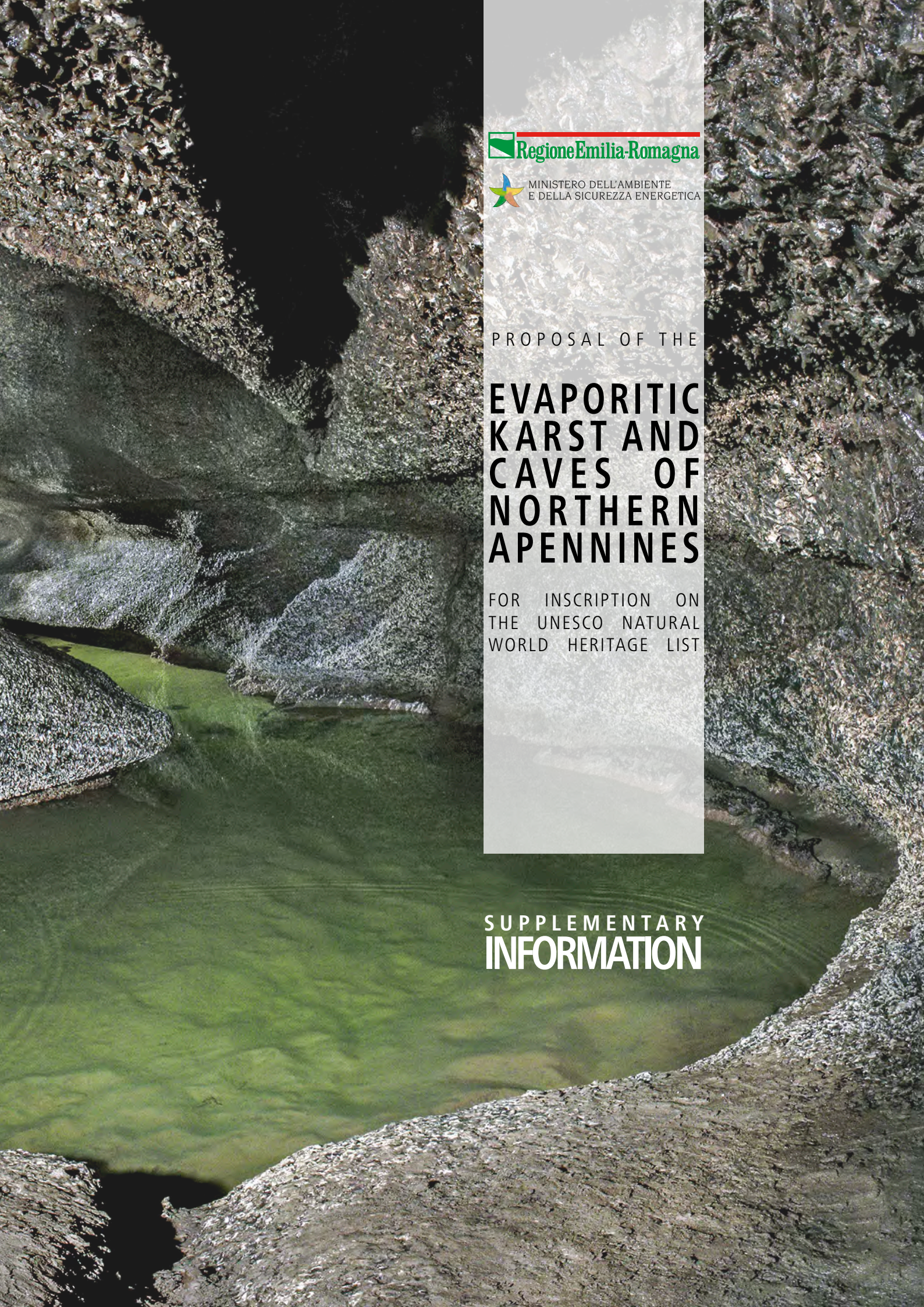

RegioneEmilia-Romagna

MINISTERO DELL'AMBIENTE
E DELLA SICUREZZA ENERGETICA

PROPOSAL OF THE

EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES

FOR INSCRIPTION ON THE UNESCO NATURAL WORLD HERITAGE LIST

SUPPLEMENTARY INFORMATION

- *(cover)*
  Stream bend in the resurgence of Rio Basino cave. Vena del Gesso Romagnola © 2008 Piero Lucci

- *(inside)*
  Dissolution features in the gypsum rock. Vei stream, Trias, Alta Valle del Secchia © 1988 Stefano Sturloni

EKCNA

graphic concept **A²studio**

RegioneEmilia-Romagna

MINISTERO DELL'AMBIENTE
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PROPOSAL OF THE

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EKCNA

SUPPLEMENTARY INFORMATION

Ministry of the Ecological Transition /
Ministero della Transizione ecologica
Emilia-Romagna Regional Administration - Department for mountains, internal areas, spatial planning, equal opportunities /
Regione Emilia-Romagna - Assessorato alla montagna, aree interne, programmazione territoriale, pari opportunità

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Acronym Legend

RER	Emilia-Romagna Region
MITE	Ministry of the Ecological Transition
FSRER	Speleological Federation of Emilia-Romagna Region
GSPGC	Speleological and Paletnological Group "G. Chierici" (RE)
GSB USB	Speleological Group & Union of Bologna
IUCN	International Union for Conservation of Nature
WH	World Heritage
c.s.	component site (or *component part* of the serial site)

Cover photo
Stream bend in the resurgence of Rio Basino cave. CS 5c, Vena del Gesso Romagnola - Monte Mauro © 2008 Piero Lucci

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IMPRESSUM

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With contributions of:

- Fausto Bonafede, Michele Vignudelli - Biology
- Marco Sami - Paleontology

EKCNA dossier **citation or reference to ND documentation** (document, paragraph, page)

all Supplementary Information and all digital documents of the nomination form (including vector files of the core and buffer zone boundaries) can be found in the attached DVD

TABLE OF CONTENTS

INTERIM REPORT

This Supplementary Information (SI) is the result of discussions among experts from the Ministry of the Environment, the technical-scientific committee of the nomination, the Appennino Tosco-Emiliano National Park, and the Emilia-Romagna Region. In addition, in order to better develop the contents and methodology of the SI, there was a specific conference call meeting with the IUCN assessment coordination.

The sequence of the SI follows the logical order of the requests contained in the interim report of the IUCN WH Panel. Each explanation is preceded by the corresponding IUCN request, shown in a blu box.

A. VALUES PROPOSED UNDER CRITERION (VIII)

1. The Panel would be grateful if the State Party could provide the full comparative analysis that underpins the analysis presented in the nomination dossier, if available, and explain (a) the benchmarks and rationales for determining the selection of the different categories of significance (1 star – present, 2 stars – significant, 3 stars – very significant), (b) the scoring system adopted for each category, (c) the relative significance of each category in defining potential OUV on the basis of qualitative and semi-quantitative comparisons, (d) the means by which comparative judgements are reached based on the analysis and (e) the extent to which international peer review of the overall comparative methodology has been undertaken. The Panel would be grateful for this to be explained both in relation to the comparison of the nominated property with other locations globally, including the Sivas Basin of Central Anatolia in Turkey, and also in relation to the selection of component parts – for instance, nominated component parts 2, 6 and 7 have been included although the comparative analysis appears to indicate that the attributes of the other nominated component parts are more significant than those of component parts 2, 6 and 7

1.a b c d e Clarification on comparative analysis methodology

The explanation of the methodology used for the comparative analysis presented in the nomination dossier is divided into two parts in order to respond precisely to the requests in (a), (b), (c), (d) and (e).

In particular:

- the first part summarises the characteristics of the benchmark and the original star-scoring system adopted by grouping the information from the annexes;
- the second part provides a numerical scoring system taking into account specific internationally recognized criteria.

I. The star-score

The comparative analysis in the Nomination Document (ND) was the synthesis of the full analyses provided in the Annexes, Annex 3.2 Comparative analisys, section "A".

The tables in the Annex 3.2 indicated the presence/absence of a given attribute, for example: a single mineral, or speleothem type. The tables provided a detailed review of the international literature and, in some cases, they were the result of direct field work of the ND Authors in the sites. The analyzed attributes were selected according to the criteria presented by Williams, 2008 and by the Operational Guidelines for the Implementation of the World Heritage Convention in 2019, but also taking in account the features compared in general reviews (Madonia & Forti 2003; Forti 2004; Gunn, 2004; Klimchouk et al., 1996; as suggested by Williams, 2008).

EKCNA dossier

- *Nomination document (Jusification) § 3.2. ND p.106 -120*

The data were split in different annexes as illustrated below:

Group of features	Criteria from	Chapter where data have been presented in detail
Climatic environment and karst style	Williams, 2008	• Annexes, A.3.2 Comparative analisys, page 6: "Evolution of the karst system"; • Annexes, A.3.2 Comparative analisys, page 10: "Current climate in the karst sites area"
Comprehensiveness of the karst system	Williams, 2008	• Annexes, A.3.2 Comparative analisys, page 4: "Main geomorphological features in the karst system"; • Annexes, A.3.2 Comparative analisys, page 5: "Known speleothems in the karst system"; • Annexes, A.3.2 Comparative analisys, page 7: "Known evaporite cave minerals"
Geology and landscape history	Williams, 2008	• Annexes, A.3.2 Comparative analisys, page 6: "Evolution of the karst system"; • Annexes, A.3.2 Comparative analisys, page 8: "Minerogenetic mechanisms"; • Annexes, A.3.2 Comparative analisys, page 9: "Age of the evaporite deposits"
Contribute of the feature to the OUV	Operational Guidelines	• See answer 1.c
How the feature provides a culturally and physically accessible manifestation of the phenomena	Operational Guidelines	• "other significant features" rows, synthesis table in the ND, page 108-109
Contribution to the representation of the integrity of the phenomena	Operational Guidelines	• All tables in the Annexes, A.3.2 Comparative analisys, described in ND chapter 2 and summarized in the side box of page 109.

The comparative analysis served two purposes: to demonstrate the OUV and to justify the seriality of the nominated property: for this reason, each table in the Annex 3.2 include an **analysis of the single component sites and an analysis of evaporitic karst sites worldwide**.

The "star" scoring system adopted in table 108-109, described a page 107, was based on the following criteria.

★ *"present" if the category of attributes is visible in the component site but does not manifest exceptional characteristics (it is however an example of the process in the particular geological and climatic conditions of the site);*

★★ *"significant" if the characteristic is present with a high diversity of manifestations of relevant scientific interest*

★★★ *"very significant" if the characteristic is exhibited, in the component site, with manifestations of exceptional scientific or informative value.*

To attribute the star-score the following approach was adopted:

- If the component part provide an example of the phenomenon that is easily accessible, assign one star;
- If the phenomena are abundant and at least one of these is of international relevance, add one star;
- If at least one phenomenon is world-unique, add one star;

The assignment of the first star is based on the data presented in the Annex 3.2 or by a presence/absence check. The assignment of the second and third star is based on the features discussed in chapters 2 and 3.

II. THE NUMERICAL SCORE

An update of the **scoring system based on a numerical approach**, according to the IUCN panel request, is presented below. The categories and information for the numerical analysis are the same already provided in the Annexes and discussed above. When an attribute is present in the considered area is assigned the value 1, whereas if the attribute is absent or the data is deficient, the value assigned is 0.

The initial result are two tables (Table 1, and Table 2, see below), where all the attributes concurring to a characteristic are summed together.

- *Table 1 Comparison among the component parts of the nominated serial property*

COMPARATIVE ANALYSIS OF THE COMPONENT PARTS OF THE SERIAL NOMINATED PROPERTY

			THEMES (GROUP OF ATTRIBUTES)	c.s.1 - Alta Valle del Secchia	c.s.2 - Bassa Collina Reggiana	c.s.3 - Gessi di Zola Predosa	c.s.4 - Gessi Bolognesi	c.s.5abc - Vena del Gesso Romagnola	c.s.6 - Evaporiti di San Leo	c.s.7 - Gessi di Onferno
CRITERION VIII	on-going geological processes in the development of landforms, and significant geomorphic or physiographic features	epigean	karst forms / geomorphology	7	4	2	16	15	11	11
			evolutionary typology	4	1	2	1	2	3	3
			hydrology (salt springs)	1	0	0	0	0	0	0
		hypogean	speleothems	4	2	12	27	30	7	7
			minerals	10	1	2	15	4	3	3
			crystal habit	6	2	3	6	3	2	2
			diapirism	1	0	0	0	0	0	0
			hydrogeology	2	1	2	3	3	1	1
		world reference	one-of-its-kind features	5	0	1	4	5	0	1
			features described for the first time in the literature	3	0	2	16	2	1	0
	additional values	climate	climate zones	1	1	1	1	1	1	1
		major stages of earth's history	evaporite age	1	1	1	1	1	1	1
			significant post-depositional phenomena	0	0	0	1	0	0	0
		record of life	syn-depositional palaeontology	0	0	0	0	1	0	0
			post-depositional palaeontology	0	0	0	1	0	0	0
			SUM OF ATTRIBUTES	**45**	**13**	**28**	**92**	**67**	**30**	**30**

cell values = number of attributes for a given theme

COMPARATIVE ANALYSIS AMONG THE NOMINATED PROPERTY AND OTHER EVAPORITIC KARST SITES IN THE WORLD

			THEMES (GROUP OF ATTRIBUTES)	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN ANATOLIA - TURKEY
CRITERION VIII	on-going geological processes in the development of landforms, and significant geomorphic or physiographic features	epigean	karst forms / geomorphology	19	10	4	2	5	15	9	2	4	7	4	6	8	6
			evolutionary typology	7	1	2	1	2	1	1	1	1	1	1	2	1	6
			hydrology (salt springs)	1	0	0	0	0	0	0	0	0	0	0	0	1	1
		hypogean	speleothems	34	16	5	2	2	10	1	2	1	4	1	2	0	0
			minerals	22	4	5	12	4	0	3	16	1	1	1	1	0	0
			crystal habit	8	3	4	2	2	3	2	4	2	1	1	3	1	1
			diapirism	1	0	0	0	0	0	0	0	0	0	0	1	0	1
			hydrogeology	4	3	2	1	1	2	1	0	1	1	1	1	0	0
		world reference	one-of-its-kind features	17	1	2	1	2	1	1	5	0	1	2	0	0	0
			features described for the first time in the literature	23	1	1	1	0	2	0	0	0	2	0	1	0	0
	additional values	climate	climate zones	2	1	1	2	1	1	1	1	1	1	1	1	1	1
		major stages of earth's history	evaporite age	2	1	1	1	2	1	1	1	1	1	1	1	1	3
			significant post-depositional phenomena	1	0	1	0	1	0	0	0	0	0	0	0	1	1
		record of life	syn-depositional palaeontology	1	0	0	0	0	0	0	0	0	0	0	0	0	0
			post-depositional palaeontology	1	0	0	0	0	0	0	0	0	0	0	0	0	0
			SUM OF ATTRIBUTES	**143**	**41**	**28**	**25**	**22**	**36**	**20**	**32**	**12**	**20**	**13**	**19**	**14**	**20**

cell values = number of attributes for a given theme

• Table 2 Comparison among the nominated property and other evaporitic karst sites in the world

Some categories already present in the Nomination Document (see p. 108-109 and 112-113) have been renamed to better match the definition of criterion (viii), namely **"on-going geological processes in the development of landforms, and significant geomorphic or physiographic features", "world reference", "major stages of Earth's history", "record of life".**

The so-called 'other significant characteristics', originally included in the ND, were removed from the comparative analysis as they were not directly related to criterion (viii).

source data used to populate the tables are included in this document on p. 38-45

Two values: "**one-of-its-kind features**" and "**features described for the first time in the literature**" replace the category named *"extent of visible phenomenon density"* in the Nomination Document, since the original definition could not be easily expressed numerically for areas that do not have a well-defined extension. The numeric values in the two rows are the count of "one-of-its-kind features" and "type-localities" presented in Additional Data 1 and 2 (see boxes alongside).

ADDITIONAL DATA 1:
OUV FEATURES FOR EACH CS

The following lists are the result of the analysis of the provided bibliography (see Annex 7.a of the Nomination Document) and in Calaforra & Forti 2021 Speleothems of Gypsum and Anhydrites Memoria 36 IIS.

CS 1 - ALTA VALLE SECCHIA

one-of-its-kind features

1) *Poiano Springs: the largest salt spring of Europe (Bottegari 1612)*
2) *Devilline: the only occurrence of this mineral in a cave (Chiesi & Forti, 1985, Calaforra & Forti 2021)*
3) *Clinochlore: the only occurrence of this mineral in a cave (Chiesi & Forti, 1985, Calaforra & Forti 2021)*
4) *Grotta di Monte Caldina: the deepest gypsum cave of the world (Franchi & Casadei, 1999)*
5) *Hypogean bends (Malavolti, 1949)*

phenomena described for the first time in the literature in the given locality

1) *Brochantite (mineral): first description in a gypsum cave (Chiesi & Forti 1986)*
2) *Magnesite (mineral): first description in a gypsum cave (Bertolani & Forti 1986)*
3) *Hypogean bends (Malavolti, 1949)*

CS 3 - GESSI DI ZOLA PREDOSA

one-of-its-kind features

1) *Palaeokarst cave developed during the Messinian speleogenetic cycle (De Waele & Pasini 2013)*

phenomena described for the first time in the literature in the given locality

1) *Sericolite (mineral): first description in gypsum cave (Santagata A., 1835)*
2) *Mirabilite (mineral): first description in a gypsum cave (Bertolani & Rossi 1962)*

CS 4 - GESSI BOLOGNESI

one-of-its-kind features

1) *Spipola-Acquafredda system: the largest meteoric gypsum cave in the world, over 12 km of mapped galleries (De Maria et al., 2012)*
2) *Chloromagnesite: the only occurrence of this mineral in a cave (Cervellati et al. 1975)*
3) *Different varieties of gypsum crystal habits, some of them the only occurrence inside gypsum caves (Tomba 1957)*
4) *Calcite-gypsum rafts: the only occurrence in the world (Forti 2003)*

phenomena described for the first time in the literature in the given locality

1) *First description of gypsum flowers over gypsum boulders (Forti 1983)*
2) *First description of a new minerogenetic processes giving rise to stalactites and stalagmites consisting of complex aggregates of Fe-Mn minerals in a gypsum cave (Forti & Rossi 1989)*
3) *First definition of a new speleogenetic process in gypsum karst allowing the development of a peculiar type of calcite (Forti 2003)*
4) *First description of calcite blades and of calcite crusts over gypsum (Forti & Rabbi, 1982)*
5) *Candles: first description of a surface karst erosional/corrosional morphology for a gypsum area (Capellini, 1876)*
6) *Epsomite (mineral): first description in gypsum cave (Laghi, 1802)*
7) *Ematite (mineral): first description in gypsum cave (Forti & Rossi 1989)*
8) *First general definition of the mechanisms allowing the evolution of paragenetic galleries in karst caves (Pasini, 1975)*
9) *First description of mirabilite mineral in a gypsum cave (Bertolani & Rossi 1972)*
10) *First description of brushite mineral in a gypsum cave (Forti 1983)*
11) *First description of lepidocrocite mineral in a gypsum cave (Forti & Rossi 1989)*
12) *First description of opal in a gypsum cave (Forti & Rossi, 1989)*
13) *First description of the speleogenetic role of condensation (Cigna & Forti 1986)*
14) *First description of dolomite as cave mineral in gypsum karst (Forti et al. 2004)*
15) *First description of calcite rootsicles in a gypsum cave (Forti 1996)*
16) *First description of the relationship existing between deviation of speleothems axes caused by earthquakes (Forti & Postpischl 1986)*

CS 5A,B,C - VENA DEL GESSO ROMAGNOLA

one-of-its-kind features

1) *The richest European Messinian palaeofauna within a cave (De Giuli et al. 1988)*
2) *Quartz crystals developing in cave at low temperature (Forti 1993)*
3) *Calcite bubbles inside a gypsum cave (Ercolani et al. 2013)*
4) *Lapis specularis "coins" (Lo Conte et al. 2020)*
5) *Manganese dendrites within gypsum crystals (Ercolani et al. 2022)*

phenomena described for the first time in the literature in the given locality

1) *First explanation of the genesis of the "mammelloni" (mamelons) structure in the Messinian gypsum (Vai & Ricci Lucchi 1977)*
2) *First description of anthropogenic gypsum flowers in a gypsum cave (Forti et al. 2019)*

CS 6 - EVAPORITI DI SAN LEO

one-of-its-kind features

1) *The only cave totally developed in alabastrine gypsum after selenite*

CS 7 - GESSI DI ONFERNO

one-of-its-kind features

1) *The largest syn-sedimentary "mammellone" (mamelon) of the world inside a cave*

ADDITIONAL DATA 2:

ELEMENTS FOR A POTENTIAL OUTSTANDING VALUE IN OTHER LOCALITIES AROUND THE WORLD

In analogy with Additional Data 1, the following lists are the result of the analysis of the provided bibliography (see Annex 7.a of the Nomination Document) and in Calaforra & Forti 2021 Speleothems of Gypsum and Anhydrites Memoria 36 IIS..

SANTA NINFA (SICILY) - ITALY

one-of-its-kind features

1) The only gypsum helictites in the world (Calaforra & Forti 2021)

phenomena described for the first time in the literature in the given locality

1) First description of gypsum tabular crystals (Calaforra & Forti 2021)

VERZINO (CALABRIA) - ITALY

one-of-its-kind features

1) The only "floating half bubbles" speleothem in the world (Forti & Chiesi 1995)

2) The only calcite organogenic flowstonein the world (Poluzzi & Minguzzi 1998)

phenomena described for the first time in the literature in the given locality

1) First description of celestite crystals in a gypsum cave (Carrozzini et al. 1996)

PODOLIA - UKRAINE

one-of-its-kind features

1) The largest hypogean gypsum cave of the world (Andreychouck et al. 2009)

phenomena described for the first time in the literature in the given locality

1) Biogenic pseudo-stalactites and pseudo-stalagmites consisting of Fe-Mn oxides and hydroxides (Andreychouk & Klimchuk 2010)

HARTZ - GERMANY

one-of-its-kind features

1) The only gypsum leathers speleothem in the world (Kupetz & Knolle 2015)

2) The only "Dolomite ash" (gypsum, calcite and dolomite powder) in the world (Kupetz & Knolle 2015))

SORBAS - SPAIN

one-of-its-kind features

1) The only gypsum balls in the world (Calaforra & Forti 1993)

phenomena described for the first time in the literature in the given locality

1) First description of gypsum fir speleothem (a stalagmite covered by coralloids) (Calaforra & Forti 2021)

2) First description of hollow stalagmites (Calaforra & Forti 1993)

[continued on p.13]

The information in the tables 1 and 2 can thus be read, for example, as follows:

- there are 7 different karst forms in CS1 "Alta Valle Secchia" vs 16 in CS 4 "Gessi Bolognesi" (Tab.1, first row).
- every Component Site sits in one single climate zone (Tab.1, 11th row): CS1 shows "Warm-summer Mediterranean climate" whereas CS 2-7 are "Humid subtropical climate". For this reason, in the second table ECKNA shows 2 climate zones.
- The same applies for evaporite age: CS1 is "Triassic" and CS2-7 are "Miocene" and there is just one evaporite age in each Component Site (Tab.1, 12th row), but consequently EKCNA spans over 2 evaporite ages in the second table. On the other hand, the Sivas Basin containing Eocene, Oligocene and Miocene evaporites, yield a score of 3.

A comparison on absolute numbers alone is not easy, since some categories can range from 0 to 30, whereas others range only from 0 to 1, depending on the number of possible types described in the row.

For this reason, a second group of tables are presented. The aforementioned absolute numbers are express as a percentage of the number of all possible manifestations worldwide. This means for example that the number of different speleothem types in CS4 "Gessi Bolognesi" (= 27) has been divided by 46, which is the total number of different known types around the word. This led to a value of 59%. This percentage is thus an indicator of the representativeness of the category in CS4, against the entire spectrum of known speleothems.

Therefore, in this locality a visitor can observe 59% of the possible type of world speleothems. This percentage also allows to compare a single Component Site against another locality in the world.

The characteristics of each site are evaluated at global scale. For this reason, also the role played in the development of the speleological science has been taken into account. This is an important point because these features are well comprehensible by the visitors, as they represent type-sites and type-references for the description of karst features anywhere else on our planet.

The data collection took place according to the description in the international literature (see Annex 7.e – Bibliographic references) and inspection of the sites by members of the scientific committee. Comparative judgments expressed in the text of the ND are a summary of the results of these analyses, integrated by a coherent

COMPARATIVE ANALYSIS OF THE REPRESENTATIVENESS VALUES OF COMPONENT PARTS ATTRIBUTES

			THEMES (GROUP OF ATTRIBUTES)	c.s.1 - Alta Valle del Secchia	c.s.2 - Bassa Collina Reggiana	c.s.3 - Gessi di Zola Predosa	c.s.4 - Gessi Bolognesi	c.s.5abc - Vena del Gesso Romagnola	c.s.6 - Evaporiti di San Leo	c.s.7 - Gessi di Onferno
CRITERION VIII	on-going geological processes in the development of landforms, and significant geomorphic or physiographic features	epigean	karst forms / geomorphology	32%	18%	9%	73%	68%	50%	50%
			evolutionary typology	44%	11%	22%	11%	22%	33%	33%
			hydrology (salt springs)	100%	0%	0%	0%	0%	0%	0%
		hypogean	speleothems	9%	4%	26%	59%	65%	15%	15%
			minerals	22%	2%	4%	33%	9%	7%	7%
			crystal habit	67%	22%	33%	67%	33%	22%	22%
			diapirism	100%	0%	0%	0%	0%	0%	0%
			hydrogeology	50%	25%	50%	75%	75%	25%	25%
		world reference	one-of-its-kind features	10%	0%	6%	52%	6%	0%	0%
			features described for the first time in the literature	15%	0%	3%	12%	15%	3%	3%
	additional values	climate	climate zones	3%	3%	3%	3%	3%	3%	3%
		major stages of earth's history	evaporite age	6%	6%	6%	6%	6%	6%	6%
			significant post-depositional phenomena	0%	0%	0%	100%	0%	0%	0%
		record of life	syn-depositional palaeontology	0%	0%	0%	0%	100%	0%	0%
			post-depositional palaeontology	0%	0%	0%	100%	0%	0%	0%
AVERAGE REPRESENTATIVENESS OF ATTRIBUTES				**30%**	**6%**	**11%**	**39%**	**27%**	**11%**	**11%**

percentages are calculated dividing the number of attributes by the number of possible karst phenomena representativeness is the arithmetic average of the percentages

- *Table 3 Representativeness of component parts attributes into the nominated serial property*

scoring system, inspired by international reviews (as listed above) and from suggestions provided by international scholars in the endorsement letters (see Annex 3.2.b).

Some of these scientists are: Prof. Paul Williams (New Zealand and author of the IUCN thematic frameworks for evaporitic karst), Prof. José María Calaforra of the University of Almeria (specialist of the karst area of Sorbas), Prof. Viacheslav Andreychouk (expert of the Pinega and Kungur area in Russia), Prof. Alexander B. Klimchouk (expert of the Podolia in Ukraine). Also some international organization offered indications on the comprehensiveness of the candidate property, including the International Union of Speleology with the endorsement of the Past Presidents Prof. Arrigo Cigna (Italy) and Prof. George Veni (USA), and of the current President Prof. Nadja Zupan Hanja, who is also UNESCO chair on karst education.

EKCNA dossier

- *Annex 3.2.b (Scientific endorsement) . ND § 3.2.c p.117 -120*

COMPARATIVE ANALYSIS OF REPRESENTATIVENESS VALUES AMONG OTHER EVAPORITIC KARST SITES IN THE WORLD

			THEMES (GROUP OF ATTRIBUTES)	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN ANATOLIA - TURKEY
CRITERION VIII	on-going geological processes in the development of landforms, and significant geomorphic or physiographic features	epigean	karst forms / geomorphology	86%	45%	18%	9%	23%	68%	41%	9%	18%	32%	18%	27%	36%	27%
			karst evolution types	78%	11%	22%	11%	22%	11%	11%	11%	11%	11%	11%	22%	11%	67%
			presence of salt springs	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	100%
		hypogean	number of different speleothemes	74%	35%	11%	4%	4%	22%	2%	4%	2%	9%	2%	4%	0%	0%
			number of minerals	49%	9%	11%	27%	9%	0%	7%	36%	2%	2%	2%	2%	0%	0%
			number of minerogenetic mechanisms	89%	33%	44%	22%	22%	33%	22%	44%	22%	11%	11%	33%	11%	11%
			diapirism	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
			hydrogeology	100%	75%	50%	25%	25%	50%	25%	0%	25%	25%	25%	25%	0%	0%
		world reference	one-of-its-kind features	74%	3%	3%	3%	0%	6%	0%	0%	0%	6%	0%	3%	0%	0%
			features described for the first time in the literature	52%	3%	6%	3%	6%	3%	3%	15%	0%	3%	6%	0%	0%	0%
	additional values	climate	climate zones	6%	3%	3%	6%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
		major stages of earth's history	evaporite age	11%	6%	6%	6%	11%	6%	6%	6%	6%	6%	6%	6%	6%	17%
			significant post-depositional phenomena	100%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	100%
		record of life	syn-depositional palaeontology	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
			post-depositional palaeontology	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	AVERAGE REPRESENTATIVENESS OF ATTRIBUTES			75%	15%	18%	8%	15%	14%	8%	9%	6%	7%	6%	15%	18%	28%

percentages are calculated dividing the number of attributes by the number of possible karst phenomena
representativeness is the arithmetic average of the percentages

- Table 4 Representativeness of ECKNA

1.* Comparison with worldwide locations, including the Sivas Basin (Turkey)

The attributes collected in Annex 3.2 are the result of the analysis of the international literature (also included in Annex 7) and direct inspection of the sites; the attribute categories derive from international reviews (e.g. Klimchouk et al., 1996 as mentioned in chapter 3.2.C) or are declined to the requirements provided by IUCN. The selection of localities is based on the international literature, including the sources suggested in Williams 2008, especially for the specificity of climate.

With regard to the **Sivas Basin of Central Anatolia (Turkey)**, from the geological point of view, its three main marine and continental Eocene, Oligocene and Miocene gypsum Formations represent outstanding examples of post-depositional phenomena including, gypsum-anhydrite transitions, halite diapirism, halite dissolution, evaporite recycling and tectonic deformation (Pichat et al., 2019). The karst area is characterized by imposing surface features such as blind valleys, sinkholes, polje, uvala, and recent collapse dolines (literature list below). Small forms such as karren and, more rare "candles" have also been documented. However, a very limited number of caves has been summarily explored and described in the literature (see list below), and most of them are of very small size (between 10 and 20 meters in length), the largest cave reaching less than 500 meters in length.

Salt springs are also present with a mean annual discharge of maximum 1.10 $m^3 s^{-1}$ (Kaçaroglu et al., 2001).

Another important difference is the lack of documented paleokarst in the Sivas gypsum and karst-related fossil remains.

In summary, referring to criterion (viii), the Sivas evaporite are surely significant and spectacular examples of on-going geological processes in the development of landforms, and geomorphic and physiographic features of surface karst, but not of hypogean karst and karst hydrology. Moreover they do not represent major stages of Earth's history (comparable to those of the Upper Triassic beak-up of the Pangea and the turning of the entire Mediterranean Sea into a giant salina at the end of the Miocene). Missing is also the record of life, from both, the evaporite rocks (crystals do not include fossils remains as in the Messinan of CS2-7) and the karst systems (as the case of CS3, CS4, CS5).

The Sivas evaporites were included in the new comparative analysis provided. New data have also been added to the tables for the Kavaje area (Albania), as new scientific fieldwork has meanwhile been conducted directly in the area by members of the nomination's scientific working group.

PINEGA - RUSSIA

one-of-its-kind features

1) *The only gypsum porcupine aggregate of cryogenic gypsum in world (Calaforra & Forti 2021)*

KUNGUR - RUSSIA

one-of-its-kind features

1) *The only aragonite antigravitative soda straws in the world (Andreychouk et al. 2013)*
2) *The only calcite subacqueous antigravitative soda straws in the world (Calaforra & Forti 2021)*
3) *The only cryogenic calcite and gypsum powder in the world (Andreychouk et al. 2017)*
4) *The only cryogenic powders (of different minerals) in the world (Andreychouk et al. 2013)*
5) *The only howlite mineral occurrence in a cave (Andreychouk et al. 2017)*

NEW MEXICO - USA

one-of-its-kind features

1) *The only Christmas tree (a combination of stalactite and stalagmite) in the world (Calaforra & Forti 2021)*

phenomena described for the first time in the literature in the given locality

1) *First description of botroidal gypsum stalactites (Calaforra & Forti 2021)*
2) *First description of gypsum powder (Calaforra & Forti 1993)*

NEUQUEN - ARGENTINA

one-of-its-kind features

1) *The only cemented gypsum powder speleothem in the world (Forti et al. 1993)*
2) *The only gypsum chimney in the world (Forti et al. 1993)*

PUNTA ALEGRE - CUBA

phenomena described for the first time in the literature in the given locality

1) *First description of bassanite powder (Chiesi & Forti 1992*

Additional references

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PICHAT A., HOAREAU G., CALLOT J.P., RINGENBACH J.C. 2019, Characterization of Oligo-Miocene evaporite-rich minibasins in the Sivas Basin, Turkey, Marine and Petroleum Geology 110, p. 587–605.

WALTHAM T. 2002 Gypsum Karst near Sivas, Turkey BCRA 29(1), p. 39-44

1.** Comparison among component parts of the nominated serial property

Component Site 2 was included in the candidate area because of the important role it has played in the history of karst hydrogeology, being one of the first sites studied for this purpose, already in the 16th century (cf. ND, p.109).

Another key aspect is the contribution of this CS for the integrity of the karst phenomenon, and its complementary to the other Component Sites, in particular CS 5a,b,c "Vena del Gesso Romagnola", as karst systems are generally arranged parallel to the gypsum outcrop.

This anomalous karst system direction is due to peculiar geological conditions, which control the base-level in oucrops that are completely surrounded by clay. This creates a hydrological condition where karst systems are not following the general slope at the Apennine margin but run parallel to it. As a result, the conduits are no crossing the strata along dip, as in CS 5a,b,c but developed along strata strike. The inclusion of CS2 thus adds to the completeness of the readability of the variety of karst phenomena in the serial nomination.

Component Site 6 "Evaporiti di San Leo" has characteristics not found in other parts of the nominated property. As far as is known the cave represent the only example in the world where karstic conduits cross alabastrine gypsum formed at the expenses of the selenite crystals. The shape of the crystals (pseudomorphs), which are up to 30 cm across, are beautifully exposed in the walls. the protected environment of the cave and the karst dissolution produced a unique exposure to observe the crystals in great details, which cannot be appreciated at surface outcrops.

In summary, CS6 provides the only example in the world where a collection of complex post-depositional phenomena (including the gypsum-anhydrite-gypsum transitions and the formation of native sulphur at the expenses of gypsum) are easily accessible and easy to understand within an evaporite cave.

Component Site 7 "Gessi di Onferno" From the geological point of view the karst landscape represent an outstanding example of a blind valley formed in clays by a single allochtonous gypsum block.

The touristic track into the cave provides one the best example of comprehensiveness of the

karst system by a stream crossing the entire gypsum outcrop, from one margin to the other, from sinkhole to resurgence. It also includes the largest mamellon of the world, a syn-depositional feature (giant load cast consisting of large gypsum crystals grouped together to form cavoli-structure), that is dramatically exposed by the dissolution phenomena leading to the formation of the conduits and large collapse rooms.

In summary, in a relatively small area of less than 1 km^2, a complete karst system, very easy to understand, can be walked by visitors starting from the relatively small blind valley. The underground touristic system, on the other hand, provides an excellent collection of easy to ready karst features (including multiple-level conduits, clastic infill, antigravitative galleries) taking the visitor through the entire crossing of the gypsum block. A sort of outstanding miniature, complete karst system containing world-grade karst features.

2. Correspondence to the accepted scientific framework for classifying evaporitic karst

2. External desk reviewers have expressed different views regarding the significance of the nominated property in relation to accepted scientific frameworks for classifying evaporitic karst. Could the State Party please provide an expanded scientific response, including references, regarding the correspondence of the nominated property to the frameworks provided in the relevant IUCN Thematic Studies (Williams, P. (2008). World Heritage Caves and Karst and Mc Keever, P.J. and Narbonne, G.M. (2021). Geological World Heritage: a revised global framework for the application of criterion (viii) of the World Heritage Convention), building on the information provided in the nomination document (p.110). This should set out to what extent the nominated property, as a stand-alone site, could be considered as the most significant option for addressing the remaining gap that was identified in the representation of caves and karst on the World Heritage List;

The nominated property responds to the requirement of Williams 2008 framework, confirmed by Mc Keever and Narbonne 2021.

In the Nomination Document, pag. 106, it is stated that "This approach aims to follow the indications reported in the IUCN document "World Heritage Caves & Karst" published in 2008, where it was noted that: in order to evaluate the coverage of karst on the world heritage List, each site needs to be reviewed in the context of three components:

i. its climatic environment and karst style

ii. the comprehensiveness of its karst system

iii. its geology and landscape history."

The comprehensiveness of karst system is proven by the numeric comparative analysis provided: 28 geomorphological features, 46 speleothemes, 45 evaporite caves minerals, 9 minerogenic mechanisms among other characteristics. An inventory of 741 caves has been published to geolocate the distribution of the aforementioned attributes, and it guided the selection of the CS and the definition of the nominated property boundaries.

Geologic and landscape history: the evaporitic deposits have been laid from seawater during two major geological events: the opening of the Tethys sea during the breaking up of the Pangea supercontinent in the Late Triassic, and during the Late Miocene "salinity crisis" which turned the Mediterranean Sea into a giant salina. The geologic evolution of this area led to the development of complex post-depositional modification of gypsum and halite during the evolution of the Northern Apennine mountain chain. Additional information about geological and landscape values are present in chapters 2 and 3 of the Nomination Dossier.

With regard to the "its climatic environment and karst style" it should be noted that, for instance, in White, Culver, Pipan, 2019 "Encyclopedia of Caves" pag. 487 it is stated that this nominated property is "the best documented example of caves formed in open karst" as proved also by comparative analysis in Annex 3.2, pag. 10.

Williams 2008 pointed out that evaporites are highly soluble and so significant landscapes occur in drier parts of the world, although in wet zones evaporite outcrops are reduced to almost no relief. Gypsum underlies karst landscapes in parts of the world that are relatively dry but not necessarily arid.

One of the most qualifying characteristics of the nominated property is that the subtropical-humid and warm-summer Mediterranean climates provides a delicate equilibrium allowing an optimum context for large and complex karst system to develop, without an extensive flattening of the gypsum outcrops.

The nominated property presents karst features that are expressed at their maximum extent because the climate conditions are the best "compromise" between wet and arid climate zones for evaporites.

For these reasons, together with the fact that there a visitor may easily access the largest variety of geological and karst features, the nominated property may be considered as the most significant example for addressing the gap of representation of caves and karst identified in the World Heritage List.

3. More details on the attributes listed for criterion (viii)

IUCN

3. In line with the above, the Panel recommends providing more details on the attributes listed for criterion (viii) on p.108-109 and p.112-113 of the nomination document. Desk reviewers noted for instance the diversity of chemical deposits and minerals associated with the gypsum caves of the nominated property as important attributes, but that precise figures and sources underpinning this claim are not provided in the comparison of the nominated property with the world's gypsum caves and the related star-rating.

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- *Annex 3.2.A (Comparative analysis) . ND § 3.2.A p.106*

The precise figures and sources have been provided in the Annex 3.2 of the ND. The annex indicates the presence of each mineral/chemical deposit/speleothem in every component site and in selected international localities. The sources for the data are also included in the Annexes, A.3.2 Comparative analisys. Some additional information are now available in a recent publication about speleothems and cave minerals in gypsum caves of the World:

CALAFORRA & FORTI 2021 Speleothems of Gypsum and Anhydrites Memoria, 36 IIS, 136 pag. (http://www.venadelgesso.it/2021/speleotemi.pdf)

B. INTEGRITY

4. Regarding the integrity of the nominated property, the Panel would be grateful if the State Party could:

a) describe, in brief, the caves and the evaporate outcrops that are not located within the nominated property, but located either within or outside the buffer zones, and explain the importance of these geo-sites (see Annex 1 – Detailed Geological Map of the nomination dossier);

b) indicate the potential (and the State Party's willingness to consider), in future, merging currently separate nominated component parts and expanding the buffer zones of the nominated property to improve connectivity and to cover all proposed attributes;

4.A Brief description of caves and evaporate outcrops surrounding the nominated property

The caves and the evaporitic outcrops not located within the nominated property are outside of any protected area and are considered of scarce geological and speleological relevance. The main reasons are:

1. limited length,
2. lack of minerals, speleothems,
3. partial or total destruction after natural collapse (extinct cave).

Only 9 caves that are actually outside of the nominated property show at least one significant geological or speleological feature: three of them are in a Buffer zone, but far from the rest of the nominated property, six are outside of any protected area.

There are three areas where the evaporite outcrops are not part of the nominated property:

1. scattered outcrops with no caves in the Triassic Gypsum (near CS1 Alta Valle Secchia);
2. scattered outcrops near Sassofeltrio (near CS7) with no caves and no specific geo-conservation measures at the moment;
3. scattered outcrops near Novafeltria (near CS6), with caves of limited size and no specific geo-conservation measures at the moment; the caves in this area have a scarce presence of carbonate and gypsum spelothems, with no particular geological and speleological interest.

The main source for this data is the "regional cadastre of caves, artificial cavities and karst areas" (cf. Nomination Document, pages 104, 125, 157). The second reference to the definition of the nominated property boundaries is the geological map at scale 1:10.000, used to locate evaporite outcrops.

EKCNA dossier

- *Nomination document (Stat of conservation) § 4.A p.125 ff.*

4.B Potential merging of separate component parts and expansion of buffer zones

The relationships between the different component parts of the nominated serial property have been carefully evaluated and selected in order to create a complete and representative series of the manifestations of the phenomenon of karst in evaporites in a humid subtropical environment, which is very particular to these latitudes. This choice has led to the inclusion in the series of all the significant areas of the phenomenon, even though these may be at a considerable distance from each other. The definition of the proposed perimeters for the core and buffer areas of the nominated property has been equally long considered, taking into account the geological attributes and the geographical and physical characteristics of the territory.

Given these premises, even though there is no preclusion by the State Party to discuss it in the future, the hypothesis of physically linking the different component parts by enlarging the buffer zones seems hardly feasible. Considering the geographical scale at which the geological phenomenon manifests itself, the main links between the component parts are of a genetic type. However, there are also physical links that manifest themselves both on the surface and in the subsurface. At the current state of knowledge, the nominated area provides most of these links. However, considering that speloeological exploration and research is constantly evolving (as it is set forth and supported by the Region of Emilia-Romagna through a specific regional law, RL 9/2006), it is not excluded that in the future the possibility of new expansions and/or connections among the component parts will be created.

Moreover, from an organisational point of view, good management links already exist, that the inclusion in the World Heritage List could further strengthen and refine. The management approach of connectivity conservation is already practised through well-established collaborative relationships between protected areas, as the nearby example of Appennino Tosco-Emiliano Biosphere Reserve also demonstrates.

The only component parts that are close enough to lend themselves to a possible fusion are 5a (Monte Penzola), 5b (Monte del Casino) and 5c (Monte Mauro), all of which are included in the Vena del Gesso regional park. This possibility has been carefully studied but there are man-made obstacles, currently insurmountable (settlements, infrastructures, various human activities), that prevent the perimeter of a single core zone. However, a single buffer zone that guarantees the ecological continuity of the area, has been established.

C. PROTECTION AND MANAGEMENT

5. Regarding the protection of the nominated property, the Panel would be grateful if the State Party could please provide

a) a succinct clarification to what extent the protection of the geo-sites is integrated in the protected area law(s) and to what extent the protective designations specifically serve the protection of geological values;

b) a map, and GIS shapefiles for each nominated component part if available, showing an overlay of key attributes (see Annex 1 – Detailed Geological Map of the nomination dossier) and all protective designations that serve the protection of the geological values of the nominated property;

c) a map clarifying prohibited activities (see p. 159-161 of the nomination document) in relation to the nominated component parts and buffer zones;

5.A THE PROTECTION OF THE GEO-SITES AND GEOLOGICAL VALUES IN THE PROTECTED AREA LAWS

Geo-sites protection is integrated in the protected area regulations and in the Natura 2000 Network sites as they are recognised and regulated through the same protection laws. In particular, the protection of the geosites of c.s. 1 is regulated by the protection laws of the Appennino Tosco-Emiliano National Park.

The protection of the geosites of component sites 2 to 7 is regulated by Regional Law no. 9/2006 "Rules for the conservation and enhancement of Emilia-Romagna's geodiversity and related activities". This law is specifically aimed at the protection, knowledge and valorisation of geosites (epigeous and hypogean), caves and karst areas in Emilia-Romagna.

- *Nomination document (Protection) § 5.B p.139-155*
- *Overall Management Strategy p.36-47*

More specifically, this law establishes that geo-sites, natural caves and karst areas located in the various protected areas of the region (regional parks, nature reserves, N2000 Network sites, protected landscapes, 'areas protected by national law') are subject to the specific regulations of the protected areas in which they are located.

In particular, the regional law stipulates that geo-sites located in regional park areas under strict protection are protected directly by each park. In the areas of the parks subject to general protection, access, research, and exploration of cavities for scientific purposes, are allowed on the basis of programmes drawn up by the speleological groups affiliated with FSRER (Regional Speleological Federation of Emilia-Romagna), and other specifically authorised speleological groups.

Geo-sites located in the N2000 network areas are protected by the protective regulations of each area and are subject to environmental impact assessment.

c.s. #	Reference laws for the protection of geosites	Comments
1	Regulations of the Appennino Tosco-Emiliano National Park Territorial Plan	the regulations include specific measures to conserve the geological heritage and the water circulation cycle. (DPR 21/05/2001, L. 394/1991)

- *Table 5 The regulatory system for the protection of geosites and geo-conservation*

c.s. #	Reference laws for the protection of geosites	Comments
2 - 7	• Regional Law No. 9 of 10/07/2006 on the conservation of geodiversity. • Regional Law No. 6 of 17/02/2005 on the entire system of protected areas and Natura 2000 sites. artt.28 e 45 • General and specific conservation measures for Natura 2000 sites (DGR n. 1147/2018); • Founding Laws regional parks: Gessi Bolognesi (LR n.11 of 2/04/1988), Vena del Gesso (LR n.10 of 21/02/2005); • Territorial park plan (Gessi Bolognesi DGR n.2283 of 02/12/1997); • Regional parks regulations: Gessi Bolognesi e Calanchi dell'Abbadessa (DGR no. 2256 of 12/27/2021), Vena del Gesso romagnola (DGR no. 2000 of 12/28/2020) and Regulations for the protection of the geological and archaeological heritage of the Vena del Gesso Romagnola (DGR no. 1202 of 09/21/2020); • Onferno Nature Reserve founding law (Regional Council Resolution No. 421 of 04/23/1991); • Onferno Nature Reserve Regulations (Rimini Provincial Council Resolution no. 3 of 28/01/2010).	Protective designations for protected areas differ according to the type of protected area (national park, regional parks, N2000 network sites, nature reserves, etc.) but all include conservation of the geological and geomorphological heritage among the specific conservation objectives.

In addition, law 9/2006 established the 'Inventory of geo-sites in Emilia-Romagna' and the 'Cadastre of natural caves in Emilia-Romagna', which are essential knowledge tools to protect geosites. The inventory and the cadastre are an integral part of the urban planning instruments.

• *Table 6 Knowledge tools of the Regional Law 9/2006 for the protection of geodiversity*

Tool	Description	web link
Geo-sites inventory	A report was created for each geo-site, containing a geological map with the perimeter of the geo-site, a geographical description, a geological description highlighting geological interest, values, protection tools, and the degree of accessibility.	https://applicazioni.regione.emilia-romagna.it/cartografia_sgss/user/viewer.jsp?service=geositi
Cadastre of natural caves	A sheet was created for each cave with a brief description, identification data, geological and speleological survey, underground water circulation diagram, and a photo gallery.	https://geo.regione.emilia-romagna.it/cartografia_sgss/user/viewer.jsp?service=grotte

All the protective designations contain precise references to the geoconservation. Although the protective designations for protected areas differ according to the type of protected area (national park, regional parks, N2000 network sites, nature reserves, etc.) but all include conservation of the geological and geomorphological heritage among the specific conservation objectives (see Tab. 7).

- Table 7
Knowledge tools of the Regional Law for the protection of geodiversity

c.s. #	protective designations	protection purposes of geological values included (abstract)
1	• Founding Act of Appennino Tosco-Emiliano National Park (Decree of the President of the Italian Republic 21 May 2001) – Annex A "Protection regulations". • L. 394/1991 art.11	*Art. 2 "Protection and promotion": The protected area ensures the conservation of geological formations, paleontological singularities, hydraulic and hydrogeological balances.* *Art. 3 "Prohibitions": In the protected area it is forbidden:* *- the removal of materials of relevant geological and paleontological interest, with the exception of that carried out for research and study purposes, subject to authorisation by the Park;* *- the opening and operation of quarries, mines and dumps, as well as the removal of minerali...(art.3)* *- to light fires;*
2	• Specific Protection measures of the SCI-SAC_ IT4030017 - Ca' del Vento, Ca' del Lupo, Gessi di Borzano (DGR n. 1147/2018)	*It is forbidden to open new quarries or expand existing ones*
3	• Specific Protection measures of the SCI-SAC_ IT4050027 - Gessi di Monte Rocca, Monte Capra e Tizzano (DGR n. 1147/2018)	*It is forbidden to open new quarries or expand existing ones*
4	• Founding Low of Gessi Bolognesi-Calanchi Abbadessa Regional Park (1988) • Territorial park plan (DGR n. 2283 del 02/12/1997) • Regional parks regulations Gessi Bolognesi e Calanchi Abbadessa Regional Park (2021) • LR n. 6/2005 art.28	*"Prohibitions": Any activity of collecting and removing fossils, minerals and concretions, as well as paleontological and archaeological findings in underground environments, opening of quarries, mines and landfills, free access to caves, lighting fires, modification or alteration of hypogeal habitats, and alteration of the underwater hydraulic system is forbidden.* *It is forbidden to open new quarries or expand existing ones*
5a, 5b, 5c	• Fouding Act of Vena del Gesso Romagnola Park (2005) • Regional parks regulations Vena del Gesso Romagnola Park (DGR n. 2000 del 28/12/2020) • Regulations for the protection of the geological and archaeological heritage of the Vena del Gesso Romagnola (DGR n. 1202 del 21/09/2020); • LR n. 6/2005 art.28	*Art. 1 "Purposes". The conservation, upgrading and valorisation of geological and geomorphological formations and outcrops of scientific, educational and landscape interest, with particular reference to elements protected by EU directives.* *Art. 6 "Prohibitions". Modification of the underground hydraulic system, alteration or modification of caves, sinkholes, resurgences or other surface or underground karst phenomena, unregulated access to caves and natural cavities, the opening of new quarries or landfills is prohibited*
6	• Specific Protection measures of the SCI-SAC_ IT4090003_Gessi Valmarecchia (2018)	*It is forbidden to open new quarries or expand existing ones*

c.s. #	protective designations	protection purposes of geological values included (abstract)
7	• Onferno Nature Reserve founding law (Regional Council Resolution No. 421 of 04/23/1991); • Onferno Nature Reserve Regulations (Rimini Provincial Council Resolution no. 3 of 28/01/2010). • LR n. 6/2005 art.45	*Art. 2 "Purposes". Ensuring the protection and conservation of natural environments with special reference to the Onferno karst complex …* *Art. 3 "Protection rules". The collection and removal of minerals, rocks and limestone concretions is prohibited* *It is forbidden to open new quarries and mines*

5.b Maps (and related GIS shpfiles) with the key geo-attributes e all the protective designations

A digital map of each nominated component part is provided (as interactive PDF multilayer), together with the 12 shapefiles used to generate them. There is a single map for each component part, except for the c.s. 5a, 5b, 5c that are contiguous and have been plot in the same map, since they all share a single buffer zone, so there are 7 PDF maps in total.

All the files can be downloaded from https://regioneer.it/EKCNA-additional-information

*During the meeting with the IUCN assessment coordination (conference call of 20 February 2023), it was agreed to provide **multilayer PDF maps** since they allow the reader to turn on/off each layer. This to facilitate the reading and the comprehension of the many protective layers overlapping in the nominated property.*

NOTE 1:
To query the multilayer map , it is necessary to open the PDF files with Acrobat Reader DC since it is the only software capable to show the layers individually, and to switch them off when necessary. If the PDF is opened in a web browser or using a preview application, the layers may be hidden or merged together..

Each map contains the following key geological attributes:

- Dolines
- Salt springs
- Caves (ranked by their scientific and speleological importance)
- Caves extension
- Surface idrography
- Hypogean water flow
- Geological units

Additionally, every map includes the boundaries of protective designations of the geological values of the nominated property, including:

- Geosites
- Natura2000
- National and Regional parks
- Legislative decree n.42/2004, Art. 136
- Protected Landscape

The basemap is a topographic map of the area at the scale 1:25 000 with an hillshade to emphasize the topography. Geological units are represented with a higher detail than in the Nomination Document and the geologic map includes also information about the Quaternary deposits. The legend provides a description of the lithology for all tectonic/ stratigraphic units.

5.c Maps (and related GIS shpfiles) with the prohibited activities

Seven multilayer PDF maps of prohibited activities are provided for each Component Site (CS5a, CS5b, CS5c are shown in the same map since they share a common buffer area). All GIS shapefiles relating to the themes selected to generate the maps are provided in EPSG:25832 (ETRS89-UTM32) coordinates.

Each map contains the following layers:

- The boundaries of the nominated property and its buffer zone;
- Gypsum outcrops (a generalisation of the geological map, where only gypsum units are shown);
- The "total protection area" boundary, that marks areas where human access is strictly restricted;
- A topographic map, with hillshade, at scale 1:25 000.
- Area where it is forbidden:

  - the damaging, disturbance and killing of local fauna;
  - the collection and damage of local flora;
  - the unmanaged introduction of allochtonous species;
  - the extraction of significant geological and palaeontological materials;
  - the morphological alterations of karst and non-karst features;
  - the modification of water regime;
  - free access to the caves;
  - affixing of advertising signs;
  - to illuminate caves;
  - the excavation and quarrying;
  - the introduction of explosives;
  - camping;
  - to light fires;
  - overflight;
  - off-road transit;
  - the development of new buildings and roads;
  - the realization of technological works;
  - land-use changes in forest areas;

All the files can be downloaded from
https://regioneer.it/EKCNA-additional-information

The 20 shapefiles used to generate the maps of the prohibitions listed on pages 159-161 of the Nomination Document include the overlay of all the polygons of the individual regulations/Zones of parks and reserves.
In this way, whoever queries a point will find the set of regulations in force at that point, including an extract of the relevant regulatory act for each individual topic.

NOTE 2:
In the PDF file, prohibited activities layers are turned off by default. To show them and to open ***multilayer PDF maps*** *it is necessary to use Acrobat Reader DC since it is the only software capable to show the layers individually, and to switch them off when necessary.*

All the maps previews are included in this document on pages p. 46-75

6.A The timeframe for the management structure implementation

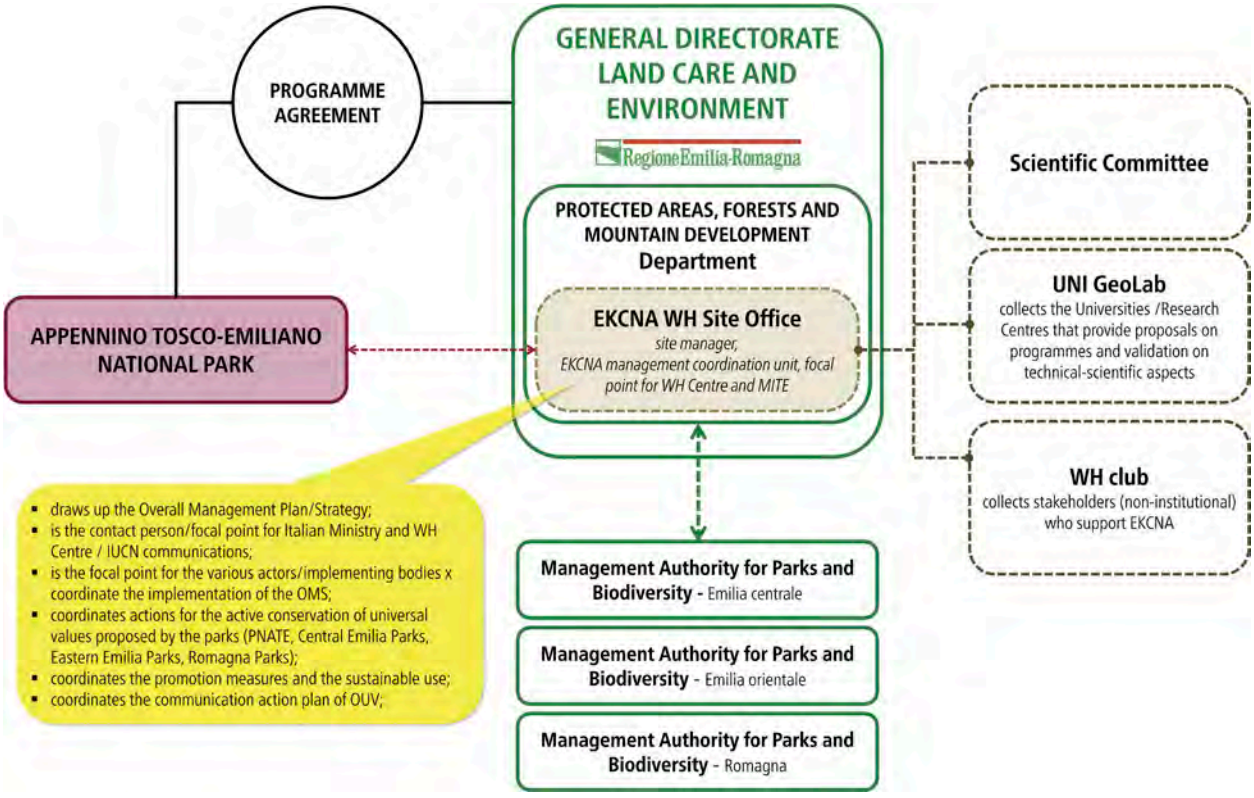
The timetable for the establishment of the proposed management structure needs a total of **18 months**. This procedure shall be divided into **two sub-processes.**

The first process concerning **the Programme Agreement** between the Emilia-Romagna Region and the Appennino Tosco-Emiliano National Park (a necessary inter-institutional pact) is going to be developed within 12 months after the potential inclusion in the WH List.

The second process, which concerns **the set-up of the EKCNA Office**, is going to be held within 6 months after the approval of the Agreement. This process has to follow these steps:

- Establishment of the ECKNA WH Site office at the Emilia-Romagna Region (Regional Act) to be followed, within 6 months, by the approval of the first management programme of the EKCNA WH Site
- Renewal of the "Memorandum of Understanding" and creation of an Institutional Committee (inter-institutional agreement among Region - Municipalities - Provinces - Park Authorities)
- Establishment of a Scientific Technical Committee (Regional Act)
- Establishment of an ECKNA WH Site supporter panel (Regional Act)

• *flow chart showing the proposed EKCNA management structure*



6.B The Monte Tondo quarry issue

It is confirmed that **the regulations applied to the quarry area** (Regional Law 10/2005 establishing the Vena del Gesso Park, and the conservation measures of the Natura 2000 Network, SAC-SPA areas) **do not allow any expansion** of quarrying outside the currently authorised perimeter.

The Regional Council has already expressed its views through various public statements, registered by the Legislative Assembly (Question N° 6048/2022 by the Deputy President of the

Region), confirming that the currently authorised perimeter consists an insurmountable limit to quarrying activities. These can continue only for the volumes that have not yet been excavated but have already been authorised by the current planning .

The current planning, the PIAE (Infraregional Plan for Mining Activities), has established the insurmountable limit of excavation within the perimeter of the current quarry, which is entirely inscribed in the buffer zone of the nominated property

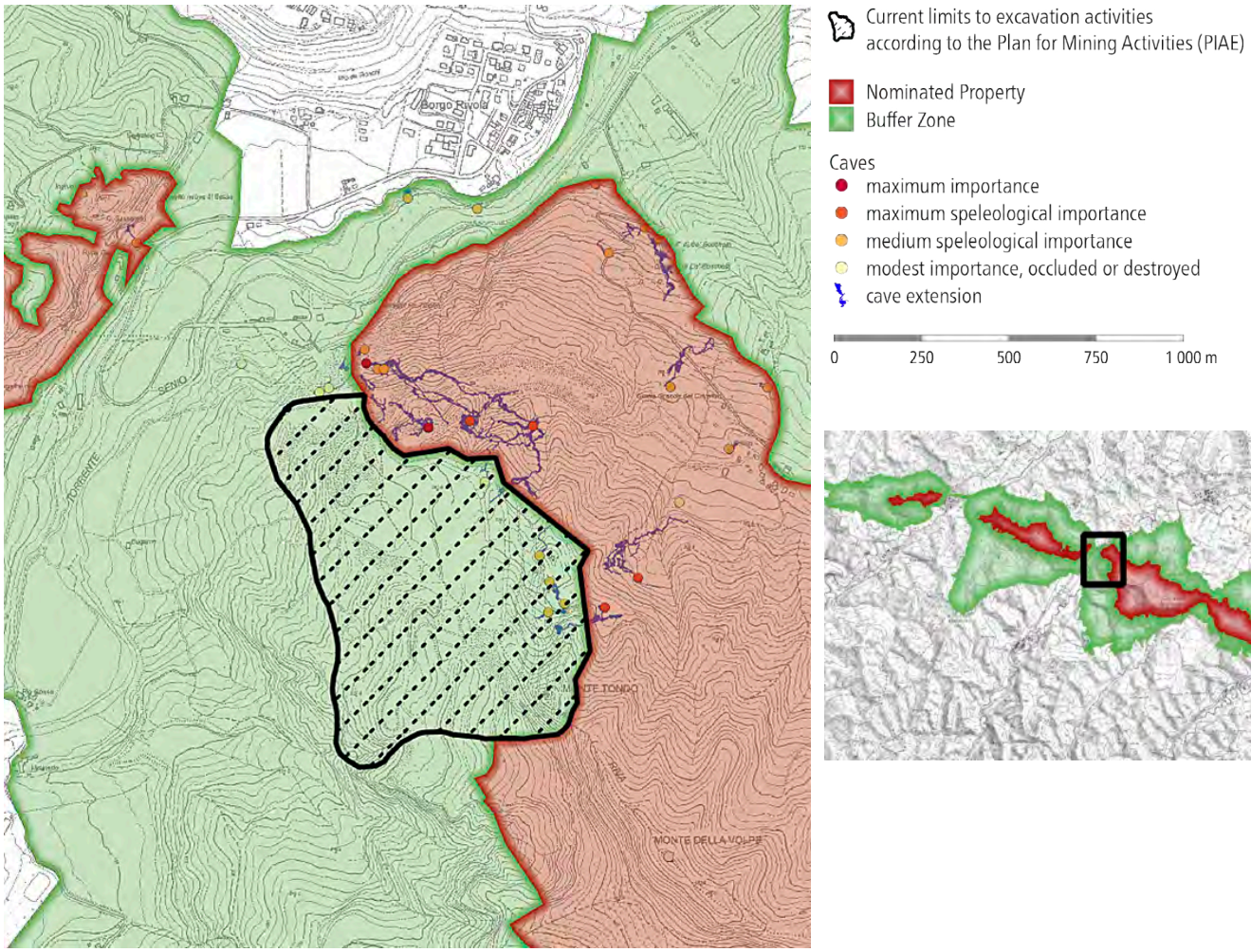
A new PIAE is being prepared, to be approved by 2024, in which the current mining limits and volumes are going to be confirmed. It is foreseeable that at the excavation rates of the recent years, the authorised mining activity will be exhausted within 10 years.

The Mining Concession also includes the project for the environmental restoration once the quarry's mining activity has ended, and the new PIAE will also approve the general guidelines for the overall landscape restoration.

The project will also deal with geological-environmental and historical-archaeological enhancement and will be publicly registered in the relevant administrations.

With the potential inscription on the WH List, the valorisation of the speleological and geological aspects ("gypsum banks", mineralogical attributes and elements of astrochronological value, etc.) will be extended and enhanced, and it will be developed in detail during the authorisation phase of the project itself.

The approval of the new PIAE by the Province of Ravenna hinges on the evaluation of the Emilia-Romagna Region, that provides binding conditions.



6.c The relationship between the nominated property and the UNESCO Biosphere Reserve

The primary objective of the Appennino Tosco-Emiliano Biosphere Reserve (ATEBR) is the conservation of an existing, sustainable relationship between man activities and the environment at the border between European and Mediterranean climates. The nominated C.S. 1 belong to ATEBR buffer zone and C.S. 2 is included in the transition zone of the reserve.

Management linkages: The coherence and complementarity of the management objectives and actions of the ATEBR and the nominated property will be entrusted to the same management authority: the Appennino Tosco Emiliano National Park. In fact, the National Park coordinates the management of the Biosphere Reserve and will also coordinate the management of CS 1 and 2 of the nominated property (CS 3 is not part of the ATEBR area).

Governance: At local scale, both the representatives of the municipalities within C.S. 1 and 2 and the Emilia Central Emilia Management Authority (*Ente di gestione per i Parchi e la Biodiversità – Emilia Centrale*), which manages the Natura 2000 Network Site of CS 2, participate in the governance of the ATEBR as members of the Territorial Management Committee.

Biosphere Reserve and Geo-conservation: The Biosphere Reserve nomination document stated how the territory of the ATEBR is endowed with a particular biodiversity and landscape diversity that is strongly conditioned - in structure and functionality - by its high degree of geodiversity (i.e. the area includes just under 200 geosites, both epigeous and hypogean). The aspect of geo-conservation in the ATEBR is dealt mainly from the pedagogical point of view, through continuous actions of dissemination and transmission of geological values, such as the publication of geological guides, the organisation of geotourism itineraries, training courses aimed at the knowledge of the geological heritage for local operators, and educational activities for schools aimed at an initial field approach to the Earth Sciences.

6.d The expertise of the protected areas staff and Carabinieri Forestali for geo-conservation

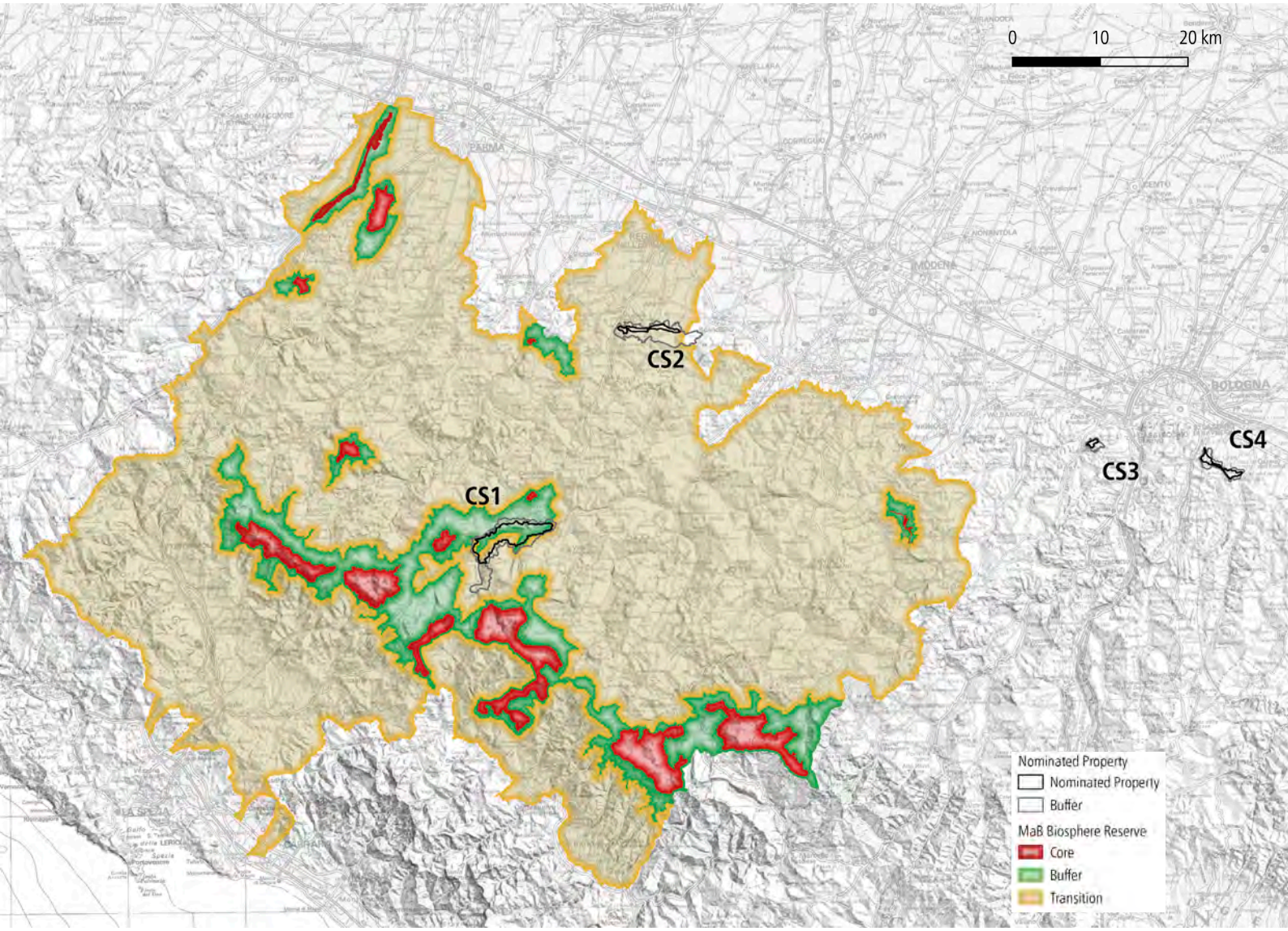
The Carabinieri Forestali are an environmental police department with high specialisation in environmental, land and water protection, as well as in the field of safety and control. They also have the task of sanctioning those who do not observe environmental protection measures. The Carabinieri Forestali are entrusted with the surveillance and guardianship of protected natural areas of national importance.

Therefore, as far as nominated property is concerned, the **Carabinieri Forestali are operational in the areas of CS.1**, included in the Appennino Tosco-Emiliano National Park. The national park area is in fact equipped with a specific department (Department of Carabinieri Forestali of the Appennino Tosco-Emiliano National Park). The staff assigned to CS.1 amounts to 11 people, including a responsible official with a degree in natural sciences and 10 forestry agents with skills acquired after a period of advanced technical-scientific training on environmental issues.

As far as geoconservation is concerned, in addition to ensuring observance of the park regulations, the Carabinieri Forestali ensure observance of the prohibition to take material of relevant geological and paleontological interest (including minerals) and to change the water regime. They also assist the Park in the conservation of geological singularities and palaeontological formations, biological communities and hydraulic and hydrogeological balances. The staff employed in the different component parts of the nominated property and their expertise are specified in the following tables.

6.e The the current and planned funding and staffing, oriented to geo-conservation

The **table of staffing** shows the human resources and expertise available to each component part, distinguishing between full-time employed staff, part-time employed staff and rangers. Overall, the staff dedicated to the management of the protected areas of the nominated property consists of 64 people, 47 of whom full-time and 17 part-time. The staff is made up of graduates in the natural and earth sciences and includes foresters, geologists, naturalists, biologists, entomologists and



- *The nominated component parts CS. 1 and CS.2 overlapped on the Biosphere Reserve of the Appennino Tosco-Emiliano*

speleologists, as well as technical specialists in wildlife, agricultural and educational sciences. With specific regard to geoconservation, the nominated area can count on the expertise of five geologists and one entomologist and speleologist. Surveillance of the nominated property is carried out by 88 specially trained rangers, including 11 Carabinieri Forestali (CS.1), and 79 Volunteer Ecological Guards (CS.2-7, see ND, p.178).

The **table of current and planned funding** shows the financial resources allocated annually to the protected areas of the nominated property, for 2022 and for the three-year period 2023-25. For funding - current and planned - the types of source (European, national, regional, and local) as well as the current and capital expenditure are specified. In 2022, the nominated property benefited from 1,080,000 Euros in total.

For the three-year period 2023-25, taking into account the potential inscription on the World Heritage List, the Emilia-Romagna Region established a considerable financial increase. In fact, for the nominated property was planned an annual badget of € 2,270,000.

This budget allocated by the E-R Region includes the resources needed for the co-ordination of activities specifically oriented towards World Heritage. Among these, there is also a special contribution (€ 50,000) for the establishment and start-up of the activities of the ECKNA WH Site Office.

Staffing

n	c.s.	*institutions*	Sources of expertise and training in conservation and management techniques					
		regional or municipal or park authority	*department / division / office*	*full-time staff*		*part-time staff*		*rangers*
1	**Alta Valle Secchia**	Appennino Tosco-Emiliano National Park	Nature Conservation Office	2 forest graduate 1 geologist 1 naturalist graduate 1 entomologist and speleologist graduate 2 biologist	7			
			Technical Office	1 agrotechnician 1 wildlife technician 1 technician in animal production science	3			11
			Sustainability education - tourism and promotion	2 experts in tourism and land promotion 1 expert in sustainability education	3			
			Adiministrative Office	3 administrative graduates	3	2 administrative assistants	2	
		Mountain Union of Municipalities of Appennino Reggiano				1 forest graduate 1 geologist	2	
2	**Bassa Collina Reggiana**	Management Authority for Parks and Biodiversity - Emilia Centrale	PNSP Collina Reggiana	2 graduates in technical-scientific disciplines	2	2 rangers	2	
				1 technical-scientific degree	1	volunteer ecological guards		10
3	**Gessi di Zola Predosa**	Emilia-Romagna Regional Administration	Servizio Aree Protette, Foreste e Sviluppo della Montagna	/		1 graduate in technical-scientific disciplines	1	5
4	**Gessi Bolognesi**	Management Authority for Parks and Biodiversity - Emilia Orientale	Area Ambiente e Biodiversità	4 graduates in technical-scientific disciplines 1 agricultural expert	5	1 humanities graduate	1	32
5a 5b 5c	**Vena del Gesso Romagnola**	Management Authority for Parks and Biodiversity - Romagna	Technical Office	1 forest graduate 1 geologist 2 naturalist graduates 1 worker	5	1 forest graduate 1 biologist	2	20
			Adiministrative Office	1 administrative graduate 2 accountants	3	1 administrative assistant	1	
6	**Evaporiti San Leo**	Management Authority for Parks and Biodiversity - Romagna	Technical Office	1 forest graduate 1 geologist 1 naturalist graduate 1 biologist 1 worker	5	1 forest graduate 1 biologist	2	5
			Adiministrative Office	1 administrative graduate 1 accountant	2	1 administrative assistant	1	
7	**Gessi di Onferno**	Management Authority for Parks and Biodiversity - Romagna	Technical Office	1 forest graduate 1 geologist 2 naturalist graduates 1 worker	5	1 forest graduate 1 biologist	2	5
			Adiministrative Office	1 administrative graduate 2 accountants	3	1 administrative assistant	1	
			TOTAL		**47**		**17**	**88**

Funding

n	c.s.	*institutions*	financial resources		annual current funding 2022		annual planned funding (for thee-years 2023-25)	
		regional / municipal / park authority	*department / division / office*	*level of funding sources*	*current expenditure*	*capital expenditure*	*current expenditure*	*capital expenditure*
1	**Alta Valle Secchia**	Appennino Tosco-Emiliano National Park	EU	european		€ 50 000		€ 70 000
			MASE	national	€ 20 000	€ 60 000	€ 130 000	€ 400 000
			RER	regional		€ 50 000	€ 50 000	€ 200 000
			Municipality	local	€ 15 000		€ 30 000	€ 30 000
2	**Bassa Collina Reggiana**	Management Authority for Parks and Biodiversity - Emilia Centrale	PNSP Collina Reggiana	regional/local	€ 5 000	€ 50 000	€ 20 000	€ 50 000
3	**Gessi di Zola Predosa**	Emilia-Romagna Regional Administration	RER	regional	€ 5 000	€ 30 000	€ 5 000	€ 30 000
4	**Gessi Bolognesi**	Management Authority for Parks and Biodiversity - Emilia Orientale	RER	regional	€ 90 000	€ 200 000	€ 270 000	€ 300 000
5a 5b 5c	**Vena del Gesso Romagnola**	Management Authority for Parks and Biodiversity - Romagna	RER	regional	€ 300 000	€ 75 000	€ 300 000	€ 90 000
			Municipality	local	€ 50 000	€ 25 000	€ 80 000	€ 50 000
6	**Evaporiti San Leo**	Management Authority for Parks and Biodiversity - Romagna	RER	regional			€ 10 000	
7	**Gessi di Onferno**	Management Authority for Parks and Biodiversity - Romagna	RER	regional	€ 50 000		€ 50 000	€ 50 000
			Municipality	local		€ 5 000		€ 5 000
	EKCNA Office	Emilia-Romagna Regional Administration	RER	regional			€ 50 000	
				TOTAL	**€ 535 000**	**€ 545 000**	**€ 995 000**	**€ 1 275 000**
				main source	€ 450 000	€ 405 000	€ 705 000	€ 720 000
			% of funding provided by the main source = Emilia-Romagna Region		84%	74%	71%	56%

The IUCN World Heritage technical evaluation mission to EKCNA was undertaken by Ms Gordana Beltram from 21 to 28 November 2022.

- *CS.4 , meeting at Museum L.Donini - Bologna, 27.11.2022- © Marco Pizziolo*
- *CS.5c, Marana former underground quarry - Brisighella, 24.11.2022- © Mauro Generali*
- *CS. 5b , Rio Basino cave - Borgo Rivola, 25.11.2022 © Cesare Micheletti*
- *CS. 6 , meeting at Pedrini Theatre - Brisighella, 24.11.2022 © Marco Pizziolo*

D. NUMBERS AND AREAS OF NOMINATED COMPONENT PARTS

7. Lastly, while the nomination dossier lists seven nominated component parts, the Panel has noted that nominated component part 5 is sub-divided into three separate nominated component parts. The serial nominated property therefore consists of nine separate nominated component parts. The Panel would thus be grateful if the State Party could please revise the list of nominated component parts accordingly, providing the names and areas (in ha) for each nominated component part

The numbering and naming of the component parts of the nominated serial property has been corrected in accordance with the operational guidelines. In particular, the three core areas of component part 5 have been renamed as follows:

- CS.5A "Vena del Gesso Romagnola-Monte Penzola",
- CS.5B "Vena del Gesso Romagnola-Monte del Casino",
- CS.5C "Vena del Gesso Romagnola-Monte Mauro".

This renaming makes it possible to keep the references in the text, tables and maps to the other component parts unaltered.

- *Nomination document (Identification) § 1.D p.11*
- *Executive Summary, p.3*

1.D GEOGRAPHICAL COORDINATES TO THE NEAREST SECOND

The geographical coordinates of the candidate Property, considered as a whole, are:

The entire nominated serial property	Latitude	Longitude
centroid	44° 13' 59" N	11° 27' 38" E
north-west vertex	44° 36' 09" N	10° 18' 53" E
south-eastern vertex	43° 51' 48" N	12° 36' 23" E

The coordinates of the centroid of each component site are as follows:

ID	Name of the component part	Latitude of the central point	Longitude of the central point	Area of nominated component part (ha)	Area of the Buffer Zone (ha)
c.s.1	Alta Valle Secchia	44° 21' 41" N	10° 23' 10" E	1596 ha	1294 ha
c.s.2	Bassa Collina Reggiana	44° 35' 06" N	10° 35' 56" E	274 ha	1385 ha
c.s.3	Gessi di Zola Predosa	44° 27' 40" N	11° 13' 13" E	57 ha	128 ha
c.s.4	Gessi Bolognesi	44° 26' 15" N	11° 24' 00" E	237 ha	325 ha
c.s.5a	Vena del Gesso Romagnola - M.te Penzola	44° 16' 44" N	11° 34' 22" E	70 ha	4775 ha
c.s.5b	Vena del Gesso Romagnola - M.te del Casino	44° 15' 49" N	11° 37' 56" E	281 ha	
c.s.5c	Vena del Gesso Romagnola - M.te Mauro	44° 14' 17" N	11° 42' 24" E	962 ha	
c.s.6	Evaporiti di San Leo	43° 55' 05" N	12° 20' 45" E	119 ha	165 ha
c.s.7	Gessi di Onferno	43° 52' 30" N	12° 32' 51" E	84 ha	276 ha
				3 680 ha	**8 348 ha**

- *Coordinate Reference System: International ellipsoid - World Geodetic System 1984 (WGS84, also called EPSG:4326). The values are expressed in sexagesimal degrees (degrees, minutes, seconds) rounded to the nearest second.*

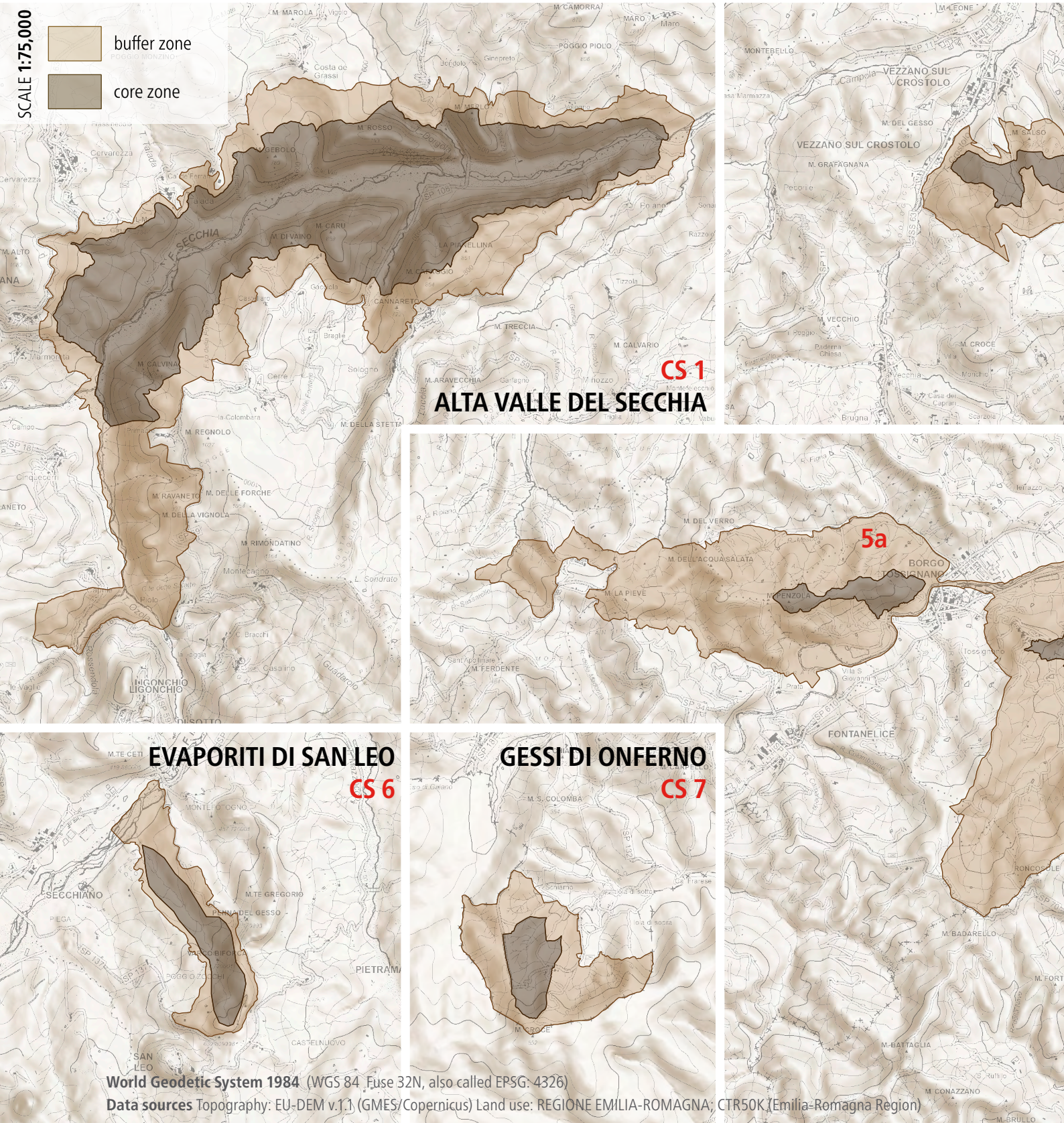
1.e Maps and plans, showing the boundaries of the nominated property and buffer zone

See detailed topographic maps of all component parts and their buffer zones in the Annex 1. The candidate area extends over a territory consisting of **9** component sites. It surrounds the entire straight ridge of evaporite outcrops that emerges on the northern slopes of the Apennines, from the "Vena del Gesso Romagnola" to the Secchia River Valley, which exposes, by erosion, some older evaporite deposits. The boundaries of the candidate Property extend also underground, to include the cavities produced by karst phenomena.

The boundaries take into account the extension of the whole karstic system, including the hydrogeological circulation and alimentation basin. A particular attention has been posed to include all the historical study areas, due to the relevance that these places had in the development of evaporite speleology, mineralogy and hydrogeology disciplines. All the major known caves in evaporites are included in the nominated property and are protected by Regional, National and International laws.

1.f Area of nominated property (ha.) and proposed buffer zone (ha.)

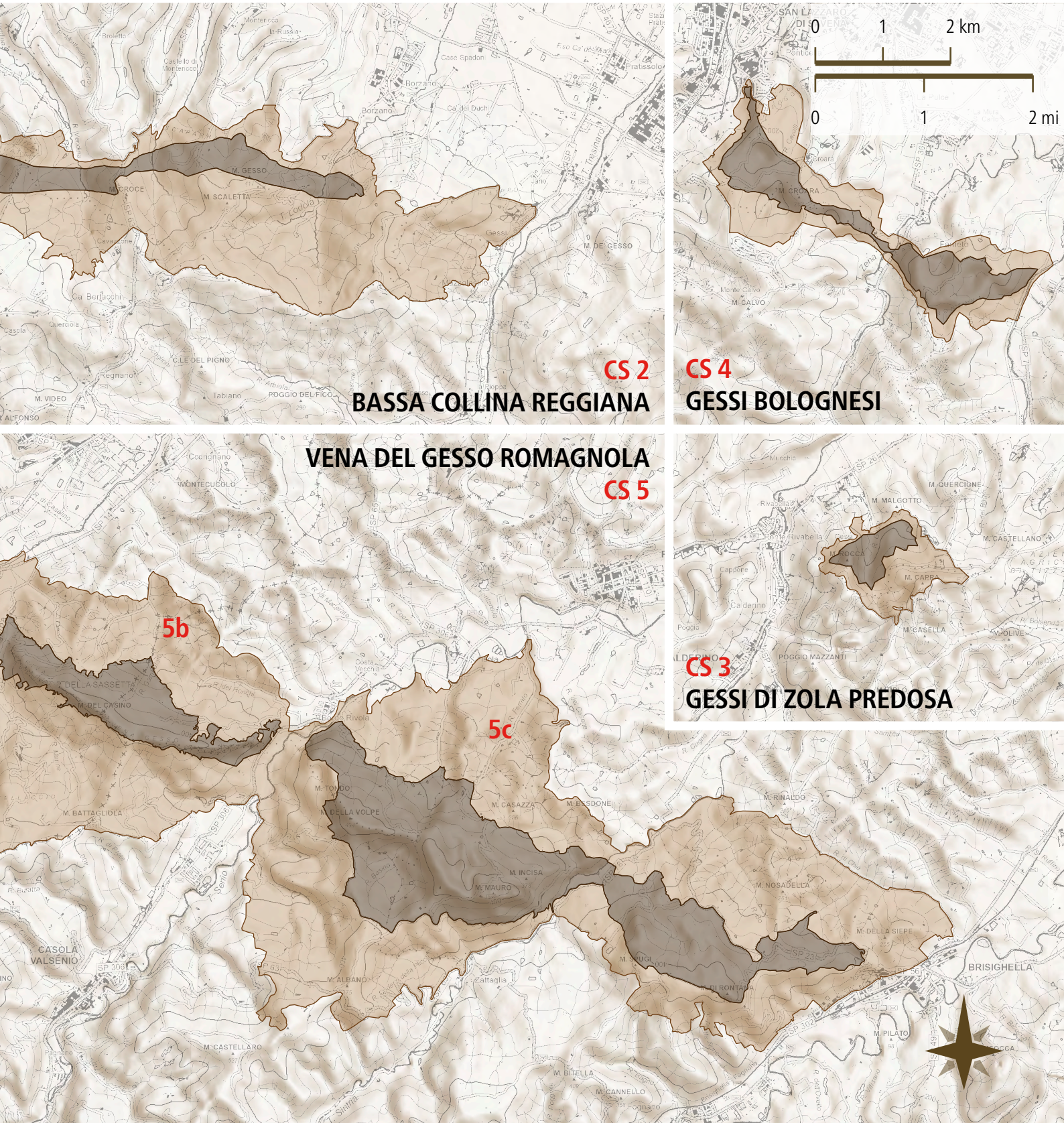
ID	Name of the component part	Area of nominated c.p. (ha)	Area of the Buffer Zone (ha)
c.s.1	Alta Valle del Secchia	1596,001	1292,320
c.s.2	Bassa Collina Reggiana	273,680	1384,753
c.s.3	Gessi di Zola Predosa	57,349	127,706
c.s.4	Gessi Bolognesi	237,225	325,109



World Geodetic System 1984 (WGS 84 Fuse 32N, also called EPSG: 4326)

Data sources Topography: EU-DEM v.1.1 (GMES/Copernicus) Land use: REGIONE EMILIA-ROMAGNA; CTR50K (Emilia-Romagna Region)

ID	Name of the component part	Area of nominated c.p. (ha)	Area of the Buffer Zone (ha)
c.s.5a	Vena del Gesso Romagnola - M.te Penzola	69,900	4774,837
c.s.5b	Vena del Gesso Romagnola - M.te del Casino	281,352	
c.s.5c	Vena del Gesso Romagnola - M.te Mauro	961,763	
c.s.6	Evaporiti di San Leo	119,350	164,990
c.s.7	Gessi di Onferno	84,460	276,126
	total surface	**3681,080**	**8345,841**



DATA & MAPS

Data

A. Comparative Analysis - Tables of quantitative data on:
   - Main geomorphological features in the karst system
   - Presence of large salt springs
   - Evolution of the karst system
   - Known speleothemes in the karst system
   - Known evaporite caves minerals
   - Minerogenetic mechanisms
   - Hydrogeology
   - Diapirism in the karst system
   - Significant post-depositional geological phenomena
   - Record of life
   - Current climate in the karst sites area (by Koeppen & Geiger, 2016)
   - World reference features
   - Age of the evaportite deposits

Maps

A. Index map

B. Maps of geo-attributes and protective designations
   - CS1 Alta Valle Secchia
   - CS2 Bassa Collina Reggiana
   - CS3 Gessi di Zola Predosa
   - CS4 Gessi Bolognesi
   - CS5 Vena del Gesso Romagnola (a. M.te Penzola, b. M.te del Casino, c. M.te Mauro)
   - CS6 Evaporiti di San Leo
   - CS7 Gessi di Onferno

C. Maps of prohibited activities
   - CS1 Alta Valle Secchia
   - CS2 Bassa Collina Reggiana
   - CS3 Gessi di Zola Predosa
   - CS4 Gessi Bolognesi
   - CS5 Vena del Gesso Romagnola (a. M.te Penzola, b. M.te del Casino, c. M.te Mauro)
   - CS6 Evaporiti di San Leo
   - CS7 Gessi di Onferno

MAIN GEOMORPHOLOGICAL FEATURES IN THE KARST SYSTEM	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world													
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
DOLINE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
KARREN	1	1		1	1	1	1	1	1				1	1					1	1	1
KARRENFIELD																				1	dd
SINKING STREAM				1	1	1	1	1	1				1	1			1			dd	dd
PONOR																				dd	dd
KARST SPRING	1	1	1	1	1	1	1	1	1	1		1	1	1				1		1	1
INTERMITTENT SPRING				1		1	1	1					1	1		1				dd	dd
SWALLOW HOLE				1	1	1	1	1	1		1	1	1	1			1	1	1	1	1
EPIKARST				1	1			1	1										1	dd	dd
SHAFT				1	1			1	1	1		1	1	1		1	1	1	1	dd	dd
SOLUTION POCKET																				dd	dd
SCALLOPS	1	1		1	1	1	1	1					1	1			1			dd	dd
RIVER CANYON (ON SURFACE)					1			1					1							dd	dd
STEEPHEAD/BLIND VALLEY	1			1	1	1	1	1	1	1		1	1	1		1	1			1	1
CANDLES (GYPSUM PINNACLES)				1	1			1					1							1	1
EXTERNAL GYPSUM FLOWERS				1				1											1	dd	dd
TUMULUS				1	1			1	1				1							1	dd
ROOFLESS CAVES					1	1	1	1												dd	dd
LARGE COLLAPSE ROOM	1			1				1					1		1		1			dd	
INTERBED GALLERY				1	1	1	1	1	1				1							dd	dd
MAMELONS (MAMMELLONI)				1	1	1	1	1					1							dd	
GYPSUM AND ANHYDRITE PROTRUSIONS	1							1												dd	dd
NUMBER OF FORMS	7	4	2	16	15	11	11	19	10	4	2	5	15	9	2	4	7	4	6	8	6
REPRESENTATIVENESS	32%	18%	9%	73%	68%	50%	50%	86%	45%	18%	9%	23%	68%	41%	9%	18%	32%	18%	27%	36%	27%

dd = data deficient

PRESENCE OF LARGE SALT SPRINGS	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world													
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
SALT SPRINGS	1							1												1	1
PRESENCE OF SALT SPRINGS	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1

EVOLUTION OF THE KARST SYSTEM		Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world														
tipology	description	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
INTRASTRATAL EVAPORITE KARST	After burial by younger sediments, karstification in evaporites may be initiated at any of the stages of intrastratal development, particularly at some stage en route back to the surface. Where poorly permeable clays or shales surround evaporites in a stratified sequence, intrastratal karst may not develop at all, and any considerable karstification will not commence until the soluble unit is exposed to the surface. The entire sequence of intrastratal karst types includes deep-seated karst, subjacent karst, and entrenched karst. They differ according to the degree to which the evaporite units are covered by overlying rocks, and hence according to the hydrogeological setting											1	1										
DEEP-SEATED EVAPORITE KARST	Deep-seated karst is not evident at the surface, and the soluble rock is not exposed. Its development is favoured where the evaporite units are sandwiched between or intercalated with carbonate or siliciclastic aquifers (Klimchouk, 2000). Dissolution may be initiated by two different hydrogeological mechanisms. In the first, transverse hydraulic communication, usually ascending, across a gypsum unit, is established between the two surrounding aquifers, giving rise to maze cave patterns, provided that the proper structural prerequisites exist.												1										
EPIGENIC ACTIVE EVAPORITE KARST	Active dissolution of evaporite rocks by infiltrating waters	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1
EPIGENIC PALEO KARST	Ancient inactive karst conduits now exposed at the surface or in underground mines, filled with sediments and locally reemptied by recent infiltration waters			1		1			1														
KARST IN ALABASTRINE GYPSUM	Active dissolution of alabastrine gypsum after anhydrite formed at the expenses of selenite rocks by burial diagenesis						1	1	1														1
KARST IN CAP ROCK-LIKE SULFATE	Active dissolution of residual sulfate rocks formed by halite dissolution	1							1											1			1
KARST IN CLASTIC GYPSUM ROCKS	Active dissolution of clastic gypsum rocks formed by turbidite and mass-flow processes						1	1	1		1												1
MAJOR EVOLUTION BY ROCK FALL AND COLLAPSE	Evolution of caves is strongly influenced by collapse structures and rock fall because of the strong tectonic deformation of the host evaporite rock	1							1														1
KARST INFLUENCED BY MINERALOGY AND HYDRATION PROCESSES	The development of karst conduits is restricted to areas where anydrite is actively hydrated to form gypsum	1							1														1
	NUMBER OF TYPOLOGIES	4	1	2	1	2	3	3	7	1	2	1	2	1	1	1	1	1	1	2	1	6
	REPRESENTATIVENESS	44%	11%	22%	11%	22%	33%	33%	78%	11%	22%	11%	22%	11%	11%	11%	11%	11%	11%	22%	11%	67%

KNOWN SPELEOTHEMES IN THE KARST SYSTEM	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world													
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
ANTHODITES (GYPSUM)				1	1			1	1		1		1							dd	dd
ANTIGRAVITATIVE TUBULARS															1					dd	dd
ANTHROPOGENIC MICROCRYSTAL AGGREGATES (GYPSUM)				1	1	1	1	1	1											dd	dd
BALLS (GYPSUM)													1							dd	dd
BIOGENIC FLOWSTONE										1										dd	dd
BOXWORK					1			1												dd	dd
CAVE BUBBLES /EMI-BUBBLES					1			1		1										dd	dd
CALCITE BLADES				1	1			1	1										1	dd	dd
CAVE PEARLS (CALCITE)			1	1	1			1												dd	dd
COATINGS	1			1	1	1	1	1												dd	dd
COINS (GYPSUM)					1			1												dd	dd
COLUMNS (CALCITE)				1	1	1	1	1												dd	dd
CONULITES				1	1			1												dd	dd
CORALLOIDS				1	1	1	1	1	1	1			1		1	1		1		dd	dd
CHRISTMAS TREE (CALCITE-GYPSUM)																	1			dd	dd
CRUSTS				1	1			1												dd	dd
DEFLECTED STALACTITES				1				1									1			dd	dd
DRAPERIES				1	1			1												dd	dd
EPITAXIAL GYPSUM CRYSTALS					1			1	1											dd	dd
FIBROUS SPELEOTHEMS			1	1	1			1												dd	dd
FIR (GYPSUM)													1							dd	dd
FLOWSTONE (CALCITE)	1	1	1	1	1	1	1	1	1	1										dd	dd
FLOWERS (GYPSUM)		1	1	1	1			1	1											dd	dd
FOLIA																				dd	dd
HELICTITES									1											dd	dd
HOLLOW STALAGMITES													1				1			dd	dd
LEATHER (GYPSUM)												1								dd	dd
MEGACRYSTALS (GYPSUM)			1	1	1			1	1											dd	dd
MICROCRYSTAL OVERGROWTH ALONG MAIN EXFOLIANTION PLANES (GYPSUM)			1	1	1			1	1		1		1							dd	dd
MOONMILK				1				1												dd	dd
MUD CRACKS				1	1			1												dd	dd
POOL FINGERS (CALCITE)					1			1												dd	dd
PORCUPINE (GYPSUM)														1						dd	dd
POWDER												1					1		1	dd	dd
CAVE RAFTS (CALCITE/GYPSUM)				1	1			1												dd	dd
RIMS					1			1	1											dd	dd
RIMSTONE DAMS	1		1	1	1			1	1	1										dd	dd
ROOTSICLES				1				1	1				1							dd	dd
ROSES (GYPSUM)			1	1	1			1												dd	dd
SERICOLITE			1	1	1			1												dd	dd
SHOWERHEADS													1							dd	dd
SPLASH DEPOSITS	1		1	1	1	1	1	1	1											dd	dd
STALACTITES			1	1	1	1	1	1	1				1							dd	dd
STALAGMITES			1	1	1			1	1				1							dd	dd
TOWER CONES					1			1												dd	dd
TRAYS				1				1												dd	dd
NUMBER OF SPELEOTHEMES	4	2	12	27	30	7	7	34	16	5	2	2	10	1	2	1	4	1	2	0	0
REPRESENTATIVENESS	9%	4%	26%	59%	65%	15%	15%	74%	35%	11%	4%	4%	22%	2%	4%	2%	9%	2%	4%	0%	0%

dd = data deficient

KNOWN EVAPORITE CAVES MINERALS	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world													
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
ANHYDRITE				1				1				1								dd	dd
ARAGONITE															1					dd	dd
ASBOLANE											1									dd	dd
BASSANITE																			1	dd	dd
BIRNESSITE																				dd	dd
BLÖDITE															1					dd	dd
BROCHANTITE	1							1												dd	dd
BRUSHITE				1				1												dd	dd
BUSERITE															1					dd	dd
CALCITE	1				1	1	1	1		1	1	1								dd	dd
CELESTITE										1					1					dd	dd
CHALCEDONY															1					dd	dd
CHLOROMAGNESITE				1				1												dd	dd
CLINOCHLORE	1							1												dd	dd
DEVILLINE	1							1												dd	dd
DOLOMITE				1				1			1	1			1					dd	dd
EPSOMITE				1				1												dd	dd
FLUORAPATITE									1											dd	dd
GAYLUSSITE											1				1					dd	dd
GLAUBERITE																				dd	dd
GOETHITE				1				1							1					dd	dd
GYPSUM	1	1	1	1		1	1	1	1		1	1		1	1		1	1		dd	dd
HALITE											1				1					dd	dd
HEMATITE				1				1												dd	dd
HOWLITE															1					dd	dd
HYDROXYLAPATITE									1											dd	dd
ICE	1			1				1			1			1	1					dd	dd
INDERITE																				dd	dd
INYOITE															1					dd	dd
JAROSITE											1									dd	dd
LEPIDOCROCITE				1				1												dd	dd
LIMONITE				1				1												dd	dd
MAGNESITE	1							1												dd	dd
MIRABILITE				1				1							1					dd	dd
OPAL	1			1				1												dd	dd
QUARTZ					1			1												dd	dd
RHODOCHROSITE											1									dd	dd
ROMANECITE											1									dd	dd
SULFUR					1	1	1	1	1	1										dd	dd
SYLVITE																1				dd	dd
THENARDITE														1						dd	dd
ULEXITE															1					dd	dd
AL-OXIDES (UNDIFFERENTIATED)										1										dd	dd
FE-OXIDES/HYDROXIDES (UNDIFFERENTIATED)	1		1	1	1			1		1	1									dd	dd
MN-OXIDES (UNDIFFERENTIATED)	1			1				1			1				1					dd	dd
NUMBER OF MINERALS	10	1	2	15	4	3	3	22	4	5	12	4	0	3	16	1	1	1	1	0	0
REPRESENTATIVENESS	22%	2%	4%	33%	9%	7%	7%	49%	9%	11%	27%	9%	0%	7%	36%	2%	2%	2%	2%	0%	0%

dd = data deficient

MINEROGENETIC MECHANISMS	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world												
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
EVAPORATION	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1
HYDRATION	1							1				1								dd	dd
DEHYDRATION	1							1											1	dd	dd
INCONGRUENT DISSOLUTION		1	1	1	1			1	1	1			1					1	1	dd	dd
REDOX REACTIONS	1		1	1	1	1	1	1	1	1	1		1		1					dd	dd
SEGREGATION														1	1					dd	dd
FREEZING	1			1				1						1	1					dd	dd
LISCIVIATION	1			1				1		1						1				dd	dd
ANTROPOGENIC PROCESSES				1				1												dd	dd
NUMBER OF MINEROGENETIC MECHANISMS	6	2	3	6	3	2	2	8	3	4	2	2	3	2	4	2	1	1	3	1	1
REPRESENTATIVENESS	67%	22%	33%	67%	33%	22%	22%	89%	33%	44%	22%	22%	33%	22%	44%	22%	11%	11%	33%	11%	11%

dd = data deficient

HYDROGEOLOGY	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world												
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
HYPOGEAN BENDS	1							1													dd
ANTIGRAVITATIVE GALLERIES			1	1	1			1	1	1			1							dd	dd
SUBMERGED CONDUIT				1	1			1	1		1	1							1	dd	dd
UNDERGROUND CANYON	1	1	1	1	1	1	1	1	1	1			1	1		1	1	1		dd	dd
NUMBER OF HYDROGEOLOGIC PHENOMENA	2	1	2	3	3	1	1	4	3	2	1	1	2	1	0	1	1	1	1	0	0
REPRESENTATIVENESS	50%	25%	50%	75%	75%	25%	25%	100%	75%	50%	25%	25%	50%	25%	0%	25%	25%	25%	25%	0%	0%

dd = data deficient

DIAPIRISM IN THE KARST SYSTEM	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world												
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
DIAPIR	1							1											1		1
PRESENCE OF DIAPIRS	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1

SIGNIFICANT POST-DEPOSITIONAL GEOLOGICAL PHENOMENA	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world												
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
SIGNIFICANT POST-DEPOSITIONAL GEOLOGICAL PHENOMENA				1				1		1		1								1	1
NUMBER OF PHENOMENA	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	1

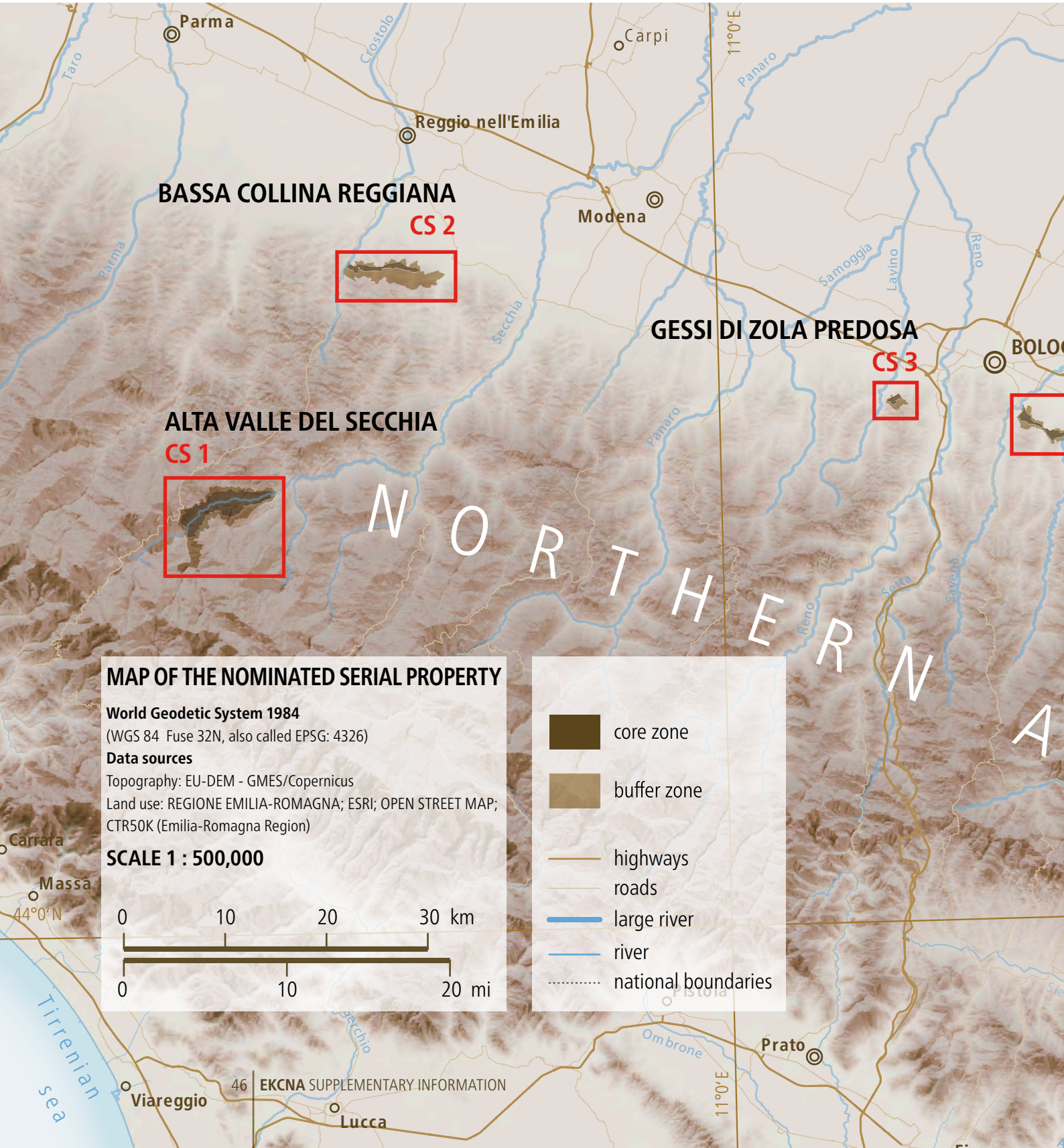
RECORD OF LIFE	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world												
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
SYN-DEPOSITIONAL PALAEONTOLOGY					1			1													
POST-DEPOSITIONAL PALAEONTOLOGY				1				1													
FEATURES DESCRIBED FOR THE FIRST TIME	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ONE-OF-ITS-KIND FEATURES	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

CURRENT CLIMATE IN THE KARST SITES AREA (by Koeppen & Geiger, 2016)			Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world														
ID	TYPOLOGY	DESCRIPTION	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
Af	TROPICAL	TROPICAL RAINFOREST CLIMATE																					
Am	TROPICAL	TROPICAL MONSOON CLIMATE																					
As	TROPICAL	TROPICAL WET AND DRY																					
Aw	TROPICAL	SAVANNE																			1		
BSh	DRY	HOT SEMI-ARID CLIMATE																					
BSk	DRY	COLD SEMI-ARID CLIMATE													1				1				
BWh	DRY	HOT DESERT CLIMATE																					
BWk	DRY	COLD DESERT CLIMATE																		1			
Cfa	TEMPERATE	HUMID SUBTROPICAL CLIMATE		1	1	1	1	1	1	1													
Cfb	TEMPERATE	TEMPERATE OCEANIC CLIMATE											1	1									
Cfc	TEMPERATE	SUBPOLAR OCEANIC CLIMATE																					
Csa	TEMPERATE	HOT-SUMMER MEDITERRANEAN CLIMATE									1	1						1				1	
Csb	TEMPERATE	WARM-SUMMER MEDITERRANEAN CLIMATE	1							1													
Csc	TEMPERATE	COLD-SUMMER MEDITERRANEAN CLIMATE																					
Cwa	TEMPERATE	MONSOON-INFLUENCED HUMID SUBTROPICAL CLIMATE																					
Cwb	TEMPERATE	SUBTROPICAL HIGHLAND CLIMATE																					
Cwc	TEMPERATE	COLD SUBTROPICAL HIGHLAND CLIMATE																					
Dfa	CONTINENTAL	HOT-SUMMER HUMID CONTINENTAL CLIMATE																					
Dfb	CONTINENTAL	WARM-SUMMER HUMID CONTINENTAL CLIMATE											1				1						
Dfc	CONTINENTAL	SUBARCTIC CLIMATE														1							
Dfd	CONTINENTAL	EXTREMELY COLD SUBARCTIC CLIMATE																					
Dsa	CONTINENTAL	MEDITERRANEAN-INFLUENCED HOT-SUMMER HUMID CONTINENTAL																					
Dsb	CONTINENTAL	MEDITERRANEAN-INFLUENCED WARM-SUMMER HUMID CONTINENTAL																					1
Dsc	CONTINENTAL	MEDITERRANEAN-INFLUENCED SUBARCTIC CLIMATE																					
Dsd	CONTINENTAL	MEDITERRANEAN-INFLUENCED EXTREMELY COLD SUBARCTIC CLIMATE																					
Dwa	CONTINENTAL	MONSOON-INFLUENCED HOT-SUMMER HUMID CONTINENTAL CLIMATE																					
Dwb	CONTINENTAL	MONSOON-INFLUENCED WARM-SUMMER HUMID CONTINENTAL CLIMATE																					
Dwc	CONTINENTAL	MONSOON-INFLUENCED SUBARCTIC CLIMATE																					
Dwd	CONTINENTAL	MONSOON-INFLUENCED EXTREMELY COLD SUBARCTIC CLIMATE																					
EF	POLAR AND ALPINE	TUNDRA CLIMATE																					
ET	POLAR AND ALPINE	ICE CAP CLIMATE																					

NUMBER OF CLIMATE ZONES	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	
Representativeness of tropical climates																						25%		
Representativeness of dry climates														25%				25%	25%					
Representativeness of temperate climates	11%	11%	11%	11%	11%	11%	11%	22%	11%	11%	11%	11%					11%					11%		
Representativeness of continental climates											8%				8%	8%								8%
Representativeness of polar and alpine climates																								
GLOBAL REPRESENTATIVENESS	3%	3%	3%	3%	3%	3%	3%	6%	3%	3%	6%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%

WORD REFERENCE FEATURES	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world														
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS BASIN
FEATURES DESCRIBED FOR THE FIRST TIME	3	0	2	16	2	0	0	23	1	1	1	0	2	0	0	0	2	0	1	0	0
ONE-OF-ITS-KIND FEATURES	5	0	1	4	5	1	1	17	1	2	1	2	1	1	5	0	1	2	0	0	0
FEATURES DESCRIBED FOR THE FIRST TIME	3	0	2	16	2	0	0	23	1	1	1	0	2	0	0	0	2	0	1	0	0
ONE-OF-ITS-KIND FEATURES	5	0	1	4	5	1	1	17	1	2	1	2	1	1	5	0	1	2	0	0	0

AGE OF THE EVAPORITE DEPOSITS	Comparative Analysis - Internal among the c.s. of the serial property							Comparative Analysis - External among the sites all over the world														
	C.S.1 - ALTA VALLE SECCHIA	C.S.2 - BASSA COLLINA REGGIANA	C.S.3 - GESSI DI ZOLA PREDOSA	C.S.4 - GESSI BOLOGNESI	C.S.5a,b,c - VENA DEL GESSO ROMAGNOLA	C.S.6 - EVAPORITI DI SAN LEO	C.S.7 - GESSI DI ONFERNO	EVAPORITIC KARST AND CAVES OF NORTHERN APENNINES	SANTA NINFA - SICILY - ITALY	VERZINO - CALABRIA - ITALY	PODOLIA - UKRAINE	HARZ - CENTRAL GERMANY	SORBAS - SPAIN	PINEGA - RUSSIA	KUNGUR - RUSSIA	DARHEDI (BIR AL GANHAM) - ALGERIA	NEW MEXICO - USA	NEUQUÉN - ARGENTINA	PUNTA ALEGRE - CUBA	KAVAJA - ALBANIA	SIVAS - TURKEY
HOLOCENE																					
PLEISTOCENE																					
PLIOCENE																					
MIOCENE		1	1	1	1	1	1	1	1	1	1		1			1				1	1
OLIGOCENE																					1
EOCENE																					1
PALEOCENE																					
CRETACEOUS																					
JURASSIC																		1	1		
TRIASSIC	1							1				1			1						
PERMIAN												1		1			1				
CARBONIFEROUS																					
DEVONIAN																					
SILURIAN																					
ORDOVICIAN																					
CAMBRIAN																					
PROTEROZOIC																					
ARCHEAN																					
NUMBER OF GEOLOGIC PERIODS	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	3
REPRESENTATIVENESS	6%	6%	6%	6%	6%	6%	6%	11%	6%	6%	6%	11%	6%	6%	6%	6%	6%	6%	6%	6%	17%


Parma
Carpi
Reggio nell'Emilia
Modena
BASSA COLLINA REGGIANA
CS 2
GESSI DI ZOLA PREDOSA
CS 3
ALTA VALLE DEL SECCHIA
CS 1
NORTHERN
Taro
Crostolo
Parma
Secchia
Panaro
Samoggia
Lavino
Reno
Setta
Savena
11°0'E
Carrara
Massa
44°0'N
Tirrenian sea
Viareggio
Lucca
Pistoia
Ombrone
Prato
MAP OF THE NOMINATED SERIAL PROPERTY
World Geodetic System 1984
(WGS 84 Fuse 32N, also called EPSG: 4326)
Data sources
Topography: EU-DEM - GMES/Copernicus
Land use: REGIONE EMILIA-ROMAGNA; ESRI; OPEN STREET MAP; CTR50K (Emilia-Romagna Region)
SCALE 1 : 500,000
0 10 20 30 km
0 10 20 mi
core zone
buffer zone
highways
roads
large river
river
national boundaries


12°0'E
Reno
Idice
Sillaro
Reno
Lamone
Senio
GNA
GESSI BOLOGNESI
CS 4
Ravenna
Imola
VENA DEL GESSO ROMAGNOLA
CS 5
Faenza
Montone
Ronco
Savio
Adriatic sea
5a
5b
5c
Forlì
Cesena
PENNINES
Rimini
Rubicone
Marecchia
44°0'N
EVAPORITI DI SAN LEO
CS 6
San Marino
Conca
Savio
CS 7
GESSI DI ONFERNO
12°30'E
Foglia

Maps of the key geo-attributes and the protective designations

Printed maps previews for reference only.
Please view them at full scale from the PDF file available in the DVD or online at link:
https://regioneer.it/EKCNA-additional-information

*To query the maps, it is necessary to download and open the PDF files with **Acrobat Reader DC** since it is the only software capable to show the layers individually, and to switch them off when necessary.*

If the PDF is opened in a web browser or using a preview application, the layers may be hidden or merged together.

Nominated Property boundaries

- Component Sites boundaries
- Buffer zones

Protective designations

- Natura 2000 protected areas
- National Park
- Regional Park
- Regional Reserve
- Geosites
- Protected Landscape
- Legislative decree n.42/2004, Art. 136

Caves

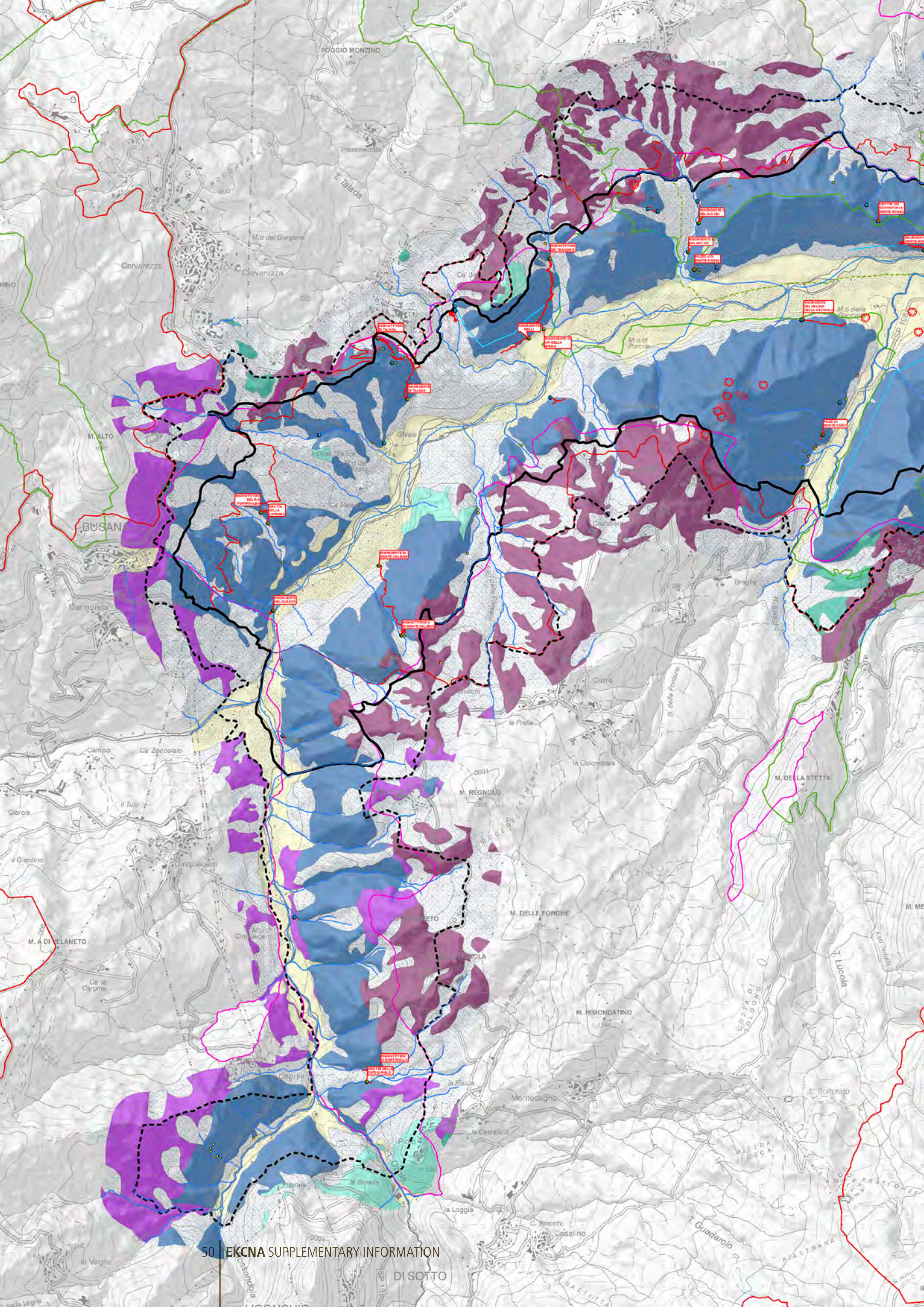
- caves of maximum importance
- caves of maximum speleological importance
- caves of medium speleological importance
- caves of modest importance, occluded or destroyed
- caves extensions

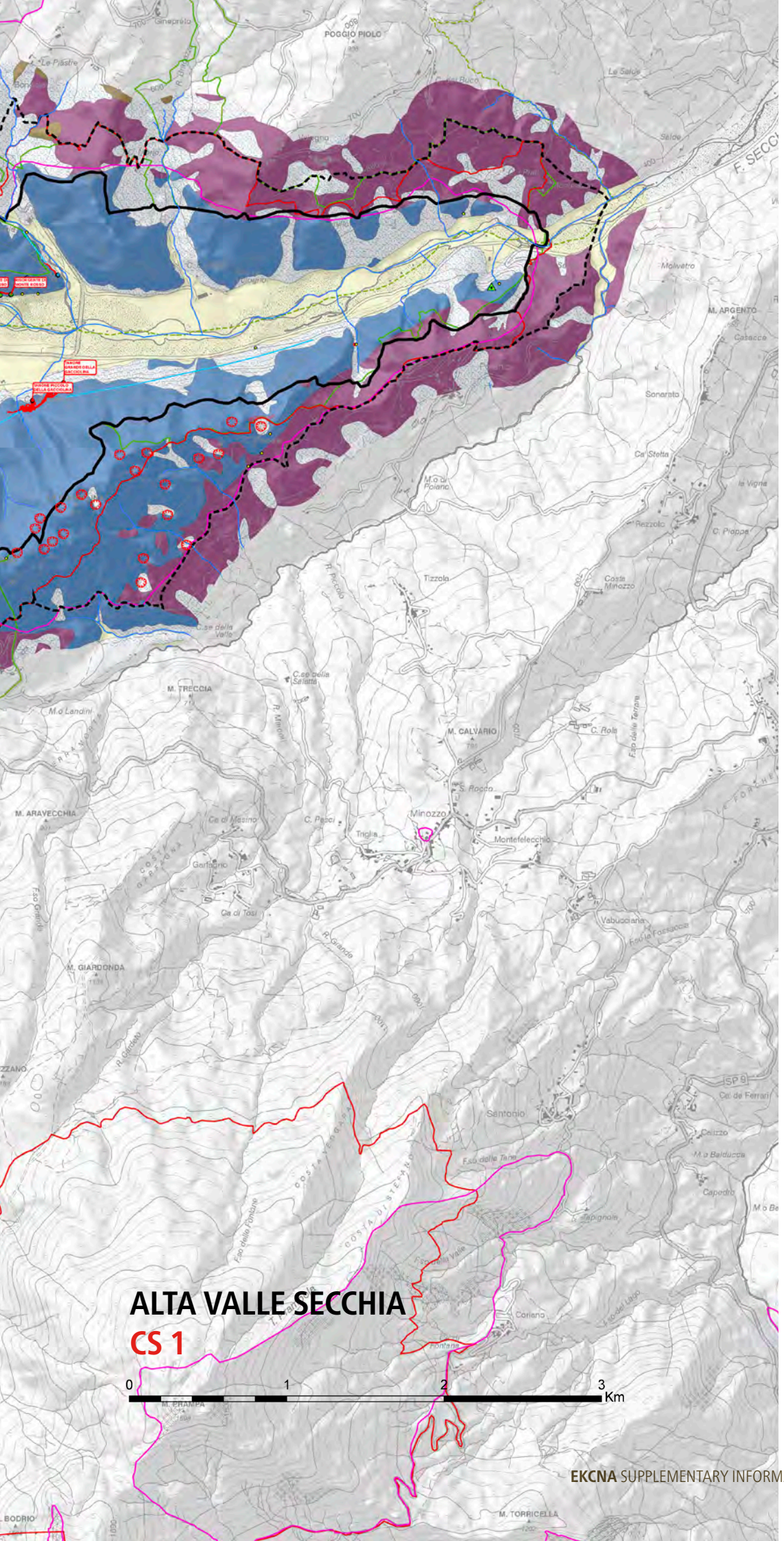
Geological and speleological features

- salt springs
- surface hydrography
- hypogean water flow
- dolines

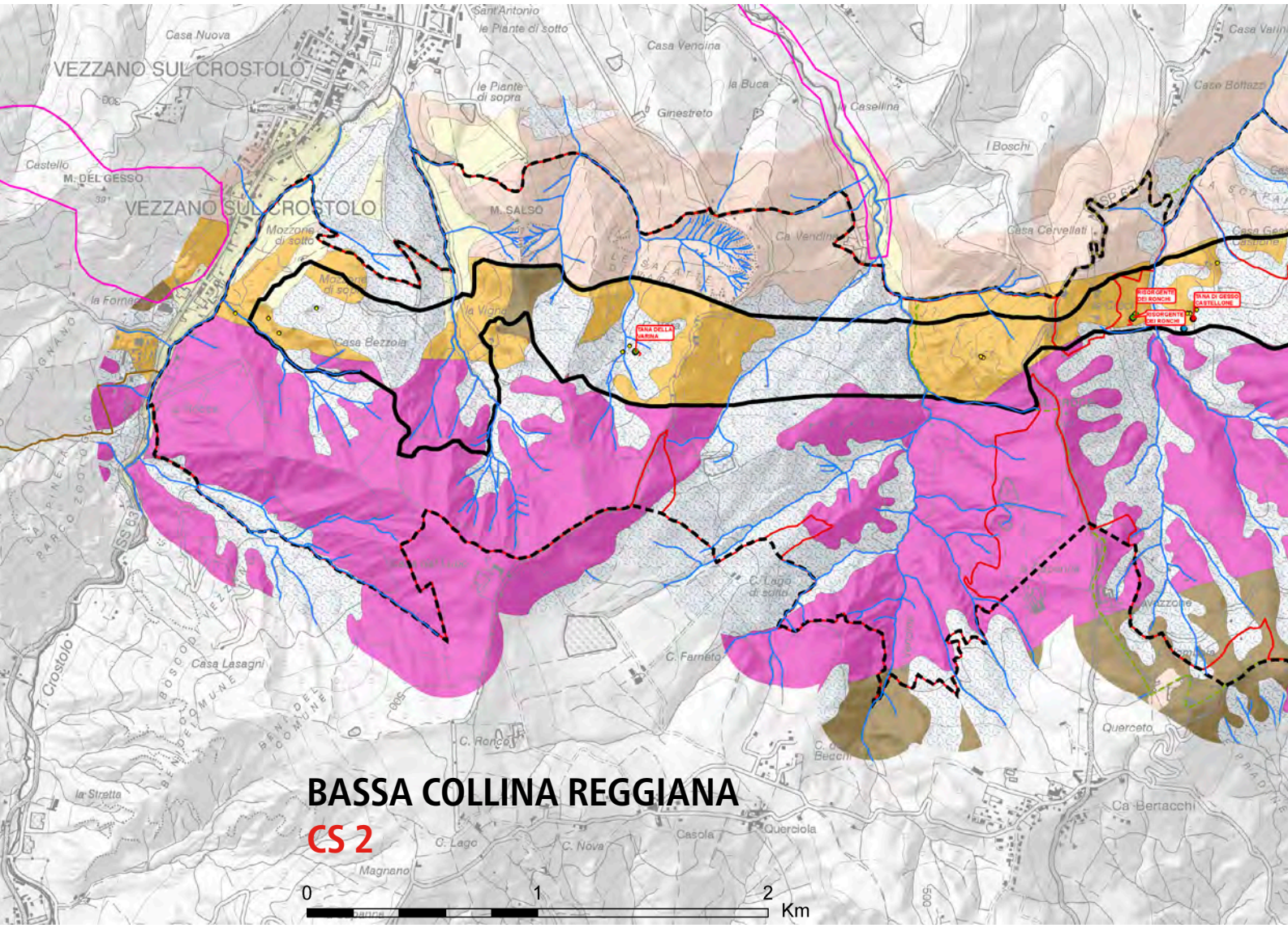
Geological units

- Continental deposits from the Quaternary
- Slope deposits
- External Ligurian Domain - Internal succession
  Classical Helmintoides calcareous flysch deposits, containing ophiolitic breccias and huge ophiolitic olistostromes. Age: Cretaceous to Middle Eocene
- External Ligurian Domain - External succession
  Ophiolitic breccias, pelagic limestones and shales, turbidite calcarenites, marlstones and marly limestones. Age: Cretaceous to Middle Eocene
- Subligurian Domain
  Transitional domain, between the continental Apulia microplate and the oceanic Ligurian Basin
- Tuscan Domain - Cervarola Unit
  The continental margin of the Apulia microplate: Shales, limestones and volcanic-bearing turbidite sandstones and conglomerates. Age: Paleocene to Oligocene
- Umbro-Marchean-Romagnan Domain
  The outermost of the orogenic wedge. They lie below the Tuscan units, are less deformed and non-metamorphic; They consist mainly of calcareous- marly sediments, hemipelagic marls, siliciclastic turbidites. Age: Late Triassic-early Messinian
- Umbro-Marchean-Romagnan Domain
  The outermost of the orogenic wedge. They lie below the Tuscan units, are less deformed and non-metamorphic; They consist mainly of calcareous- marly sediments, hemipelagic marls, siliciclastic turbidites. Age: Late Triassic-early Messinian
- Apenninic Epiligurian Succession (pre-evaporitic)
  Sedimentary succession that non-conformably covers only the Ligurian Units
- Gypsum and clay. Messinian Mediterranean evaporitic phase
- Post-evaporitic reworked gypsum, gypsarenite, dolomite-limestones, bituminous clays
- Post-evaporitic conglomerates, sandstones, clays, breccias. Pliocene-Pleistocene
- Thrust-slices with Ligurian affinity
- Shear zones with cataclastic dolomite, limestone, gypsum and anhydrite, shales, amphibolites, quartzites


POGGIO MONZINO
Frassinedolo
T. Talada
M.te del Gorgone
Cervarezza
M. ALTO
BUSANA
Marmoreto
Campo
Ca' Zoccolaio
Giarola
Il Tuto
il Giardino
Cinquecerri
M. A DI VELANETO
Ca' la Carpine
Coprile
M. REGNOLO
M. DELLE FORCHE
M. RIMONDATINO
M. DELLA STETTA
Corre
le Pralle
la Colombara
R. delle Fontane
Brugna
la Piezza
Montecagno
la Castellina
la Loggia
C. Brecchi
Casalino
T. Guadarolo
T. Lucola
PIETRA TOSCA
DI SOTTO
le Vaglie
SP 19

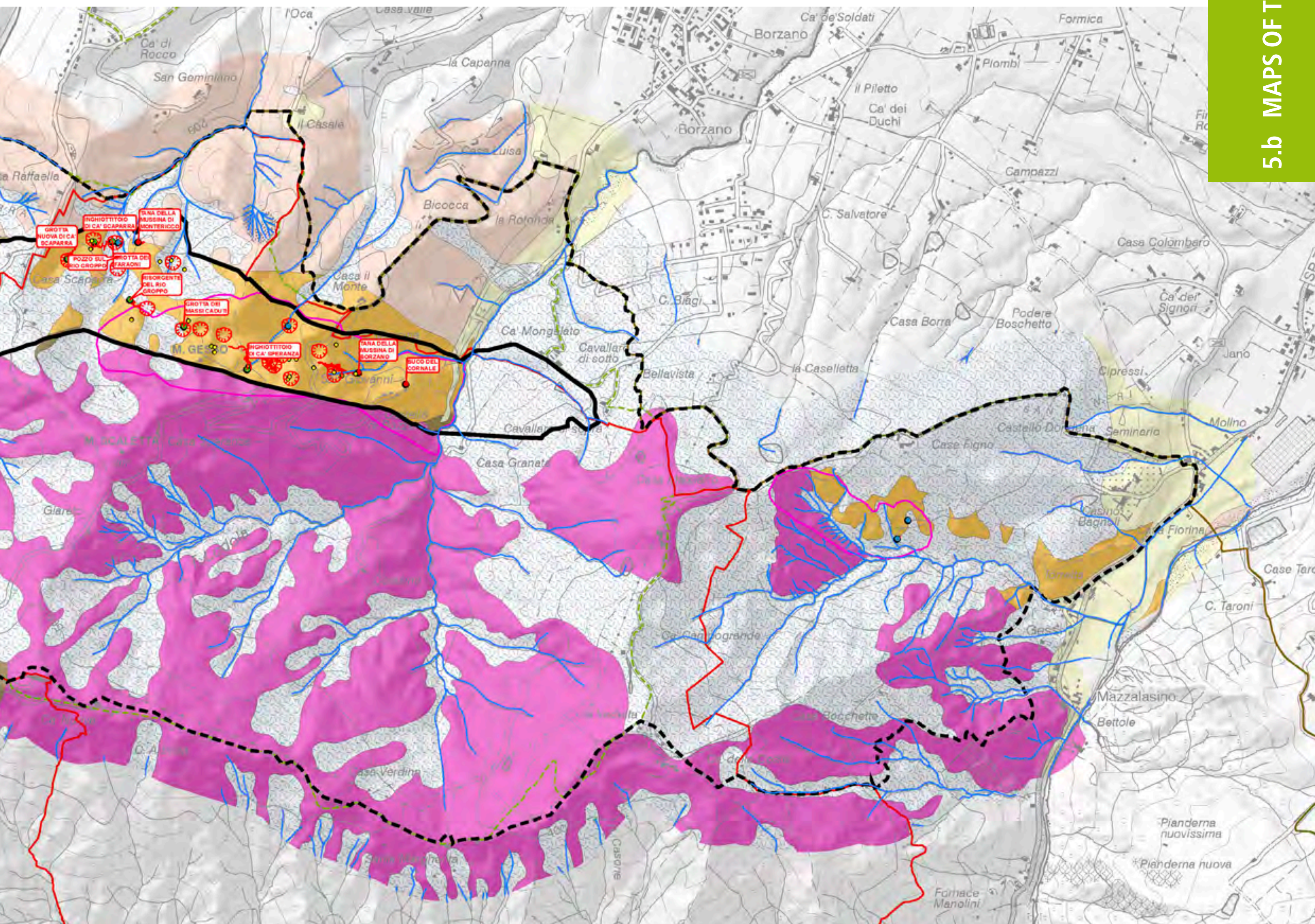


ALTA VALLE SECCHIA
CS 1

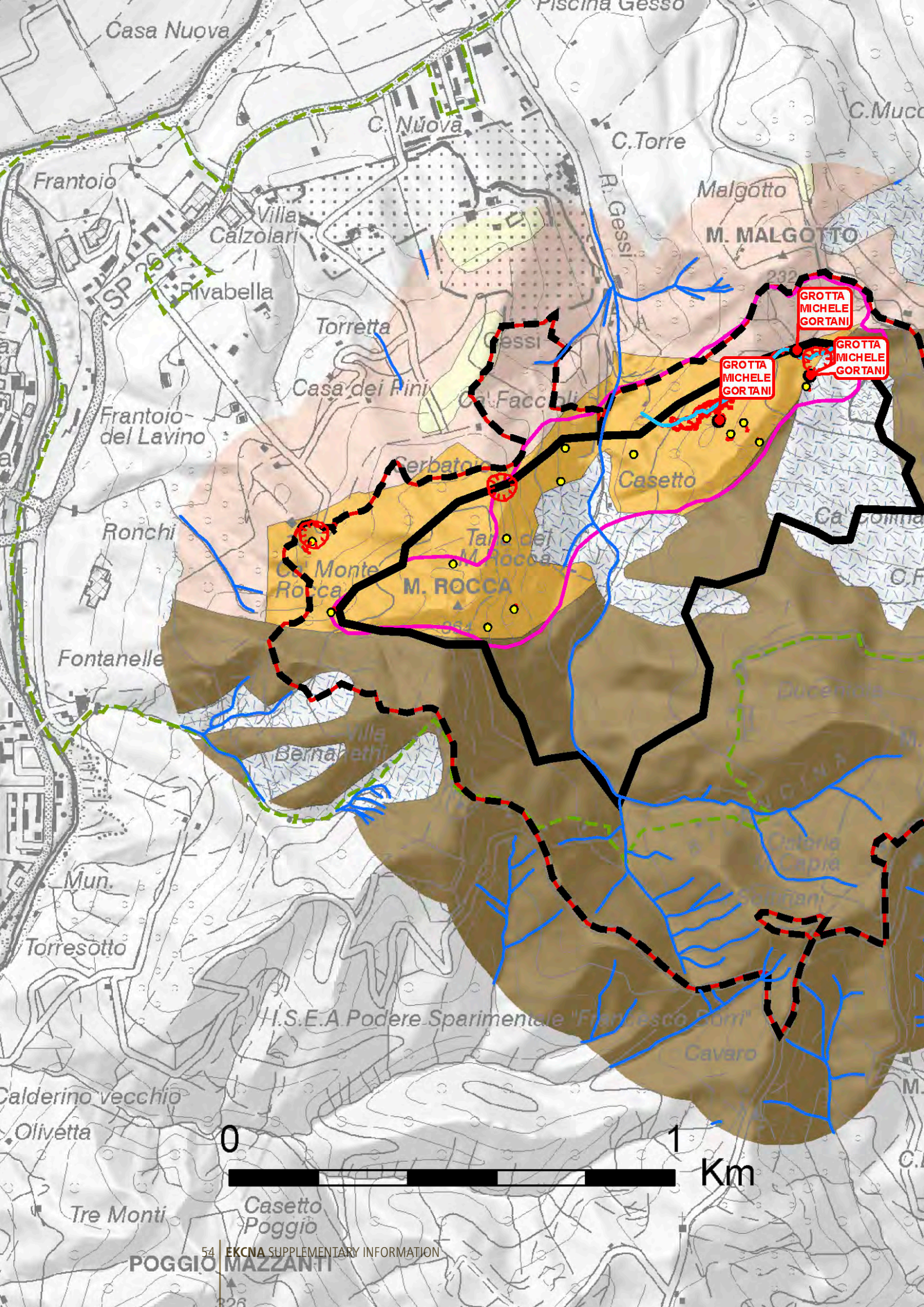


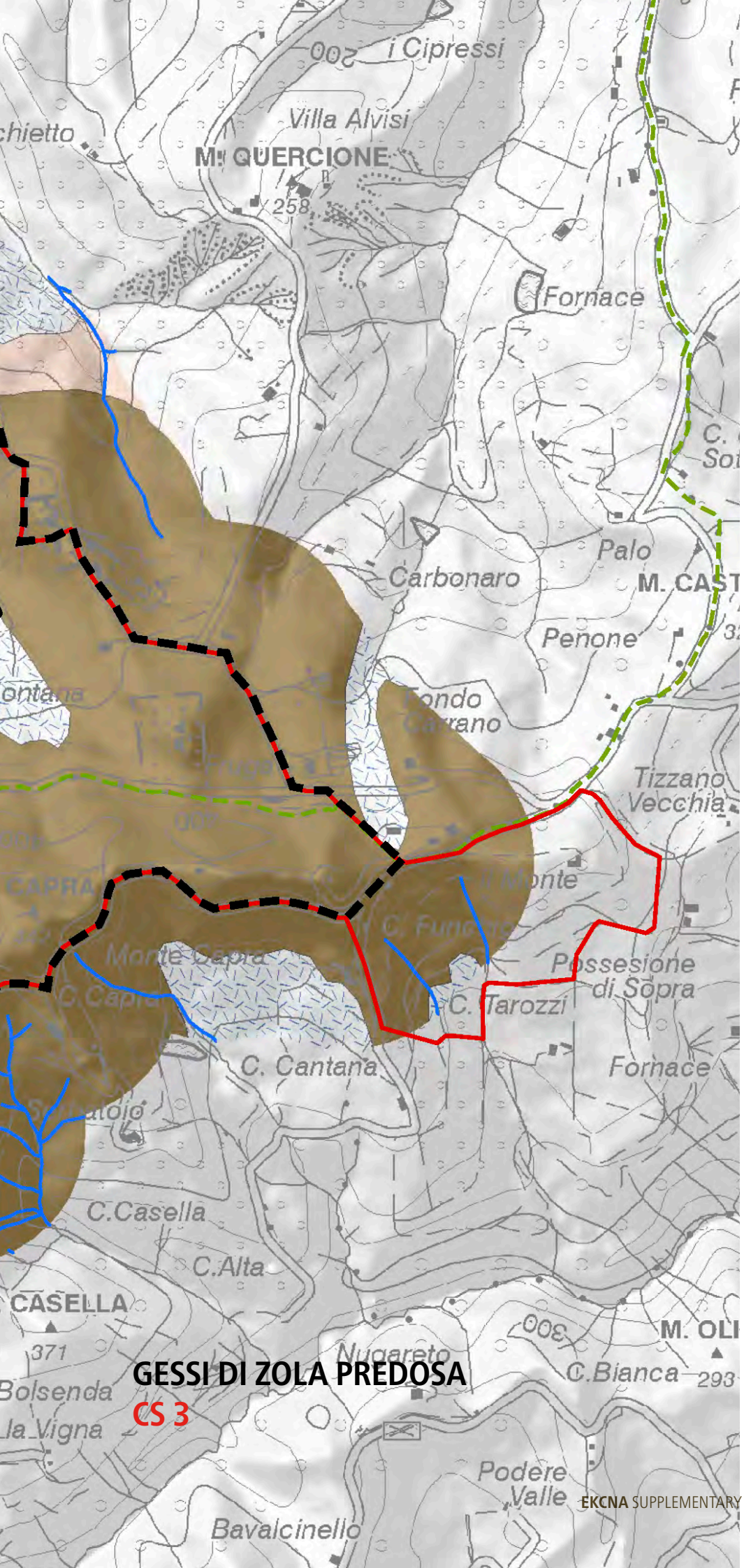
BASSA COLLINA REGGIANA

CS 2



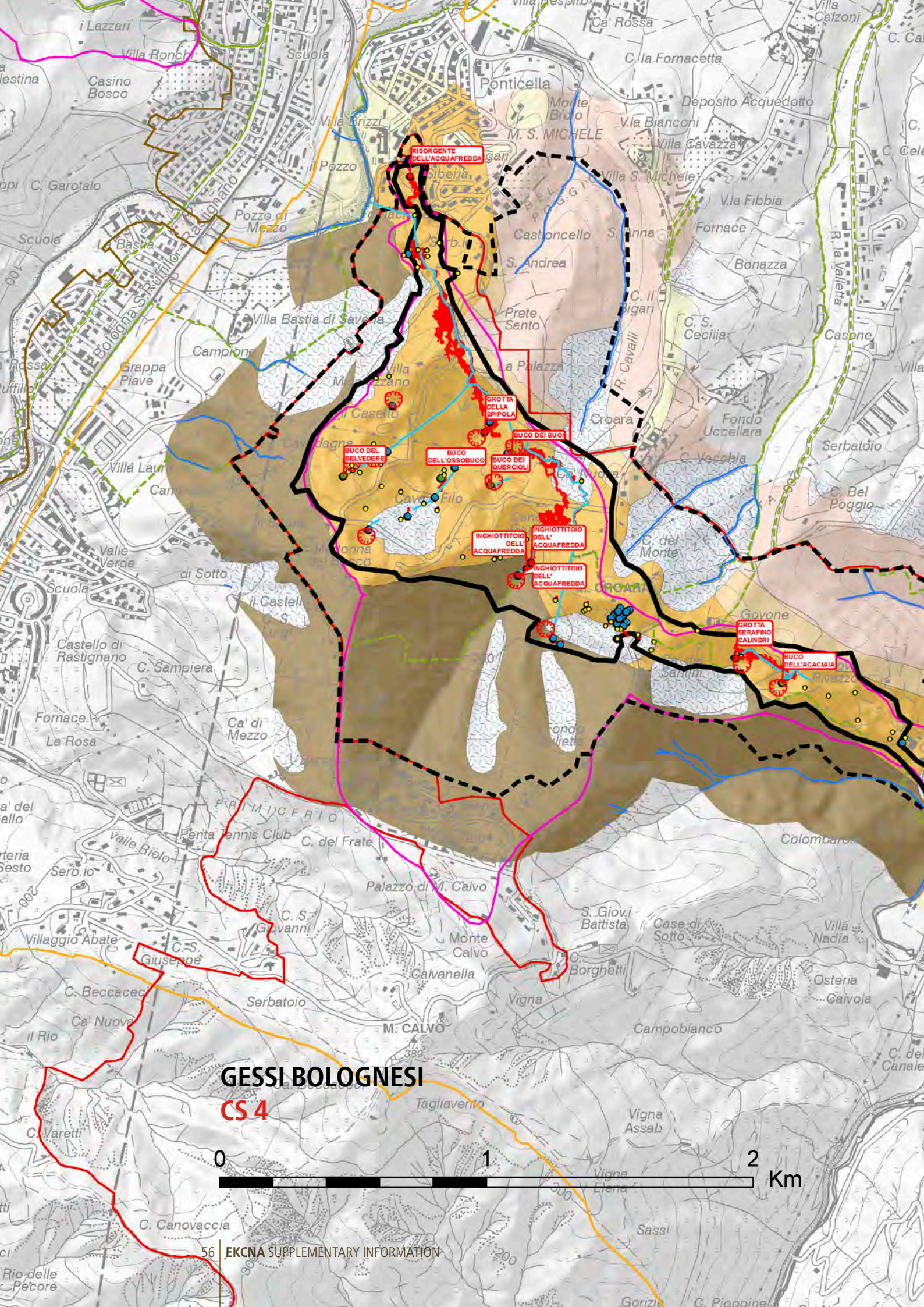
l'Oca
Casa Valle
Ca' di Rocco
San Geminiano
la Capanna
il Casale
Casa Luisa
Bicocca
la Rotonda
Raffaella
Casa Scaparra
GROTTA NUOVA DI CA' SCAPARRA
INGHIOTTITOIO DI CA' SCAPARRA
TANA DELLA MUSSINA DI MONTERICCO
POZZO SUL RIO GROPPO
GROTTA DEI FARAONI
RISORGENTE DEL RIO GROPPO
GROTTA DEI MASSI CADUTI
INGHIOTTITOIO DI CA' SPERANZA
TANA DELLA MUSSINA DI BORZANO
BUCO DEL CORNALE
M. GESSO
San Giovanni
Casa il Monte
Casa Granata
Bellavista
C. Biagi
Borzano
Ca' de'Soldati
Formica
Piombi
il Piletto
Ca' dei Duchi
Campazzi
C. Salvatore
Casa Colombaro
Ca' de' Signori
Podere Boschetto
Casa Borra
la Caselletta
Jano
Cipressi
Seminario
Molino
Fiorina
Case Tarc
C. Taroni
Mazzalasino
Bettole
Pianderna nuovissima
Pianderna nuova
Fornace Manolini
Casore

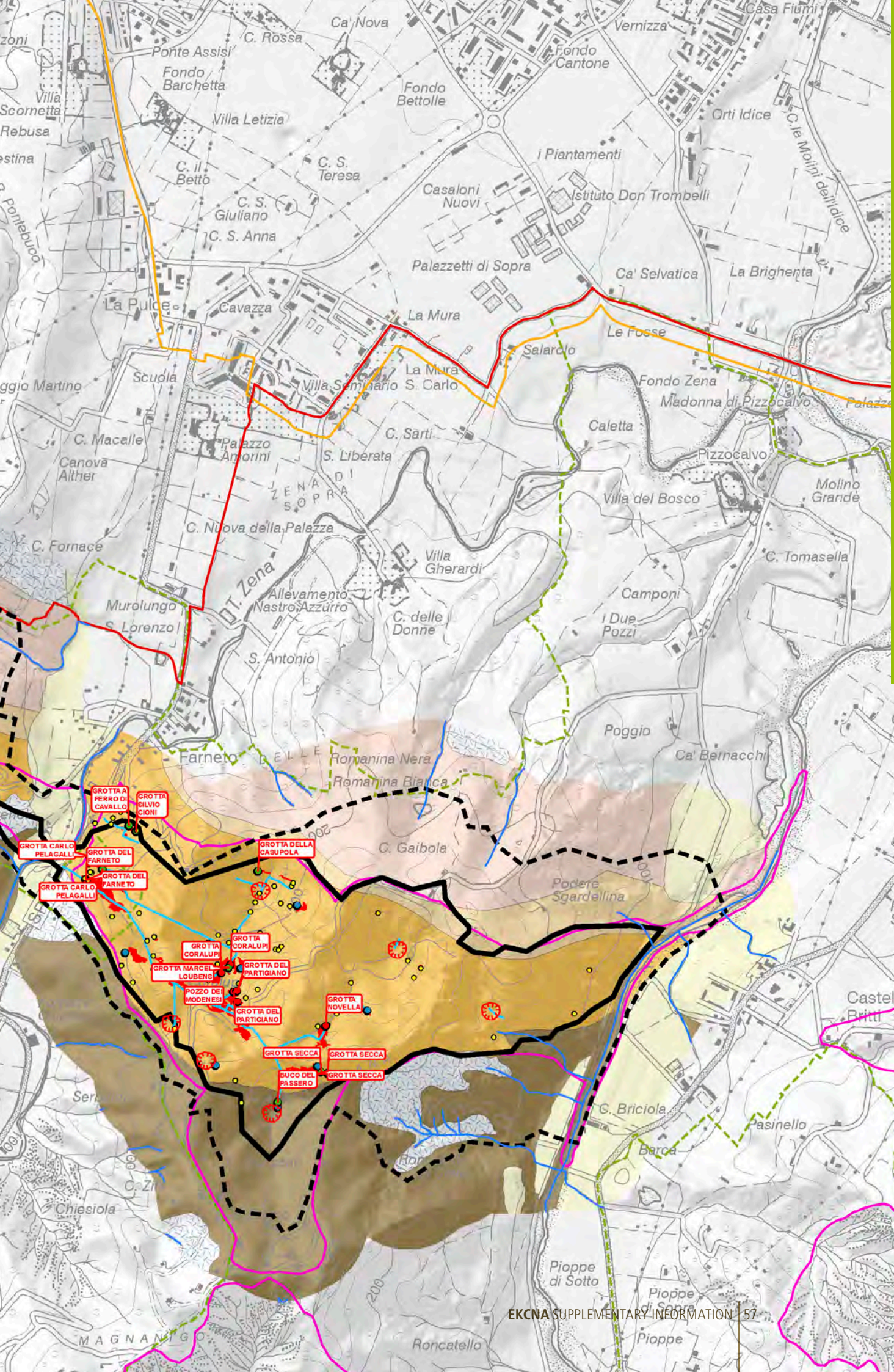

Casa Nuova
C. Nuova
Piscina Gesso
C.Torre
C.Muc
Frantoio
Villa
Calzolari
SP 26
Rivabella
R. Gessi
Malgotto
M. MALGOTTO
GROTTA
MICHELE
GORTANI
GROTTA
MICHELE
GORTANI
GROTTA
MICHELE
GORTANI
Torretta
Gessi
Casa dei Pini
Ca' Facchini
Frantoio-
del Lavino
Cerbatoio
Casetto
Ronchi
Tana del
M. Rocca
Col Monte
Rocca
M. ROCCA
Fontanelle
Villa
Bernardethi
Pucciola
Osteria
Capra
Mun.
Torresotto
I.S.E.A Podere Sperimentale "Francesco Corni"
Cavaro
Calderino vecchio
Olivetta
0
1
Km
Tre Monti
Casetto
Poggio
POGGIO MAZZANTI

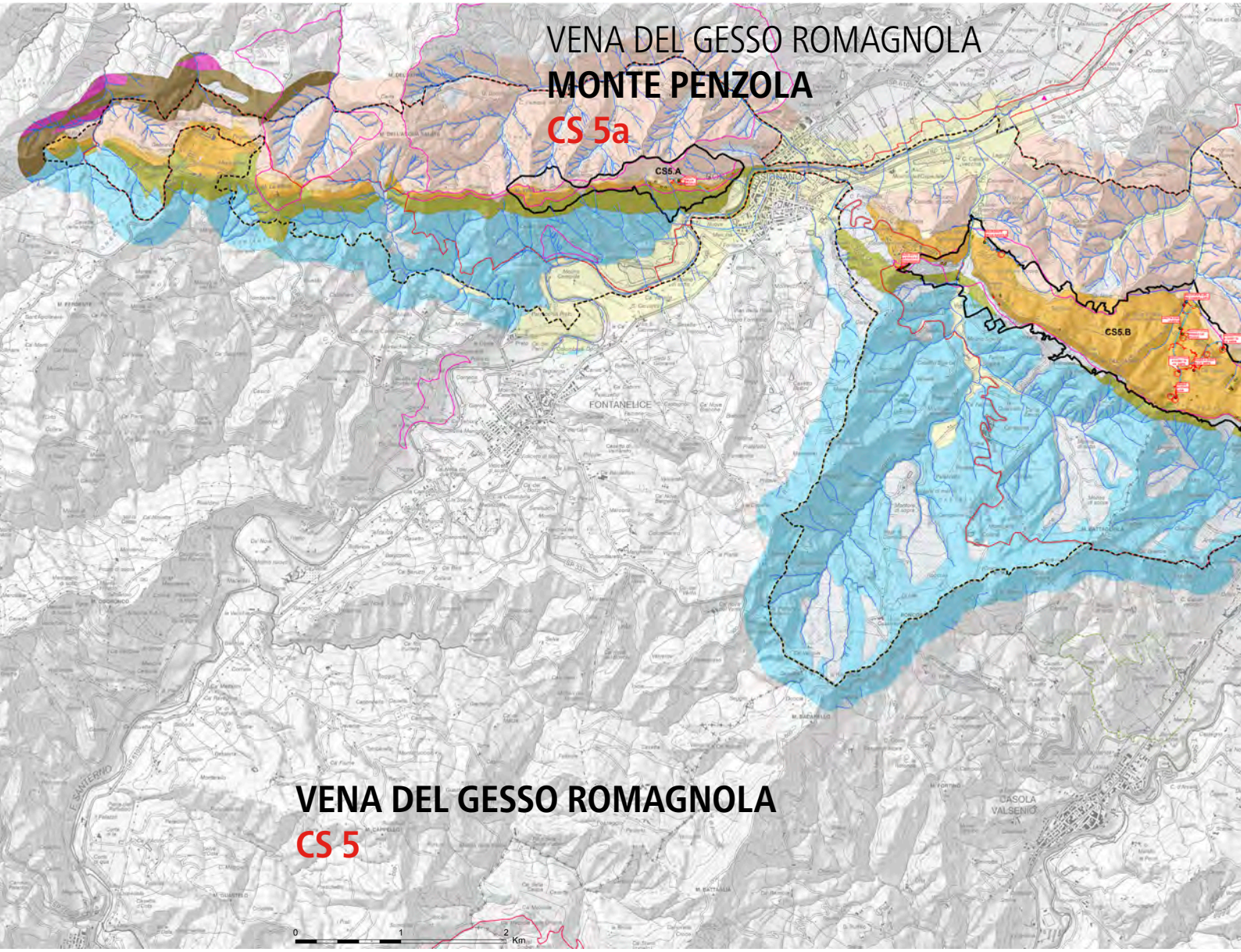


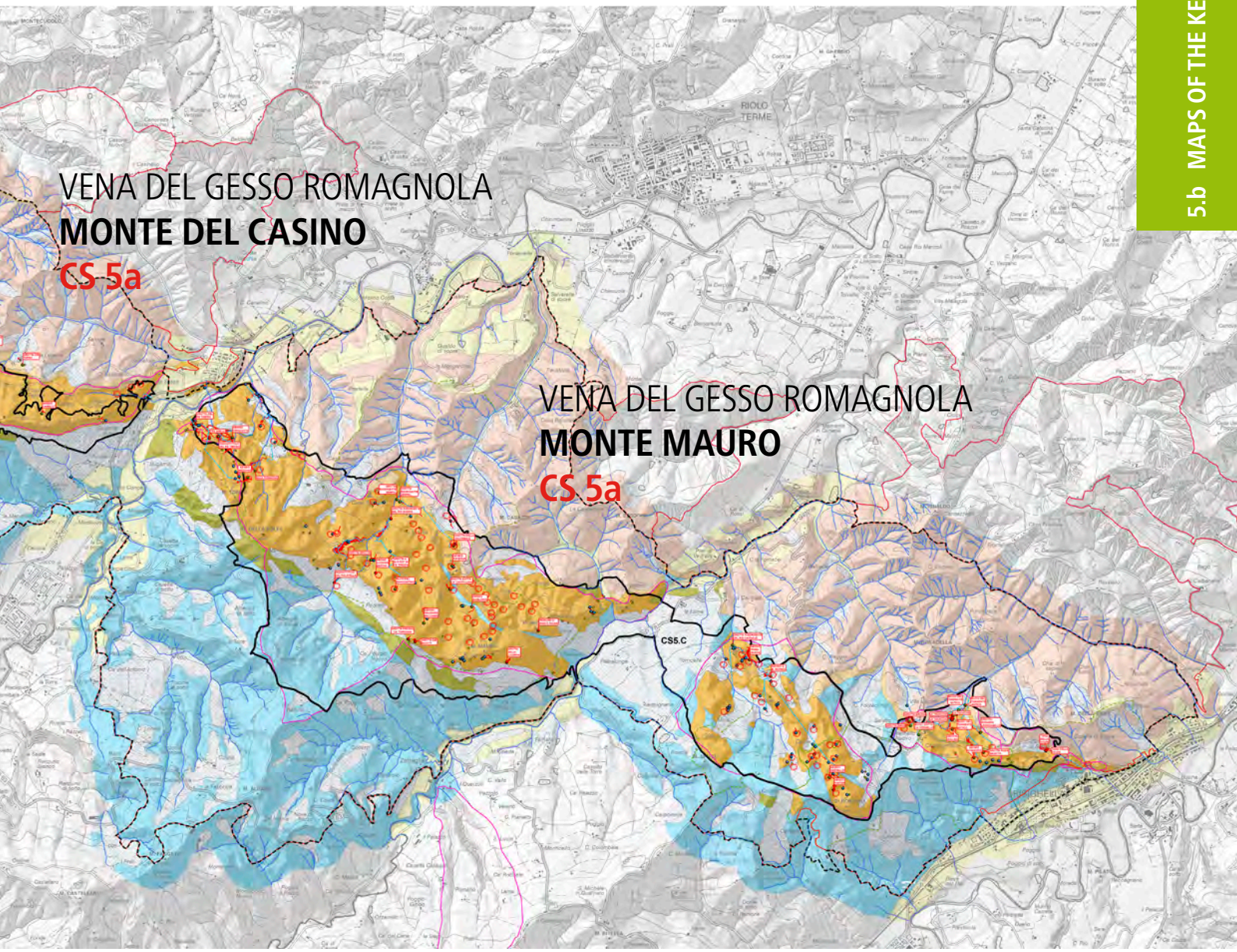
GESSI DI ZOLA PREDOSA

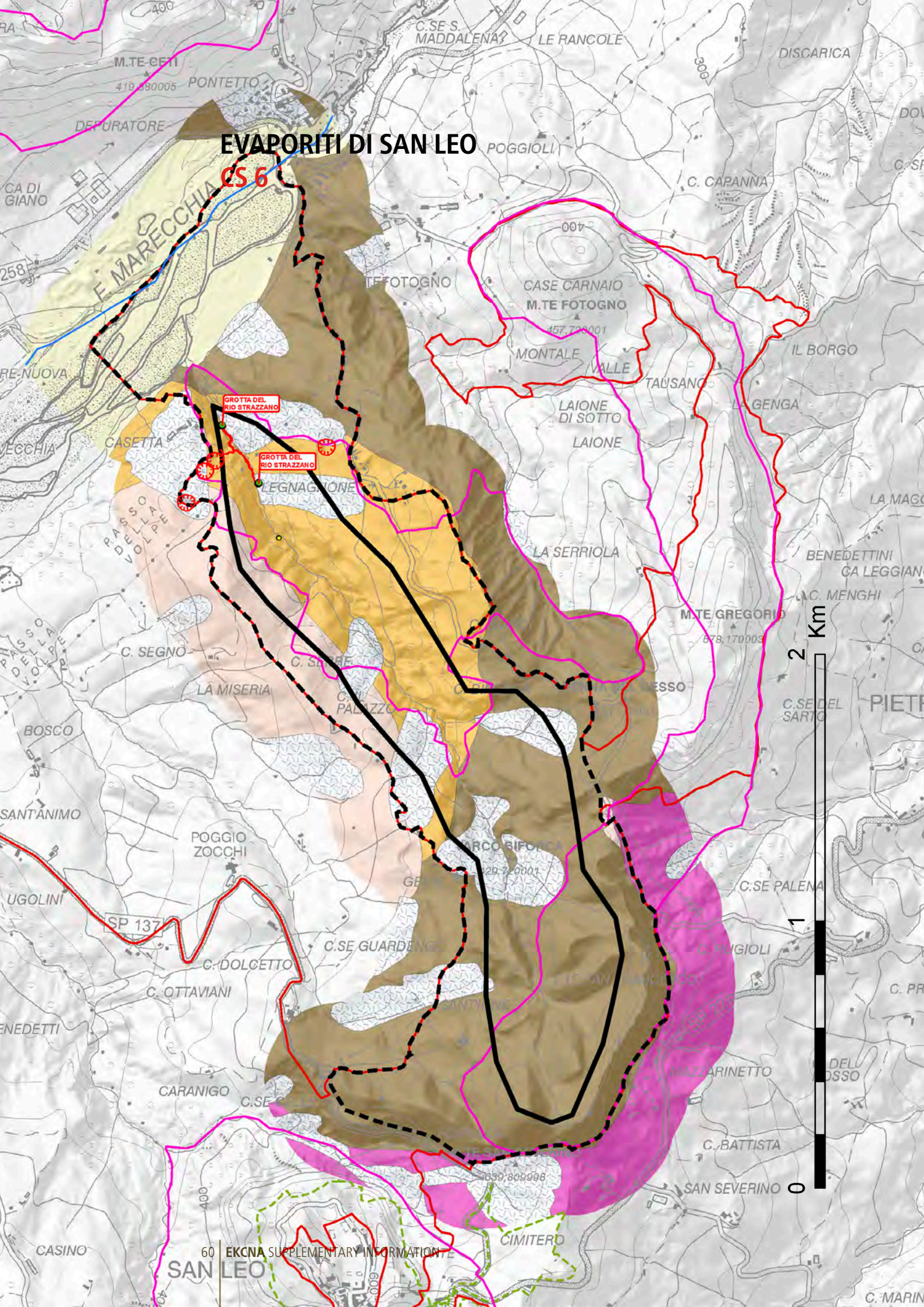
CS 3

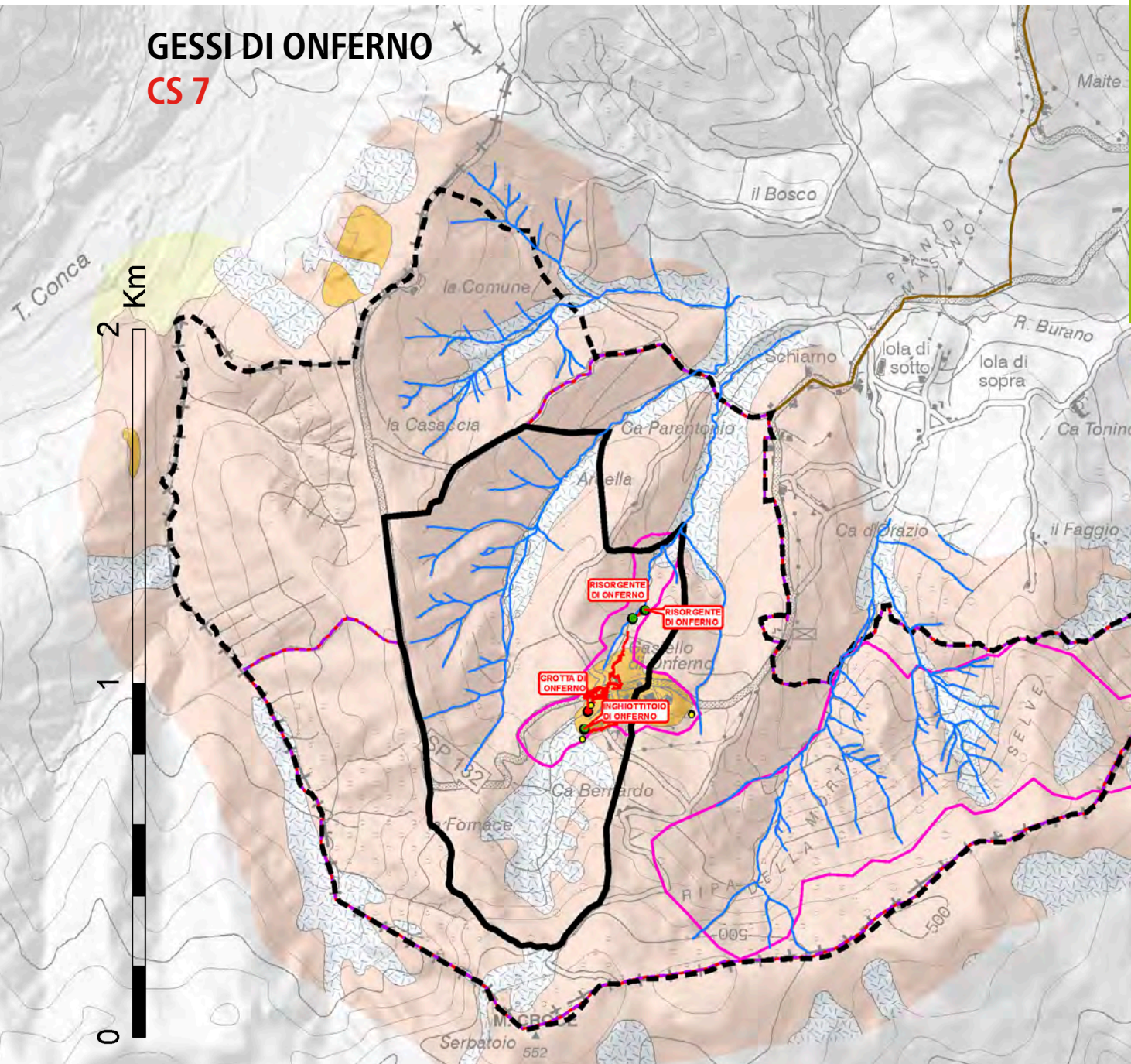

RISORGENTE DELL'ACQUAFREDDA
GROTTA DELLA PIPOLA
BUCO DEI BUOI
BUCO DEL BELVEDERE
BUCO DELL'OSSOBUCO
BUCO DEI QUERCIOLI
INGHIOTTITOIO DELL' ACQUAFREDDA
INGHIOTTITOIO DELL' ACQUAFREDDA
INGHIOTTITOIO DELL' ACQUAFREDDA
GROTTA SERAFINO CALINDRI
BUCO DELL'ACACIAIA
GESSI BOLOGNESI
CS 4
0
1
2
Km


Ca' Nova
C. Rossa
Ponte Assisi
Fondo Barchetta
Villa Scornetta
Rebusa
Villa Letizia
C. il Betto
C. S. Teresa
C. S. Giuliano
C. S. Anna
Fondo Bettolle
Vernizza
Casa Fiumi
Fondo Cantone
Orti Idice
C.le Molini dell'Idice
i Piantamenti
Casaloni Nuovi
Istituto Don Trombelli
Palazzetti di Sopra
Ca' Selvatica
La Brighenta
La Pulce
Cavazza
La Mura
Le Fosse
Salardo
Scuola
Villa Seminario
La Mura S. Carlo
Fondo Zena
Madonna di Pizzocalvo
C. Macalle
Palazzo Amorini
C. Sarti
S. Liberata
Caletta
Pizzocalvo
Canova Alther
Molino Grande
Villa del Bosco
C. Nuova della Palazza
C. Fornace
Villa Gherardi
C. Tomasella
Allevamento Nastro Azzurro
Camponi
Murolungo
S. Lorenzo
C. delle Donne
I Due Pozzi
S. Antonio
Poggio
Ca' Zaoli
Scuola
Ca' Bernacchi
Farneto
Romanina Nera
Romanina Bianca
GROTTA A FERRO DI CAVALLO
GROTTA SILVIO CIONI
GROTTA CARLO PELAGALLI
GROTTA DEL FARNETO
GROTTA DELLA CASUPOLA
C. Gaibola
Podere Sgardellina
Piana di Sopra
Casetta
GROTTA CORALUPI
GROTTA MARCEL LOUBENS
GROTTA DEL PARTIGIANO
POZZO DEI MODENESI
GROTTA NOVELLA
Castel dei Britti
GROTTA SECCA
BUCO DEL PASSERO
C. Briciola
Pasinello
Barca
Chiesiola
Pioppe di Sotto
Pioppe di Sopra
Pioppe
Roncatello
MAGNANIGO


VENA DEL GESSO ROMAGNOLA
MONTE PENZOLA
CS 5a
CS5.A
CS5.B
FONTANELICE
CASOLA VALSENIO
VENA DEL GESSO ROMAGNOLA
CS 5
0
1
2
Km


VENA DEL GESSO ROMAGNOLA
MONTE DEL CASINO
CS 5a
VENA DEL GESSO ROMAGNOLA
MONTE MAURO
CS 5a
RIOLO TERME
CS5.C


EVAPORITI DI SAN LEO
CS 6
GROTTA DEL RIO STRAZZANO
GROTTA DEL RIO STRAZZANO
M.TE FOTOGNO
SAN LEO
0
1
2 Km


GESSI DI ONFERNO
CS 7
T. Conca
0
1
2 Km
la Comune
il Bosco
Maite
Schiarno
Iola di sotto
Iola di sopra
R. Burano
la Casaccia
Ca Parantonio
Ca Tonino
Ca d'Orazio
il Faggio
RISORGENTE DI ONFERNO
RISORGENTE DI ONFERNO
GROTTA DI ONFERNO
INGHIOTTITOIO DI ONFERNO
SP 182
Ca Bernardo
Fornace
Serbatoio
552
500

Maps of the prohibited activities

Printed maps previews for reference only.
Please view them at full scale from the PDF file available in the DVD or online at link:
https://regioneer.it/EKCNA-additional-information

Nominated Property boundaries

Component Sites boundaries

Buffer zones

Prohibited activities

gypsum outcrops

damaging, disturbance and killing of local fauna

collection and damage of local flora

unmanaged introduction of allochtonous species

extraction of significant geological and palaeontological materials

excavation and quarrying

introduction of explosives

camping

overflight

off-road transit

motorboats use

modification of water regime

new buildings and roads development

realization of technological works

land-use changes in forest areas

affixing of advertising signs

free access to the caves

to light fires

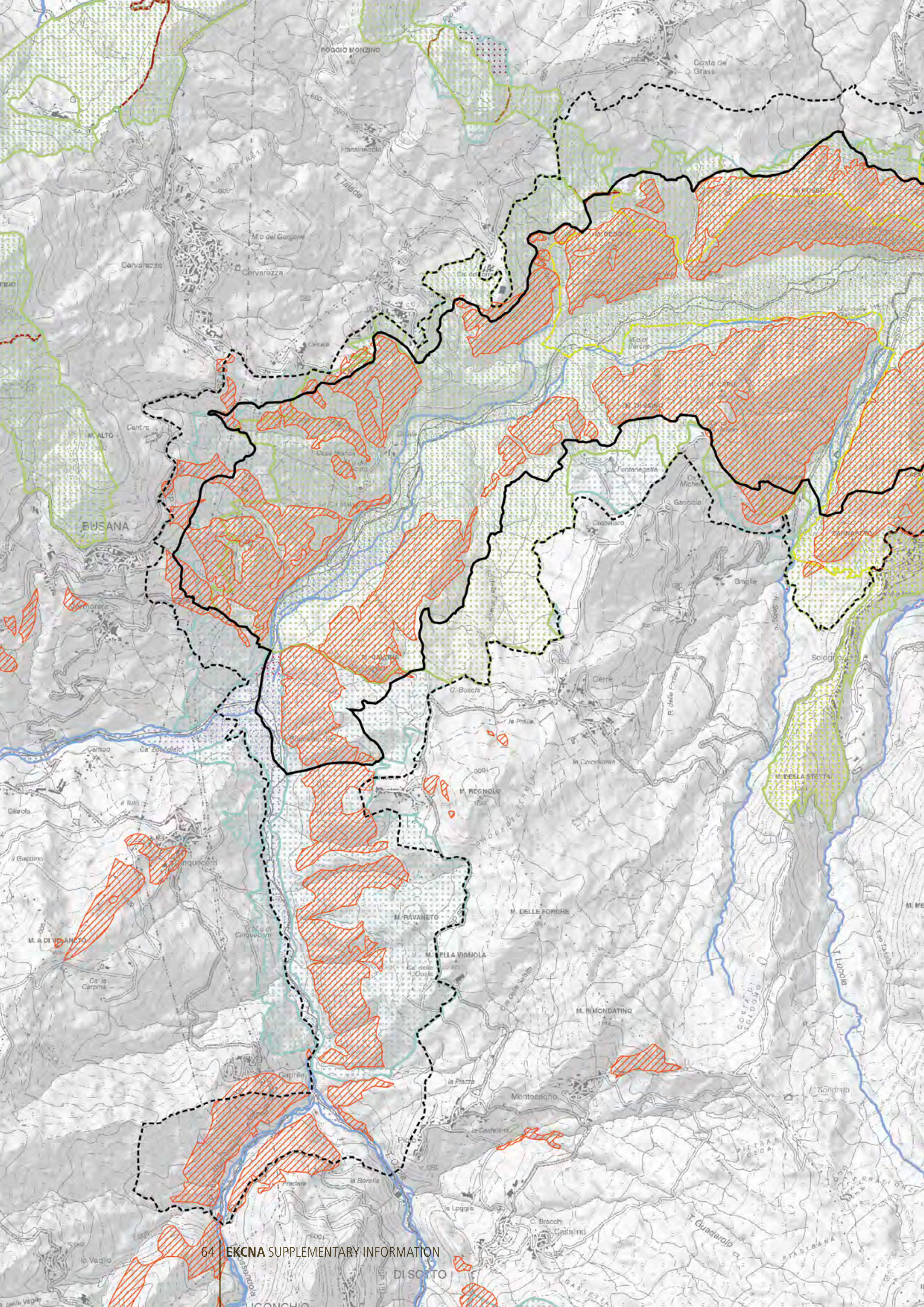
to illuminate caves

morphological alterations of karst and non-karst features

total protection area

*To query the maps, it is necessary to download and open the PDF files with **Acrobat Reader DC** since it is the only software capable to show the layers individually, and to switch them off when necessary.*

If the PDF is opened in a web browser or using a preview application, the layers may be hidden or merged together.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Brugna
Sologno
M. REGNOLO
M. RAVANETO
M. DELLE FORCHE
M. DELLA VIGNOLA
M. RIMONDATINO
Montecagno
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la Piazza
la Borella
le Loggie
C. Bracchi
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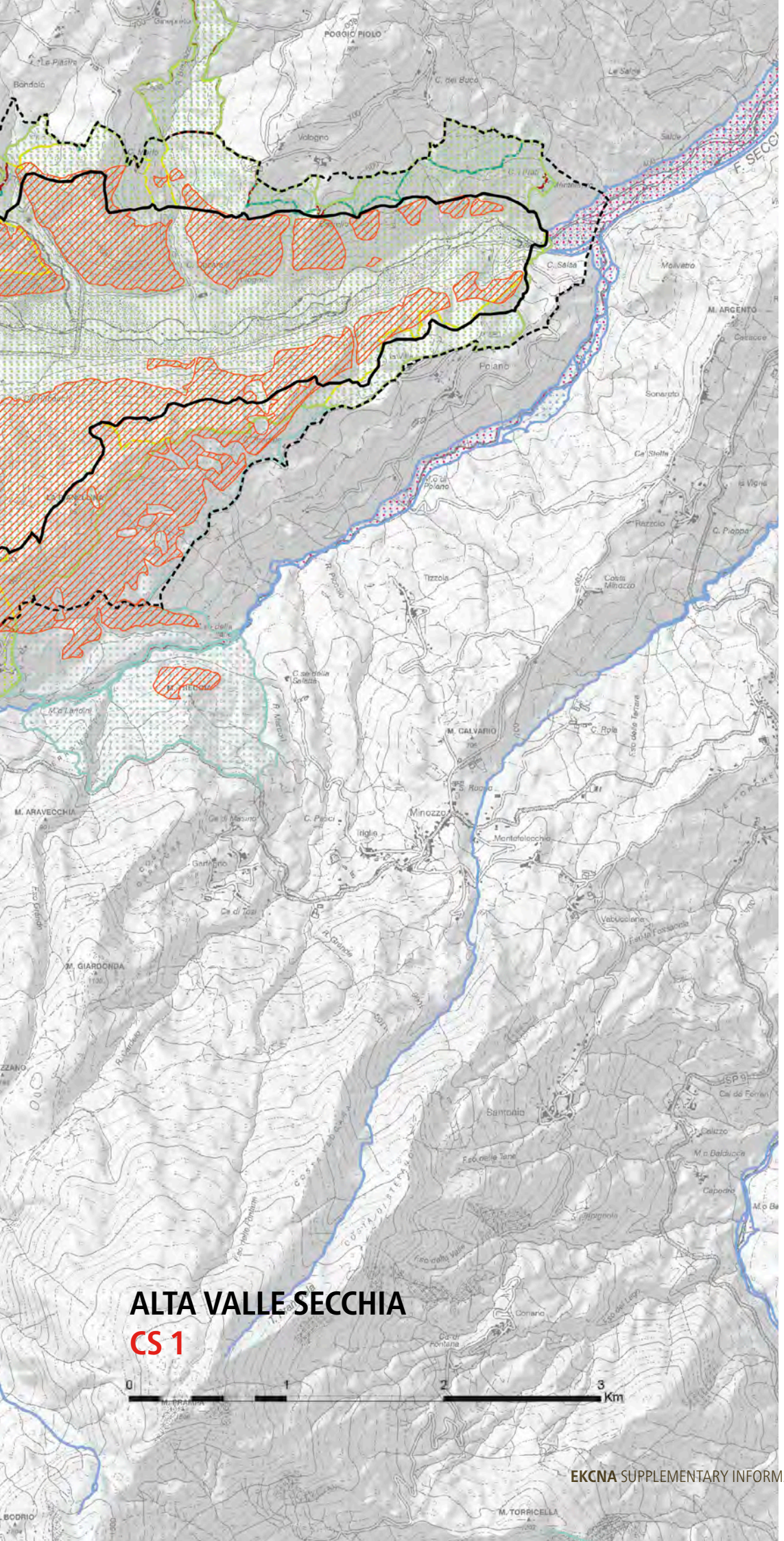
T. Guadarolo
DI SOTTO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Poiano
Sonarato
Ca' Stella
la Vigna
C. Pioppa
Tizzola
Costa Minazzo
M. CALVARIO
C. Rola
M. ARAVECCHIA
C. Pesci
Minozzo
Triglio
Montefolecchio
Vetticciano
M. GIARONDA
Santonia
SP 9
Calizzo
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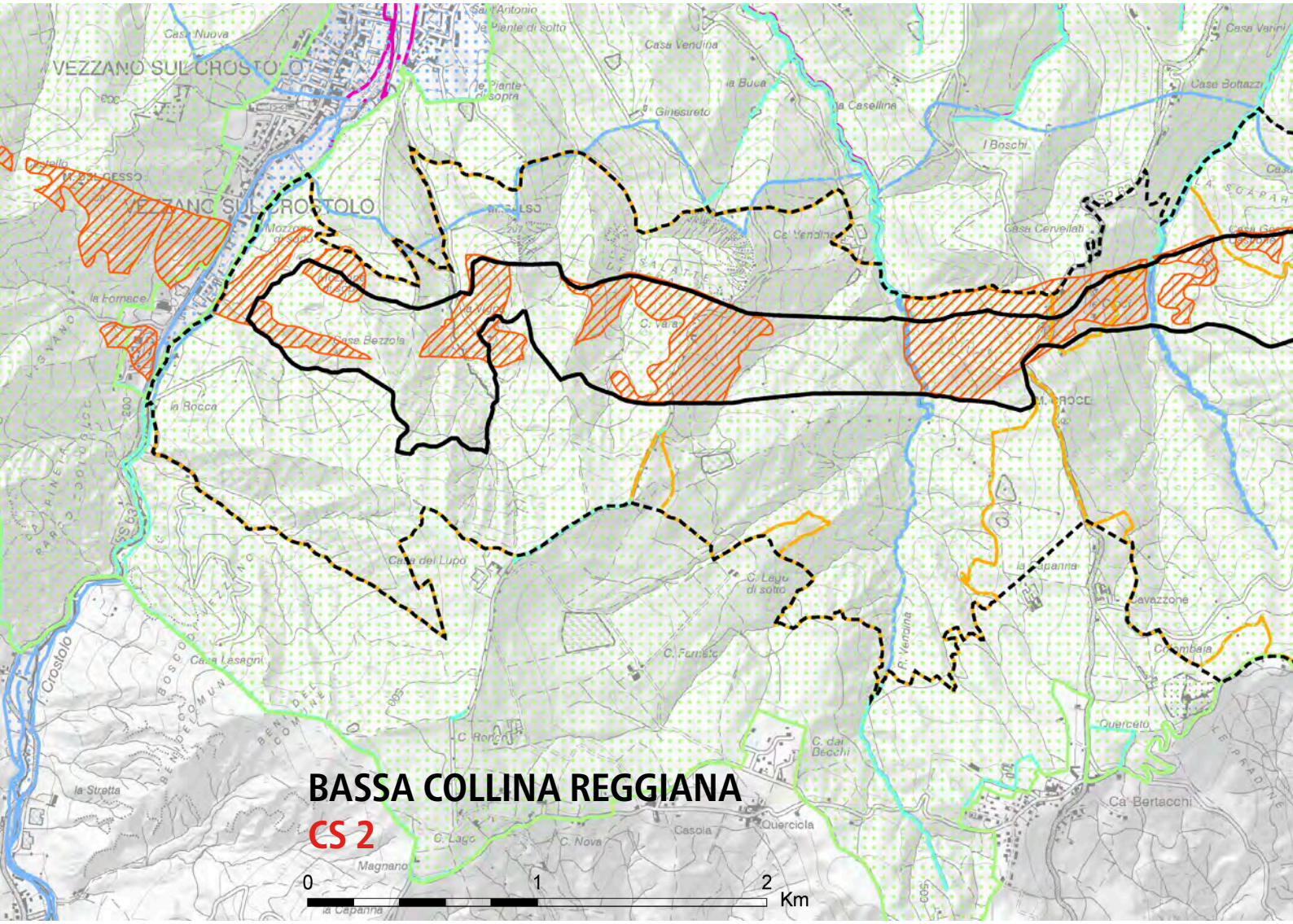
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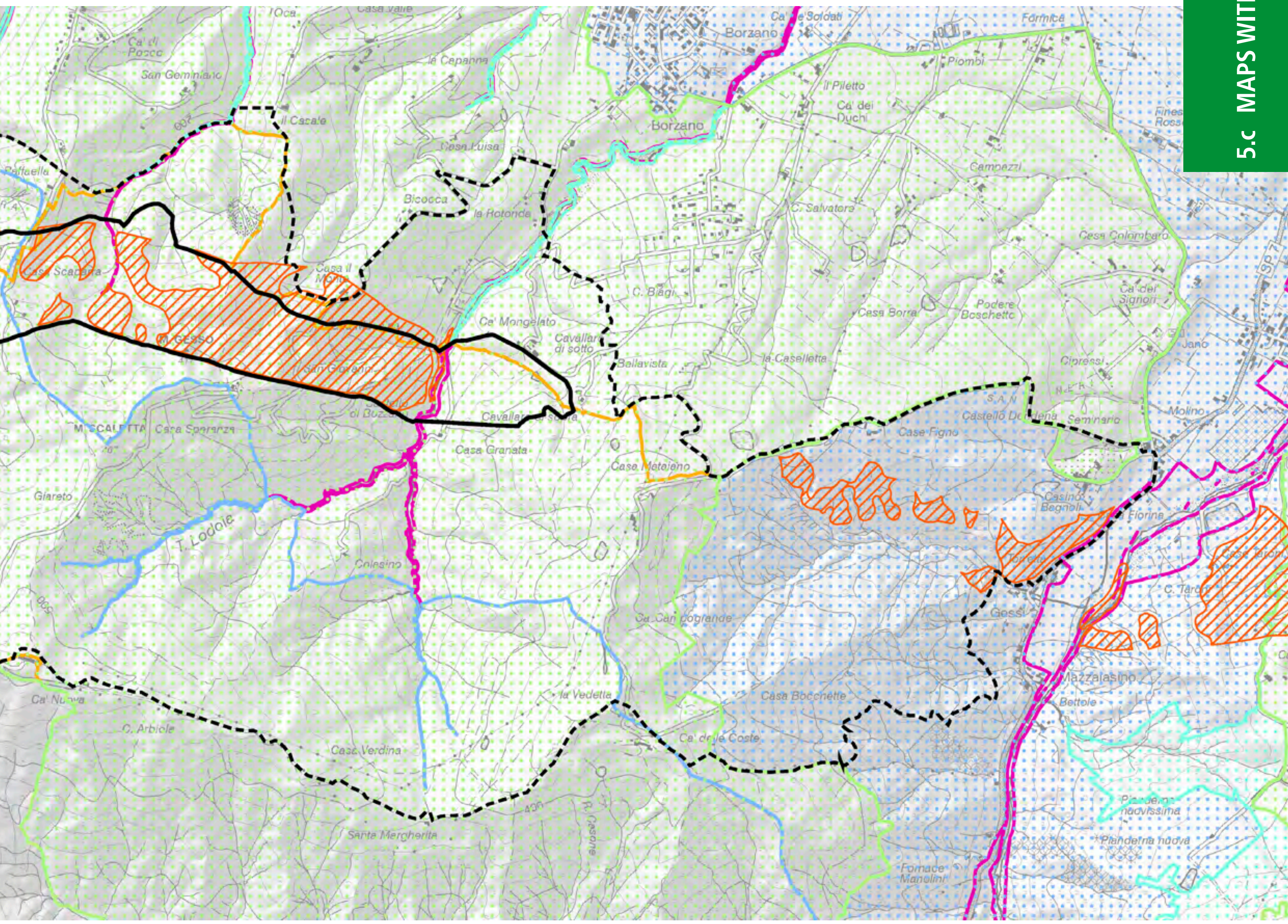
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Piombi
Il Piletto
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Campazzi
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San Gemminiano
la Capanna
Il Casale
Casa Luisa
Bicocca
la Rotonda
C. Salvatore
Casa Colombaro
Ca' dei Signori
C. Biagi
Casa Borra
Podere Boschetto
Casa Scabaia
Ca' Mongelato
Cavallara di sotto
Bellavista
la Casellotta
Cipressi
Jano
Molino
M. Gesso
Casa Sperenza
Casa Granata
Casa Metateno
Castello Dodena
Seminario
Case Figno
Giareto
T. Lodola
Colesino
Casino Bagnoli
Fiorine
Torretta
Gessi
Ca' Campogrande
C. Tarchi
Mazzalasino
Casa Bocchette
Bettole
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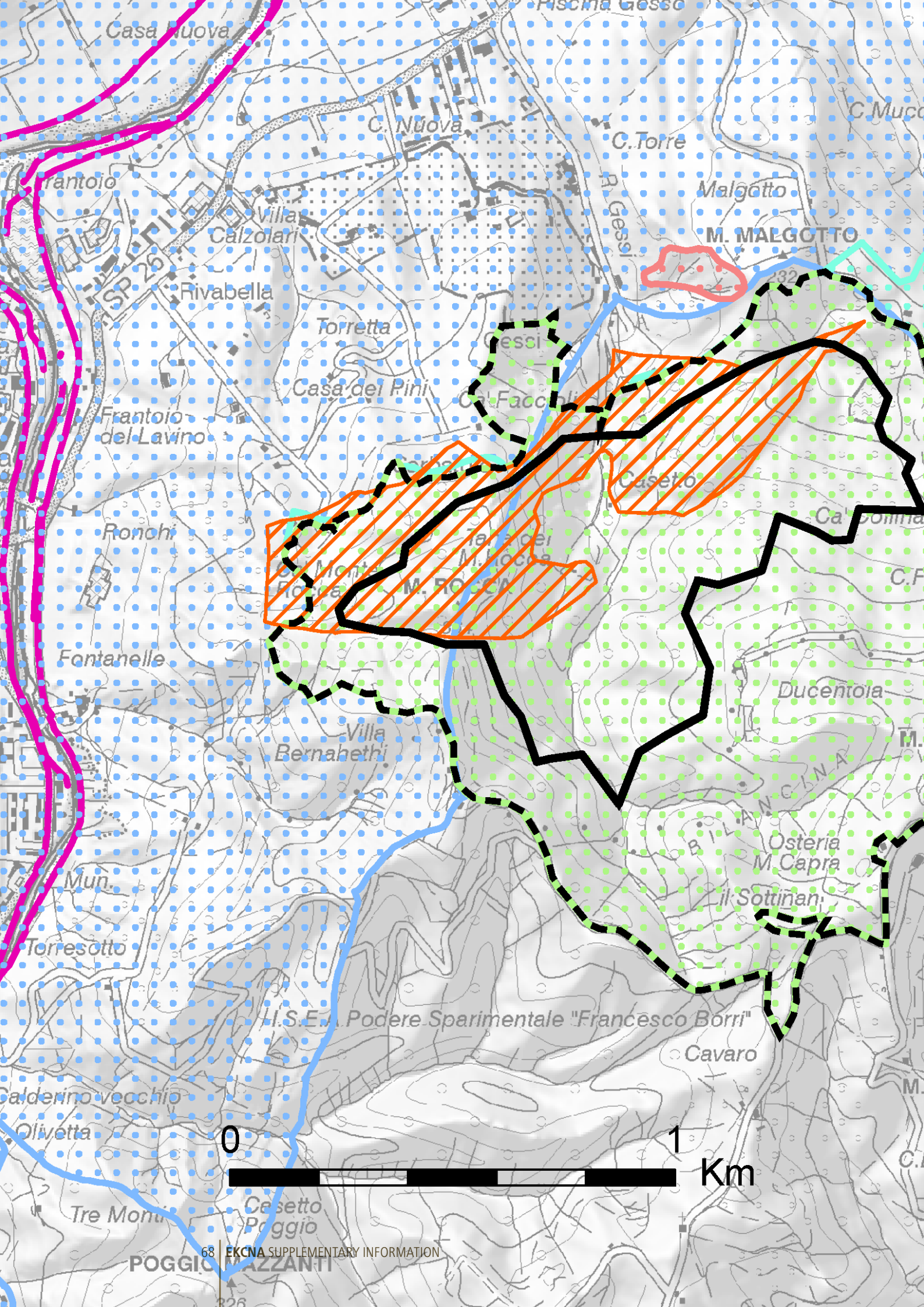
Ca' delle Coste
Santa Margherita
R. Castone
Fornace Manolini
Piandelma nuova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Ponchi
Fontanelle
Villa Bernabethi
Ducentola
Osteria M.Capra
Il Sottinan
Torresotto
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Cavaro
Olivetta
Tre Monti
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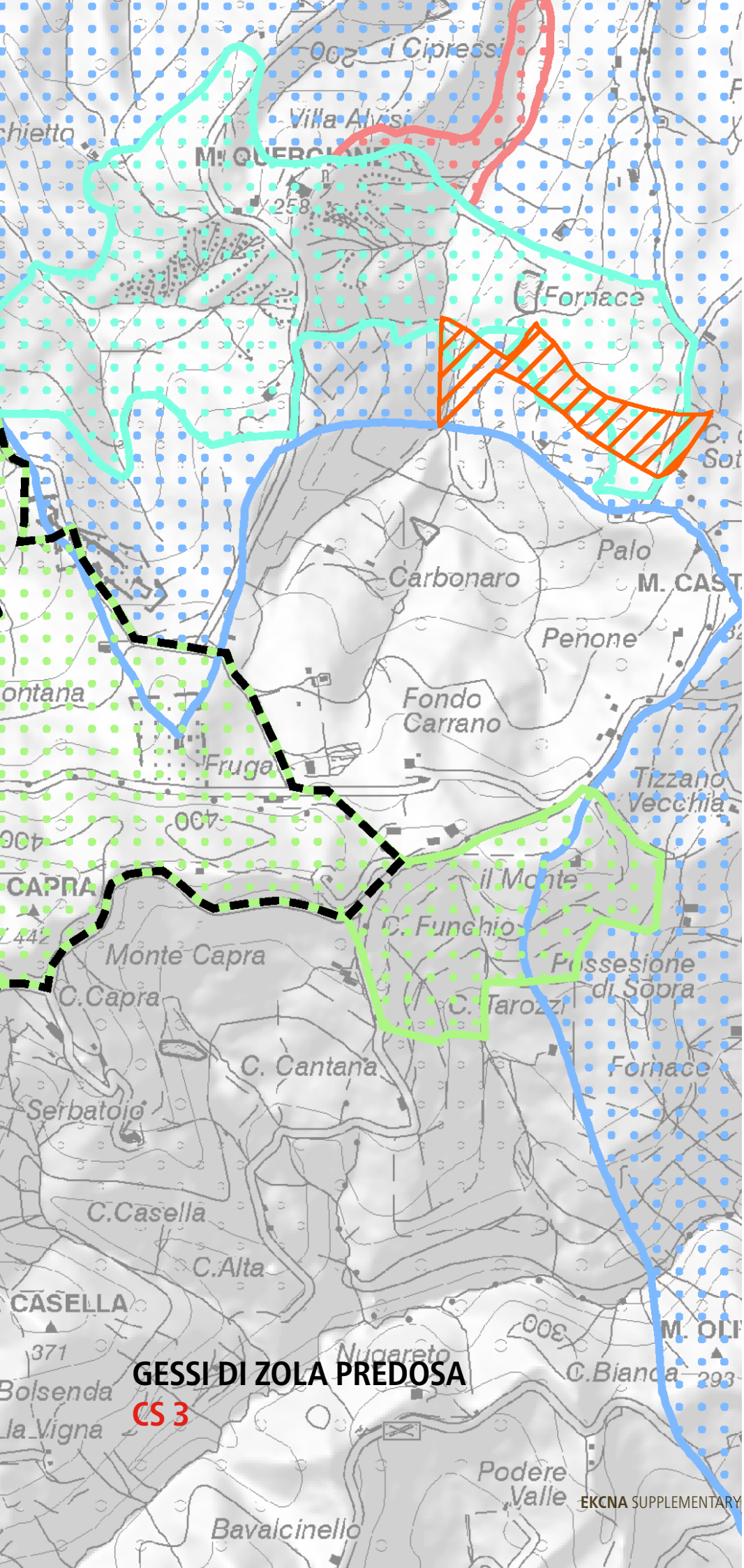
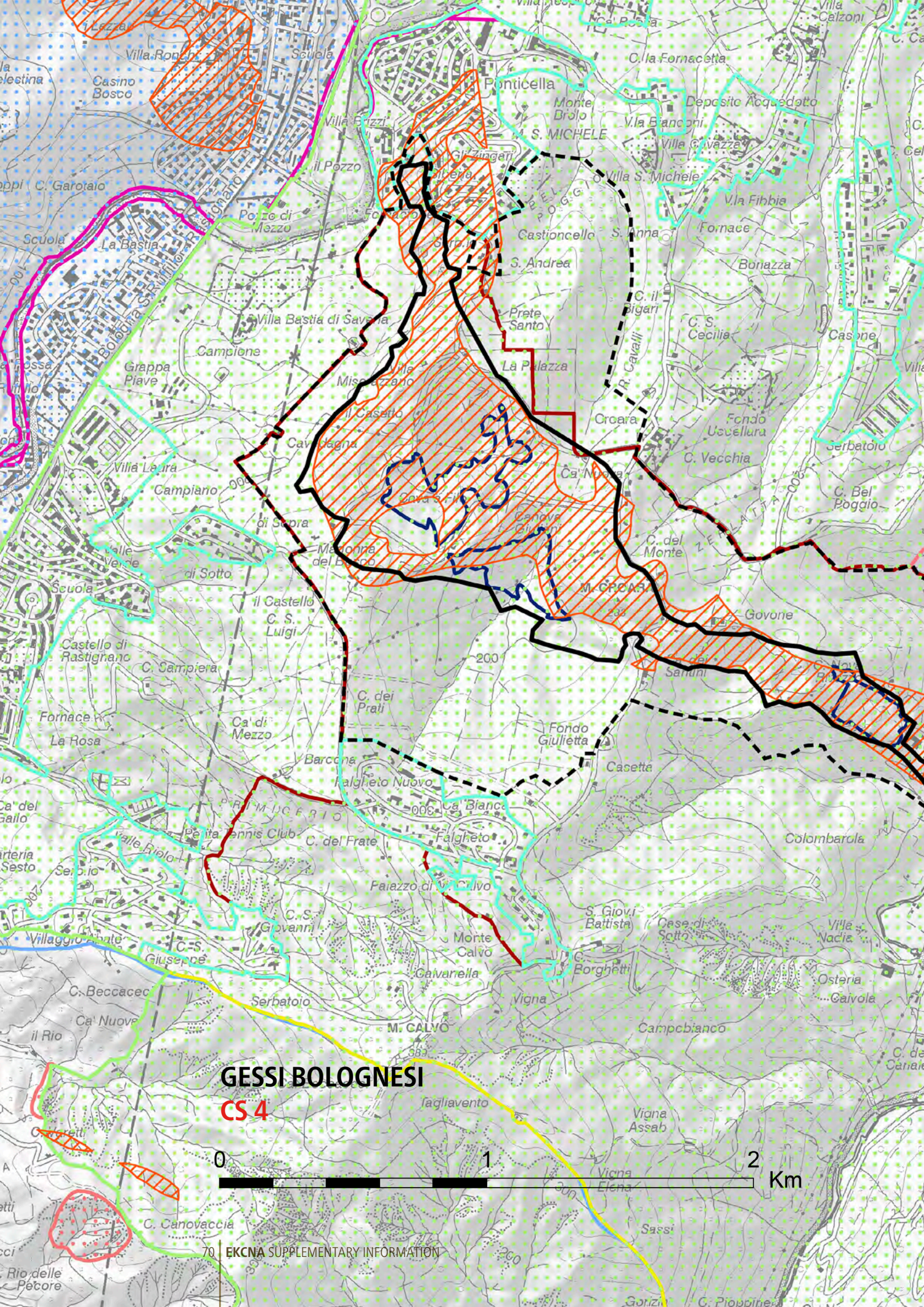


GESSI DI ZOLA PREDOSA

CS 3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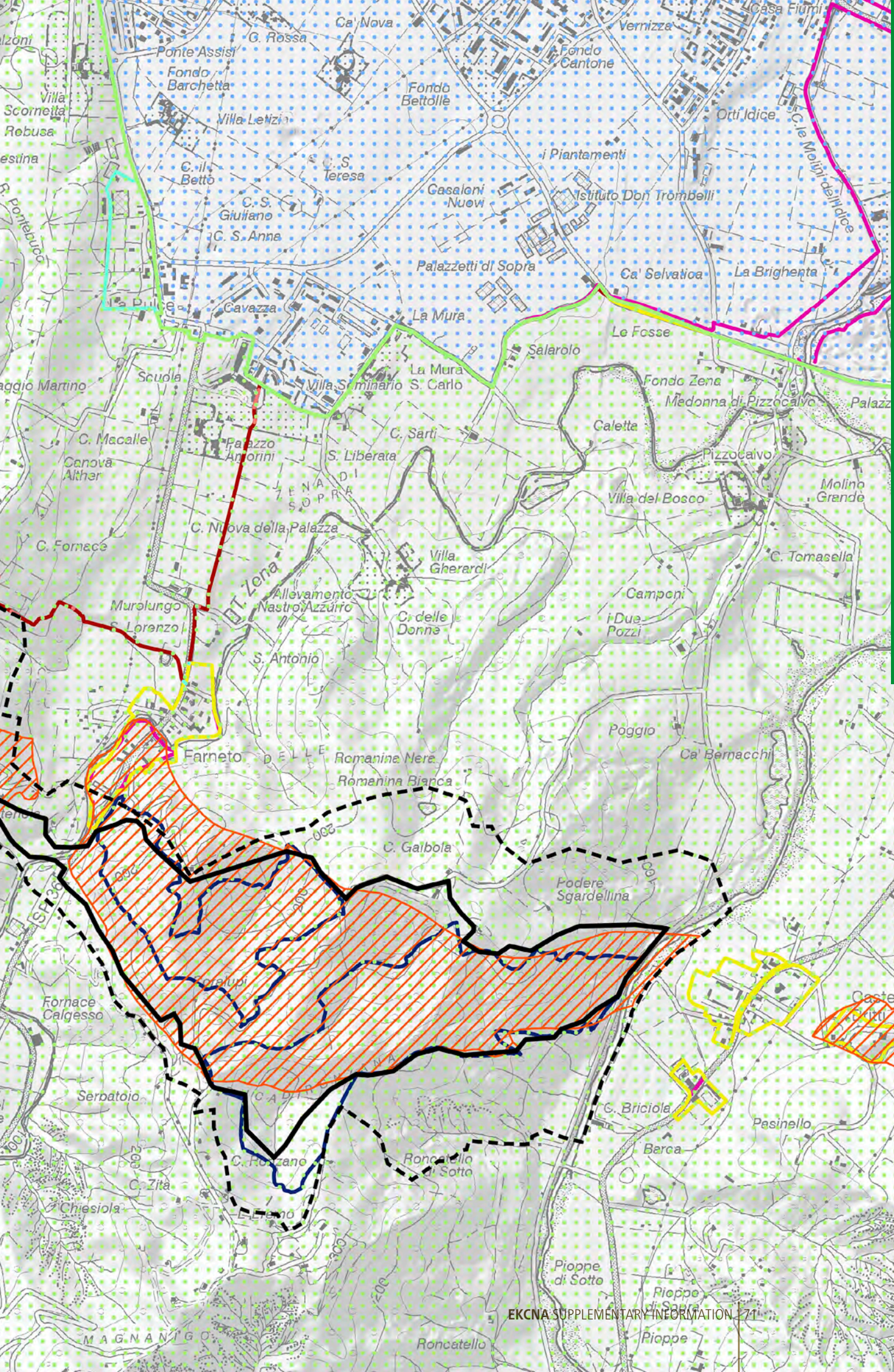
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Casa Fiumi
G. Rossa
Ponte Assisi
Fondo Cantone
Fondo Barchetta
Fondo Bettolle
Villa Scornetta
Robusa
Villa Letizia
Orti Idice
C.le Molini dell'Idice
i Piantamenti
C. il Betto
S. Teresa
Casaloni Nuovi
Istituto Don Trombelli
C. S. Giuliano
C. S. Anna
Palazzetti di Sopra
Ca' Selvatica
La Brighenta
Cavazza
La Mura
Le Fosse
Salarolo
Scuola
La Mura S. Carlo
Villa Seminario S. Carlo
Fondo Zena
Madonna di Pizzocalvo
Palazz
C. Macalle
Palazzo Amorini
C. Sarti
Caletta
S. Liberata
Pizzocalvo
Canova Althar
Villa del Bosco
Molino Grande
C. Nuova della Palazza
C. Fornace
Villa Gherardi
C. Tomasella
Allevamento Nastro Azzurro
Camponi
Murolungo
C. delle Donne
i Due Pozzi
S. Lorenzo
S. Antonio
Ca' Zaoli
Scuola
Poggio
Farneto
Ca' Bernacchi
Romanina Nere
Romanina Bianca
C. Galbola
Podere Sgardellina
Piana di Sopra
Fornace Calgesso
Serbatoio
C. Briciola
Pesinello
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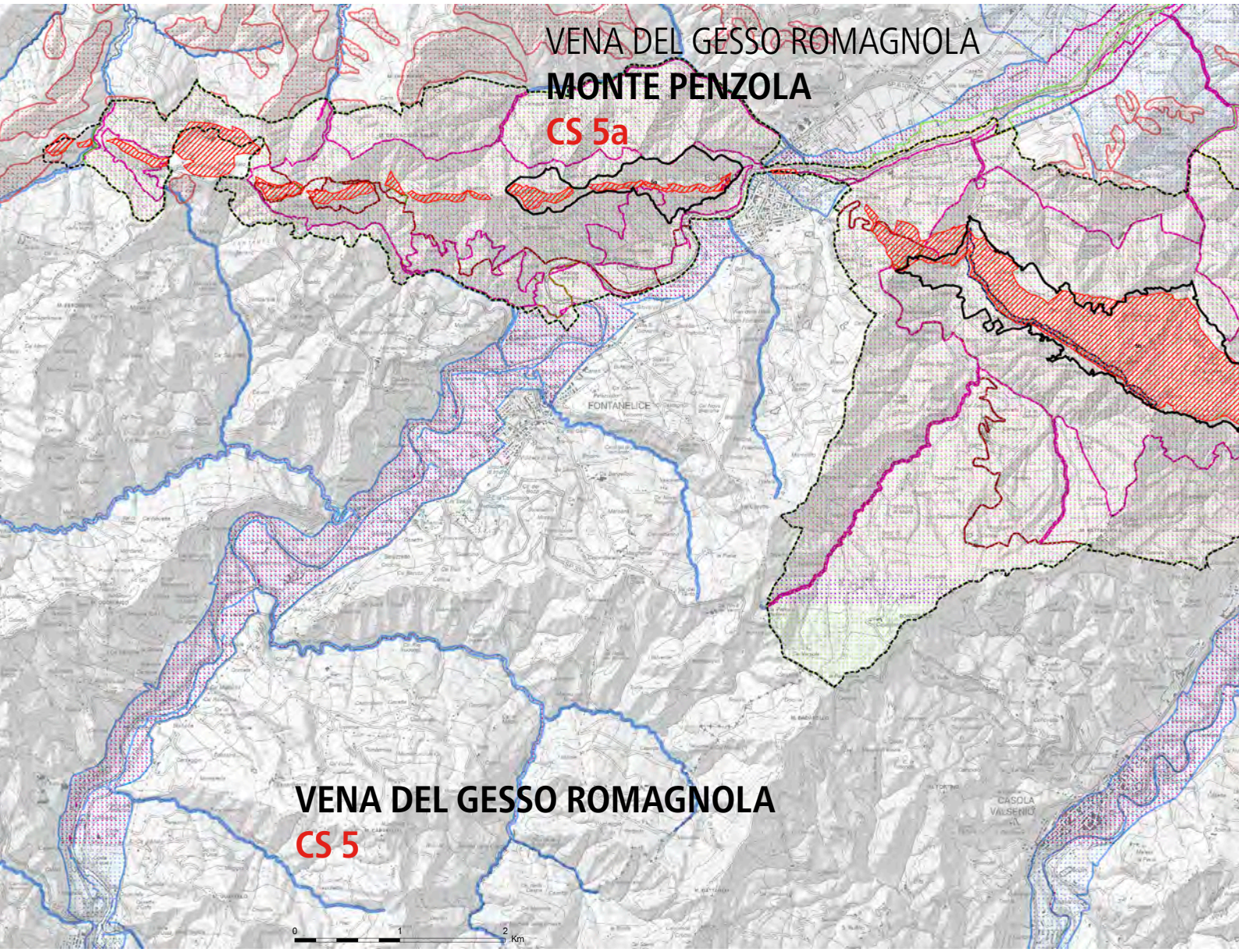
Roncatello
MAGNANIGO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CS 5
CASOLA VALSENIO
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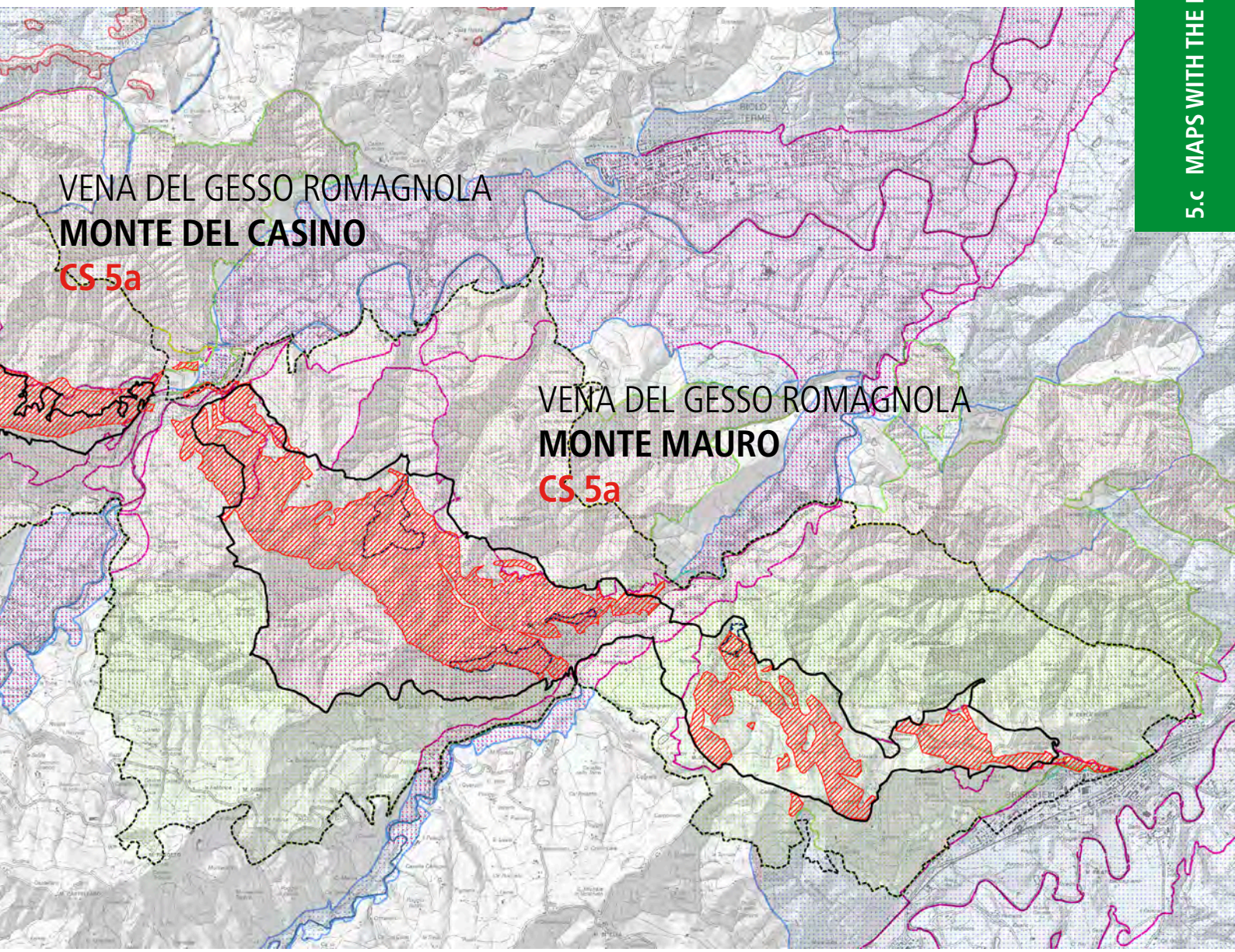
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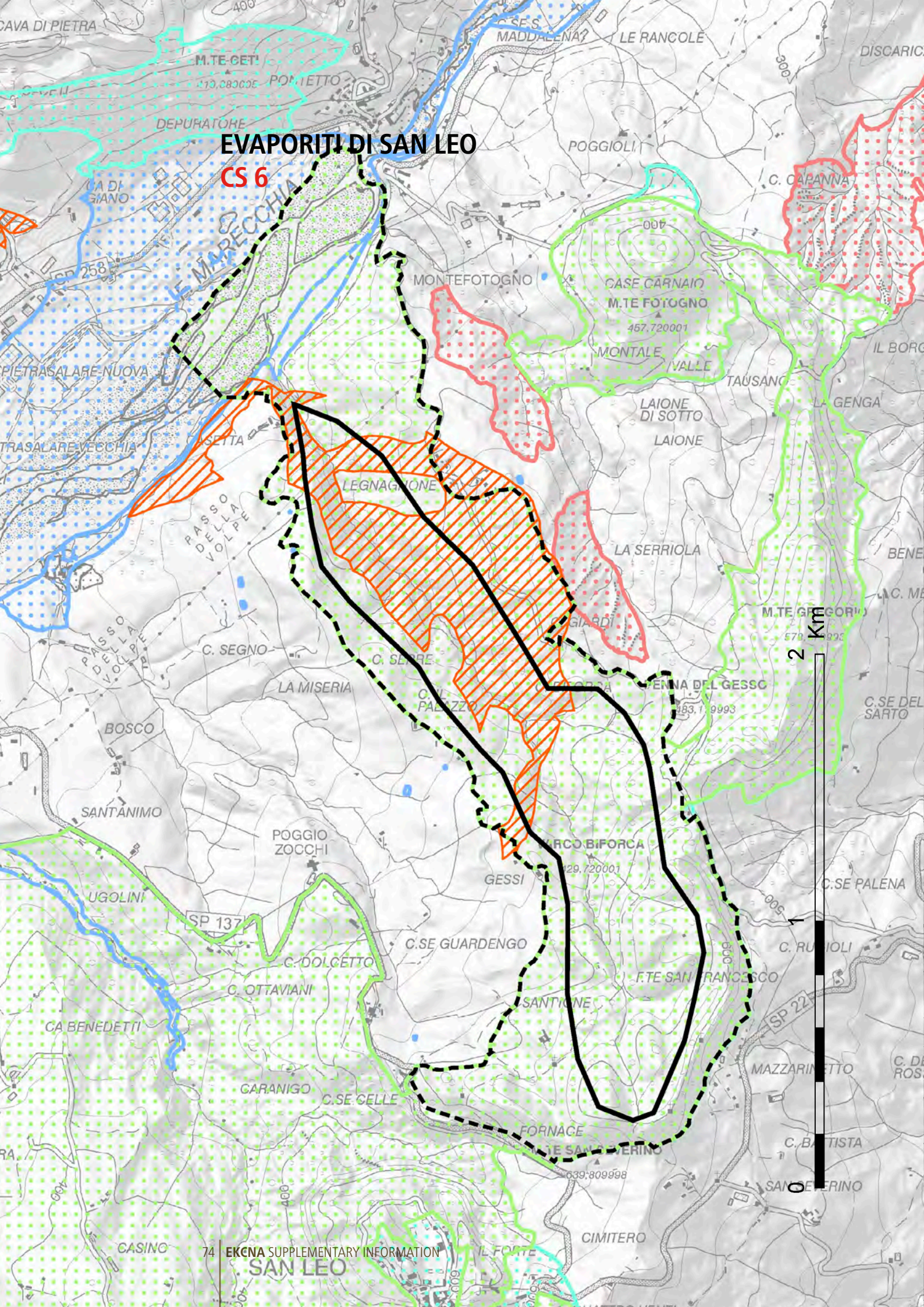
CS 5a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TAUSANO
LAIONE DI SOTTO
LAIONE
LA GENGA
LEGNAGIONE
LA SERRIOLA
M.TE GREGORIO
C. SEGNO
LA MISERIA
BOSCO
SANTANIMO
POGGIO ZOCCHI
GESSI
C.SE GUARDENGO
C. DOLCETTO
C. OTTAVIANI
CA BENEDETTI
CARANIGO
C.SE CELLE
FORNACE
SANTIONE
C.SE PALENA
C.SE DEL SARTO
MAZZARINETTO
SAN SEVERINO
CIMITERO
IL FORTE
CASINO
SAN LEO
POGGIOLI
C. CAPANNA
LE RANCOLE
DISCARICA
PIETRASALARE-NUOVA
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GESSI DI ONFERNO

CS 7

EKCNA_Supplementary Information_2023

- EKCNA-SI_Supplementary Information_2023.pdf

EKCNA-SI-Q1_Comparative-Analysis

- EKCNA-SI-Q1_quantitative-analysis-data_2023.xlsx

EKCNA-SI-Q5b_Attributes-and-protection

- README.pdf
- EKCNA_M_CS1 Geo-attributes and protective designations.pdf
- EKCNA_M_CS2 Geo-attributes and protective designations.pdf
- EKCNA_M_CS3 Geo-attributes and protective designations.pdf
- EKCNA_M_CS4 Geo-attributes and protective designations.pdf
- EKCNA_M_CS5abc Geo-attributes and protective designations.pdf
- EKCNA_M_CS6 Geo-attributes and protective designations.pdf
- EKCNA_M_CS7 Geo-attributes and protective designations.pdf
- EKCNA_M_GIS Data_Geo-attributes and protective designations
  - EKCNA source shapefiles answer 5b.zip

EKCNA-SI-Q5c_Prohibited-Activities

- README.pdf
- EKCNA_M_CS1 Prohibited activities.pdf
- EKCNA_M_CS2 Prohibited activities.pdf
- EKCNA_M_CS3 Prohibited activities.pdf
- EKCNA_M_CS4 Prohibited activities.pdf
- EKCNA_M_CS5abc Prohibited activities.pdf
- EKCNA_M_CS6 Prohibited activities.pdf
- EKCNA_M_CS7 Prohibited activities.pdf
- EKCNA_M_GIS Data_Prohibited activities
  - EKCNA source shapefiles answer 5c.zip

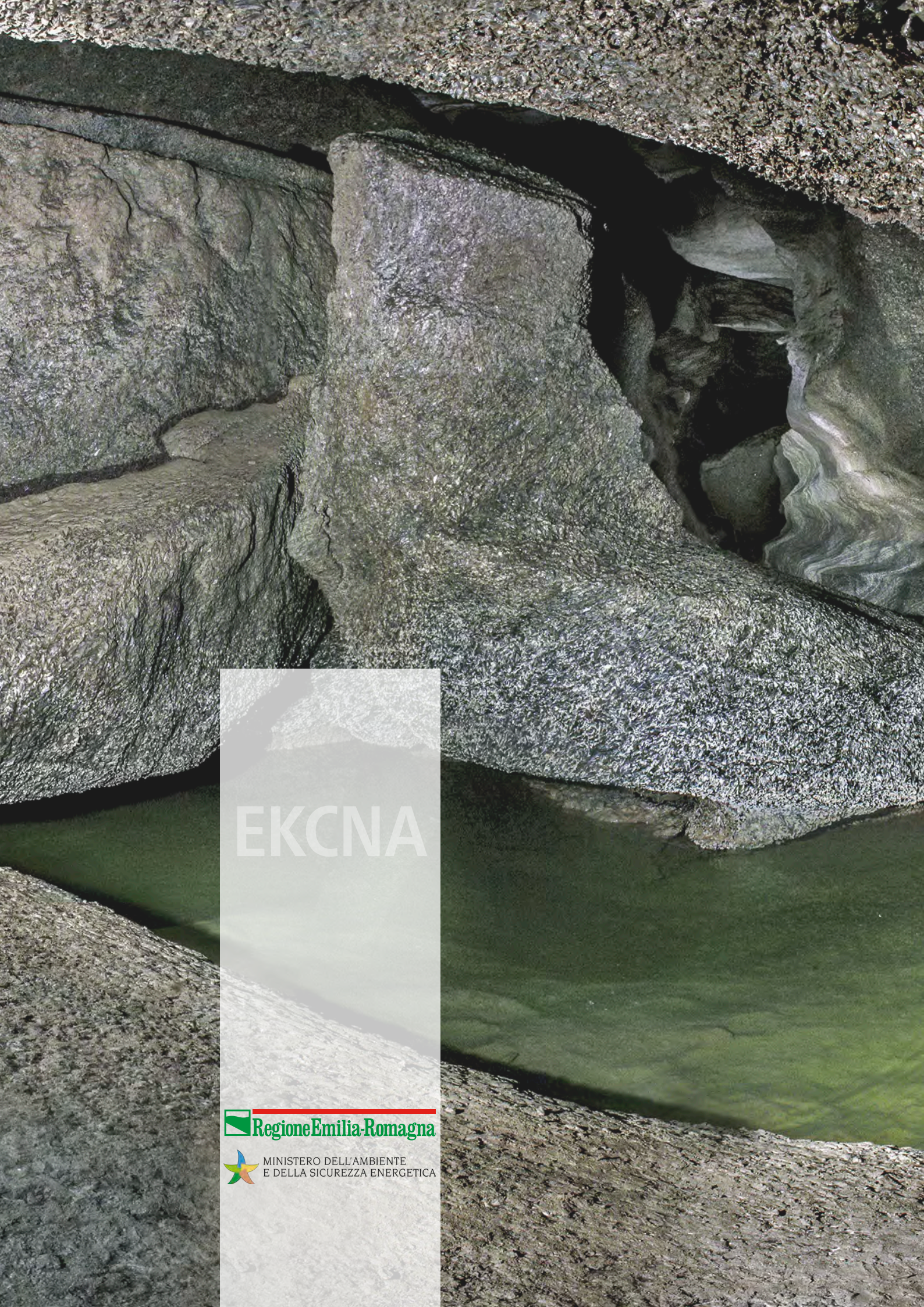
EKCNA-SI-Q6e_Staffing_and_Funding

- EKCNA Staffing data.xlsx
- EKCNA Funding data.xlsx

EKCNA_Nomination Documents_2022

- EKCNA-ND-A_Executive-Summary-EN_2022.pdf
- EKCNA-ND-B_Nomination-Dossier_2022.pdf
- EKCNA-ND-C_Annexes_2022.pdf
- EKCNA-ND-D_Maps-and-Plan_2022.pdf
- EKCNA-ND-D_Maps-and-Plan-M1_2022.pdf
- EKCNA-ND-D_Maps-and-Plan-M2_2022.pdf
- EKCNA-ND-D_Maps-and-Plan-M3_2022.pdf
- EKCNA-ND-D_Maps-and-Plan-M4_2022.pdf
- EKCNA-ND-E_GIS-property-boundaries_2022.zip
- EKCNA-ND-F_project-OMS_2022.pdf

EKCNA



EKCNA

Regione Emilia-Romagna

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E DELLA SICUREZZA ENERGETICA