which VBA is no more fully supported, was written using the open-source scripting language Python (Beri M., 2007) , which is one of the framework suggested by ESRI for the automation of geoprocessing functionality (ArcGIS Desktop 10 Help).

The conceptual model of the tool is described in Fig.2:

- In the first step the user places the event on the map by its coordinates and then fills a form with the main information regarding to the event (name, description, date, operator, location, contaminant, notes, etc). Other information (administrative data, lithology and hydrological complex in which the event falls) is obtained automatically by the tool using typical GIS overlay techniques, able to extract information from other layers based on spatial location (spatial queries). The information provided is

of course dependent on the available layers for that site.

- The second step is a proximity analysis aimed to narrow the area that could be potentially interested by contamination. The analysis is done considering a "buffer" area around the event, whose radius increases with the permeability of the hydrogeological complex in which the event falls.
- In the third step the drinking water resources that fall within the buffer area are individuated and possibly the water managers are warned for an eventual interruption of the water supply. As data on drinking water resources come from different databases, an archive that integrates various sources has been built. This archive is essentially a summary table containing the main information of the point and the database to which it belongs (for more detailed information).
- The last step consists in a complete characterization of the event based on the available layers. In particular the parameters to be used in transport models should be gained in this phase. For this reason the available databases ("target archives") storing various types of data at local and national scale collected from different sources in different time and with different scale and extent should be already linked to the GIS tool. The "target archives" have the purpose of storing maps in such a way that it is immediately usable in case of emergency. For each event, the thematic raster and vector layers that insist on the event area are automatically loaded into a specific GIS project. This operation is based on a comparison of extents between each layers available to be loaded in the GIS and the event area defined by the extent of the buffer polygon: if the intersection is not null, the layer is loaded, otherwise not.
- The tool works in a flexible way: the procedure could be run both in "an automated mode", without changing any parameters (by non-expert users) or in "parametric mode", that allows the (expert) user to change the value of parameters (for example the distance of the buffer for the proximity analysis) and to run the application repeatedly observing the variability of results as a function of the inputs.

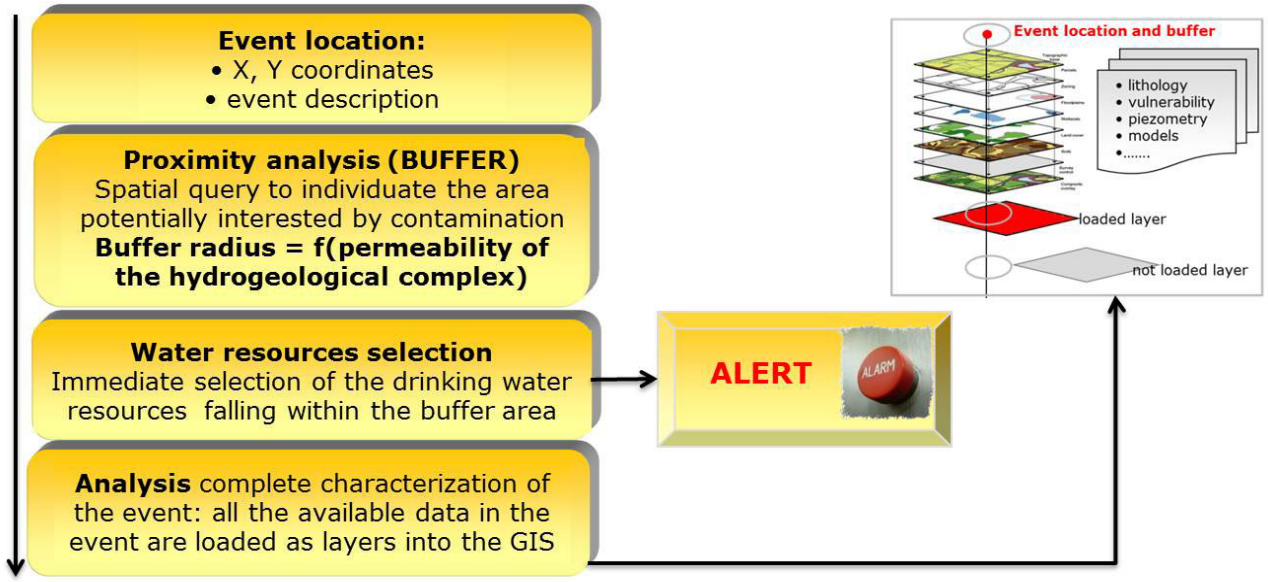

Figure 2 – The conceptual model of the tool.

CONCLUSION

A decision support tool has being implemented using ArcGIS (ArcInfo license) and Python scripting language in order to automate the GIS data processing for the detection of possible sources involved in an event of accidental pollution. The aim of the application is to be a simple way for quickly returning the answers for pre-alert and successively to facilitate the consultation of the available layers to support analysis of greater detail.

ACKNOWLEDGEMENTS

The research is co-funded by the Italian Civil Protection Department.

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THE 1:250.000 SCALE GEOLOGICAL MAP OF PIEMONTE (NW ITALY). PRELIMINARY LAYOUT.

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KEY WORDS: geological maps, geological database, geological knowledge sharing, Alps, Apennines, Po Plain.

PRESENTATION OF THE MAP: PRELIMINARY LAYOUT

A first release (a simplified graphical layout) of the 1:250.000 scale Geological Map of Piemonte (northwestern Italy) has been realized by CNR IGG Torino and ARPA Piemonte with the collaboration of DST - University of Torino and DIATI - Politecnico of Torino.

The scope of the map is to synthesize the surface and sub-surface geology of Piemonte region in order to give an exhaustive reference map for geological studies and to support geo-environmental analysis and planning at regional scale.

Piemonte is a large region and has very complex geological settings: Paleozoic to Tertiary metamorphic and non-metamorphic units stacked in the Alpine-Apennine orogenic system, Paleogene to Neogene peripheral basins filled by mainly terrigenous continental to marine sediments and widespread Quaternary continental deposits, at surface on the hill systems and mountain ranges and in the subsurface of the alluvial Po Plain.

Significant efforts were addressed to homogenize and correlate data collected at different scales and with different purposes through a large time span, using recent and early geological mappings and studies (1:50.000 scale maps of the CARG project, 1:100.000 scale maps of Geological Map of Italy, available local maps, unpublished fieldworks etc...).

A conceptual model has been developed to organize in a logical scheme the adopted classification criteria that have been used to define the "Legend scheme".

The Alpine-Apennine system and related basins have been represented and classified by a ranking scheme consisting of eight classification levels, starting from the main geomorphological subdivisions down to the tectono-stratigraphic units and/or synthemes and finally to the elementary stratigraphical and/or lithological instances.

In the frame of this scheme, the Quaternary continental succession has been subdivided into three main basins: the Western Po basin, the Alessandria basin and the Savigliano basin. The fluvial and glacio-fluvial succession has been then subdivided into morphostratigraphic units in order to allow reconstruction of the architecture and evolution of the three main basins. Conversely in the Alpine-Apennine chain the cover deposits have been grouped into generic lithological units (fluvial, lacustrine, glacial and gravitative)

MAP DATABASE AND METADATA: A DIGITAL MEDIUM FOR GEO-THEMATIC DATA STORING

The first release of the 1:250.000 scale Geological Map of Piemonte provides only a graphical layout of the project. The compilation of the informative content of the Map-related Database is still in progress. Each topological element of the map can be described referring to eleven attribute classes, while standard INSPIRE Metadata Classes for each of the significant data set are going to be described.

A further release of the map will represent also subsurface data below the alluvial northern and southern Piemonte Po plain, as a result of a starting scientific collaboration with ENI.

The 1:250.000 scale Geological Map of Piemonte provides then a synthesis of surface and subsurface geology of the region useful for three-dimensional geological models and syntheses. Furthermore, it would represent a digital medium for storing varied thematic geo-environmental information, since the scheme of its relational database has been designed to host more detailed information (at least up to 1:25.000 scale) compared to this first release of the map.

A OPEN SOURCE GIS APPLICATION TO THE ENVIRONMENTAL DATA: THE TUSCANY REGION SUBSOIL USE ATLAS DATABASE

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(3) Consorzio LaMMA, Sesto Fiorentno, 50019, Via Madonna del Piano n.10

KEY WORDS: geothematic data , geodatabase, GIS, 3D modeling.

TITLE OF SECTION

The importance of having a Continuous Territorial Geological lies in the possibility of being able to make it usable by the public authorities and professionals. Hence arises the need to correlate data collected for the obtaining of layers derived from the basic geology, geomorphologic maps, such as mineral resources.

The purpose of this association was to create a data base on the spatial distribution of the subsoil in Tuscany due to the use of the same. Then highlight the protections, constraints, rules, problems and conflicts related to use of the subsoil and the possible impact on planning.

The characteristics of Subsoil Use Atlas will be the ones to create a regional-scale consistency, with full compatibility with other regional database, to achieve high fidelity of the real situation and therefore be easy to update.

The project phases include the retrieval of reference databases such as Geological Database (BDG),

Quarries Mines Database (BDGM),Water Resources Database (BDSRI), Geological Surveys Database (BDIG), Thermal Mineral Water Database (BDCAMT) and Wells Geothermal Database (BDPGS).

The next step consists in the creation of a new data structure derived from the intersection of information obtained from databases previously listed. The data derived from the operation of intersection allow to identify classes of criticality according to one classification proposed by the region of Tuscany in accordance with current regulations (Fig.1: Relationship of criticality).

The formal description of the relationships between the entities in our possession and information related to them, belong to the main stages of conceptual design.

The conceptual design is to analysis of scientific documentation relating to the domain specific

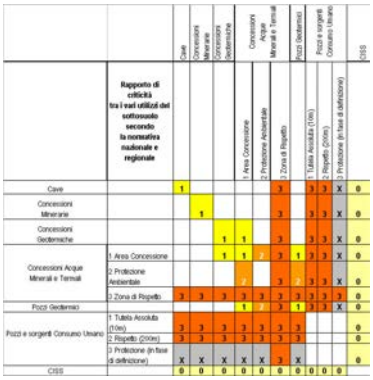


Figure 1 – Relationship of criticality.

knowledge which is represented, in our case, from the layers of information and relative documentation connected to it.

These documents provide a detailed description of the geometric characteristics and the entities that make up the database and have brought us a homogeneous layers of information design and the relationships between them.

The first step was therefore the analysis of the documentation that has allowed us to achieve an integrated processing of geometries and attributes for setting up a new database.

For the realisation of the new Database we made use of open source software like PostgreSQL with PostGIS (database server) for the management of the Data Base and QGIS for his view.

The software open source PostgreSQL is an Object-relational DBMS that is a relational DBMS in which data is represented through tables and tables are managed using a high-level language called SQL Strucured Query Language acronym.

This software has been joined by another open source software, PostGis, which provides geographic support.

Through the use of SQL language, it was possible to realize a procedure (fig. 2: Database implementation workflow) that allows us to create and manage the new structure of Data Base (fig. 3: Excerpt of SQL procedure).

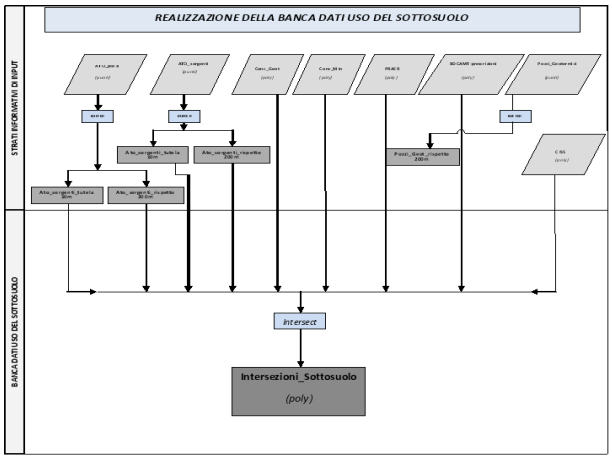


Figure 2 – Database implementation workflow.

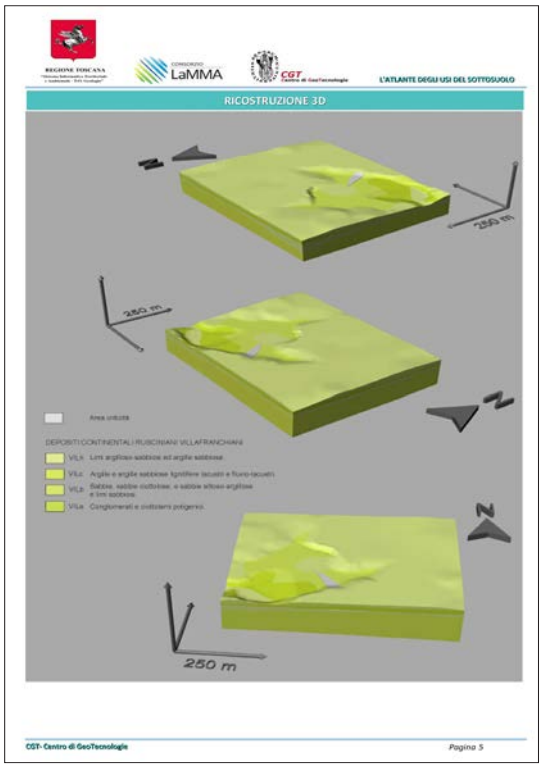
The final stage is the implementation of descriptive monographs of criticality, highlighting the causes, types, the impact on the resources concerned and finally formulating hypothesis.

The descriptive monographs are structured in four parts. In the first section is the 2D representation of individual areas with critical legislation (Fig. 4: 2D and 3D Representation), follows the description of the layers of information, the next

```
CREATE SEQUENCE IF NOT EXISTS
        intersezioni_sottosuolo_gid_seq
                INCREMENT BY 1
                MINVALUE 1
                NO MAXVALUE
                START WITH 1
;

CREATE TABLE IF NOT EXISTS
        intersezioni_sottosuolo
                (
                gid integer NOT NULL DEFAULT nextval('intersezioni_sottosuolo_gid_seq'::regclass),
                tip_int character varying(100),
                id_reg1 double precision,
                cmi1 character varying(100),
                id_reg2 double precision,
                cmi2 character varying(100),
                crit character varying(254),
                id_non integer,
                non character varying(100),
                nome_non character varying(100),
                pdf_path character varying(100),
                the_geom geometry
                )
;

ALTER TABLE
        intersezioni_sottosuolo
        ADD CONSTRAINT
                enforce_dims_the_geom
        CHECK (ndims(the_geom) = 2),
        ADD CONSTRAINT
                enforce_geotype_the_geom
        CHECK (geometrytype(the_geom) = 'POLYGON'::text OR the_geom IS NULL)

;

CREATE INDEX
        intersezioni_sottosuolo_the_geom_gist
                ON intersezioni_sottosuolo
                USING gist (the_geom)
;

-- // ato_pozzi_tutelaUm-praer \\

INSERT INTO
        intersezioni_sottosuolo
                (
                id_reg1,
                id_reg2,
                tip_int,
                crit,
                cmi1,
                cmi2,
                the_geom
                )
SELECT DISTINCT
        a.id_reg,
        b.id_reg,
        'ato_pozzi_tutelaUm-praer',
        '3',
        'Pozzo Acquedottistico',
        b.tipo_area,
        geom(st_dump(st_intersection(a.the_geom, b.the_geom)))

FROM
        ato_pozzi_tutelaUm AS a,
        praer AS b
WHERE
                a.descr_uso = 'Acquedottistico'
        AND
                st_intersects(a.the_geom, b.the_geom)
        AND
                GeometryType(st_intersection(a.the_geom, b.the_geom)) = 'POLYGON'
;
```

Figure 3 – Excerpt of SQL procedure.

part shows the analysis of regulatory detail. The next section shows the 3D reconstruction of the area containing the criticality with geological detail analysis and conclusions.



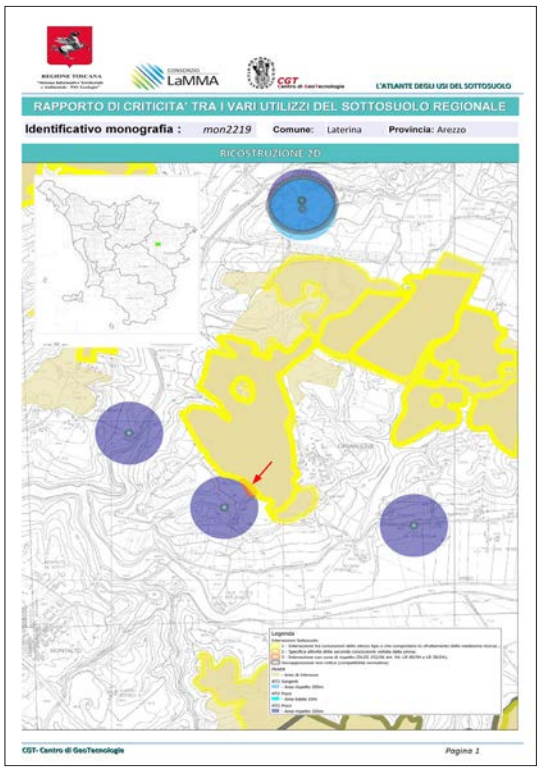


Figure 4 – 2D and 3D Representation.

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Directive 2007/2/CE of the European Parliament and of the Council of 14 March 2007 establishing an INfrastructure for SPatial InfoRmation in the European Community (INSPIRE).

ENTERPRISE GEODATABASE AND GEOTHEMATIC DATA : THE 1:10000 CONTINUOUS GEOLOGICAL MAP OF TUSCANY REGION

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KEY WORDS: geothematic data , geodatabase, GIS

TITLE OF SECTION

Till now the Tuscany Region share the information needed for the above mentioned activities through the official geological and geomorphological regional cartography, published in her geographical web site as raster or vector format, like 728 different tiles at the scale 1:10000. These data are derived from different survey, in various periods, made by scientific committees of disparate Tuscan Universities. Consequently the data are really accurate but not so up to date and, in particular, not so homogeneous long the whole Regional area. For these reasons, there are some area that are too difficult to study, because the data can come from different tiles that don't interfaces each other, with consequent problems to interpret them, and maybe can have different age, so they don't have the same meaning.

The data model (Figure 1) and its metadata are according to the structure of other existed geographic databases of the Tuscany Region (e.g., Database of Subsoil and Hydric Resources) and INSPIRE (INfrastructure for SPatial InfoRmation in Europe) legislation (Directive 2007/2/CE of the European Parliament and of the Council of 14 March 2007).

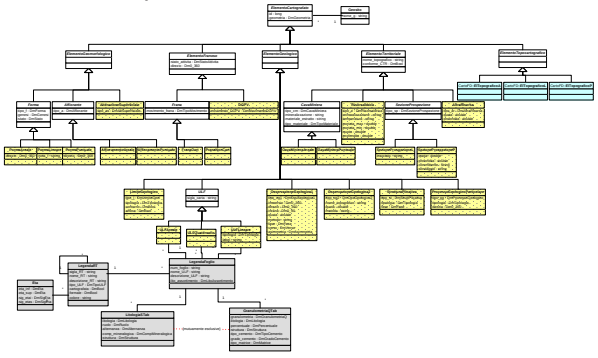

Figure 1 – Data Model.

The digital data have stored in a ESRI™ SDE geodatabase data model that represents a multi-user relational geographic database, using the ArcGIS/ArcInfo editing powerfull and the scalability of a Open Source Data Base Management System (DBMS) like PostgreSQL 8.3, to manage vector (feature class on feature dataset) and raster data, tables, topological rules and relationships (association between objects in a geodatabase) in order to be able for a object or a class to access to the attribute of another object of a different class. (ATZENI et alii, 2009).

A enterprise data acquisition architecture, as that one provided from ArcSDE (Spatial Database Engine) technology, gives the chance to increase the map production, with a articulate workflow based on a large number of user who can edit the same dataset, the same area too and, furthermore, exactly on the same feature. This capability it's really useful to edit a continuous and very accurate dataset, with a lot of features, that must be edited, updated and deleted simultaneously, without data and acquisition fragmentation.

All these properties can warrant a unique data consistency, excluding not needed redundancies, with a real productive concentration of the data editing operation and managing, through a series of tools dedicated to check every possible violation by the users that overrides defined constraint. In fact there are more scenarios in which the editors can work in this kind of system but, in every case, the system detects always potential conflicts that can amendable from the Database Administrator (DBA), with a reconciliation with the stable state of the data.

The whole above consideration are relevant to explain the particular carefulness to create a big and important geothematic dataset thought to provide a relevant tool for the risks prevention and environmental planning, shared on Internet with a WebGIS service (www.geologiatoscana.it) (Figure 2).

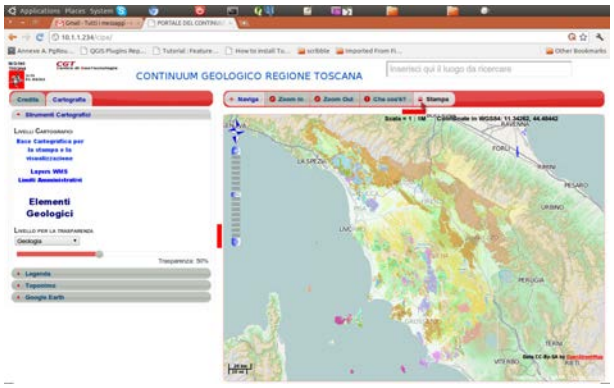

Figure 2 – A view of WebGIS site.

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LANDSLIDE MAPPING: IMPROVING ACCURACY AND EFFICIENCY

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KEY WORDS: Landslide mapping, aerial photo-interpretation, orthorectification, vectorialization, GIS, open source, susceptibility, risk.

INTRODUCTION

Landslide inventory maps are a key issue to document the type and extent of mass movements in small (slope scale) to very large (country scale) areas, for geomorphological studies, and for landslide hazard and risk assessment (Guzzetti et al, 2012 and references therein). Geomorphologists usually prepare landslide inventories by aerial photo interpretation (API) of stereoscopic images aided by field survey. Criteria adopted for the visual image analysis derive from the heuristic interpretation of photographic and morphological features of the image, such as shape, size, colour tone, texture and pattern. An established procedure for transferring photo-interpreted information to a GIS environment is traditionally organized according to the following stages: (i) landslide information are drawn directly on an undeformable plastic film superimposed to the aerial photograph, (ii) the interpreted data are transferred on a plastic sheet superimposed to the topographic map, (iii) the photo-interpreted layer is scanned, imported and georeferenced as a raster file in a GIS project (iv) geomorphological elements are manually digitized and encoded through the compilation of a geo-database. This traditional method is time consuming, resource demanding, and depends on the experience of the geomorphologist. As a result, landslide inventory maps can be affected by mapping errors (positioning and shape) of the single landslides (Ardizzone et al., 2002).

We recently explored new GIS applications and tools that can help geomorphologists to digitize, store and publish landslide data more accurately and efficiently. We developed and tested a procedure that exploits GIS applications for the digitization and storing phase, and GeoServer for the creation of web-gis services.

In this work we describe the new procedure and compare it to the traditional method. Advantages and needed further developments are also highlighted.

MATERIALS AND METHOD

The new method developes starting from the API analysis, and is organized in the following steps: (i) ortho-rectification of the aerial photograph and its geomorphological elements; (ii) raster tracing of the geomorphological elements portrayed on the image; (iii) compilation of a geodatabase; (iv) publication of the features on a web-gis service. The former step exploits the GRASS GIS script i.ortho.photo. The script requires a number of input data, such as the scanning of the aerial photograph (Fig. 1A) and the superimposed undeformable plastic film, a DTM, an orthophoto map, and the camera parameters of the aerial photograph (Rocchini et al, 2010). Figure 1B shows the result of the ortho-rectification step. For the raster tracing step, we exploited ArcScan extension of ArcGIS 10, which provides a number of tools for raster to vector data conversion. Input file is a grid raster file (1 bit) of the only geomorphologic features. Vector features (lines and polygons) are stored in output shapefiles.

Figure 1 – (A) IGM b/w aerial photograph. Result of the visual interpretation is portrayed. (B) Orthorectified aerial photograph. (C) Web-gis screenshot.

For the third step, which is common to the traditional procedure, a geographical database is is compiled according to the photo-interpreted information. Both proprietary and open source GIS software can be used. Finally, the ortho-rectified aerial photographs (raster files), and the shapefiles of the geomorphologic features, are loaded on a relational database with geographical extension (PostgreSQL/PostGIS). For this operation SLD (Style Layer Description) styles need to be associated to the shapefiles. Then, WMS services are generated by GeoServer, and WMS layers are loaded on a web-gis project (Fig. 1C).

RESULTS AND CONCLUSIONS

A landslide inventory map was prepared for the same area adopting the traditional and the new method. To compare the resulting maps, we used for reference a topographic base map 1:10.000 scale. Figure 2 summarizes the mismatch between the two inventories. Some of the landslides were mapped in a slightly different geographical location and have a comparable area (landslides (e) and (f) in Fig. 2). For landslides (a) and (d) positional mismatch is acceptable, while landslide area was overestimated following the traditional approach. Lastly, for landslides (b) and (c) dimension and positional mismatch results unacceptable.

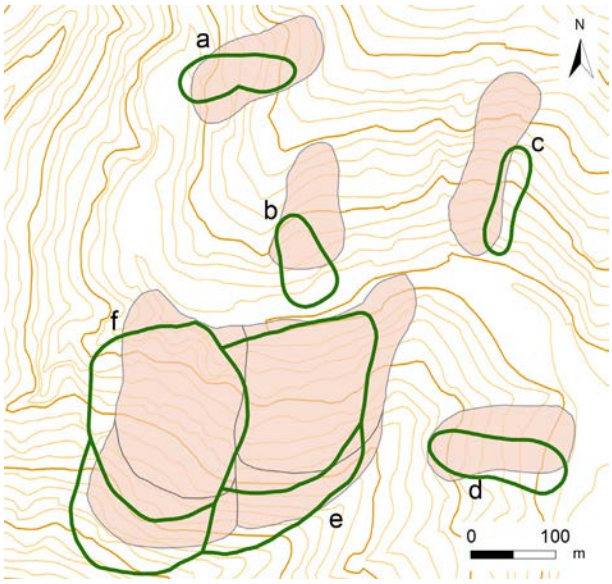

Figure 2 – Comparison of landslide mapping following the traditional procedure (pink polygons) and the new procedure (green lines). Letters from (a) to (e) indicate single landslides.

Visual comparison of the two inventories reveals that the extent of smaller landslides ((a), (b), (c), (d) in Fig. 2) is overestimated in the inventory carried out using the traditional procedure. As a result, landslide frequency-area statistics (Malamud et al., 2004) derived using the two procedures could be slightly different.

Lastly, comparison of the landslide inventories prepared by the two different methods revealed that the traditional method introduces errors that can affect the evaluation of landslide susceptibility, hazard, vulnerability and risk.

ACKNOWLEDGEMENTS

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CARGO: A GEOLOGIC WMS PROTOTYPE MASH-UP GOOGLE FOR ANDROID, IPHONE, PC, MAC.

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KEY WORDS: CARG, Google Mashup, WMS.

INTRODUCTION

The need to always have local land maps and, in particular, a geological mapping has led to the development of a prototype mash-up (a "customization" of Google maps) called CARGO, to be used by both fixed devices (PC, laptop etc..) and by mobile devices (essentially based on Android or Mac-OS operating systems). CARGO allows a user-friendly browsing of several WMS web-based services available in the Emilia Romagna region, such as regional topography, geological mapping, soil maps, in addition to other specific topics. Cargo has been developed by means of HTML 4 and JavaScript languages and version three of Google API. Since this is an html page, it does not require any installation on the device being used (as is instead the case for apps), which allows employees to provide updates free from versioning and / or use restrictions tied to the use of a specific hardware or device.

Figure 1 – (1) CARGO mash-up: (1) main page (2) layers opacity management (3) Menu Help.

MASHUP FUNCTIONALITIES

The prototype mash-up on its main page (1 in Figure 1) involves the uploading of a two curtain menu for a separate management of specific themes. The right menu allows you to change the background (orthophotos, satellite images etc..) While the left menu allows you to access and manage WMS themes, by providing them with variable opacity using a pop-up menu in the upper left corner of the frame (*Setting* in image 2 in Figure 1). This also provides you with the ability to upload external kml / kmz data from a remote server. The Geological Survey logo is located at the lower right corner. By clicking on it, you can access the geological map caption and other utility functions, such as external links or the mash-up use manual (shown in image 3 in Figure 1). CARGO finally

provides you with the geolocalization of the device used and the immediate use of maps related to the user's location.

CARGO is currently available in the prototype version and is already tested by the Geological Survey and Civil Protection Service of the Emilia Romagna Region. The prototype mash-up is freely available upon request by e-mail to the author.

ACKNOWLEDGEMENTS

I am grateful to Marica Landini and Francesco Marucci for fruitful discussions.

GIS MAPPING REFERENCES: A COMPLEMENTARY SUPPORT TO GEOLOGIC CARTOGRAPHY. EXPERIMENTATION THROUGH TWO GEOLOGICAL SHEETS OF THE CARG PROJECT

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KEY WORDS: CARG, Geologic literature

INTRODUCTION

The scientific geological literature is a valuable resource. To date, it has not yet had an adequate appreciation to the detriment of knowledge of the use of natural resource and land governance.

The main reason lies in the dissemination of scientific articles only through specialized journals and conferences, which has made information not sufficiently accessible and has thus affected scientific culture itself.

Scientific culture is in fact heavily affected by the type, language and distribution of journals. Any obsolescence of the publication and the difficulty to find it is a further obstacle to accessibility and readability.

The major scientific publishing groups have tried to solve these problems by creating synthetic query mechanisms (key words) exhaustively describing the contents of the scientific work already in the title. Then, each publisher would not only develop digital copies of scientific papers, but also search engines for their publications.

Within the framework of the CARG project (development project of the Geological and Geothematic Map of Italy at a 1:50.000 scale), the geological map is closely linked to illustrative notes, namely synthetic descriptions, which usually contain a bibliography of selected scientific papers based on the scientific content of the map. However, in some cases, not very recent scientific papers, whose contents, however, cover relevant aspects of the land are omitted, as is the case, for example, of derelict mining sites, since they are considered to be publications related to past economic aspects and therefore no longer significant.

OUTLINE OF THE PROJECT

A deepening and broadening of bibliographic sources linked to the areas related to the CARG cartography, is possible by integrating an additional layer in the information system containing data on all the scientific production concerning the area under study, beyond what has already been reported in literature.

In this way any scientific work with a geographical-geometric component becomes a highly accessible valuable piece of knowledge of the area.

The set of areas associated with several scientific articles reported at this level of information would, allow to obtain accurate data mining providing a full view of scientific findings achieved in a specific scientific location, once a full acquisition of bibliographical references is completed.

This information layer would allow to update all scientific literature, completed as a result of the local area study, and to facilitate the migration of scientific findings from hard copy to the digital version, by supplementing and / or further enhancing the work that is already in progress within national libraries.

Besides, at present, the dissemination of digital scientific findings is no longer linked to a specific geographic query and visualization.

Studies are currently under way to reach that goal, by defining the geolocation methodology of bibliographic material. To this regard, two experimental geological sheets published within the framework of the CARG project are under construction and developed by adopting the same technique used to tag the photographic images on the Internet. Thus, specific librarian standard metadata, supplemented with geographical components, would be present within every single digital document.

GEOLOGICAL MAPPING IN THE CARPATHIANS ORIENTED TO PREPARE MAPS FOR THE PURPOSE OF PETROLEUM INDUSTRY

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KEY WORDS: geological mapping, GIS, Carpathians.

HISTORICAL BACKGROUND

The Polish Outher Carpathians, which within Polish borders extend longitudinal to a length of about 330 km, are the area of the oldest petroleum industry. The crude oil exploration and production started here in the middle of XIX century. After over 150 years of exploration the Polish Carpathians are still being the intrests of petroleum industry and almost the whole area is licensed. The recognition of a geological structure is the main task during hydrocarbon exploration and accurate geological maps represent an important component of such recognition process.

Before the II Word War an intensive geological identification was conducted mainly in the Eastern Carpathians and Carpathian Foredeep, which resulted in numerous maps. However, the systematic geological mapping in the Polish Carpathians was initiated in fifties as a part of the project aimed at implementation of the Detailed Geological Map of Poland (DGMP) at the scale of 1:50 000. Mapping work was coordinated by the Polish Geological Institute (PGI) and was conducted within section areas according to the international division of maps. Currently, the whole area of the Polish Carpathians has been already mapped. Nevertheless, not all the map sheets have been published so far.

According to the authors' experience the existing maps can be insufficient for the petroleum application. The usefulness of those maps is limited especially if the area of interest overlaps on two or even more map sheets because of both the content of the map as well as its form:

First of all, individual sheets have been prepared by different authors and over a long time. For these reasons adjacent sheets are very often inconsistent in terms of their geological content. It regards mainly the amount and character of lithostratigraphic divisions, but also the interpretation of geological structure. It resulted mainly from the fact that views on geology of the Carpathians changed over decades, as well as it was due to differences in outcropping condition.

- Secondly, most sheets are available only in analog form (as paper maps or rasters), even if they have been prepared after developing the Geographic Information System (GIS) programs.

AREA AND METHODS OF WORK

Since the set up of Geokrak Company twenty years ago one of our main activity has been geological mapping for the purpose of petroleum industry. We have worked out our own workflow, which combines traditional and proven methods of field research with digital technologies. Standardization and synthesis of data obtained from various sources is done with the use of GIS software since the very beginning of map preparation. It has not been a standard procedure in mapping of the Carpathians by PGI, even in the case of maps prepared in the last decade.

The geological maps updated by Geokrak staff have been based principally on regular field work, but also various other information, especially data from shallow and deep boreholes, micropaleontological studies and various digital materials (Fig. 1).

Micropaleontological data have always been one of the most important soure of information used in the preparation of geological maps in the Carpathians. It is a tool, which provide a valuable biostratigraphic data, also in our work. Our micropaleonto-logical and palynological studies are focused on foraminifera, organic/calcareous dinocysts, calpionellids and fossil playnomorph assemblages. They let us to perform an stratigraphic assignment for each collected sample and have a great impact in map construction process and in the further interpretations of geological structure. We also provide an chemostratigraphic analysis of both organic and carbonate origin stable carbon isotopes. This method let us to perform a stratigraphic scheme for sections that are barren in stratigraphically relevant taxa.

Geological mapping done on the ground is supported by interpretation of aerial photos, remote sensing analysis and use of three-dimensional

representation of the ground surface, which is generated from digital elevation models (DEMs). Photogeological interpretation can reveal many structures which are difficult to recognise in the field or even cannot be detected at all at ground level.

A special software “The Dip Data” has been developed by Geokrak geologist to facilitate preparation of geologic map. It allows importing of data from GPS and adding description to each field observation point. Farther on “The Dip Data” allows to export of all input data to the GIS software. Field points can be shown on a topographical or any other raster background which enables simultaneous usage of field database with other information during preparation of the map (Fig. 2).

In the era of widespread use of GIS softwares there is a growing need for updating of archive maps in the Carpathians in order to prepare consistent maps in a digital form. The GIS software gives the possibility to analyse more data than in case of traditional map processing, which affects the accuracy of the mapping geological structure. According to our experience even verification of the archive maps, e.g. only with the use of photogeological interpretation, may significantly change the these maps. Moreover, digital version of geological maps are more helpful in processing of geological data during determining the prospects for exploration of hydrocarbons, e.g. some of the data in a form of thematic layers in GIS software can be directly imported to the software used in interpretation of seismic data which facilitates the processing of the last data.

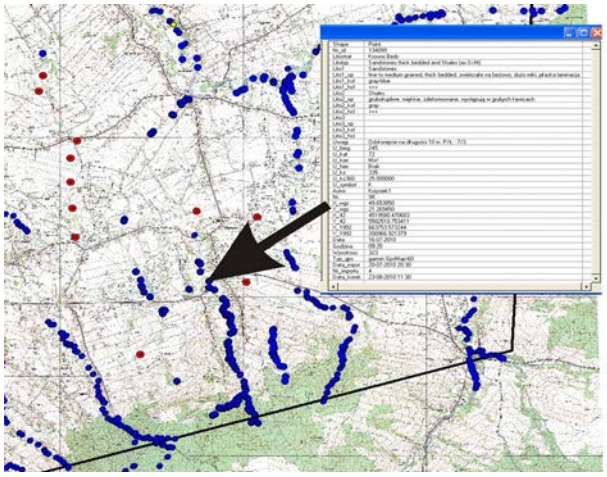

Figure – 2. Field observation point on a topographical raster background. The data for one of the point displayed in right corner.

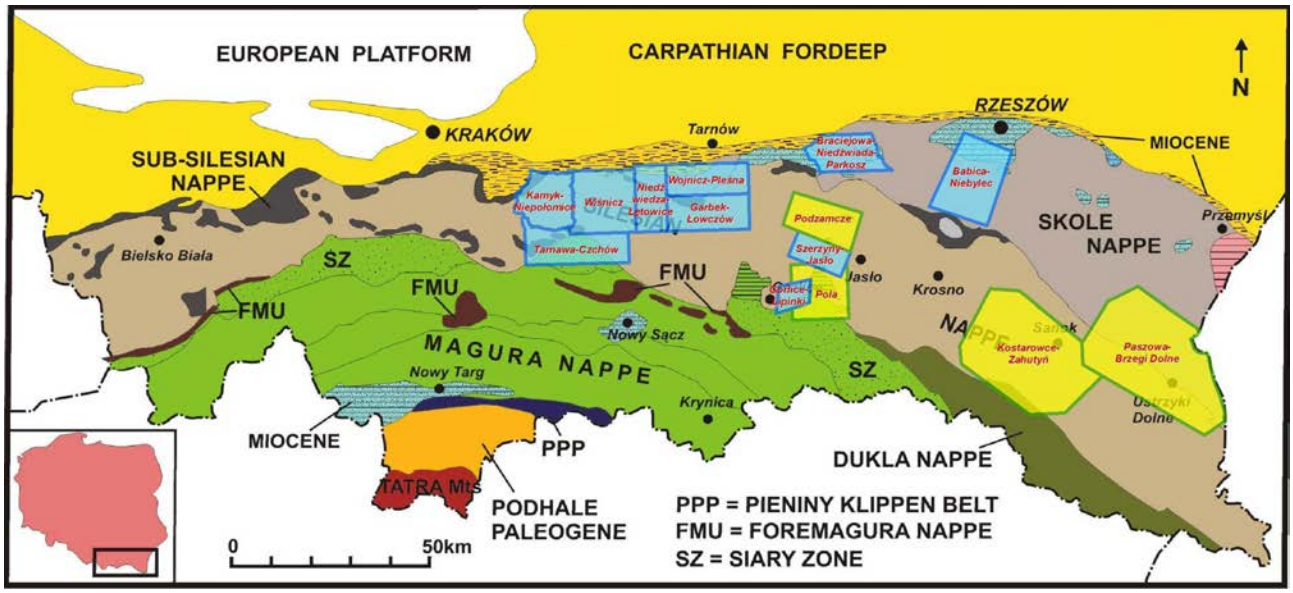

Figure 1 – Tectonic map of the Polish outer Carpathians (after Książkiewicz, 1962) with areas mapped by Geokrak geologists (blue ones – based primary on field research, yellow ones - based on revision of archive geological maps and using of data from shallow boreholes, micropaleontological studies and digital materials) .

THE COPPERBELT WEB MAPPING APPLICATION- AN OPEN SOURCE SOLUTION FOR ENVIRONMENTAL MONITORING OF MINING AREAS

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KEY WORDS: web mapping application, open source, environmental monitoring, mining areas, Copperbelt, Zambia.

INTRODUCTION

An Environmental Data Management System which was developed during the Copperbelt Environmental Project (CEP) (Staudt, 2009) was further developed towards an open source web mapping application during a co-operation between the Geological Survey of Finland (GTK) and Department of Surveying Sciences of Aalto University.

The project is a pilot project for such activities in Zambia and can be further developed by involved stakeholders such as the Zambian Environmental Management Authority (ZEMA), Ministry of Environment, University of Zambia, Surveying Department or Geological Survey of Zambia just to name a few. The development environment is open source online servers and applications in order to reduce costs and to give other stakeholders and investors the possibility to establish similar services in the future.

The application was developed with open source tools which include such technologies as *Geoserver, Drupal, PostgreSQL, PostGIS* and others using the open layers technology. The application is currently able to display mining areas and environmental data that include monitoring stations using Google/ Open Street Maps technology as base layers.

The prototype of the The Copperbelt Web Mapping Application was developed during a year long lasting course in “GIS Application Development” as a part of the Master’s Programme in Geoinformatics instructed at the School of Science and Technology, Aalto University in 2011 and is currently further developed by the authors.

With the application it is possible to add or download data using the content management system *Drupal* and *Geoserver* after registration as a user. The system is intended to be used by ZEMA formerly Environmental Council of Zambia (ECZ) as an online tool to manage the environmental monitoring of the mining areas in the Copperbelt. At the moment a *PostgreSQL* database, which contains historical environmental monitoring data, is part of the system. This database was created by using data provided by the Zambia Consolidated Copper MinesInvestment Holding (ZCCM-IH). Newly monitored environmental data can be easily added or imported by ZEMA inspectors. If the application is accepted by the ZEMA it is possible to provide training in usage and maintenance of the system.

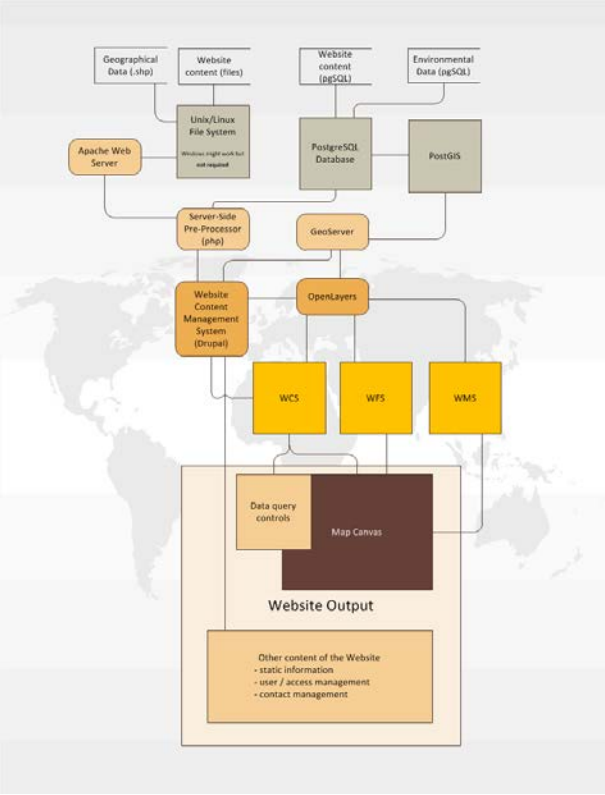

Figure 1 – Overview of the used technologies, tools and services behind the web mapping application.

PROPOSED SYSTEM ARCHTECTURE

The different technologies to realize such a system with open source tools is illustrated in Figure 1.

The system consists of the following open source tools:

- *Drupal:* an open source content management platform
- *Geoserver or other*: an open source server to publish and edit geospatial data
- OpenLayers: a pure JavaScript library for displaying map data in most modern web browsers
- *PostgreSQL*: Open source RDBMS (Rational Database Management System) similar to MySQL
- PostGIS: open source software program that adds support for geographic objects to the PostgreSQL object-relational database

The following Web Services will be supported as GIS data output from the server side:

- *WFS*: Web Feature Service
- *WMS*: Web Map Service
- *WCS*: Web Coverage Service

RESULTS AND FUTURE WORK

The newly developed web mapping application is a useful tool to organise and manage all relevant GIS and environmental data in connection with the monitoring of mining areas in the Copperbelt (Figure 2). The combination of different open source tools has proved to be competitive with commercial out-of-the-box solutions. The prototype will be further developed adding new functionalities such as the upload of new monitoring data and visualisation tools which will show monitoring values as time series and validate them against existing environmental standards.

ACKNOWLEDGEMENTS

The authors would like to thank Pekka Sarkola and Prof. Kirsi Virrantaus from Aalto University for supervising the work. Michael Staudt wants to thank the Finnish Graduate School in Geology for partially funding the work during the years 2010-2011.

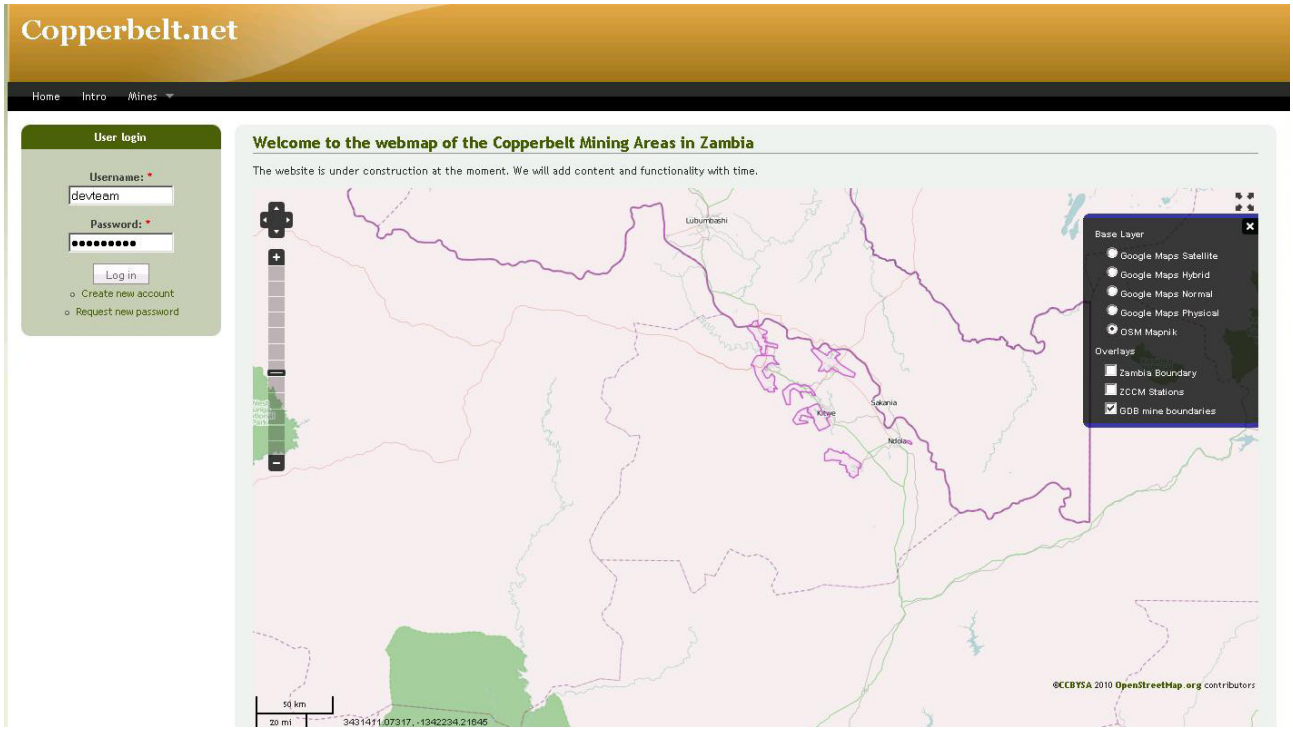

Figure 2 – Starting screen of the Copperbelt Web Mapping Application

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INTEGRATION OF GEOLOGY, GEOMORPHOLOGY, TOPOGRAPHY AND ANCIENT CARTOGRAPHY DATA THROUGH THE USE OF GIS TECHNIQUES: THE URBAN RESEARCH CASE OF FERRARA AND THE EVALUATION OF THE ENVIRONMENTAL HAZARDSOF IN THE URBAN AREA

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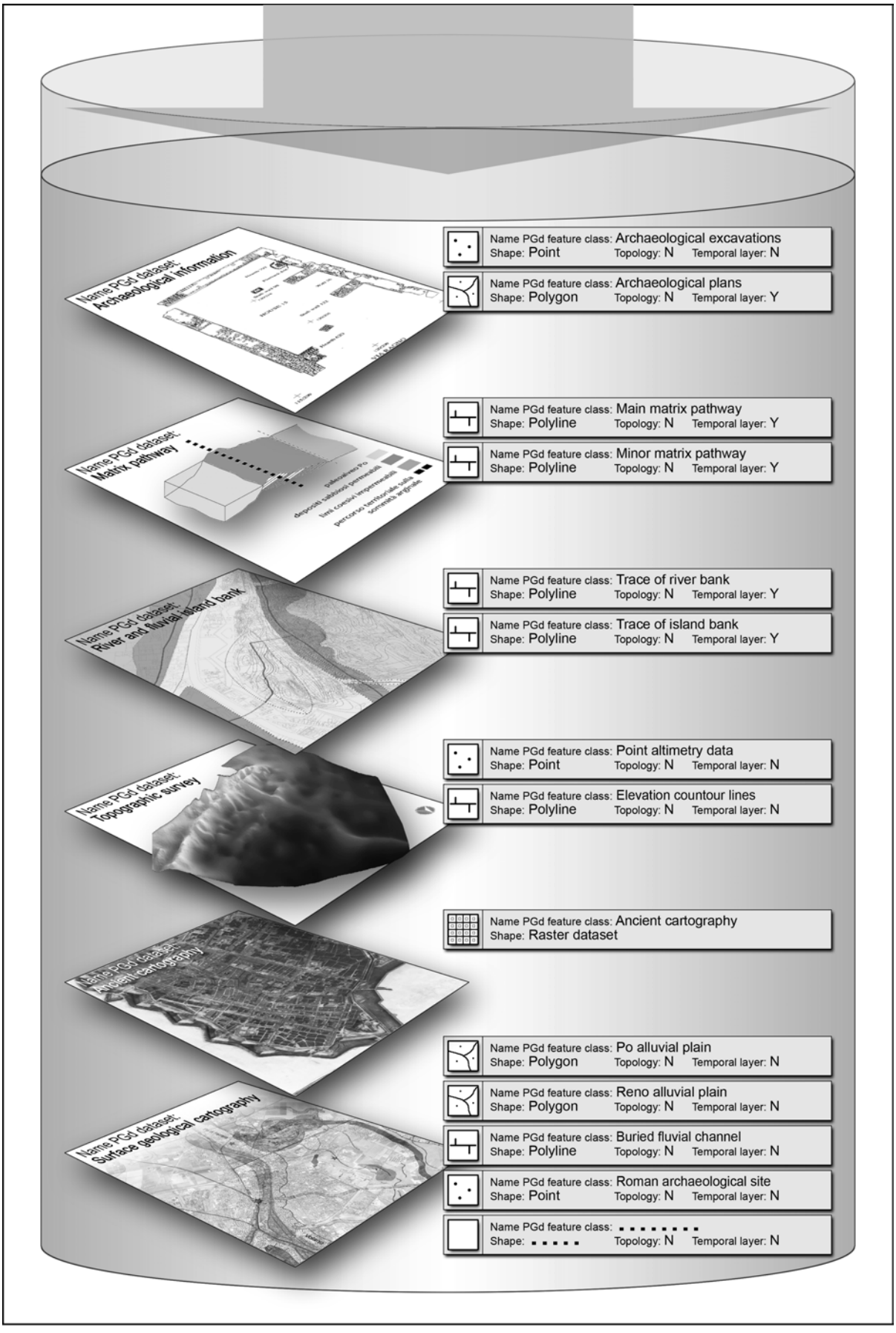
KEY WORDS: Alluvial Plain, Po Valley, Stratigraphy, Historic Seismicity, Town History, Urban Management, .

The effective management of an urban area overgrown on an important historic city requires a deep knowledge of both its natural and human history and its present day state. Ferrara developped in the lower alluvial plain of the Po, from early Medieval to modern times, generating a large historic nucelous, recognized as an UNESCO site, together with the adjacent Po Delta coastla environments. Subsurface data and geotechnical information were integrated with the historic record od the seismic damage on building structures induced by the 1570 earthquake. This historic evidnece could improve the seismic hazard evaluation in a town develloped on the tectonic acrive front of the burried Apennine chain. Organic compound pollution of underground waters related to the petrochemical industry is important in the urban area and require a 3D modelling of the aquifer bodies and of their relationships with the urban structures. The river flooding hazard from the elevated Po, Pandaro and Reno river is great. An accurate modelling of the geomorphological structures and topographic organization of the area is fundamental to asses the flooding pathways anr risks. The town history record a strong interaction between the depositional evolution of the Po and Reno river systems and the urban growth of city. Understang this evolution requires the integradation of a wide spectrum of data sources, ranging from subsurface drilling and cone penetration tests to satelite remote sensing, from archeological evidence to the georeferencing and interpretation of historic map, from literary sources to the surveyng of the present-day building tissue. Data by themselves deprived of any historic value, such as geological mapping, geotechnical investigations, or geoidal elevation measures can rise up to playing a key role in the urban history understanding, through their spatial and chronological integration into a complex data set. The interdisciplinary synthesis of these rich information set needs an accurate and amogeneus topographic framework, encompassing the whole of the data and the ability to store, analyse and retrive geocoded data that only a geographic information system can provide. The GIS computerising environment makes the spatial integration of a wide spectrum of punctual, linear, and 2D data, possible. The accurate geoconding of the data required a preciosion topographic survey and the creation of a DTM elevation modelling of the entire historic centre and sourrounding areas. The interpretation of the interdisciplinary data was grounded on the chronological synthesis of written, archaeological, architectural, radiomentric and isotopic (^{14}C) dating sources. The synthesis made possible by these novel tools progressively enable the long, intricate urban history of Ferrara to be unravelled and the relevance of the historical heritage understood. Proposals for the historic tissue preservation, the urban management, the mitigation of the seismic hazard, and the energy efficiency improvement were derived from the integrated analysis of the urban tissue.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WEBGIS OF FLOODING AND EXCEPTIONAL RAINFALL IN METAPONTINO

Emanuele Tataranni

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KEY WORDS: webgis, Metapontino, flooding, rainfall, Basilicata.

INTRODUCTION

The webgis EvAlMet (www.evalmet.it) arises from the need to create a tool that is able to monitor and take a census of the floods in the Metapontino.

Although increasingly frequent exceptional weather events, institutions and local authorities have not yet developed joint projects.

The project is so innovative as Evalmet allows local governments to interact, exchange information flows and closer to the citizen, and be used for purposes of civil protection.

The heart of the whole information system is the database. It contains several tables that are queried according to the requests that you make using the shortcut menu.

To get an idea of the size and potential of the database, just look at the numbers:

- 68 observation stations;
- more than 650,000 records relating to the daily records;
- 500 records cataloging the sources of news;
- 536 records cataloging the damage recorded in the municipalities;
- more than 100 records of multimedia material.

The project is totally open source: the website was created in PHP and using MySQL database(with spatial extension) management. The only cost was then the domain registration.

WEATHER DETECTION

EvAlMet allows the consultation of the measurements carried out by the following types of stations:

- thermometers;
- rainfall;
- hydrometric;
- flow;
- drainage.

The data were produced by various public authorities through selecting a defined cutoff between 1916 and 2011. The managing bodies of the stations give their data prior authorization, so Evalmet can protect the confidentiality whit password access.

At each station is given a web page that lists all the features of the station:

- name;
- location (geographic coordinates);
- characteristics of the instrumentation;
- list of years in operation.

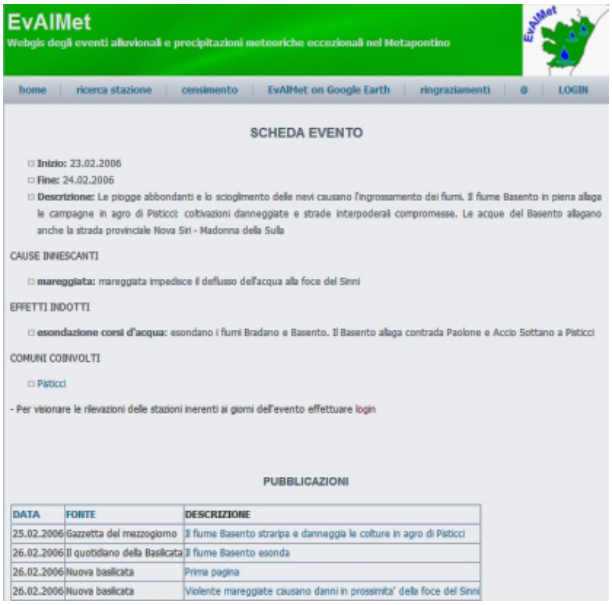

Figure 1 – Scheme of functionality.

CENSUS OF FLOODS

EvAlMet offers you free access to a database containing an inventory of exceptional weather events occurring in the time interval 1959-2011. Each event is cataloged and is presented by a card bearing the following information:

- duration;
- causes of trigger;
- induced effects;
- reports with news articles.

In addition, for each municipality affected by the

disaster there is an account of the damage, pictures and video georeferenced.

GOOGLE EARTH

In the section of the site “EvAlMet on Google Earth” you can observe the measuring stations and the entire collection of photographic material. A time bar will allow to know at any time the detection stations activated and multimedia content related to each exceptional event. By clicking on the elements a pop-up windows appear and allow you an effective connection with the website. The choice of using Google Earth as a mapping tool, although a proprietary software, is linked to the widespread that it has a worldwide scale. However, all spatial information is stored in the database and therefore can be viewed with opensource tools.

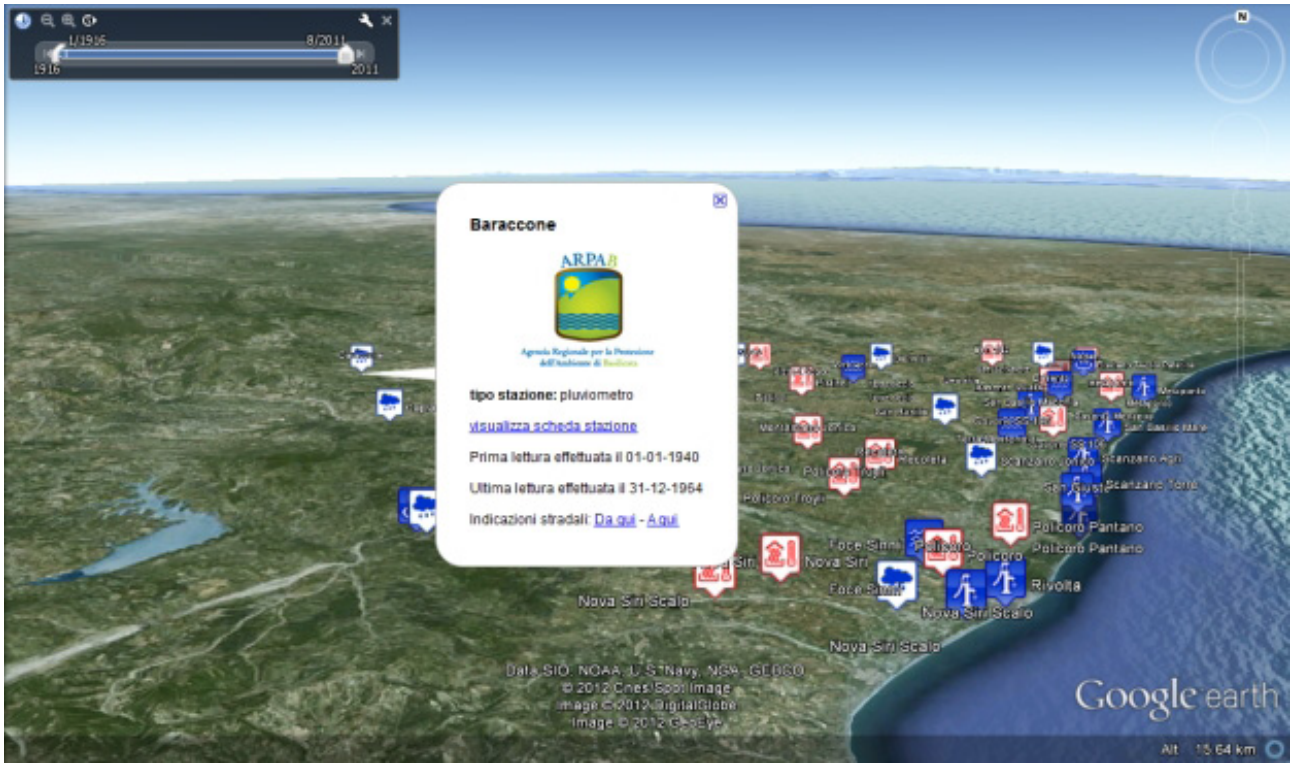

Figure 1 – EvAlMet on Google Earth.

DEVELOPMENTS

The potential of webgis Evalmet is the possibility to upgrade at any time the database (operation done even by inexperienced users) without having to modify the code and interface of the web pages. The project is therefore in constant development and is open to all forms of fruitful collaboration.

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I am grateful to: Daniele Simoncini, Arpab, Protezione Civile Basilicata, Alsia, Legambiente Matera, Comando dei Vigili del Fuoco Matera, Pino Gallo, Filippo Mele, Dott. Antonio Trivisani.

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THE "SPIGNO MONFERRATO" 212 QUADRANGLE: NEW GEOLOGICAL MAP AND GEODATABASE

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KEY WORDS: geological mapping, Geographic Information Systems, vector-based drawing software, Voltri Massif, Western Alps

INTRODUCTION

We are carrying on a geological map project, financed by Regione Liguria, that covers the Ligurian part of the Spigno Monferrato 212 quadrangle. The mapped area (about 350 km2) straddles the Savona and Genova provinces in central Liguria.

We perform the field mapping at 1:10,000 scale, for a final rendering at 1:25,000 and 1:50,000 scale. Associated with the geological outcrop map we built up a relational database in order to store all the information collected during field work.

Our goal is to produce both a high graphic-quality geological map and to create a geological database. The only way to link these two elements is to use a vector drawing software with GIS capabilities. For these purposes we used Adobe Illustrator CS4 and Avenza MaPublisher 8.3.3.

THE MAP & THE GEODATABASE

The mapped area falls inside the HP metaophiolitic Voltri Massif of the Western Alps (Fig. 1) (e.g. Chiesa et al., 1975; Capponi and Crispini, 2002) and thus encompasses rocks belonging to the Ligurian-Piemontese Domain and locally to the Piemontese and pre-Piemontese Domains.

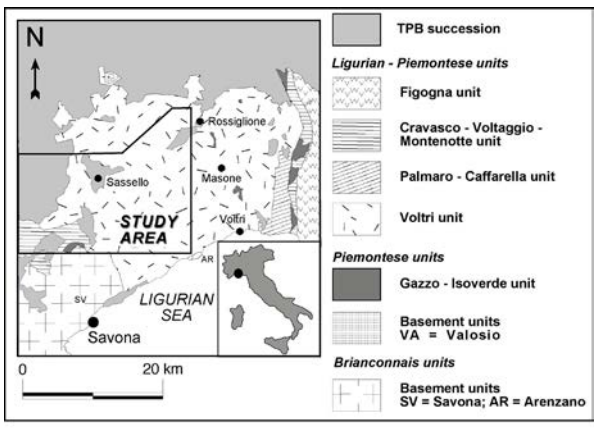

Figure 1 – Location of the mapped area.

This area is characterised by a structurally complex bedrock (e.g. Fig. 2) overlaid by late to post-orogenic deposits.

Figure 2 – Interference pattern of type 3 of Ramsay and Huber (1987) in metasediments

The starting point for drawing a geological map is the outcrop map; working with a GIS software this map summarizes geological data not only in a graphical way (vector data) but also through a relational database containing both numerical, alphanumerical and boolean attributes.

The map is made of different data that have to be handled by the software using four types of GIS features:

- georeferenced raster images (Coordinate System: Monte Mario – Italy, Zone 1),
- polygons,
- straight lines;
- points.

Polygons represent the outcrops of different lithologies, and they have a specific graphic style (reported in the legend), defined by fill (colors and textures) and stroke (weight, color, dash pattern). The associated database contains different kind of information such as outcrop descriptions and photos, presence of rock samples, asbestos minerals, fossils etc. (Fig. 3).

Lines represent faults and are characterized by a specific stroke and color.

We show as points different kinds of information: sampling locations that are represented as a

non-oriented symbol and attitude data that are represented on the map as oriented symbols (e.g. arrows) in order to express the real orientation of planes (e.g. schistosity, bedding, faults, fractures) and lines (e.g. fold axes, lineations). Both have an associated database made of different fields (e.g. macroscopic and microscopic samples description, reliability rank of attitude data, etc.). The mapping project involves also the report of many other geological data collected during field work such as relevant paleontological sites, quarrying and mining sites, caves, springs etc distributed on the area. We represent as points, distinguished on the map by different symbols, the location of these geological elements. All of these have an associated database that can be updated with new information deriving from specific analysis and studies.

In order to manage this map project we chose Avenza MAPublisher® 8.3.3 for Adobe Illustrator® CS4. Developed as a suite of plug-ins for Adobe Illustrator, MAPublisher is the bridge between the graphics capabilities of this vector-based drawing software and the GIS potentiality, to produce high-quality maps. This software is able to manage simultaneously both georeferenced data and simple graphical and text elements, and, unlike the most part of GIS programs, it can manage text data as a feature instead of a mere object label: this means that MAPublisher allows you to create an attribute schema linked to a text object.

The geodatabase is essential to draw the interpretative geological map; in fact it allows to manage and analyse a large amount of data. Thanks to powerful GIS tools we can make spatial or attribute-based queries to extract data from the dataset and then we can process them using complex spatial analysis aids and external applications.

To exchange and integrate data with other research groups, we have to read files from other graphical (such as Macromedia Freehand®, Bentley Microstation® and Autodesk AutoCad®) and GIS software (e.g. ESRI ArcGis®) and to export our project both as shape files and text files. Finally, we use a GPS device during fieldwork to precisely locate outcrops since MAPublisher® 8.3.3 is able to download gps data that are stored as lines or points in our map project. Lines represent the fieldworkers' tracks and points the exact location of outcrops, samples and other remarkable geological features.

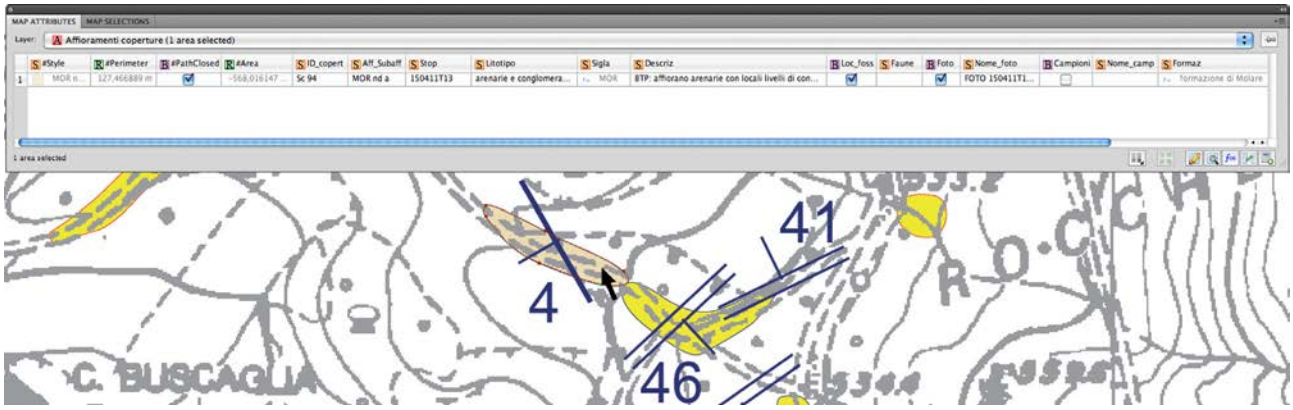

Figure 3 – Attributes schema associated to a selected polygon

CONCLUSIONS

Here we show the preliminary output of this graphical-GIS map and the potential of spatial and attribute-based queries on the databases associated to different features. This kind of approach allows various improvements: simplifying the interpretation work, linking field data and outcrop data with many information and obtaining high-quality geological maps.

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WASTE CONTAINMENT SITE SELECTION USING GIS AND MULTICRITERIA ANALYSIS: A TUNISIAN CASE STUDY

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KEY WORDS: MSW landfill, multi-criteria evaluation, GIS, site selection, ELECTRE.

INTRODUCTION

The appropriate site selection for municipal solid waste (MSW) landfill or evaporation pond of liquid waste is considered an important and necessary issue for waste management in order to reduce environmental impacts and risks associated to this practice. The selection of a containment appropriate site requires processing and evaluation of a significant amount of spatial data with respect to various siting rules, policies, considered as factors and constraints of this process. The present work presents an integration of multi-criteria decision analysis and overlay analysis using GIS to support selection of municipal solid waste landfill and olive mill wastewater evaporation pond respectively in Ariana and Sfax cities in Tunisia.

METHODOLOGY

The site selection process was completed in two stages. In the first stage, the constraints differentiate suitable areas. In the second-stage, the candidate sites were ranked based on a variety of factors by the use of fuzzy multicriteria decision analysis and ELECTRE method.

Constraints are those Boolean criteria that limit our analysis to particular geographic regions. In contrast, factors define some degree of suitability for all geographic regions. They permit the evaluation of alternatives issued from the previous step. Hence, the following steps describe the typical procedure:

(a) Thematic maps were represented as layers of geographic data, including geologic, hydrological, hydrogeological and demographic data. Then, all the map layers were converted to a raster format (cell of 100 mx100m). Each cell was considered homogenous unit for any considered criteria.

(b) The constraints, based on the Boolean criteria (true/false), were used to differentiate suitable areas for a waste containment site from those unsuitable under any condition. Boolean images were given the values of 0 (suitable site) and 1 (unsuitable site) for the land suitability.

(c) The factors were standardized to a continuous scale of suitability from 0 (least suitable) to 10 (most suitable) in a GIS environment by fuzzy membership functions.

(d) The Weighted Linear Combination (WLC) aggregation method for preparing the suitability maps was applied. Suitability maps for each set of factors were combined to create three scenarios to allow determination of the more suitable site.

(e) ELECTRE III method was used to rank sites and finally specify the most preferred alternative.

SITE SELECTION

The examined criteria and their associated values and limits were selected based on the relevant international literature relative to disposal sites and waste management (Joerin 1997 ; Morjani 2002 ; Mahini and Gholamalifard 2006 ; Kouame et al. 2007 ; Chang et al. 2008 ; Sumathi et al. 2008; Hasan et al. 2009 ; Sharifi et al. 2009 ; Wang et al. 2009 ; Moeinaddini et al. 2010 ; Nas et al. 2010; Dai et al. 2001). Local expert judgements and assessments via questionnaires were also used. The constraints criteria include soil permeability, elevation, slope, coastal zone, sub-soil characteristics, depth to impermeable layer, depth to ground water table, water supply, wetlands, distance from rivers, proximity to irrigational canals, land cover, distance from roads, protected areas, residential areas, site area. The factors include land cover suitability, olfactory and sonorous impacts, population density, distance from waste production centres and distance from road.

The digitization and analysis of the thematic maps for the study areas were performed within the framework of the well known desktop GIS software: Arc View GIS 3.2. The criteria required in this GIS application included: The 1:50000 topographical maps (25 m intervals) covering the study area were digitized manually into a computer. The slope and elevation maps were developed from the digital elevation model data generated from the digitized contour lines. The groundwater levels and the impermeable layer properties (depth and thickness) were supplemented with field investigations

carried out on piezometers. Streams and faults were extracted from the geologic map using map query extension. Residential area, wetlands and roads were obtained from the land cover maps. The population density required the building of geographical database linked to alphanumeric database that consider the spatial variability of population. The above-mentioned base maps were compiled at scale of 1:50000 for the study area. All vector base maps were then converted to raster (cell size 50 m x 50 m), using the Spatial Analyst tool extension of the Arc View GIS.

Therefore, a total of 32 sites were found to be suitable for olive mill waste water evaporation in the Sfax region and 5 sites for municipal solid wastes landfilling in the Ariana City.

These sites are ranked in priority order based on environmental and economic consideration and using The ELECTRE III method. The selection of the final site, however, requires further geotechnical and hydrogeological detailed analyses.

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THE INTERREG PROJECT GEORG: TRANSBOUNDARY HARMONIZATION OF GEOLOGICAL DATA

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KEY WORDS: Upper Rhine Graben, geopotentials, 3D-modeling, subsurface geology, seismic interpretation.

THE GEORG PROJECT

In the project GeORG (Geopotentials of the deep Upper Rhine Graben) partners from Germany, France and Switzerland prepare and analyse geological data of the Upper Rhine Graben (URG).

The URG is a 300 km long and 35 to 50 km wide rift and wrench basin with an Eocene to Quaternary sedimentary fill up to 5 km thick. It represents a central segment of the European Cenozoic Rift system ranging from the Mediterranean Sea to the North Sea (see Abstract Rupf & the GeORG Project Team and Fig. 1).

Rifts like the URG are known to potentially host oil and gas reservoirs. Therefore, exploration activities in the URG, especially by drillings and seismic campaigns have been intensive in the last century.

Within the context of recent discussions on climate change and sustainable use of natural resources, new geopotentials of the URG, e.g. deep geothermal energy, potential use for CO_2 sequestration or deep aquifer reservoirs have come into focus.

The GeORG project aims at a transnational geological database and a geological 3D model of the URG to assess these geopotentials.

HARMONIZING DATA IN GEORG

Although a huge amount of geological information on the URG exists, these data cannot be analysed directly for the following reasons:

- Data have been stored in different national coordinate reference systems. Reliable and consistent coordinate transformation methods have to be defined within the project.

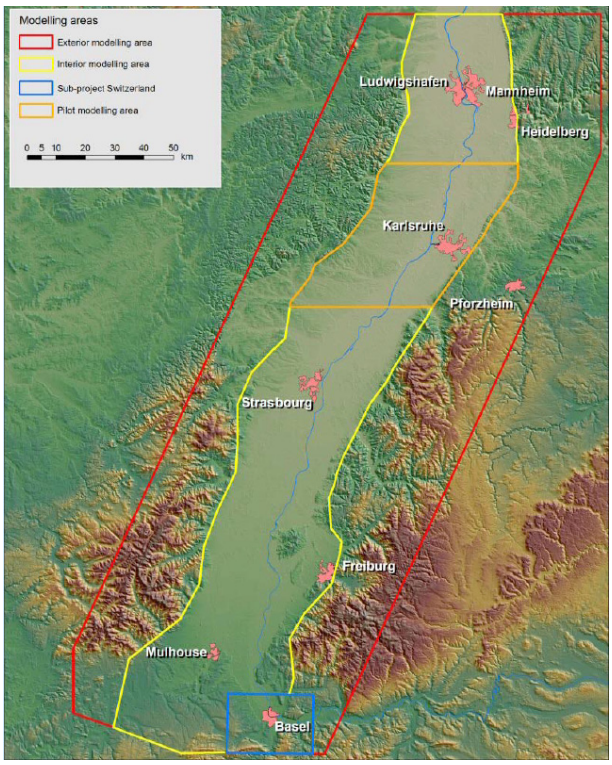

Figure 1 – Modeling areas in the GeORG project. The 3D model block corresponds with the interior modeling zone (yellow outline).

- The geological nomenclature of the graben deposits evolved in the first decades of exploration and has been revised several times since. Therefore, same rocks might have different names in well data of neighbouring oil concessions, while same names might be given to partly different units.
- Seismic data has originally been processed with

different algorithms and to different levels.
- The parameters of rock properties have been stored in separate local databases with different structure and definitions, e.g. different units of measurement and data correction methods.

Geometric, semantic and technical harmonization of all input data has turned out to be essential prior to any regional-scale geological interpretation and 3D-modeling. To eliminate the confusing use of geological terms for graben deposits, a new, transnationally aligned geological nomenclature has been developed and applied to > 2000 well data sets. A total amount of 5400 km of seismic profiles has been reprocessed with modern algorithms. It is the first time that such an amount of subsurface data is gathered, harmonized and analysed in the URG.

ESTABLISHING A CROSS-BORDER WORK FLOW

Fig. 2 illustrates the workflow in GeORG. Detectable faults and stratigraphic horizons are modelled in 3D from the interpretation of 2D seismics and well data. The 3D model is then parameterized with hydrogeological and geothermal properties in order to derive information on geopotentials.

The project partners contribute to GeORG with their respective special skills, e.g. seismic processing is performed by French partners, while 3D-modeling is assigned to German and Swiss partners. Bundling individual strengths and transferring special know-how leads to a mutual benefit for all partners and improves the project results significantly.

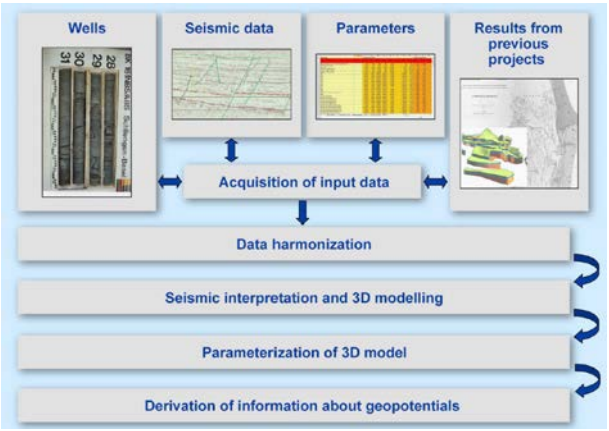

Figure 2 – The workflow in GeORG.

GEORG-GEOPORTAL AND GEORG-SDI

The GeORG-Geoportal will be the core platform for accessing GeORG metadata, map previews and standard webservices (e.g., CSW, WMS, WFS, see Fig. 3). The geodata infrastructure of GeORG will be based upon open source software components (e.g., GeoNetwork, GeoServer, UMN Mapserver, OpenLayers) and will take into account implemented specifications of the INSPIRE directive.

For the use of data from the oil and gas industry reliable authentification methods to comply with restricted rights of data usage are implemented.

Figure 3 – Screenshot of the GeORG-Geoportal (see www.geopotenziale.org).

By ensuring the interoperability of digital products from GeORG, reliable geological information of the geopotentials of the URG will be made available to interested users, planners and decision supporters and will be useful as basic information for planning future projects and investments.

ACKNOWLEDGEMENTS

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INSPIRE THEME 'NATURAL RISK ZONES' - A GEOSCIENTIFIC REVIEW

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KEY WORDS: INSPIRE, natural risk, natural hazard, georisk, geohazards, data specification, hazard classification, mapping.

INTRODUCTION

INSPIRE (INfrastructure for SPatial InfoRmation in Europe) is a directive of the EU (Directive 2007/2/EC, O. J. L108 of 14.3.2007, pp. 1-14) aiming to create an infrastructure for spatial data in Europe that shall help to make spatial information from public organisations more accessible and interoperable. INSPIRE addresses 34 spatial data themes arranged into three annexes. Related to geosciences, at least to a certain degree, are the INSPIRE themes 'Geology' (Annex II), 'Soil', 'Energy Resources', 'Mineral Resources', and 'Natural Risk Zones' (all Annex III).

Whilst the data specifications for Annex I themes were already adopted in 2010, the data specifications for Annex II and III themes have not been adopted yet. In June 2011, the second version of the data specifications for Annex II and III themes was published by the Thematic Working Groups (TWG) for consultation and testing. Until 21st October 2011, registered Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO) could review the data specifications and test the mapping of pre-existing INSPIRE relevant datasets. *Within this paper, results of the consultation and testing of Annex III theme 'Natural Risk Zones' as well as suggested modifications are presented.*

SITUATION IN GERMANY

As Germany is a federal republic whose federal states are largely autonomous in regard to its internal organisation, a large number of INSPIRE relevant data are managed by the 16 federal states. This applies e.g. to geoscientific data like drilling results, geological, hydro-geological or geohazard maps, and 3D geological models. These data are collected, processed and updated by the State Office for Geology or State Geological Survey of each state. Due to historical reasons (some of the precursor organisations of today's State Geological Surveys were established in the second half of the 19th century, decades before the Federal Republic of Germany was founded), each State Geological Survey used its own terminology and definitions, e.g. for stratigraphic units. In the meantime, different working groups were established and many steps have been taken to harmonize the terminology and definitions (e.g. LBEG, 2010).

In 2007, the national working group geohazards *('Personenkreis Geogefahren')* consisting of experts from the State Geological Surveys and the Federal Institute for Geosciences and Natural Resources (BGR) agreed on common minimum standards for assessing, evaluating, and displaying geohazards in terms of susceptibility maps (Personenkreis Geogefahren, 2007). In anticipation of INSPIRE, the working group aimed at defining minimum standards that correspond to widely recognized geoscientific standards and that can be easily transferred to and adopted by others.

In the context of the INSPIRE process, a national working group consisting of experts from various State Geological Surveys under the lead of the BGR Hanover was established in 2010. The main tasks of this working group are to support the elaboration of the INSPIRE data specifications relevant to geoscientists and to review the drafts especially from the perspective of data providers.

INSPIRE THEME 'NATURAL RISK ZONES'

The 'natural risk zones' theme includes all kind of natural hazards, like e.g. storms, floods, mass movements, wild fires but also animal stampedes or meteorites. All these natural hazards are covered by the core model and the coverage model, which differ from each other only by the data type (vector data vs. raster data). For floods, the data specification contains a special application scheme which is an extension of the core model.

One key aspect of core and coverage model is the applied hazard classification. Currently, the hazard classification is done by a mandatory attribute making reference to a few predetermined (but not precisely defined) high-level hazard categories and a voidable attribute providing additional, more detailed information about the specific hazard

type which is not predetermined and which can be defined by each data provider.

CONSULTATION AND FEASIBILITY TESTING

For the consultation, we reviewed the data specification of the INSPIRE theme 'Natural Risk Zones' in detail. We focussed on general aspects of core and coverage model and assessed the applicability for common geohazards.

We used data from the GeoLa project (*www.geola-bw.de*) of the State Office for Geology, Resources and Mining of Baden-Württemberg (LGRB) for the feasibility testing, Within the GeoLa project, mass movement hazard, subsidence hazard, karstification/subrosion hazard, and ground heaving hazard are assessed for the entire territory of Baden-Württemberg by collecting data of past events and by means of numerical modelling on the basis of geological information and a precise digital elevation model obtained from airborne laser scanning.

The feasibility testing was done by filling matching tables for each of the tested datasets and by documenting the results and all emerged difficulties. The following requirements were checked: (1) Can the GeoLa attributes be matched with INSPIRE attributes so that all non-voidable (i.e. mandatory) INSPIRE attributes can be provided? (2) Can all constraints specified in the data specification be satisfied?

RESULTS AND CONCLUSIONS

During the review of the data specification it soon became evident that from the perspective of geoscientists the hazard classification on which the data specification is based is very unpractical for two main reasons.

(1) The concept of high-level hazard categories with few predetermined but not precisely defined categories and voidable, user-definable specific hazard types leads to wrong classifications and does not support comparability of different datasets. Currently, combining and merging datasets from different data providers is extremely difficult and time-consuming if not impossible. Thus we suggest providing a predetermined and defined multi-level hazard classification.

(2) Usually, geoscientists are distinguishing between the following geohazards: earthquakes, volcanism, mass movements, karst/subrosion, problematic soils and rocks, and natural gas emanations. However, in the classification currently proposed in the 'Natural Risk Zones' data specification, some of these geohazards either are not included (like e.g. problematic soils and rocks) or cannot be clearly assigned to one of the hazard categories (like e.g. mass movements). Especially the differentiation between 'dry mass movements' and 'wet mass movements' seems to be not feasible in practice.

Therefore we suggest modifying the natural hazard classification with regard to geohazards as shown in Table 1. The two-stage classification introduced by the TWG is retained. The suggested second-level geohazard classes are adopted from the national working group geohazards.

Level 1	**Level 2**
Geohazards	Earthquakes
	Volcanism
	Mass movements
	Karst/subrosion
	Problematic soils and rocks
	Natural gas emanations
Hydrological hazards	Floods
Meteorological hazards	Storms
Climatologic hazards	Droughts
	Extreme temperatures
	Wild fires

Table 1 – Modified natural hazard classification for INSPIRE. Note: Modifications were only made for geohazards.

Due to the above mentioned classification problem and/or due to a lack of definitions for the possible natural hazard classes, mapping of the tested GeoLa datasets was not or only to a certain extent possible. We thus suggest including precise definitions for all natural hazard classes.

During feasibility testing another issue became obvious. Most GeoLa attributes could be matched with INSPIRE attributes. But, according to the data specification, the likelihood of occurrence for observed hazards has to be quantified (this is a constraint). However, it is not possible in practice or it is not common practice to quantify the likelihood of occurrence for several geohazards like karst collapse or mass movements. Thus we recommend omitting this constraint.

In summary, it can be said that the consultation and feasibility testing of the 'Natural risk zones' data specification revealed a number of critical points that have to be addressed for the revision of the data specification.

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LBEG (2010): *Symbolschlüssel Geologie – Symbole für die Dokumentation und Verarbeitung geologischer Feld- und Aufschlussdaten*. Landesamt für Bergbau, Energie und Geologie, Hanover, 202 pp.

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SPECIAL SESSION - INSPIRE / SPATIAL DATA INFRASTRUCTURES

Thursday, June 14th 9.00 – 18.45

The INSPIRE/SDI Session, organized in collaboration with European Commission, will present the final results of the development of the geoscience related data models and specifications, produced by selected domain experts from EU member states. These aim at improving access, interoperability and harmonization of geoscience data in Europe – the main objective of the EU INSPIRE Directive. The Session will also give opportunity to discuss any issues related with the interoperability and harmonization of geoscience data.

Detailed information on the INSPIRE legislative process and related materials are available here: http://www.ec-gis.org/inspire/

Chairpersons:
Robert Tomas, European Commission, Directorate General - Joint Research Centre; **Kristine Asch,** BGR, German Federal Institute for Geoscience and Raw Materials;
Francois Robida, BRGM, French Geological Survey;
Carlo Cipolloni, ISPRA, The Institute for Environmental Protection and Research, Italy.

Time	Subject/ Speaker
09:00 – 09:20	Opening speech (Lorenzo Broccoli, Direttore generale Organizzazione, Personale, sistemi informativi e telematica)
	Opening Statements (R. Tomas, K. Asch, F. Robida, C. Cipolloni)
Towards The INSPIRE Implementation in Geosciences Session 1 - Chair: R.Tomas	
09:20 – 09:40	Current status of the development of the INSPIRE legislation related to geoscience information. (R. Tomas, EC - JRC)
09:40 – 10:00	The role of EuroGeoSurveys in the INSPIRE Data specification process (F. Robida, BRGM)
10:00 – 10:20	Final INSPIRE Data Specification on Geology (J-J Serrano – BRGM)
10:20 – 10:40	Final INSPIRE Data Specification on Groundwater (T. Nalecz, PGI)
10:40 – 11:10	Coffee Break
11:10 – 11:40	Final INSPIRE Data Specification on Mineral Resources (J. Vuollo, GTK)
11:40 – 12:00	Final INSPIRE Data Specification on Energy Resources (M. Tuchyna, EC-JRC)
12:00 – 12:20	Final INSPIRE Data Specification on Natural Risk Zones (M. Harrison, BGS)
12:20 – 12:40	Final INSPIRE Data Specification on Soil (A. Arnoldussen, The Norwegian Forest and Landscape Institute)
12:40 – 13:00	Discussion
Towards Global Geoscientific Data Interoperability Session 2 - Chair: K. Asch	
14:00 – 14:20	OneGeology – F. Robida
14:20 – 14:40	OneGeology-Europe Data harmonization – K. Asch
14:40 – 15:00	The Italian view on OneGeology-Europe and INSPIRE – Marco Pantaloni
15:00 – 15:20	Baden-Württemberg the INSPIRE Geology test bed – A. Hagemeister?
15:20 – 15:40	From regional maps to the EU scale: The INSIRE challenge for Hydrogeology – B. Wagner
15:40 – 16:10	*Coffee break*
Towards Global Geoscientific Data Interoperability Session 3 - Chair: F.Robida	
16:10 – 16:30	The impact of the INSPIRE Directive on geological data models of NGS – F. Perez Cerdan
16:30 – 16:50	BoreholeML in the light of INSPIRE. J. Richter
16:50 – 17:10	EuroGeoSource data portal – What do users expect? K. Heirman
17:10 – 17:30	Data conversion or a wrapper mediator? The Italian example of INSPIRE implementation. C. Cipolloni
Panel Discussion Session 4 - Chair: Carlo Cipolloni	
17:50 – 18:10	Concluding statements by the Chairs (R. Tomas, EC-JRC; K. Asch, BGR; F. Robida, BRGM; C. Cipolloni, ISPRA)
18:10 – 18:45	Discussion
18:45	End of the workshop

INSPIRE DATA SPECIFICATION ON GEOLOGY

Jean-Jacques SERRANO (1); John LAXTON (2), INSPIRE Thematic Working Group (3)

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(3) Members of the Thematic Working Group, http://inspire.ec.europa.eu/index.cfm/pageid/2/list/30

KEY WORDS: Geology, Geophysics, Geomorphology, Hydrogeology, INSPIRE, GeoSciML.

OVERVIEW

In the INSPIRE Directive the Geology theme is defines as “Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology”. The scope has been defined by explaning the terms of the definition, and taking into account some legal texts as the Groundwater Framework Directive.

The geology domain for INSPIRE covers three sub-domains: geology, geophysics, and groundwater. This paper presents only geology and geophysics, as groundwater is described in another paper.

To specify the data model several use cases have been detailed.

The existing standard to exchange geological data (GeoSciML) was also taken into account.

To address all requirements of the use cases, but to provide a simple data model for the legislation, the Thematic Working Group decided to provide a core model (as a proposal for the legislation) and extensions to address more requirements.

The data specification for ‘Geology’ covers three sub-domain areas: Geology, Geophysics and Hydrogeology. Geomorphology is included in the Geology sub-domain. The Geology domain data specification is based closely on GeoSciML which has been incorporated into the INSPIRE foundation schema. GeoSciML has been developed by an international geological working group under the auspices of the Commission for Geoscience Information (CGI) of the International Union of Geological Sciences (IUGS).

THE CORE DATA MODEL

Geology, Hydrogeology and Geophysics sub-domains have a core and an extension application schema.

The core schema for the Geology sub-domain is designed to provide the basic information required to meet the use cases, whereas the extension schema allows the provision of more detailed information on Geologic Structures, Boreholes, Geological Age, and Physical Properties.

This figure shows only the feature types and their relationships. It does not include data types and code-lists.

MappedFeature_Core and GeologicFeature_Core are central classes in the model. The abstract GeologicFeature_Core class represents a conceptual geological feature that is hypothesized to exist coherently in the world, and includes as sub-types the main information classes in the model. The implemented Geologic Feature instance acts as the “description package”. A MappedFeature provides a spatial representation of a GeologicFeature, and the occurrence association from GeologicFeature to MappedFeature allows for several spatial representations of the same Geologic Feature, for example in maps of different scales or a 3D model as well as a 2D map. The specification association from MappedFeature to GeologicFeature allows only one Geologic Feature to be represented by any Mapped Feature.

There are three sub-types of GeolgicFeature in the data model: GeologicUnit, GeologicStructure and GeomorphologicFeature. *A Geologic Age is the age of some Geologic Event occurring.*

Borehole_Core is a generalized class for any narrow shaft drilled in the ground.

A Collection_Core is a container for items to be bundled in WFS response documents.

The GeophysicsCore application schema is mainly restricted to location and basic metadata of the most important geophysical features. The GeophysicsExtension application schema provides a wider range of classes to help share geophysical results with the public

Fundamental classes defined in the core model, are related to well-known geophysical concepts as measurements, and surveys:

- GeophMeasurement is a generic feature type that models the field observation procedure with its location, spatial characteristics and related metadata. The related projectedGeometry is necessary when measurement setup is 3 dimensional, to define a 2D geometry for displaying purposes
- GeophSurvey is used to document geophysical campaigns and projects

GeophMeasurement is a generic feature type

that models the field observation procedure with its location, spatial characteristics and related metadata. In the core model GeophMeasurement has three subtypes: GeophStation, GeophProfile, and GeophSwath.

Geophysical activity is usually organized into campaigns and projects. GeophSurvey is used to document such activities by providing attributes for location, extent and responsible parties. The core model does not make a difference between campaigns and projects. Type of GeophSurvey is restricted in the core model to airborneGeophysicalSurvey, gravitySurvey, and magneticSurvey. In the extension model more types are available.

THE EXTENSIONS OF THE GEOLOGY DATA MODEL

For the geology sub-domain the extension is based on GeoSciML v3.0 that provides more classes and properties to describe physical parameters, alteration, metamorphism, …

For the geophysics sub- domain the extension has been designed by the TWG.

Geophysics has a long history of international industry standards. Methods extensively used in the hydrocarbon industry, like seismic and borehole logging have their strong standards that are used worldwide by global exploration companies. The Society of Exploration Geophysicists (SEG) takes the responsibility of developing and maintaining international geophysical standards. On the other hand, there are a large number of methods widely used in geological and environmental studies, mineral, geothermal, building material exploration that do not have real standards and suffer from the abundance of ad hoc formats and the difficulties of data exchange.

Geophysics has just started to move to the direction of ISO and OGC standards and it will take time before this process leads to a generic schema based standard such as GeoSciML in geology, or CSML in climate science. Due to the large number of techniques and application fields the world of geophysical data management is very heterogeneous, and creating a generic data model is extremely difficult.

ACKNOWLEDGEMENTS

We are grateful to all members of the Thematic Working Group Geology and Mineral Resources, and the EC/JRC team.

REFERENCES

[Directive 2007/2/EC] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

Web site describing the GeoSciML data model standard used to provide the INSPIRE data model for Geology: www.geosciml.org

A GROUNDWATER ISSUES IN INSPIRE DIRECTIVE DATA SPECIFICATION

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KEY WORDS: spatial data infrastructure, INSPIRE, geoinformation, data specification, groundwater, aquifers, hydrogeology.

INTRODUCTION

Hydrogeology of the title has not received a separate thematic section among the 34 themes of INSPIRE, which is the European Union Directive establishing Spatial Data Infrastructure in Europe. INSPIRE sets up a framework of data, technology, policies, standards, and human resources, necessary to facilitate the sharing and using of spatial information. The implementation phase is critical for the whole initiative. Initially, groundwater issues were to be combined to the theme Hydrography, to eventually become a subtopic of Geology. The Thematic Working Group Geology & Mineral Resources (TWG GE-MR) is one of national experts group and is responsible for preparing the data specification (DS) for geology, hydrogeology, geomorphology and mineral resources. Data specification is based on the ISO19131 'Geographic Information – Data Product specifications' standard and allow to define the scope of spatial information, which in future will be provided by individual Member States as mandatory resources.

GROUNDWATER IMPORTANCE

In many regions, groundwater are the primary source of public supply of drinkable water, which is of particular concern in the EU and is reflected in the Water Framework Directive (WFD). The main aim of the WFD was a need for a consistent framework for the legislation on water management in Europe. Delivering the range of water information is completing the tasks defined in the water management plans, which are a direct consequence of the WFD regulation. To ensure current and future generations access to good water quality as well as enable the use of water for industry it is necessary to deliver reliable groundwater status data.

TWG GE&MR works clearly demonstrated that the range of topics covering WFD issues is divided among several INSPIRE themes. Of course the main part is located in Hydrography (surface waters) and Geology (groundwater), but also in other themes: Area Management (reporting), Environmental Facilities (monitoring) and Production and Industrial Facilities (abstraction objects). Therefore, in many cases building the consistent data model required to find common cross-theme agreements.

HYDROGEOLOGY IN DATA SPECIFICATION

Hydrogeology describe the flow, condition of occurrence and behaviour of water in underground environment. It is a science located between hydrology and geology, while both have a strong influence on the groundwater resources creation.

The INSPIRE hydrogeology data model considers the main areas of groundwater system: aquifers located in different rock structures, groundwater bodies and hydrogeological objects.

The principal model aim is to capture the main classes of these areas and to provide the logical links between them.

Knowledge of aquifers location as well as groundwater parameters allow rational abstracting process planning. On the other hand water abstraction affect the natural conditions of the whole system, since their change can have a significant effect on a variety of ecosystems dependent on groundwater. Therefore special attention has been paid to the description of natural and man-made objects (such as wells and springs) and their interaction with the natural system.

Dynamic groundwater models and the dynamic flow of groundwater are out of scope of the core model and need more detailed groundwater modelling approaches. Also out of scope are detailed measurements on the quality and chemical composition of groundwater and timeseries measurements of groundwater level within groundwater wells.

SUMMARY

The experience gained under the TWG works clearly indicate groundwater as a multilevel issues. The INSPIRE data specification deliver only general model of domain, but on the other hand open a space for discussion and specific extension models development to cover detailed range of hydrogeology issues.

Hydrogeology is not, as is the case of geology (GeoSciML), described by none of the international standards. Some of solutions presented in the Canadian GroundWaterML (GWML) model were tested during the TWG works on the specification, but unfortunately they were not fully applicable for European condition.

The groundwater information is widely used in various decision support processes, and therefore the need for developing the common hydrogelological data model to become international standard should be promoted.

REFERENCES

Data Specification on Geology – Draft Guidelines v. 2.0 http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_GE_v2.0.pdf.

Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (the INSPIRE directive).

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive).

FINAL INSPIRE DATA SPECIFICATION ON MINERAL RESOURCES

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(4) INSPIRE Thematic Working Group; http://inspire.ec.europa.eu/index.cfm/pageid/2/list/30
KEY WORDS: INSPIRE Data Specification, Mineral Resources, EarthResourceML, Raw materials initiative, Mining Waste Directive, Core and Extension Model.

OVERVIEW

In the INSPIRE Directive, Mineral Resources (MR) theme is defined as "Mineral resources including metal ores, industrial minerals, etc., where relevant including depth/height information on the extent of the resource (Directive 2007/2/EC)"
To specify the scope of MR for INSPIRE, the terms contained in the definition have been clearly explained in the description section. Reference material have been analysed, and particularly:

- Two legal texts providing requirements for the data specification:
- The raw materials initiative
- The management of waste from extractive industries
- The standard data model EarthResourceML for Mineral resources,
- The work currently done in European projects

All this analysis has been completed by the description of the most relevant examples of use of mineral resources in various domains:

- Management of resources and exploitation activities
- Environmental impact assessments.
- Mineral exploration
- Promotion of private sector investment

After the analyses, the TWG decided to provide two application schemas:

- **the core data model**, related to the main object types and properties requested by all examples of use: the location of mineral resources (Mines and Earth Resources), the main commodities, and the exploitation type,
- **the extension**, to address more properties, but optional, able to provide more attributes describing mineral resources, specially to meet requirements from the Raw Materials Initiative and the Mining Waste Directive

The data specification for MR is based closely on EarthResourceML v. 2.0 (http://www.earthresourceml.org/), a model that describes Earth Resources independent of associated human activities, permitting description using mineral deposit models encompassing internationally recognised deposit classifications, mineral systems and processes. EarthResourceML was developed by the Australian Chief Government Geologists Committee (CCGC) but is now under the governance of the Commission for Geoscience Information (CGI), a commission of the International Union of Geological Sciences (IUGS). In this version of the INSPIRE MR model the relevant parts of EarthResourceML have been incorporated into the MR package, but in subsequent versions it is intended to incorporate EarthResourceML into the INSPIRE foundation schema.

The work done in the TWG has provided some input to the ERML model. A part of these new classes, properties, (code lists) has been accepted by the CGI WG and are included in ERML v.2.0

DATA MODEL - CORE

An overview of the MineralResourcesCore application schema is given in Figure 1. This figure shows only the feature-types, data types and their relationships.

As can be seen the data model has two principal components: one, centred on ***EarthResource*****,** describes the natural material of potential economic value, and the other, centred on ***MiningFeature*****,** describes the working of the *EarthResource*.

The ***Earth Resource*** identifies the kinds of observable or inferred phenomena required to classify economic and sub-economic earth resources:

- The *MineralOccurrence* could be a prospect, an occurrence, a mineral deposit, an ore deposit
- The *Commodity* describes the material of economic interest in the *EarthResource*
- The OreMeasure is an estimated or calculated amount of ore and grade that exist within an EarthResource, in terms of its resource, reserve and endowment
- *The MineralDepositModel describes the essential attributes* of a class of mineral deposits used to classify the EarthResource

- An EarthResource has an associated ExplorationActivity to describe the process leading to the discovery and assessment of the resource.

The *resourceExtraction* association from *EarthResource* to *MiningActivity* enables the Mining Activity which extracts the Earth Resource to be described.

The abstract ***MiningFeature*** class represents a conceptual feature that exists coherently in the world. This corresponds with a *Mine* or a *Mining Activity*, locatable and identifiable features in time and/or space.

- A *Mine* is an excavation for the extraction of mineral deposits. 'True' mines are underground workings and open-pit workings (also called open-sky mines) generally for the extraction of metallic commodities. The Mine feature also includes open workings generally for the extraction of industrial minerals, commonly referred to as quarrie
- The *Mining Activity*, related to a Mine, describes the process of extracting metallic or non-metallic mineral deposits from the Earth.

The MR data model uses the INSPIRE Geology Data Model to describe geological components.

Many properties in the data specification require constraint by code lists, and in many cases appropriate vocabularies already exist in the domain or have been developed in connection with EarthResourceML (http://resource.geosciml.org/). All code lists (17 for core model and 6 for extension) for the Mineral Resources application schema are external code lists (mainly governed by IUGS/CGI).

EXTENSION

The MineralResourcesExtension application schema allows, optionally, for extra information to be provided principally to meet the requirements of the Raw Materials Initiative and the Mining Waste Directive.

The overview of the extension data model for Mineral Resources is shown in figure 2.

By comparison with the core data model it can be seen that there are additional Earth Resource classes in the extension schema (yellow background): *MiningWaste and MiningWaste Measure, MinedMaterial and Product,and MineralSystem, SupergeneProcesses,* and *EarthResourceMaterial.*

To describe **Mining Waste** and Mining Waste Measure:

- Waste type
- Material
- Processing type
- Storage type
- Waste measures (density, grade per commodity, volume)
- Environmental Impact

To describe Products and Mined Material.

To describe the **composition** of the Earth Resource with Earth Resource Material:

- Material as Earth Material defined in GeoSciML
- Proportion of the material in the earth resource
- Role of the material described (host rock, alteration product, …)

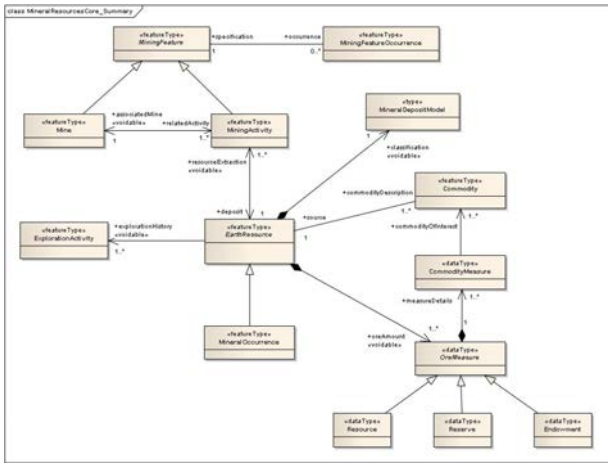

Figure 1 – UML class diagram: Overview of the MineralResourcesCore application schema.

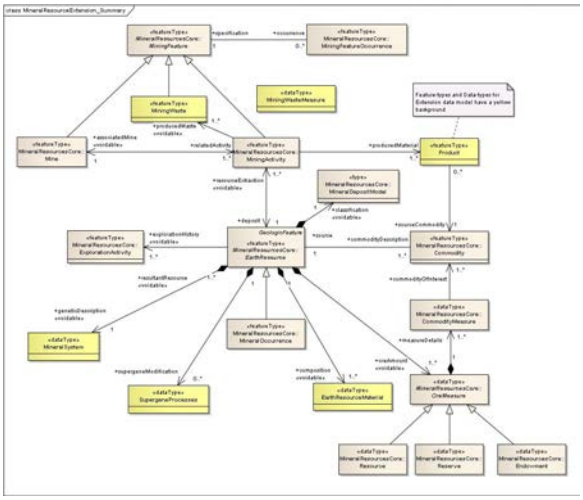

Figure 2 – UML class diagram: MineralResourcesExtension application schema Overview.

INSPIRE DATA SPECIFICATION ON ENERGY RESOURCES

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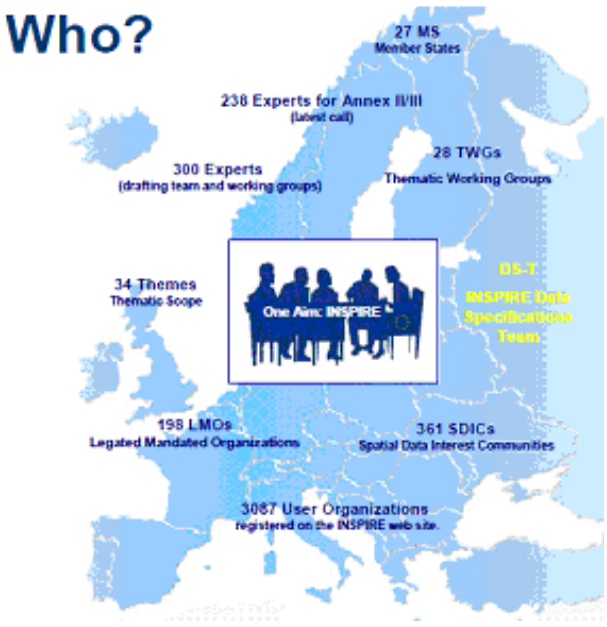
KEY WORDS: Spatial data infrastructure, INSPIRE, interoperability, energy non/renewables, resources, modelling, implementation.

INSPIRE AND ENERGY RESOURCES

Environmental sustainability requirements balancing with requirements to maintain and improve the society life standards bring new challenges into the area of cross domain legislation harmonisation. Establishment of Infrastructure for Spatial Information in the European Community (INSPIRE) represents the evidence of legislation driven initiative. This initiative is facing to the harmonisation challenges within the Community environmental policies and policies or activities which may have an impact on the environment. Achievement of this effort is underpinned by the concept of interoperability, understood within the INSPIRE as the possibility for spatial data sets to be combined, and for services to interact, without repetitive manual intervention, in such a way that the result is coherent and the added value of the data sets and services is enhanced. Spatial information plays nowadays crucial role in decision supports processes on top management level as well as within the simple and everyday life related citizens needs. Energy resources represents on of the 34 domains, INSPIRE is defining as “Themes” summarised in the 3 annexes of the Directive 2007/2/EC. Definition of Energy resources within the INSPIRE scope includes hydrocarbons, hydropower, bio-energy, solar, wind, etc., where relevant including depth/ height information on the extent of the resource. Energy Resources are included in Annex III with the aim to provide an essential thematic frame, allowing exchange of Energy Resources related spatial information across Europe in an interoperable way.

PARTICIPATORY PROCESS

In order to achieve establishment of the framework allowing interoperable exchange of spatial data via spatial data infrastructures, participatory process of additional legislation and technical documentation development has been defined and deployed. Leading role undertaken by European Commission with the close involvement of relevant stakeholders communities representatives led into development more detailed set of legislations (Implementing Rules) closely delineating the scope of five main INSPIRE components (Metadata, Network Services, Interoperability of Spatial Data and Services, Data Sharing and finally Monitoring and Reporting), including accompanying technical documentation (Guidelines). Interoperability of Spatial Data and Services (ISDS) represents the component dealing mainly with the definition of the spatial data content and structure for all themes within the INSPIRE scope. Main outcome of the activities within this component are the Guidelines documents (Data Specifications) developed following the requirements of the INSPIRE Directive as well as ISDS Regulation (Commission Regulation (EU) No 1089/2010). The INSPIRE data specification on Energy Resources has been prepared following the participative approach based on consensus building principles. The stakeholders, based on their registration as Spatial Data Interest Communities (SDICs) or Legally Managed Organisations (LMOs) had the opportunity to bring forward user requirements and reference materials, propose experts for the Thematic Working Groups (TWGs) responsible for the specification development, and to participate in the consultation (review) and testing of the data specifications.

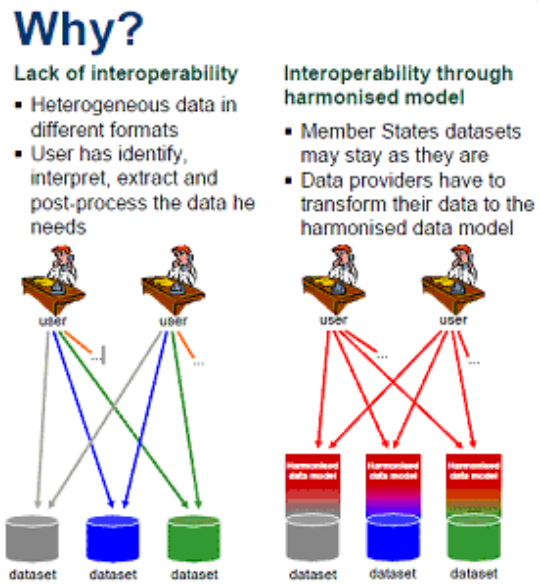


FROM REQUIREMENTS TO RULES

Data Specification framework documents, user requirements and use cases defined by stakeholders as well as TWG Energy Resources members, ongoing standardisation activities, including related projects, initiatives, stakeholders consultation and testing and best practices from national, cross-border and international played an important role in the Data Specification development process. The specification process took place according to the methodology detailed for INSPIRE respecting the requirements and the recommendations of the INSPIRE Generic Conceptual Model, which is one of the elements that ensures coherent approach and cross theme consistency with other themes. Fulfilment of the data specification process is achieved by delivery of Data Specifications, which are used as a base for development of legally binding Implementing Rules.

PURPOSE

The main purpose of Data Specification on Energy Resources is to allow identification of geographical locations of Energy Resources, providing information about their extent. The topic of Energy Resources plays a very important role nowadays and this data specification reflects all the main aspects of this domain providing a harmonised structure for various energy resource types across the member states as well as links to the other related domains. Information about location and the potential of Energy Resources can have significant impact on the environment. This impact can be represented by positive as well as negative aspects therefore appropriate knowledge about the extent, distribution and volumes of the resources plays an important role.



CONTENT AND STRUCTURE

Energy resources within the INSPIRE context are features defining an inferred or observable spatial extent of a resource that can be, or has been, used as a source of energy. Considering the INSPIRE definition as well as scope of the remaining INSPIRE themes, Energy Resources are covering both subcategories of primary energy resources: non-renewable and renewable resources. Ensuring the domain consistency a set of common base Energy Resource types is introduced within the data specification. Considering different viewpoints for representing energy resources the data specification is supporting both discrete and continuous features representations depending on the chosen universe of discourse. The concept of energy resources provides focus to the resource type aspect, documenting of relevant classifications, extent/distribution/potential of the resources, their quantification as well as unified approach for units of measurement. In addition support for the energy resources statistics will provide the opportunity to monitor the energy situation at country level as well as at international level.

CONCLUSION AND FUTURE

The provision and implementation of this harmonised data specification should significantly contribute to the main priorities, targets and flagship initiatives of Europe 2020 strategy within the mechanisms of establishing a European spatial data infrastructure. The main value of the INSPIRE Energy Resources data specification is in providing the framework for Energy Resources related spatial data exchange. In addition this framework is characterised by its versa-tile yet flexible structure. Data providers are thus able to publish their existing data in the most convenient way and users can easily discover, evaluate and use appropriate data for their specific needs. As soon as new generic or theme specific needs and requirements are identified, appropriate activities within the framework of INSPIRE implementation and maintenance will have to take place (INSPIRE Data Specification on Energy Resources 2.0, 2011).

ACKNOWLEDGEMENTS

The Thematic Working Group Energy Resources, Drafting Team Data Specifications, the

JRC data specifications team and the INSPIRE stakeholders - SDICs and LMOs.

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NATURAL RISK ZONES- A FRAMEWORK FOR SPATIAL DATA INTEROPERABILITY

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KEY WORDS: INSPIRE, Hazard, Risk, interoperability.

INTRODUCTION

INSPIRE Directive (2007/2/EC) defines Natural Risk Zones theme as: "Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions."

This specification is the work of the Natural Risk Zones thematic working group. A multinational team of experts volunteered from the community of SDICs (Spatial Data Interest Communities) and LMOs (Legally Mandated Organisations) of INSPIRE.

The data specification has been compiled using reference material submitted by SDICs and LMOs and the responses to a user requirements survey and public consultation during the summer of 2011 from which 400 responses were received. The team themselves have had to draw on their own expertise and that of their organisations and other groups to develop agreed use cases in a selection of areas pertinent to Natural Risk Zones.

The scope of the Natural Risk Zones data specification is potentially very large and this presentation will demonstrate this fact. Natural Risk Zones also involves significant engagement with other thematic areas from INSPIRE. This involvement stems from the nature of hazard, exposure, vulnerability and risk. Several other thematic areas input attributes vital to understanding the nature of hazard, yet others are vital in the understanding of exposure. In working on the scope of the Natural Risk Zones theme four use cases have been created for;

Floods, Landslide, Forest Fire and Earthquake. These will be used in the presentation to demonstrate the use of the data specification.

The approach taken to model Natural Risk Zones is generic in its treatment of each of hazard, exposure, vulnerability and risk, with a core model, whilst allowing extensibility to be more specific where possible and required. Flood risk is significantly more precisely defined than other hazards, due in part to the development of the Floods Directive (2007/60/EC). In collaboration with Floods Directive personnel, we have been able to demonstrate the extensibility of the model, providing an example application schema specifically targeted at floods.

One of the main purposes of hazard and risk maps is to inform in a clear way thus supporting effective communication between modellers, data providers, policy makers and the citizen. We hope that this data specification can play a part in making this communication better.

This presentation will concentrate on explaining the applicability of the model to the community, explore some of the more interesting aspects of creating a model to encompass everything from floods to asteroid impact and look at the benefits of interoperability in the natural hazards discipline.

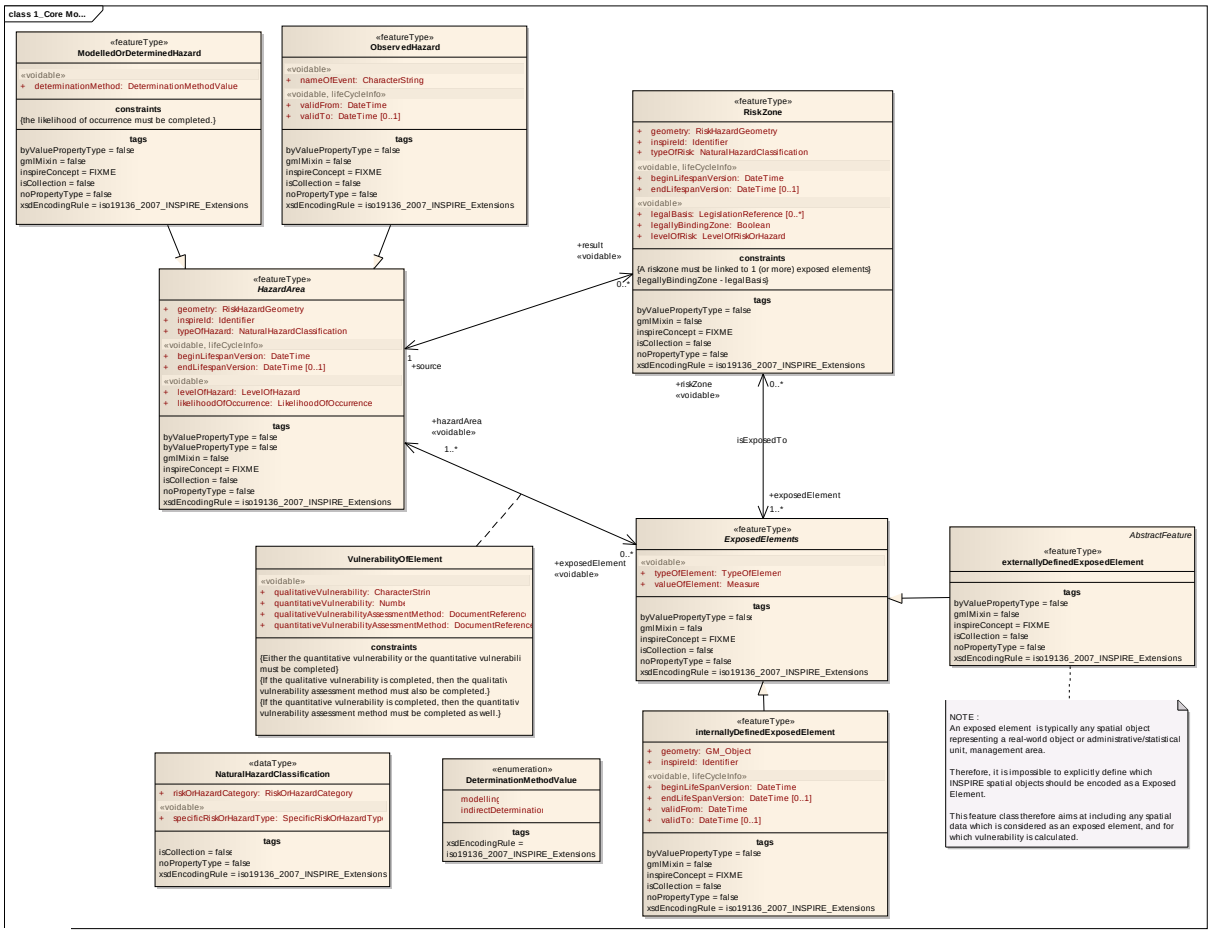

Figure 1 – Universal Markup Language Core Model of Natrual Risk Zones .

ACKNOWLEDGEMENTS

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THE INSPIRE DATA SPECIFICATION SOIL AND ITS RELEVANCE FOR SOCIETY

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KEY WORDS: soil, inspire data specification

INTRODUCTION

The need for soil data is increasing at all levels in society. In 2006 the European Commission adopted the Soil Thematic Strategy (COM(2006)231final).

Soil data are used for improving agricultural production, to prevent environmental damage by agriculture and other land use and to establish a sustainable land management.

After the Second World War many European countries established soil mapping programs with the aim to increase agricultural production. Each country developed its own soil classification system. During the 1980s environmental issues became important and soil data were used for the reduction of for example erosion. Reducing soil contamination caused by industrial activities, military exercise fields etc. became an important issue in many European countries. During the 2000s the role of soil in mitigating climate change became a part of the agenda. The methodology for soil mapping was more and more harmonised and the European Soil Bureau Network established in the 1990s the European Soil Data Base (1:1000,000).

The main objective of INSPIRE is to exchange geographical environmental data at European level, with a main focus of an exchange across the borders between the different domains. During 2010 – 2012 data specifications for the 25 domains part of Annex 2 and 3 of the INSPIRE Directive were developed. Domain Soil is part of the Annex 3.

The INSPIRE Directive (Directive 2007/2/EC) defines Soil as follows: “Soil and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity”.

Soil can be considered as a non- renewable resource and fulfils many different (ecosystem) functions.

Based on the definition the scope for the soil theme contains the following elements:

a) **Soil inventories**, providing one-off assessments of soil conditions and/or soil properties at certain locations and at a specific point in time, and **soil monitoring**, providing a series of assessments showing how soil conditions and/or properties change over time.
b) **Soil mapping**, providing a spatial presentation of the properties linked to the soils, including soil types; typically, soil maps are derived with the help of data available in soil inventories
c) **Thematic maps** derived from soil information, possibly in combination with non-soil data.

There are at present very few adopted EU Directives putting strict requirements on soil data. In most cases soil is only involved in an indirect way. Depending on the country, soil related legislation can be present at national level. Some of the national legislation, touching on soil, was established as consequence of EU legislation (for example the Water Frame Work Directive).

THE INSPIRE DATA SPECIFICATION SOIL

The INSPIRE Soil model contains a core model and 2 extensions.

The core model contains a core of objects and attributes that are considered to be essential to act as a basis for further Inspire legislation.

Two extensions to the Core were developed for Contamination resp. Soil Derived Information. An extension demonstrates how a particular case can be implemented starting from the Core Model, by adding objects and attributes.

The Core model exists two important parts – a Soil Survey oriented and a Soil Delineation oriented part.

The Soil Survey oriented part deals with all the processes related to gathering of soil data in the field, either with a soil mapping, a soil inventory connected with a contamination, or a soil monitoring where a site is revisited at regular times.

Central in the Soil Survey part is gathering information on the site where the survey was done and gathering information on the characteristic soil properties found at a site.

Only the soil physical and chemical properties are included in the model in the case they are relevant for one or more adopted EU directives. Contaminants are here treated as a chemical parameter on the same line as for example nutrients. Contamination itself is not part of the core.

The soil delineation part describes how to reach a soil map. Data on each soil type are described in the soil profile description the so called Observed Soil Profile. From each soil type one Derived Soil Profile is described on the basis of these real world descriptions.

Per definition INSPIRE is free of any scale. However a soil map has always a scale. In the situation of a large minimum unit it is not possible to delineate separate soil polygons. In this case a Soil Body is recognised consisting of groupings of certain single soil types occurring together in a certain mixture.

The World Reference System for Soil Resources (WRB) is used in the model as standard. As already earlier mentioned many countries developed their own national soil classification system when starting soil mapping programs. Not all these systems are automatically convertible into WRB. In this case also information can be given about the national soil type name.

In the addition to the core 2 extensions were developed: soil contamination and soil derived information.

The extension on soil contamination is meant to include formal conclusions on contaminated sites after a site has been confirmed to be contaminated. The value to collect this information is the facilitation of measures to promote human health, drinking water protection, environmental protection and the protection of produce and giving these measures an effective direction.

The remediation and site management may involve temporary protection and restriction measures, cleaning or partial cleaning over longer or shorter periods, change of land use, or isolation or immobilization of the pollutants.

The second extension deals with Soil Derived Information. For society the soil type map is in general of minor importance. In use are mainly the soil derived maps. Sometimes it is possible to derive directly from the soil data base a soil derived map, for example a pH map.

In other cases a soil derived map is derived with the help of a model. A known example is here the soil erosion risk map. The soil erosion model uses amongst others the data from the soil data base and calculates for each soil polygon the erosion risk.

Soil derived maps are for example in use in Agro Environmental Schemes, in writing environmental plans at farm level, and land planning.

Many soil derived maps are only calibrated for regional or national conditions, which may hinder the use of the data across national borders.

Since INSPIRE is aiming at interoperability and not necessarily harmonisation a number of existing harmonisation challenges were encountered of which the use of an uniform soil classification system is the biggest one.

RELEVANCE FOR SOCIETY

In INSPIRE the interoperability across national borders and across domain borders is very important. An important requisite is also that Member States are not forced to do additional data capture in the field.

The INSPIRE soil model is not representing a soil data base. So it will not be possible to use it for doing analysis etc.

The Core model represents a structure for the exchange of the most important soil data – on this moment these data are relevant for one or more EU legislations. Parts of the core will be placed in the INSPIRE legislation and Member States will be obliged to follow the given structure and specification. It is to be expected that over time the structure can be built out.

ACKNOWLEDGEMENTS

We are grateful to all participants of the Thematic Working Group (TWG) INSPIRE Soil who developed the Data Specification for Soil.

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PROGRESS OF SEMANTIC HARMONISATION OF "GEOLOGY" DATA ACROSS EUROPE: ONE-GEOLOGY-EUROPE, THE CGI AND INSPIRE

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KEY WORDS: Data harmonisation, Europe, IGME 5000, IUGS/CGI, INSPIRE

BACKGROUND

For more than two centuries each geological survey in Europe (and across the world) has, developed its own national way to map, describe and portray their geological map units. In the last 20 – 30 years, with the advent of IT, also different ways of modelling and describing the digital data have been developed in the different organisations.

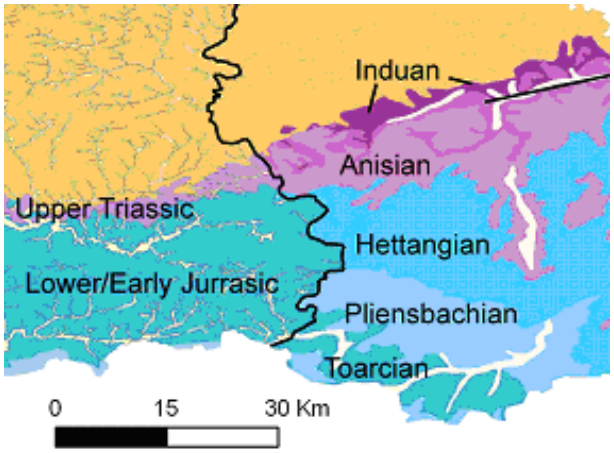

Figure 1 – Example for former harmonisation issues across the national boundaries of France and Germany concerning the age of rock units.

However, the European Commission and many users require consistent geological data, which does not change its attributes or portrayal as it crosses political boundaries, e.g. for cross-boundary regional planning, prediction of flooding events or the mitigation of its effects, use of groundwater bodies across political boundaries etc. The EC INSPIRE Directive, as well as the EC Water and Soil Directives are specifically addressing these issues.

The need for harmonised European geological data was already recognised in the year 1881 at the second International Geological Congress in Bologna, where the first cross-boundary international mapping project of Europe started The International Geological Map of Europe and the Mediterranean Regions at the scale 1 : 1 500 000 (Asch, 2003). This substantial international endeavour was finally completed in 2000 (BGR & UNESCO) and was soon followed by the completion of the first harmonised digital spatial dataset of Europe - the 1 : 5 Million International Geological Map of Europe (Asch, 2005) which was published as a web mapping application and a paper map. The data compilation of the geology for these two map projects was carried out and coordinated centrally at the Federal Institute for Geosciences and Natural Resources (BGR), Germany, and its predecessors under the Umbrella of the Commission of the Geological Map of the World (CGMW) in cooperation with European Geological Survey organisations and universities.

THE APPROACH OF ONEGEOLOGY-EUROPE

OneGeology-Europe was a pan-European project with the aim to deliver web accessible, semantically and technically interoperable geological data, with "progress towards harmonisation", for the whole of Europe, at a 1:1 million scale. The project is representing the European contribution to the OneGeology global initiative. Each of the 20 participating European geological survey organisations is providing access to geological data via the internet by implementing and hosting an interoperable web service to deliver their national geological data in a semantically interoperable form. The original national databases, internal geological survey's classifications and vocabularies, however, remain unchanged.

AGREED DATA MODEL AND VOCABULARY

Unlike these previous projects, the project OneGeology-Europe (1G-E) is built upon a distributed digital model that leaves the data with the responsible Geological Survey organisations. The 1G-E data model is implemented in GeoSciML, a global Geoscience Mark-up language developed by the IUGS Commission on Geoscience Information (CGI).

Nevertheless, the rocks of Europe are not unique and the 1G-E was developed on the base

of the existing vocabulary of the global IUGS-CGI Concept Definition Task Group: a global group of experts which are developing a global vocabulary for the GeoSciML model. As a result of scrutiny of the existing global base and examination of the needs of European geology, > 100 new terms were added, new concepts introduced, definitions altered and adapted. The outcome is that what is being developed to describe the geology of Europe is going to be a part of what can be used to describe geological units globally.
It is used also by the global One Geology project and for the implementation of the INSPIRE "geology" theme.

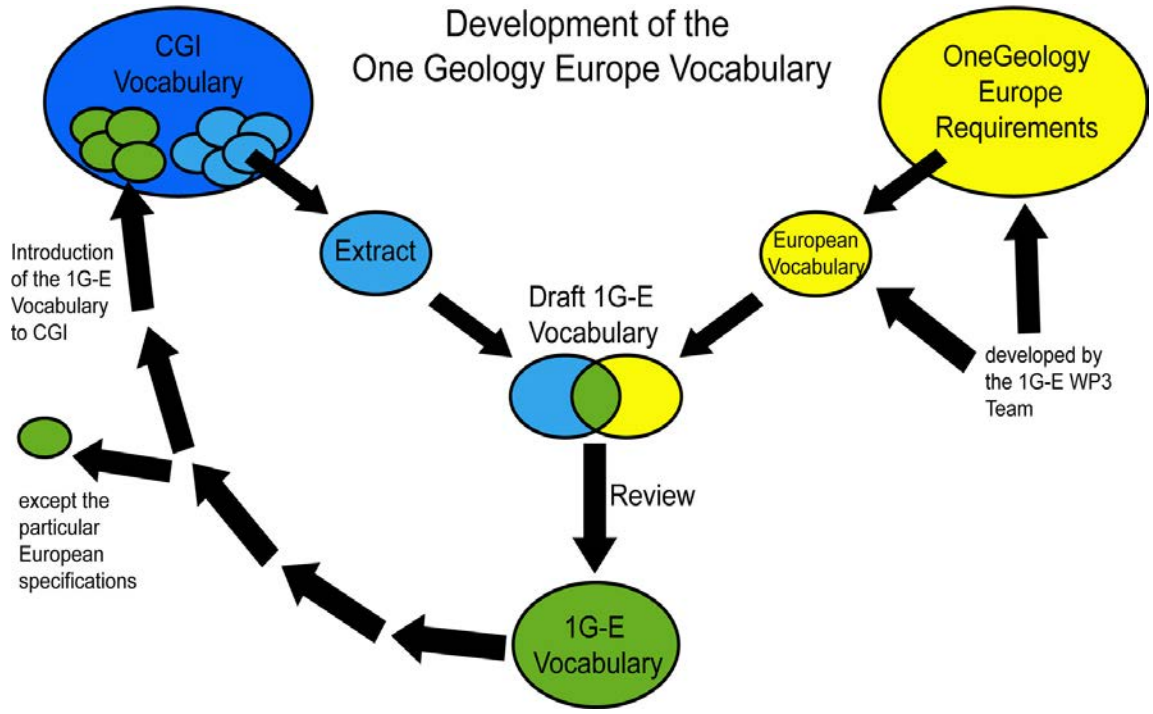

Figure 2 – Relations of the CGI vocabulary, the 1G-E communities' requirements and the final OneGeology-Europe vocabulary

The 1G-E vocabulary is created to be consistent with the GeoSciML schema and feature types, and it uses subsets of the CGI/GeoSciML vocabularies (e.g. for lithology).

"PROGRESS" TOWARDS HARMONISATION

It is a well known fact that geological formations are crossing, without any changes, any political boundary, - but for centuries from one country to another the properties of the same rock formations have been described differently (e.g. regarding the lithology, the age, faults, or the genesis, see example age in fig. 1). Furthermore, the rock formations are being portrayed differently from one national Geological Survey to another.

Thus, the issues that need to be tackled to scientifically harmonise geological data from distributed data sources across political boundaries posed a considerable challenge. It encompasses mainly semantic and geometric issues but also issues related to management and communication.

Due to the more than 9000 kilometres of political boundaries between and around the 1G-E participating countries it has been impossible to harmonise the geology of the 1G-E 20 national distributed data sets across its political boundaries. However, within the 1G-E project a short study has been undertaken to identify the issues that need to be dealt with in order to scientifically harmonise geological data from distributed data sources across political boundaries. This encompasses scaleand semantics related issues, differing national mapping various generalisation approaches. Scientific and cooperative methods for a pragmatic harmonisation process have been introduced and underpinned by distinctive examples developed within the project. Finally, recommendations for future harmonisation endeavours from distributed data sources were expressed.

The work had not been done in vain. Notwithstanding the challenges of many multinational players and datasets, OneGeology-Europe provided an excellent test bed the geology Data Specifications of the INSPIRE Directive and to-date it can be observed that the main properties and code lists

and part of the data model have been included to the INSPIRE geology Data specifications.

ACKNOWLEDGEMENTS

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THE ITALIAN VIEW ON ONEGEOLOGY-EUROPE AND INSPIRE

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KEY WORDS: OneGeology-Europe, INSPIRE, geological map, data harmonisation.

ONEGEOLOGY-EUROPE AND INSPIRE

OneGeology-Europe is a pan-European project finalised to the delivering of a web accessible, semantically and technically interoperable geological dataset, with “progress towards harmonisation”, for the whole of Europe at 1:1 million scale.

OneGeology-Europe has been addressed issues relating to data licensing, multilingual aspects, sharing of geological knowledge, geological data harmonisation and demonstration of best practices in provide and use of spatial geological data in the public and private sectors. The project has been divided into 10 Work Packages (WP), composed of experts and professionals from various European Geological Survey and Organizations with considerable experience in their field; it is based on geological data provided by each of the European Geological Surveys.

The interoperability of geological datasets was the main effort of the WP3. It worked on the specification for geological spatial data and an interoperable 1:1M scale dataset for the whole of Europe. This includes vocabularies to describe lithology, age and genesis of the rocks, tectonic structures, term definitions and relations. Based on the specification it identified the generic and specific geometric and semantic harmonisation issues.

The WP3 delivered the essential basis for that endeavour: the “OneGeology-Europe Data Specification” (Asch et alii, 2010a); this document presents in detail the classifications, relationships, definitions, terms and Uniform Resource Names (URN); it is based, as far as possible, on existing standards and explains their use and encoding in GeoSciML. This specification also form one of the foundations and inputs for the future INSPIRE Geology Data Specification

These procedure and architecture constitute a significant contribution to the development of INSPIRE, by developing systems and protocols for sharing, finding, viewing and downloading of geological European spatial data.

The EC, in the INSPIRE Directive, specifically address the consistence of geological data and of attributes and portrayal across political boundaries. Therefore it is essential the realization of an harmonised and interoperable geological data set.

THE ITALIAN CONTRIBUTION

The Geological Survey of Italy – ISPRA, participate to the OneGeology-Europe project as reference institution for Italy.

The geological spatial data made available by the Survey derives from the recently published 1:1M Geological Map of Italy, realized in preliminary form in 2008 (presented at the 33rd International Geological Congress in Oslo) and printed in 2011 in the occasion of the 150 years anniversary of the Italian Unity (Compagnoni et alii, 2011) (Fig. 1).

This map has been realized using innovative criteria, representing the information for lithological and stratigraphical characterization of rocks, for the identification of depositional environments, and evidencing the Hercynian and Alpine orogenetic events.

Figure 1 – The Geological Map of Italy 1:1M scale, printed in 2011, used for the geological spatial data base.

The legend has been structured, for sedimentary rocks, based on litho- and chrono-stratigraphic criteria related to regional geodynamic or biological events; afterwards these units have been grouped in depositional environments and, furthermore, on the belonging to a various orogenetic cycle. Volcanic rocks have been subdivided by petrogenetic or chemical characters; they have been successively grouped on palaeogeographic domain defined by magmatic events related to geodynamic phases.

For the intrusive rocks the main distinction has been made on the age of intrusion and distinguished in two categories (Alpine Cycle and "Triassic" and Hercinian Cycles). Metamorphic rocks have been characterized by the age of the metamorphic event (joined to the orogenetic cycle), and further grouped on the metamorphic degree and distinct on the pressure-temperature characters.

In total, there are 104 different units of legend, to which have been added the main tectonic symbols (thrusts and faults). This 1:1M scale Geological Map of Italy introduce innovative concepts of cartography besides those traditional of litho- and chrono-stratigraphy.

The data model is based on the geological information present in the legend description of the units and on the Scientific/Semantic Data Specification and Dictionaries schema (Asch et alii, 2010a).

In the main table are allocated all the information on age (from - to) and lithology subdivided into 5 order of lithotypes listed in order of abundance. Due to the complexity of the structure of the legend, based "not simply" on lithology, a hard work has been made to define the main and secondary order lithologies.

THE HARMONISATION PROCEDURE WITH THE NEIGHBOUR COUNTRIES

The WP3 as done a detailed work on the harmonisation issue and, during the process made by each Geological Survey with respect to the neighbour countries, some problems have been found.

These can be indexed in two classes: semantic and geometric harmonisation issues.

In particular, for the semantic, the most significant was the completely different description of the same geologic unit across the border, which involves a different predominant lithology attribution. Similarly to this there was sometimes a different age attribution, particularly for Palaeozoic units; this could be due to the level of detail of researches, or for ageing of related studies.

Other problems come from the geometrical discontinuity of geological structures and units or, sometimes, from the use of different geographical reference systems.

Referring to the French-Italian border harmonisation procedure, the presence of potential problems was expected due to the geological complexity of that sector of the Alpine chain: the Western Alps are a Europe verging collisional belt originate from the ancient Ligure-Piemontese ocean, that represent the western sector of the Tethys. This part of the Alpine Chain is a stack of metamorphic units nappe system made up by continental and oceanic rocks accreted during Paleogene by the subducting ocean lithosphere and European passive margin above the Adriatic mantle. They overthrusted towards the Molasse foredeep and European foreland during Cretaceous-Neogene age.

This geological complexity did suggest, from the earliest stages of review, the presence of numerous harmonisation problems between the two countries, both for lithology attribution than for age.

Minor problems emerged in the harmonisation work along the boundary between Italy and Slovenia. In this case the rocks pertaining to a sector of the Alpine chain characterised mainly by limestone and dolostone units belonging to the Dinaric domain and to the Adriatic foreland.

Here the problems arose were mainly on lithological assignments, because of the difficult to discriminate between a main limestone rather than dolomite main component.

Because of failure in providing geological maps of Switzerland and Austria, has not been made the harmonisation with these two countries.

CONCLUSIONS

The experience developed in the OneGeology-Europe project, both in terms of semantics and geometric harmonization, suggests that, despite the difficulties inherent in the procedures, the harmonization process of spatial geological data should be implemented as an indispensable element in the Spatial Data Infrastructure.

This means that in the spatial data implementing rules should be introduced technical criteria for data harmonization at European level, overcoming the difficulties highlighted in the OneGeology-Europe project.

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FROM REGIONAL MAPS TO THE EUROPEAN SCALE: THE INSPIRE-CHALLENGE FOR THE EXAMPLE OF HYDROGEOLOGY

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KEY WORDS: INSPIRE, hydrogeology, data model, data specifications, geodata infrastructure.

INTRODUCTION

The INSPIRE Directive requires member states to provide online map data falling under the content of the Annexes 1 to 3 in formats defined by data specifications. This is a great challenge for regional geological surveys, since they have to make their data compatible threefold to regional, national and European geodata infrastructures.

The article illustrates this process for the example of digital hydrogeological map data of the Geological Survey of Bavaria. Hydrogeology is contained in the data specification for geology, which was published in June 2011 on the INSPIRE website. In the following a short lineout of the different approaches is being given and in the conclusion a comparison between the regional and the European scale will be provided together with a prospect of challenges ahead.

BAVARIAN DATA MODEL

The hydrogeological survey of Bavaria was intensified in the 1990s with the aim of a countrywide hydrogeological map in the scale 1 : 50,000. Already at that time it was recognized, that an important outcome of the dataset should be a seamless digital map available on the internet in a searchable format. This required the buildup of a spatial database containing all mapped features and their logical relations and code lists for the parameters. At that time such a model didn't exist. Therefore a new model was developed and a spatial data base for the map data of the hydrogeological survey of Bavaria based on the model was programmed (WAGNER et al. 2006). The maps are available online in a web portal (www.bis.bayern.de) and as web map service (WMS) within the Bavarian geodata infrastructure.

DATA MODEL OF GERMAN GEOLOGICAL SURVEYS

Another European directive, the Water Framework Directive (EC-WFD), required Geological Surveys to provide countrywide consistent hydrogeological maps. It was soon recognized, that these data also had to be available on the internet and that the integration of the digital data of regional geological surveys into a national spatial database would be much easier, if common standards could be used. These standards were agreed upon by the working group "HK50" (PLUM et al. 2011). Since the Bavarian hydrogeology data model had already been programmed and tested successfully, basic principles of the German model were taken over from that model.

Figure 1 shows the core of the data model with basic relations, which are outlined as follows: The essential features of hydrogeological maps (besides the point data) are groundwater bodies represented by groundwater contour lines and hydrogeological units, normally represented by outcrop maps of the upper aquifer. By definition the groundwater body is contained in one or more adjacent hydrogeological units of similar hydraulic conductivity. The aquifer system is the rock container for the groundwater body, consisting of one or more hydrogeological units. Also, in a hydrogeological unit, several separate groundwater bodies may exist. Thus the relation between hydrogeological units and aquifer system becomes n : m; the relation between aquifer system and groundwater body is 1 : 1 and finally the relation between groundwater body and piezometric surface is 1 : n (a groundwater body can have n piezometric surfaces depending on time).

THE EUROPEAN DATA MODEL

On the European scale a hydrogeology model was developed, which similar to the Bavarian and German approach is based on the principal relations of feature types representing the rock and groundwater part of the maps. In the present state the data model is more complex than the latter approach but due to foreseen difficulties in the

mapping process this is in discussion based on the simpler approach outlined above.

CONCLUSION

A challenge in the fulfillment of requirements of the INSPIRE Directive will be the mapping of regional map data into the European INSPIRE model. The hydrogeology data model presented in the data specifications on the INSPIRE website is now in review under consideration of the comments from the feasibility and fitness for purpose testing phase, which ended in October 2011. In the presentation at EUREGEO, the latest state of the data model will be presented and the feasibility of the mapping of the regional map data to the new European standard will be discussed.

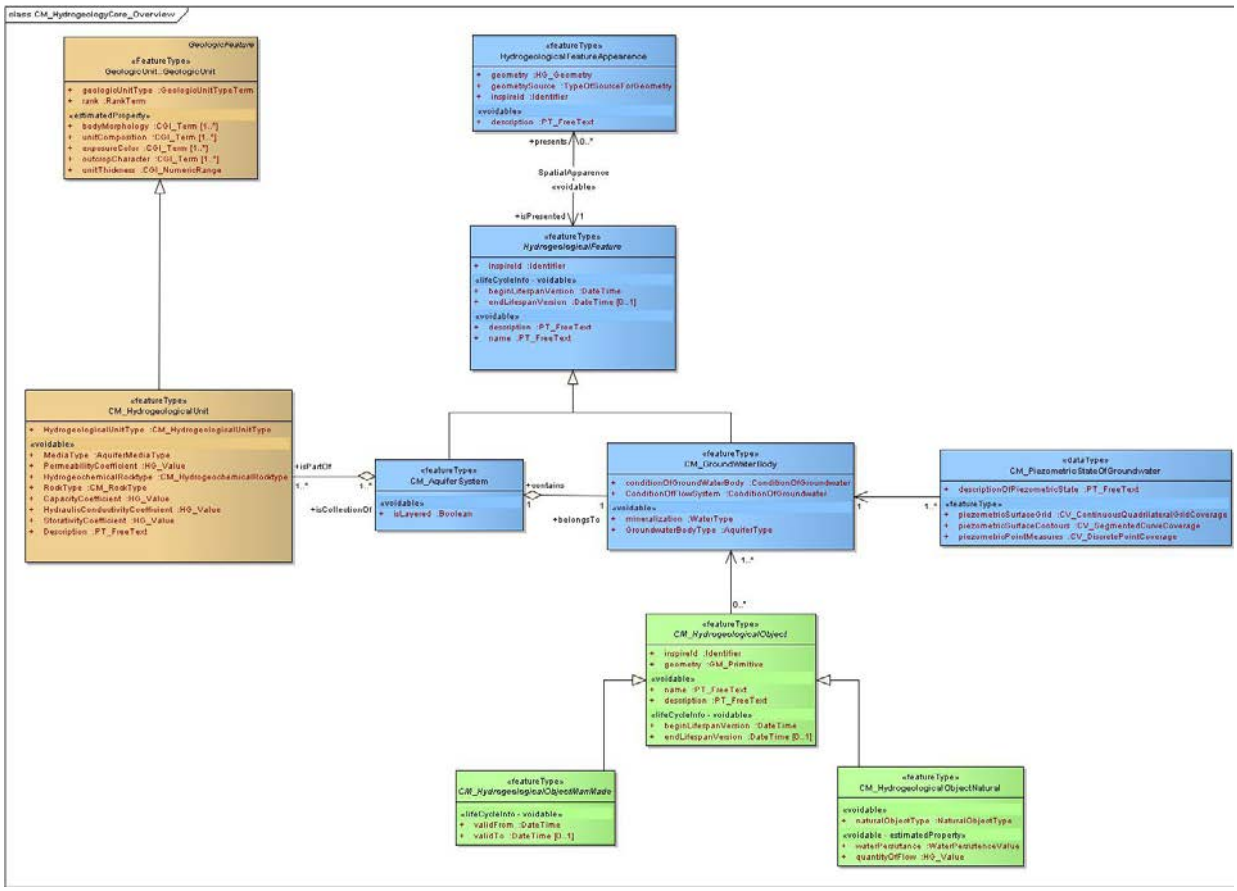

Figure 1 – Scheme of hydrogeology data model of Geological Surveys of Germany.

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THE IMPACT OF THE INSPIRE DIRECTIVE ON GEOLOGIC DATA MODELS OF GEOLOGICAL SURVEYS. THE IGME (SPAIN) CASE

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KEY WORDS: INSPIRE, geologic data model, IGME

INTRODUCTION

The purpose of the INSPIRE Directive is to set up an Infrastructure for Spatial Information to fulfil the requirements of the Community environmental policies, (European Union 2007). A total of 34 spatial data themes, allocated in three Annexes, have been established. Several activities on this data have to be performed in order to reach full data interoperability across the Community. Public authorities involved must harmonize their data complaining the data specifications, create metadata and provide a number of network services. One of the spatial data themes is "Geology", comprising geomorphology, hydrogeology and geophysics. Regardless the narrative description, the data specifications consist of one or more application schemes and feature catalogues, and a set of vocabularies of controlled terms. The Geology sub-domain data model has been divided onto a core with basic properties and an extension with additional properties. This data model is founded on GeoSciML (http://www.geosciml.org), (Inspire TWG on Geology, 2011), a development from an international expert group supported by the IUGS (International Union of Geological Sciences).

Most of Geological Surveys have created their own geologic data models during the last 20 years, reflecting mainly the contents of paper maps. This is the case of the Instituto Geológico y Minero (IGME) of Spain, where the paper map legacy on digital maps is quite strong.

After comparing both data models, INSPIRE and IGME, important differences have been found and the first conclusion has been that IGME shouldn't adopt the INSPIRE model as an IGME model.

IGME GEOLOGIC DATA MODEL

This is a simple but useful model encompassing the feature classes and the feature types depicted in the Spanish geological maps at 1:25.000. 1:50.000 and 1:200.000 scales. Main feature classes are: geologic units, geologic contacts, faults, folds, structural measurements, elements of metamorphic processes, landforms, mineral occurrences and water points. Without doubt, the geologic unit is the central feature of the model, most of the queries on geologic data are related with the properties of the geologic units. Its attributes are the author description, which encloses genetic and descriptive aspects, the lithology and the geological age. The model also includes the topological relationships between geologic units and its boundaries, that is, geologic contacts and faults; and between geologic units and the structural measurements.

INSPIRE GEOLOGY SUB-DOMAIN DATA MODEL

In this model the MappedFeature and the GeologicFeature are the central classes. The abstract feature GeologicFeature "represents a conceptual feature that is hypothesized to exist coherently in the world", (Inspire TWG on Geology, 2011). Geologic features are linked with another important feature, GeologicEvent, where geologic processes, geologic environment and geologic age are described.

The spatial representation of a GeologicFeature is carried out by means of the MappedFeature class. Both of them have a common attribute, named ObservationMethod, to specify the certainty of the observations.

Under the GeologicFeature three instanceable features have been defined: GeologicUnit, GeologicStructure and GeomorphologicFeature. The description of the geologic units is quite well set out, specially in terms of composition and constituent materials. But the lack of a more detailed vocabulary of lithology terms may restrict the full potential use of the geologic data. Besides, faults are the unique type of geologic structure taken in account, so that finding out the geologic structure beneath the surface may be a complex task.

COMPARATIVE ANALYSIS AND PROPOSAL

IGME's geologic data model covers an important number of geologic structures, some of them are survey points, providing a helpful data set to understand the geological structure in deep. However, the INSPIRE geology sub-domain data model has other advantages concerning the physical description of the geologic units and their composition and genetic issues.

It's clear that the IGME can't take up the INSPIRE model as the new IGME's model. But it can't afford to keep a two geologic models system neither, even though specific interchange methods between them may be developed. In spite of the fact that the INSPIRE requirements would be complained, a double geologic model would drive into a data inconsistency in a short term.

The first approach is to consider a new geologic data model produced by the union between both models, IGME and INSPIRE. Then, the INSPIRE model would became a view of the new IGME's model. However, since the INSPIRE data model seems to be too complex in some aspects, two key questions come about.

First question: should the data model include only the mandatory elements or all of them?

Second question: available data and new collected data might be managed in different ways?

It's clear that for the new spatial data the full INSPIRE model should be implemented. A special effort would have to be done in order to set up a reliable methodology to collecting new data and to spreading it among field geologists Thus, new geologic spatial data will provide a full range of potential uses.

Nevertheless, the choice for the spatial data already available, which must be extensively restructured before by October 2015, it is not easy. The best approach is to look at the results of the testing of the INSPIRE geology data specifications carried out in the IGME in 2011.

This test was done using the seamless digital geologic mapping at 1:50.000 scale, known as GEODE. The starting point of it has been the Geologic Map of Spain at 1:50.000 scale, called MAGNA, a national mapping programme which lasted almost 35 years, concluding in 2003. The GEODE data set is still in progress, but it's expected to be finished in 2013. Leaving aside that every MAGNA map has its own memoir and a full collection of samples, analysis and studies, GEODE has three outstanding features: all data in digital format, unit map continuity throughout the country and complete matching with the official topographic data. So, GEODE spatial data set is one of the best suitable data for implementing the INSPIRE specifications.

The rates of the testing have been as follows:

A) Effort in "geologic units/day" by specialist complaining all the INSPIRE model (full option): 1.3.

B) Effort in "geologic units/day" by specialist fulfilling only the mandatory features types and attributes (mandatory option): 7.

Implementing whole the INSPIRE geology sub-domain model (or full option) has to be done with a detailed in deep study of each geologic unit, mainly searching through the MAGNA maps and its related information. So that the performance in the first case is quite low.

If that option were selected for GEODE spatial data, which has nearly 5800 geologic units, 20 men/year would be needed to complete all the country. Otherwise, scarcely 4 men/year would be required for this task.

These figures make unfeasible the "full option", apart from that the "mandatory option" cover all the essential geological unit properties such as unit type, rock composition and geologic age.

In summary, the IGME's proposal is to set up a new geologic data model produced by merging the IGME's model and the INSPIRE model. This geologic data model will be applied to the new geologic spatial data collected from now on. A subset of this model, including at least all of the mandatory INSPIRE elements, will be used for the available geologic spatial data. But a further analysis will be done in order to enlarge this model subset with other relevant properties like the genetic process.

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BOREHOLEML IN THE LIGHT OF INSPIRE

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KEY WORDS: XML, GML, INSPIRE, borehole, SDI, geology.

BACKGROUND

Among other kinds of information on the underground, data on boreholes are of outstanding importance due to its high relevance for all geoscientific disciplines.

In Germany, borehole data are managed in the geological survey organisations of the individual federal states. Hence, the databases for borehole data differ in their structures to a large extent.

At the same time, most of the data requests directed to the geological surveys are related to borehole data - partly with a cross-border background. In this situation, the lack of an exchange format became a serious obstacle to meet nationwide requirements.

In order to overcome this problem, a special working group was set up in 2003. The main goal of the group was the development of an XML-based and GML compliant format with a controlled vocabulary.

Another important intention for the work was the consideration of the results and experiences from the EU-project “eEarth”.

THE MODELLING PROCESS – APPLICATION OF INSPIRE’S MODELLING FRAMEWORK

Considering user requirements and the situation at the provider’s side an initial UML model for BoreholeML was created. This model has been integrated into the INSPIRE Generic Conceptual Model framework. So the consolidated UML model of INSPIRE and included geostandards like metadata (ISO 19115) or geometry feature types in GML (ISO 19136) had been integrated. After the validation of the model it was implemented into a GML application schema by a transformation of the UML-model using the same software tools as used in the INSPIRE data specification process:

- Enterprise Architect ® for UML-modelling
- Subversion® as revision control system
- ShapeChange for transforming UML (XMI) into GML-application schema (XML-Schema).

THE MODEL – MAIN FEATURES

For practical reasons, the 2-level concept of representing borehole data, designed in the EU project “eEarth” was adopted:

- The top level of information is represented by the class *Borehole* (Fig. 1), giving information on master (header) data including the identification and technical and/or legal availability of detailed data. With this low-level metadata it is self-contained.
- The second level – implemented in versions 2 and 3 - holds the detailed data itself. This is an optional data level.

Figure 1 - The main class Borehole

The version 3 of BoreholeML was published in 2011. It contains improved structures for header information and layer data as well as structures for drilling, filling, installation, groundwater measurements and logging/sampling methods applied.

Further main features of BoreholeML include:

- The whole specification with definitions of all elements is available in German and in English.
- Majority of attributes and classes is optional. So users are free to decide what information to provide.
- List fields supported by -extensible- bilingual key lists.

Details of the model can be explored on http://www.infogeo.de/boreholeML.

meta-information needed by the users for an overview of existing detailed data and for requests to access further detailed data.

The latter refers also to the legal availability of detailed borehole data – a field which is attributed with a growing importance in an emerging SDI.

The actual significant differences between the two models become obvious when examining the concepts for layer data and other detailed data.

Apparently, the INSPIRE model aims at a maximum of interoperability between borehole data and map data. This leads to complex structures in a wide network of dependencies on a

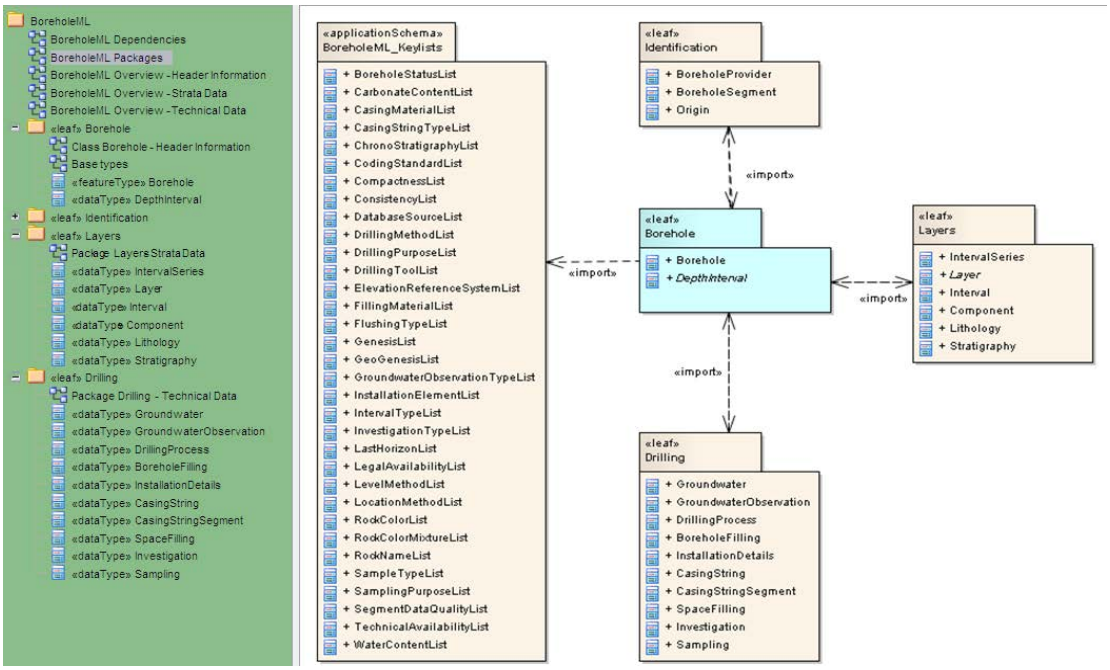

Figure 2 – BoreholeML Packages: logical diagram

WHY TO USE BOREHOLEML? A LOOK ON INSPIRE

At first, the consideration of borehole data as *the* primary geological data in the INSPIRE data specification is much welcomed!

A comparison between the two models seems to be reasonable, since both are made for quite similar purposes in a similar situation.

Looking at the borehole part of the present version 2 of the INSPIRE data specification the base structures of both models seem to be quite similar:

- Classes for header information/metadata (feature/ data types BoreholeCollar, BoreholeDetails, …)
- FeatureTypes for layer data, sampling data etc. (samplingCurve, MappedInterval).

Comparing the structures for header data, BoreholeML considers both some more generic information (e.g. *organisation* as the provider of the borehole data vs. *coreCustodian)* and more variety of foundation schemas. This complexity can be hard to understand for users and even harder to serve for providers. At that point, BoreholeML with structures typically used and approved in borehole databases is regarded as a clear concept oriented both at the typical needs of users and at the providers abilities.

FIRST APPLICATION, OUTLOOK, CHALLENGES

The first application of BoreholeML 3 is the new (cross border) German borehole data portal. Also after first contacts with former eEarth partners BoreholeML is considered as principally suitable for a multinational SDI. In this context, an actual multilingual support with interfaces to multilingual thesauri is considered as the next important challenge for the further development.

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EUROGEOSOURCE DATA PORTAL – WHAT DO THE USERS EXPECT?

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Keywords: Mineral resources, geo-energy resources, Web GIS system, user requirements

INTRODUCTION

The EuroGeoSource project aims to provide data on geo-energy and mineral resources through an internet data portal. The system will allow users to identify, access, and (re)use aggregated geographical information on geo-energy and mineral resources, covering a significant part of Europe and coming from a wide range of sources in an interoperable, multifunctional and seamless way.

Fourteen partners are involved in the project (Figure 1) with a duration of three years (April 2010 –March 2013).

The project is co-financed by the European Commission under the European Research Area, Competitiveness and Innovation Framework Programme (CIP), theme "CIP-ICT-PSP 2009.6.2 Geographic Information" and it's contributing to the annex III of the Inspire Directive.

IDENTIFICATION OF THE USER REQUIREMENTS

The expectations of the potential data portal users' are one of the main concerns of the EuroGeoSource project. To identify the user's expectations regarding the content and the functionalities of the EuroGeoSource data portal, a public inquiry has been held. The results are available in the completed report[1] (D 2.1).

Potential users have been identified in 9 countries and at European level, from different sectors (public, private, research...). Answers were collected over a duration of 3 months. In total, 1041 organisations were contacted and 187 of them participated to the public consultation. The public and private sectors are best represented, respectively 41% and 37% of the participants.

THE INQUIRY CONTENT

The questionnaire was structured around 6 topics: the data requirements, the data use, the data access, the integration with existing datasets, the scope of the data portal and finally the data portal functionalities.

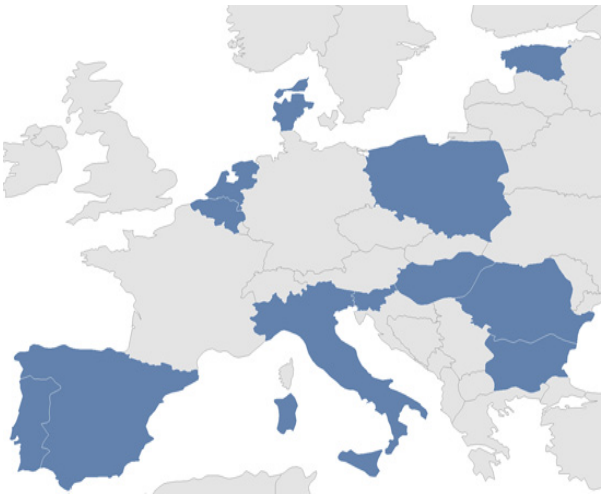

Figure 1 – In blue, the European partners: 11 geological surveys (TNO, EGK, GeoZS, GEUS, IGR, LNEG, MAFI, MOEW, PGI, RBINS, SGSS), one university (UZ) and two private companies (Geodan, GSL).

THE USERS' DATA EXPECTATIONS VARY ACCORDING TO THE DOMINANT RESOURCES PRESENT IN THE USERS' COUNTRY.

Nevertheless, the main interests concern the non-metallic minerals (construction materials and industrial minerals), followed by the geo-energy resources and finally the metallic minerals mined in Europe.

Regarding the use of this information, a difference between public and private sectors can be observed. The private companies plan to use the portal for mineral policy and/or industrial planning, while the public institutes will use it mainly for educational purposes and governmental planning.

Currently, access to information regarding geo-energy and mineral resources is limited. This low international data accessibility is related to the lack of data harmonisation between different countries, the relative data scarcity in digital format and irregular data updating. All the users confirm that the cross-border EuroGeoSource data portal will be very useful in filling this current void.

Users expect the possibility to combine different datasets on the portal in order to address specific issues. They expect a combination of several different datasets: more particularly geological, geographical, ecological and land-use data. Most of this data is already available on other European data portals (e.g. OneGeology Europe, Natura 2000, Open street map).

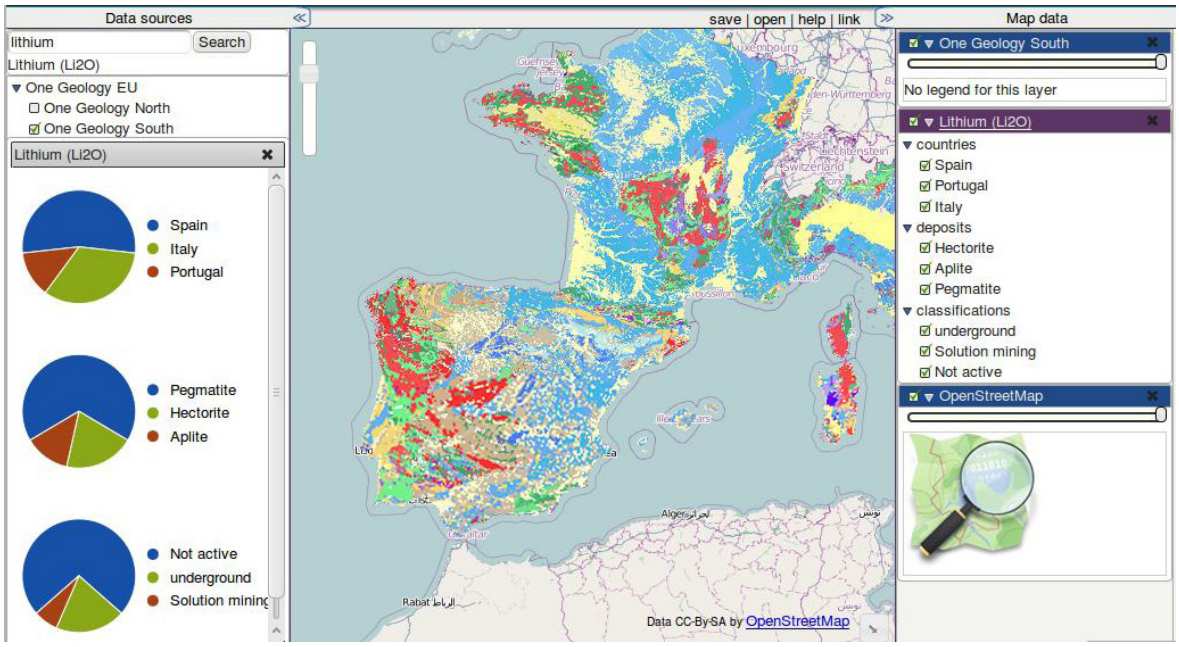

Figure 2 – A first prototype of the EuroGeoSource data portal. On the left side, information about the commodity (here: lithium), how it is distributed in Europe (country, deposit, status). On the right side, the active layers (here: One Geology) and the specifications of the layers (transparency, order,...)

According to the users, the portal should be able to address specific problems such as the sustainable use of geo-energy and mineral resources, and promote the exploration and production of those resources in Europe. This issue can be addressed by proposing pertinent related datasets on the portal.

Regarding the functionality, the potential users expect the classic option of a GIS portal, the possibility to search information using the geographic location or keywords, to view the search results on a map or in graphs or tables (Figure 2). Finally, they would like to be able to download the search results.

Through this public inquiry, we observed different groups of potential users with different expectations and user preferences towards the EuroGeoSource data portal. According to the users, this portal will solve the current limited access to international information on geo-energy and natural resources. It should also promote the interoperability, which implies that other datasets should be available for consultation through the portal.

IMPACT

The obtained results were often different than what the EuroGeoSource team originally expected (e.g. a low interest regarding strategic minerals such as Rare Earth Elements)

This public consultation will make sure the design of the data portal is moulded to the potential users' expectations, while taking the different requirements of the different type of users (individual citizens vs. policy makers) into account. The recommendations drawn from the inquiry are currently used for the next step of the project.

This portal could become a useful tool for policy makers and the application of the Raw Material Initiative[2], launched by the EC in 2008, because it will give an overview of the European geo-energy and natural resources.

Finally, this project contributes to the Inspire Directive, which aims to establish an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment.

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DATA CONVERSION OR WRAPPER MEDIATOR, WHICH IS THE BEST PRACTICE TO MANAGE DATA MODEL? AN ITALIAN EXAMPLE OF APPLICATION OF INSPIRE TEST DATA MODELS.

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KEY WORDS: GeoSciML, INSPIRE, Data model, Geology, habitat.

INTRODUCTION

In June of the 2011 EC-JRC has published the Data model relate to the Annex II and III of INSPIRE themes and for more Institutes is an important phase to analyse and understand the feasible of those models. The aim of this work is to show the results of test carried out by ISPRA on several themes of Annex II and III, but also to highlighted the general problems due to the data conversion.

ISPRA has produced about 70 comments relate to 10 themes of INSPIRE and has elaborated 8 matching tables for 6 our datasets that has allowed also to evaluate the effectiveness of some software able to convert data schema or contents.

THE PROBLEMS AND RESULTS OF INSPIRE TEST

The test phase in ISPRA has involved mainly 8 themes of Annex II, as Geology and Annex III as: Environmental monitoring facility, Area management/restriction/regulation zones & reporting units, Natural risk zones, Oceanographic geographical features, Sea Regions, Habitats and Biotopes, Species distribution. The great part of test has been performed on Geology, where it could be produced several matching tables, two web service conversions and some examples how match data.

In particular we have produce a mapping table related to Geology-Core part relatively to Geomorphology feature and Geologic Unit associated; and another mapping table has been build on the Boreholes that represent the Geology-Extension part of Geology data model. On the same data using different geological dataset like Geology map at the scale 1:25.000 (CARG project), 1:500.000 and 1:1.000.000 or an extraction of our dataset of Deep Boreholes for oil exploration we have produce WFS Instance documents (an example is shown in figure 1) to highlighted the complexity or the feasible of data to map INSPIRE Data Model. A similar approach is also been done for the ISPRA dataset on the Habitats and Biotopes.

The major problems find during the Test procedure are due to the unreadable of Data model schema from a domain expert, most of biologist or geologist are not freehandedly to use UML schema or XML documents. ISPRA to solve that problems has realised short course to introduce and explain how use the model; and a great response has been obtained using the Data Model in html format available in the INSPIRE portal (...).

After perform feasible test of INSPIRE data models, we have also tested 3 tools to transform and publish data: for transformation at the data model level has been used *GoPublisher* (Snowflake), just for WFS/WMS publication we have tested *GeoServer* version 2.1.2 (but at the moment aren't available WFS 2.0) and we have tried to adjust for the transformation of WFS encoding at the level of Client/Server side the *Exwos* (provide by the BRGM) that it's a java wrapper used also from us in the OneGeology-Europe project. The results of these test it's interesting because especially the *Exwos* that

after a first set-up step, where the manually configuration requires a long process, the tool is much more useful rather the other software. In fact allow us to convert just at the front hand part in multiple standard in the same web service (WMS/WFS) to be compliant with the same dataset and service to two or more data models standard.

POSSIBLE SCENARIO IDENTIFIED

In consideration of SDI Architecture developed in ISPRA and in particular in Geological Survey of Italy at the end of test, two different scenario are feasible. The first scenario take in account the data that at the moment are not complient with INSPIRE data model and which required more changing; for these data we need to rebuild datbase in compliant format as INSPIRE and than publish the data using standard web service (WMS, WCS and WFS) configurated with INSPIRE schema. In the second scenario the data are in great part compliant with INSPIRE data models and two option are available at the moment: the first is to make the small changes to the databases and, as

in the previus scenario, publish the data using just in one standard web service compliant with INSPIRE (a unique option to publish data); the other option allow us, after make small modifications to DB to use uppon the web services publish as OGC standard, a wrapper interface that could be set-up in two or more domains to transform the cliant requests and the server response in different encoding format to be simultanely in line with INSPIRE and some other national or international standard.

ACKNOWLEDGEMENTS

I'm grateful to ISPRA research team that allow me to perform the Test on INSPIRE Data Specification model (http://sgi2.isprambiente.it/cocoon/geosciml/page/INSPIRETEST.htm).

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```
<wfs:member>
  <gsml:MappedFeature xmlns:ns1="http://www.opengis.net/gml/3.2" ns1:id="isprasgi.gmf.354">
    <gsml:observationMethod>
    <gsml:positionalAccuracy>
    <gsml:resolutionScale>
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    <gsml:shape>
    <gsml:specification>
        <gsml:GeologicUnit ns1:id="isprasgi1">
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            alternation of sand-gravel and clay. Partialy cemented.</ns1:description>
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            <gsml:purpose>typicalNorm</gsml:purpose>
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                    <gsml:youngerNamedAge xlink:href="urn:cgi:classifier:ICS:StratChart:200908:Holocene" xlink:title="Holocene"/>
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                    <gsml:incrementalDisplacement xsi:nil="true" nilReason="missing"/>
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                    "Interval starts"/>
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                    <gsml:targetRole xlink:href="#isprasgi.gm.354" />
                    <gsml:target>
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                                    <value xlink:href="http://resource.geosciml.org/classifier/cgi/featureobservationmethod/0014"
                                    xlink:title="Synthesis from multiple sources"/>
                                </CGI_Term>
                            </gsml:observationMethod>
                            <gsml:purpose>instance</gsml:purpose>
                            <gsml:geologicHistory xsi:nil="true" nilReason="missing"/>
                            <ge-core:naturalGeomorphologicFeatureType>Alluvial terrace</ge-core:naturalGeomorphologicFeatureType>
                        </ge-core:NaturalGeomorphologicFeature>
                    </gsml:target>
```

Figure 1 – Instance document example for Geomorphology Feature on the Geology-Core model.

SPECIAL SESSION "NATURAL RESOURCES AND RISKS IN THE MEDITERRANEAN"

Tuesday, 12th June 2012 15.00 – 18.30

The session, organized in collaboration with EuroGeoSurveys, should stimulate a technical and political discussion on the main geo-environmental questions of the Mediterranean. Climate change, soils, water resources, coastal systems management, energy resources and natural risks are the tasks of the discussion that will focus on the contribution that Earth Sciences should make to ensure that the quality of growth in the future leads to a sustainable future for the Mediterranean.

Opening:

Paola Gazzolo, Assessore alla Sicurezza territorial. Difesa del suolo e della costa. Protezione civile. Regione Emilia-Romagna

Renata Briano, Assessore all'Ambiente e sviluppo sostenibile, attività di protezione civile, caccia e pesca acque interne, altra economia e stili di vita consapevoli. Regione Liguria

Bernardo de Bernardinis, President of the Italian Institute for Environmental Protection and Research (ISPRA)

Chairpersons:

Luca Demicheli, Secretary General of EuroGeoSurveys, The Geological Surveys of Europe Invited lectures

- GEOHAZARDS IN THE MEDITERRANEAN AREA - AN OVERVIEW – **Marko Komac**, President of EuroGeoSurveys and Director General of the Geological Survey of Slovenia, and **Tina Peternel** Geological Survey of Slovenia
- INTEGRATED COASTAL ZONE MANAGEMENT PROTOCOL AS A FRAME FOR MANAGING COASTAL SYSTEMS IN THE MEDITERRANEAN – **Marko Prem**, Deputy Director Priority Actions Programme/Regional Activity Centre (PAP/RAC)
- FRESHWATER AVAILABILITY IN THE MEDITERRANEAN REGION – A CONSTRAINT TO REGIONAL SUSTAINABLE DEVELOPMENT – **Anthony Rizzo**, Chief Executive Officer of the Malta Resources Authority
- THE ROLE OF THE GEOLOGICAL SURVEYS OF AFRICA IN THE MEDITERRANEAN REGION – **Lhacène BITAM** (Algeria), President of the Organisation of African Geological Surveys (OAGS)
- CLIMATE CHANGE FROM THE GLOBAL TO THE LOCAL SCALE – **Stefano Tibaldi**, Director General ARPA - Regional Environmental Protection Agency of Emilia-Romagna
- COASTAL SYSTEMS UNDER CHANGING METEO AND CLIMATE CONDITIONS – **Agustin Sánchez-Arcilla**, Catalonia University of Technology (UPC) Barcelona
- IMPACTS OF LAND AND SOIL RESOURCES ON FUTURE DEVELOPMENT OF THE MEDITERRANEAN REGION - **Pandi Zdruli**, International Centre for Advanced Mediterranean Agronomic Studies Mediterranean Agronomic Institute of Mari (CIHEAM – IAMB, Italy)
- The abstract of this communication is published in the session 2 "Soil and planning"
- SUBSIDENCE MONITORING AS KEY FACTOR FOR ENVIRONMENTAL SUSTAINABILITY OF THE OIL AND GAS PROJECT **- Francesco Italiano** and **Fabio Casolini**, ENI Italian Central-Northern District (Italy)

SPECIAL SESSION ON SOIL: SEALING AND CONSUMPTION

Tuesday, 13th June 2012 9.00 – 13.00

1. Overall context.

Chairpersons:

Paola Gazzolo, Assessore Sicurezza Territoriale. Difesa del suolo e della costa. Protezione Civile

Giuseppe Bortone, Direttore Generale Ambiente. Difesa del suolo e della costa. Regione Emilia-Romagna

Moderator:

Thomas Strassburger, European Commission, DG ENV

9:00-9:10 Soil and soil functions: Luca Montanarella, European Commission, DG JRC

9:10-9:20 Soil sealing and land take: Thomas Strassburger, European Commission DG ENV

9:20-9:30 From land take to soil sealing: a shared approach by north Italian Regions; Graziella Guaragno, Regione Emilia-Romagna

9:30-9:40 Land take and Soil Ecosystem Service losses, Francesco Malucelli, Regione Emilia-Romagna

9:40-9:50 Protecting soil for protecting man: Costanza Calzolari, National Research Council, CNR IRPI

9:50:10:00 Wheat and land use planning: Francesco Sacchetti

10:00-10:20 Coffee break and preliminary view of the poster session

2. Challenges for the governance of soil consumption.

Chairperson:

Tiberio Rabboni, Assessore Agricoltura, economia ittica, attività faunistico-venatoria, Regione Emilia-Romagna

Moderator:

Nicola Filippi, Regione Emilia-Romagna

10:20-12:30 Andrea Segrè (Dean of Agriculture at Bologna University); Saverio Senni, (Tuscia University); Angela Galasso (Italian Agency for the Countryside and Responsible and Ethical Agriculture,AiCARE); representatives of Solidarity economy coordination of Emilia-Romagna (CRESER); Christian Steiner (Land and Soil Alleance); representatives of the regional Land Reclamation Syndicates, Municipalities, Builders, River Basin Authorities, stakeholders, citizens.

12:30-13:20 Lunch

13:20-14:00 Showing of documentaries/films on soil sealing

The daily programme on soil continues with Session 2 - Soil and land planning

SESSION 2 - SOIL AND LAND PLANNING

Tuesday, 13th June 2012 14.00 – 18.30

3. Insights from case studies

Chairperson:

Enrico Cocchi*,* Direttore Generale Programmazione territoriale e negoziata, intese. Relazioni europee e relazioni internazionali, Regione Emilia-Romagna

Moderator:

Luca Montanarella*,* European Commission, DG JRC

14:00-15:20 Soil Survey - Potentials for the future Robert Taildl
Monitoring soil consumption: strengths, weaknesses, and effectiveness of different monitoring approaches in Italy, Aldo Treville
The impact of land take and soil sealing on the EU's ability to produce food, Ciro Gardi
The rules governing the protection of agricultural land in Poland, Agnieszka Pyl
Governance of soil consumption in Catalonia, Emilio Ascaso-Sastrón and Marc Vicens-Ferrer
How to contrast land take: planning experiences in Emilia Romagna Region, Barbara Nerozzi
The case study of the industrial Ceramic District, Barbara Guandalini, Nazaria Marchi
Valorisation of the flatland-hill passages as multi-use elements structuring the peri-urban landscape of "the city of ceramics", Raffaele Berti, Vittoria Montaletti
Analysis of the relation between Contaminated Sites and Urban Planning, Igor Villani

15:20-15:40 Coffee break

4. Integration of the issues collected in the sessions: 1. Overall context, 2. Challenges, 3. Insights

Chairpersons:

Alfredo Peri*,* Assessore Programmazione territoriale, urbanistica, reti di infrastrutture materiali e immateriali, mobilità, logistica e trasporti, Regione Emilia-Romagna

Moderator:

Mario Catizzone

15:40-17:30 Discussion and Closing Statements: Pillas for the governance of soil consumption

17:30 18:30 *Poster Session*

SPECIAL SESSION "GEOLOGICAL CARTOGRAPHY IN ITALY AND IN EUROPE: PERSPECTIVES AND OPPORTUNITIES"

Thursday, June 14th 9.00 – 13.00

Organized in collaboration with EuroGeoSurveys, Istituto Superiore per la Protezione e la Ricerca Ambientale, Federazione Italiana Scienze della Terra, Consiglio Nazionale dei Geologi Italia.

Geological cartography is a fundamental tool for the knowledge of the territory, soil and subsurface, and it is an essential requisite for territorial planning, for an efficient and sustainable use of natural resources and for mitigation and prevention of the risks associated with natural phenomena, among other questions. At European level the status of the geological cartography projects is extremely different both for the legislation framework, the scientific programme and the sensitivity of the political and administrative systems. The session should stimulate a technical and political discussion on the perspectives and the opportunities of the geological cartography in Europe with a special attention to the Italian situation.

Chairperson:
Silvio Seno, Federazione Italiana Scienze della Terra

Invited lectures

- Geological Cartography in Europe: an overview – **Luca Demicheli** General Secretary of EuroGeoSurveys
- The social and economic benefits and impacts of geological maps, data and models **Richard Hughes** of the British Geological Survey.
- *The abstract of this communication is published in the session 11 "Mapping data and information systems"*
- The need for a programme for regional geological mapping – **Xavier Berastegui** of the Institut Geologic de Catalunya, on behalf of the Geological Surveys of Bayern, Emilia-Romagna and Catalunya.
- The role of geological cartography in the assessment of natural hazards: the new EC-funded database of European seismogenic sources - **Gianluca Valensise** Senior Scientist of Istituto Nazionale di Geofisica & Vulcanologia

ROUND TABLE (Italian language)

Bernardo De Bernardinis President of the Italian Institute for Environmental Protection and Research (ISPRA)

Gianvito Graziano President of the Consiglio Nazionale Geologi

Silvio Seno President of the Italian Federation of Earth Science

Raffaele Pignone, Head of the Geological, Seismic and Soil Survey of Emilia-Romagna Region

Luigi Carmignani, Università di Siena – Centro di Geotecnologie

Fabrizio Galluzzo, ISPRA - National Contact Point of the CARG Project

HOSTED MEETINGS

In parallel session, the 7th EUREGEO hosts the following events:

- EuroGeoSurvey National Delegates Forum
- GIT (Geology and Information Technology) Annual Meeting – Geological Society of Italy
- Local forum of the European project Geo.Power

EUROGEOSURVEY NATIONAL DELEGATES FORUM

EuroGeoSurveys is the organisation of the Geological Surveys of Europe, the national institutions responsible for geological inventory, monitoring, knowledge and research. Our principal purpose is to provide public Earth science knowledge to support the EU's competitiveness, social well-being, environmental management and international commitments'. In our day-to-day activities, we promote the contribution of geosciences to European Union affairs and action programmes underpinning European policies and regulations for the security, health and prosperity of society, and providing technical advice for the European Union Institutions. We also provide a permanent network between the Geological Surveys of Europe and a common, but not unique, gateway to each of the Members and their national networks. We organise four statutory meetings a year to decide our strategy action programme, to facilitate networking among our members and promote their specific activities and projects.

7TH GIT MEETING – BOLOGNA2012

The 7th Meeting of Geology and Information Technology Group – GIT (Italian Geological Society) will be held during the 7th EUREGEO. The two parallel events represent a unique opportunity for meetings between the GIT Group and those deal with the Information Technology in the various fields of geosciences, at the international level.

During the Meeting the GIT members will present scientific contributions on industrial and research experiences, with particular attention to some topics proposed in the EUREGEO context (e.g.: Slope instability, Popularisation of geosciences, Seismic risk, Mapping data and information systems).

Evaristo Ricchetti Award: the best scientific contribution presented, during the GIT Meeting, by young researchers (under 32) will be awarded based on criteria of innovation, technical/scientific qualities, achievements and future goals.

LOCAL FORUM OF THE EUROPEAN PROJECT GEO.POWER

The general objective of the European project GEO.POWER, 2 years long, is exchange best practices related to low enthalpy energy supply and - after a technical and cost/benefit assessment - to evaluate the potential of reproducibility . This is necessary to prepare the ground to the transfer some of the selected best practices within the Mainstreaming Programmes of the regions participating into the project during the current programming period 2007-13 as well as in the future regional framework instruments.

The 2nd Local Forum, hold on June 14th, will focus on the most recent studies by the University of Bologna (DIENCA) and on the ongoing projects of the regional offices. The forum will show also some GCHP plants recently achieved in Emilia-Romagna.