A PILOT STUDY OF AN OPHIOLITE AQUIFER WITHIN THE EMILIA-ROMAGNA APENNINES: THE MONTE NERO, PARMA AND PIACENZA PROVINCES.

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AQUIFERS IN THE EMILIA-ROMAGNA APENNINES

For the last five years, the Servizio Geologico, Sismico e dei Suoli has been studying the main aquifers in the Emilia-Romagna Apennines, the mountain area in the southern part of the region. The starting point was the publication of the "Masterplan on geo-environmental hazards" (Viel, De Nardo & Montaguti, 2003) comprising thematic maps at the scale of 1:250,000. One of these maps deals with groundwater pollution risk at a regional level: here the main aquifers in the Emilia-Romagna Apennines were mapped for the first time, given the lack of pre-existing, widespread data.

These aquifers in fractured rocks and overlying slope debris accumulations are informally named "rocce-magazzino" ("storage-rocks"); the 1:250,000 map showing their distribution in the "Masterplan" was used as a reference for the Piano di Tutela delle Acque (PTA, regional Plan for Water Protection) adopted in 2005 (figure 1).

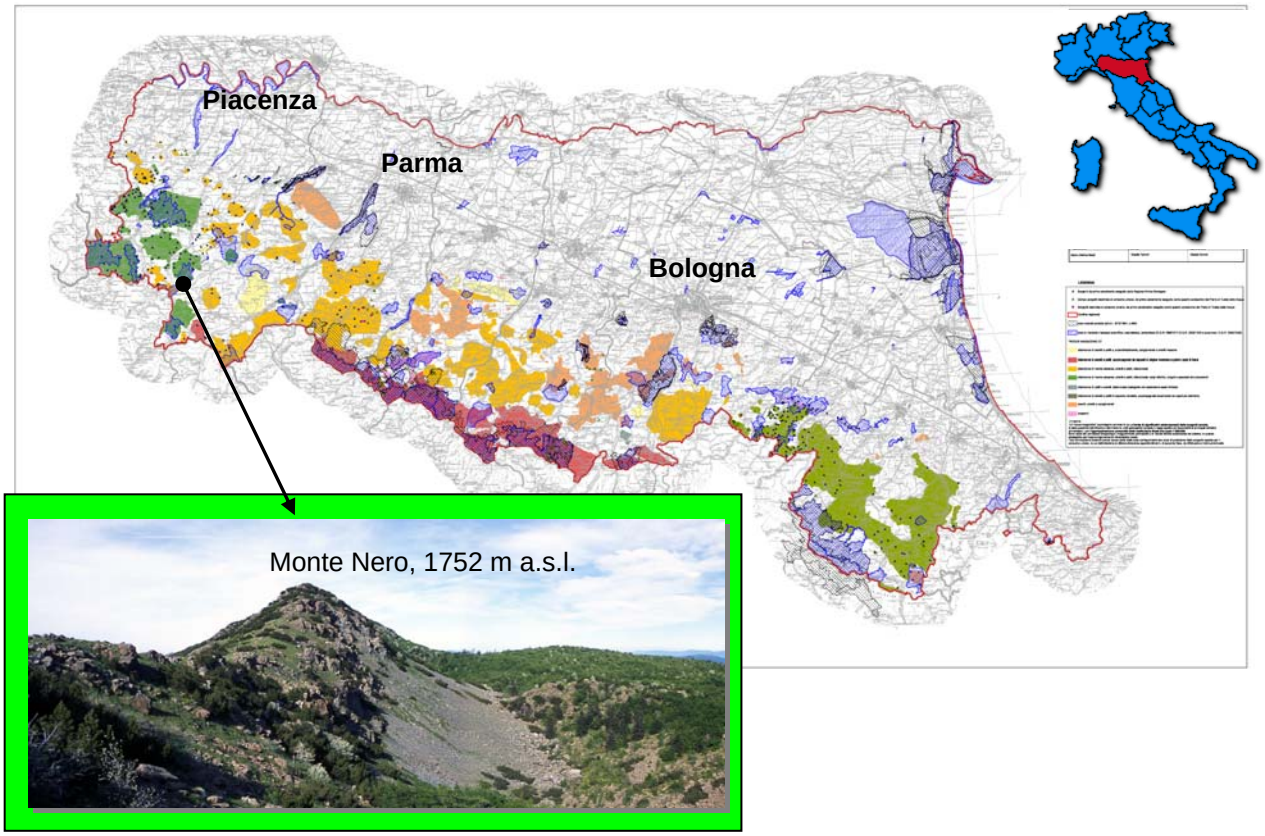

Figure 1- location of the study area

To draw the "rocce-magazzino" it was necessary to collect and digitalise data of the most important springs in the provinces (the administrative subdivisions of Italian regions), consulting the archives of regional Institutions for the management of water-use permits (the Servizi Tecnici di Bacino, mainly). Computerized data bases for the Piani Territoriali di Coordinamento Provinciali (PTCP, land use plans at a provincial level) were also utilized. Using the GIS programme ArcView, the results of this first inventory of springs were compared with the geological maps available at the Servizio Geologico, derived from the 1:50,000 sheets of the New Geological Map of Italy (CARG Project). The distribution of inventoried springs presents significant concentrations in correspondence to permeable hydrogeologic complexes, mappable as "rocce-magazzino". The framework provided by the "Masterplan" was able to be implemented locally, thanks to studies carried out by the Servizio Geologico, consisting of:

- implementation of the inventory of springs and creation of a data base. For example, thanks to the experience provided by the "Masterplan", an inventory at municipal scale has been carried out and data increased nearly eighteen times in the Parma province.[1]
- detailed mapping of the "rocce-magazzino" at a provincial scale for land use purposes, according to the PTA
- research on aquifers of particular interest, both from a quantitative and a qualitative point of view. The pilot study in the Monte Nero area is an example of this third item, and will provide a framework for more detailed hydrogeological studies on groundwater chemistry.

GEOLOGICAL SETTING

The Monte Nero, reaching 1752 metres in elevation, is located at the boundary between the provinces of Parma and Piacenza. It is one of the main ophiolitic bodies in the Emilia-Romagna Apennines: a slab of serpentinized peridotites, tectonically superposed on the overturned, arenaceous turbidites of the lithologically compound "Casanova Complex ". The latter is also made up of minor, serpentine and basalt ophiolitic slabs interbedded within turbidites. Argillite, chaotic units of the "Palombini Shales" formation separates the "Casanova Complex" from the underlying, overturned, marly-calcareous and arenitic turbidites of the "Flysch di Monte Caio" formation. All these geological units belong to the External Ligurian Domain, their age ranging from Early to Late Cretaceous. Quaternary units are represented by very coarse-grained debris accumulations; in the northern side of the Monte Nero relief (Piacenza province), they are of clear morainic origin, sedimented during the Wurmian glaciation. Behind relict, morainic circles, small endoreic lakes formed, giving origin to peaty deposits ("torbiere"). Quaternary units are more compound in the southern side (Parma province), where debris accumulations are mostly associated with large, rockslides which mobilized slices of the Monte Nero peridotites downhill; pit developed in counterslopes. Similar slides have been interpreted as developed in morpho-climatic conditions very different from the present ones, in the Wurmian postglacial.

GROUNDWATER IN THE MONTE NERO AREA, FIRST RESULTS

In the Masterplan, large ophiolitic bodies have been classified as "rocce-magazzino" at a regional level. Given the lack of pre-existing detailed hydrogeological studies, the Monte Nero is an ideal area for understanding the relationship between geology, the distribution of springs and groundwater chemistry. Here, fractured peridotites, coupled with permeable Quaternary units, offer favourable conditions for infiltration and a lot of non-ephemeral springs are to be found. No springs are used to feed aqueducts and the Monte Nero belongs to a protected area because of its naturalistic importance at a European level (Siti di Importanza Comunitaria, SIC). In 2005, fifty springs were surveyed during the summer; air and water temperature, discharge, ph and conductivity were measured. A number of the springs ("Fontana Gelata", "Nove Fontane") are also to be found in historical Italian topographic maps, surveyed in the period 1930-1940, indicating their local importance. The first priority was to obtain an updated, digitalized geological map at the scale of 1:10,000 suitable for the GIS programme ArcView. The following maps have been compared:

- Terranova and Zanzucchi, 1982 "Il gruppo ofiolitico dei Monti Maggiorasca e Nero (Appennino Ligure-emiliano): carta geologica ed interpretazioni geodinamiche"
- 1:25,000 maps of the n. 215 sheet "Bedonia", Elter and Zanzucchi co-ordinators, New Geological Map of Italy
- 1:10,000 maps of the Emilia-Romagna official geological map, issued by the regional Servizio Geologico
- The Inventory of Landslides attached to the PTCP, Parma province

Subsequent field surveying and photo interpretation were required to synthesize and harmonize data. The most relevant change with

[1] Surveyers: Massimiliano Trauzzi, Luigi Lopardo and Elisa Fava, for the Servizio Geologico

regard to pre-existing geological maps was the perimetration of detached peridotite slabs, emplaced by mass-sliding; their uppermost boundary is a steep-slope surface, making up a NE-SW oriented trench, nearby the Monte Nero watershed. These large, compound landslides have a preparing cause in the superposition of the fractured peridotites on the shaly “Casanova Complex”, which presents a SE, down slope dipping regional foliation. A new map was thus obtained and initial scrutiny reveals the surveyed springs are mostly concentrated in correspondence to large, compound landslides on the southern flank, and their distribution is coherent with the inferred location of main sliding surfaces. The pilot study will be completed by further field measurements and sampling for chemical characterization.

Matching data on springs with the detailed, synoptic map it will be possible to attain a clearer understanding of the extent of recharge areas and of the contribution of groundwater to local water balance.

CONCLUSIONS

For the study of aquifers in mountain areas, detailed geological and geomorphological mapping is required. This method is applied to the ophiolitic aquifers in the Monte Nero area, where further hydrogeological investigations on springs (i.e data collection on discharge rates and groundwater chemistry) are based on a thorough understanding of the local geological framework.

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