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GEOMORPHOLOGY AND CULTURAL HERITAGE OF THE PONCI VALLEY (FINALESE KARSTIC AREA, LIGURIAN ALPS)

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The Finalese is an area of great geomorphological and cultural value, with major scientific, landscape, socio-economic, and historical features that offer opportunities for investigating the relationships between issues concerning geodiversity and land use.

This paper presents the geomorphological and environmental profile of the Ponci Valley, which is located in the Finale Ligure (Savona) hinterland, and its relationship with the presence of some artefacts of Roman age (13-12 B.C.).

The Ponci Valley, which is composed mainly of bioclastic limestones and secondarily of underlying dolomitic limestones, is included in the more extensive Finalese karstic area including several plateaus (i.e. Manie, Camporiundu, and Bric dei Frati). The Ponci Valley is a relict valley that was once more extensive than it is today and was later captured by the adjacent Sciusa and Corealto streams.

The lithological features, geomorphological evolution, and morpho-structural relationships between the outcropping lithotypes, through a marked infiltration of rainfall and an underground flow, caused the formation of karstic surface and underground phenomena whose evidence is provided by the presence of cockpits, dolines, and uvalas as well as several swallow-holes, springs, and caves; the latter are mainly located along the contact between the dolomite and bioclastic limestones.

Along the Ponci Valley, five Roman bridges can be observed, three of them are still well-preserved, as well as embankment protection structures and some remains of road parts: these represent one of the best evidences of the *Via Iulia Augusta*, a remarkable example of the ancient Roman roads system that can still be observed in western Liguria. Favourable climatic conditions throughout the year, together with the valuable landscape and environmental aspects, led to a growing interest in terms of tourism and sport and the consequent creation of hiking and mountain bike trails, in addition to the well-established caving and climbing.

This site has geomorphological, environmental, and archaeological value and in all it can be acknowledged as a geosite of Mediterranean importance. Thereby it represents an asset of high cultural and landscape value for which protection and enhancement measures must be undertaken to preserve it and, at the same time, to promote sustainable tourism.

KEY WORDS: Karstic phenomena, Stone georesources, Roman bridges remains, Geotourism, Ligurian Alps.

INTRODUCTION

General interest in aspects of earth sciences associating the natural landscape with cultural heritage is growing: the concept of Cultural Geomorphology has been introduced in this scenario with scientific explanations and innovative research methodologies. According to current definitions (Panizza, 2001; Panizza & Piacente, 2003; Reynard, 2008) this subject aims to investigate the geomorphological elements of a region by considering it a natural landscape asset and for its relationship with cultural assets of architectural, historical and archaeological types.

The relationships between geomorphology and the cultural elements can be considered schematically according to two reciprocally integrated viewpoints: i) geomorphology meant as a component of a territory's cultural heritage; ii) the relationships between some cultural components of a territory and the geomorphological context in which they are inserted (Panizza & Piacente, 2008; 2009; Reynard, 2009a; 2009b).

This paper presents the geomorphological and cultural heritage of the Ponci Valley, which is located in western Liguria, in the Finalese area: this region plays an international geomorphological role with major scientific, landscape, socio-economic, and historic-environmental features providing opportunities for an in-depth study of the scientific issues mainly concerning geodiversity and geoarchaeology (Panizza & Piacente, 2000; Gray, 2004; Panizza, 2005; Dowling & Newsome, 2006; Brandolini & *alii*, 2007).

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The Finalese is one of the most charming areas of the Mediterranean sector. Its geomorphological features are well-known, being characterized by a series of plateau and ridge zones with a number of peaks of limited elevation, but mainly representing rocky towers isolated by deep canyons: Rocca di Perti (360 m), Rocca Cornei (357 m), Rocca degli Uccelli (332 m), and Bric dei Crovi (382 m). This area includes several karstic springs and is crossed by a few water courses, some of which flow underground; terraced landforms, flood plains, and karstic depressions, swallow-holes, and caves are found here. The high rocky coast between Capo Noli and Capo della Caprazoppa exhibits small bays with pocket beaches. The central part of this area features the *Pietra di Finale Auct.*, composed of bioclastic vacuolar limestones with corals, typically white-rose coloured; the great layers of Dolomites of S. Pietro dei Monti outcrop around it, intercalated by dolomitic limestones with small gastropods and quartzites. Except for small cultivated areas and isolated cores at the area margins on the Manie plateau and valley floor connecting the «Rocche» (rock towers), the Mediterranean landscape has a very natural character despite the presence of abundant evidences of ancient human settlements dating back to all the historic periods until the Palaeolithic.

The Ponci Valley, in particular, is bounded by the Verzi mountains and the rocky spur of Rocca del Corno: this is a relict valley, with the stream erosion being scarcely relevant nowadays. The waters that have incised it are presently flowing underground owing to karstic phenomena and their blowout occurs at the Acquaviva spring in the nearby Sciusa Valley.

The valley preserves the most relevant and monumental evidence of the Roman communications routes in Liguria: the ancient *Via Iulia Augusta* from Vado Ligure (*Vada Sabatia*) turned towards the hinterland to avoid hazardous active coastal cliffs, running behind Capo Noli, and entered this valley from the north across the Magnone Pass (Bulgarelli, 1996; Bulgarelli & Massabò, 2001).

Vestiges of five huge bridges crossing the desiccated water course can still be observed today. These were built using the stone probably extracted from the quarries that can be visited along the trail; after the Ponte dell'Acqua, at Cà du Puncin, it is possible to climb up to the Ciappa del Sale where, from the Mediterranean scrub, there is a panoramic view of the coast and adjacent Maritime Alps.

The Ponci Valley is a tourist attraction for free-climbers, who find several equipped rock walls, and speleologists; however its trails are also frequented throughout the year by hikers and mountain-bikers.

For this reason a growing educational and hiking interest has recently developed through the planning of geoexcursion and geotouristic trails.

The purpose of this paper is to provide an in-depth geological and geomorphological analysis, considering the landscape's cultural features and its interaction with human presence and activity in order to underline the tourist and cultural values of the area.

GEOGRAPHICAL SETTING

The Ponci Valley is located in the province of Savona and includes the municipalities of Finale Ligure, Vezzi Portio, and Noli (fig. 1). This valley mainly runs N-S for about 3 km and is separated westward from the valley of the Sciusa Stream by the ridge of the relieves Rocca del Corno (302 m), Rocca degli Uccelli (369 m), and Bric Carè (482 m). It is bounded to the northeast by the Manie plateau, the valleys of the Corealto and Noli streams, the Bric dei Monti (443 m), and a series of minor relieves extending as far as the Bric Briga (320 m).

The Ponci Valley represents the northeast sector (5.9 km²) of the Sciusa Stream valley (26 km²), and its mouth is to the east of the Finale Ligure town; the Ponci Stream has two main left-bank tributaries, the Landrazza and Armetta streams.

Since more than three decades ago, plans have been made to set up the Finalese Regional Park in this area, which belongs to the European ecological network Natura 2000, which was established to ensure the habitat protection of environmentally valuable areas including the Sites of European Interest. The sector that has been studied, among more than a hundred sites of the Ligurian region, belongs to the Finalese-Capo Noli Site of European Interest.

Furthermore the Manie plateau is one of the 39 karst areas in Liguria (Manie/Capo Noli area), spreading over almost 14 km² and containing more than 2.5 km of the total length of surveyed caves.

With an annual mean rainfall of about 900 mm and an annual mean temperature of about 15 °C, this area shows the typical Mediterranean climate with dry summer and rainy remaining periods, particularly in the autumn.

Climatic features can be described by using data collected by the meteorological stations at Calice Ligure (at 70 m a.s.l.), Manie (297 m), Rialto (376 m), Feglino (160 m), and Colle del Melogno (1028 m), which provided data series in the period between 1950 and 1995.

Precipitations rise linearly with altitude and range between about 900 mm/y along the coast (Pietra Ligure and Capo Noli) and more than 1200 mm/y at Colle del Melogno, which represents the saddle along the Tyrrhenian-Po River ridge. Annual mean temperatures vary similarly, ranging from about 16 °C along the coast to below 10 °C at Colle del Melogno (fig. 2).

If Calice Ligure is considered a typical station, precipitations exhibit an absolute maximum in October (120 mm) and a relative maximum in March (108 mm), whereas the minimum is recorded in July with values less than 30 mm. Air temperature in the same period shows a minimum in January and February, between 6 and 7 °C, and a summer maximum slightly above 22 °C in July and August.

As mentioned below, landform evolution in the area is associated with karstic phenomena and running waters, with a different extent of the catchment area compared to the hydrogeological basin: rainfall distribution over seasons exhibits comparable values in winter, autumn, and spring with about 260-280 mm; in the three summer

FIG. 1 - Location of study area with Roman communication routes in Liguria and geological sketch map of Finalese and surrounding sector: 1) plio-quaternary deposit; 2) bioclastic limestone - *Pietra di Finale Auct.* (Miocene); 3) dolomitic limestones and quartzites (Mesozoic-Cenozoic); 4) porphyroids, prasinite, and quartzschists («External Brianzonese», Carboniferous-Permian); 5) porphyroids, prasinite, and quartzschists («Internal Brianzonese», Carboniferous-Permian); 6) metamorphic schists («Internal Brianzonese», Carboniferous-Permian); 7) granites, gneiss, and amphibolites («Internal Brianzonese», Carboniferous-Permian); 8) main karstic plateau. The rectangle shows the location of Ponci Valley.

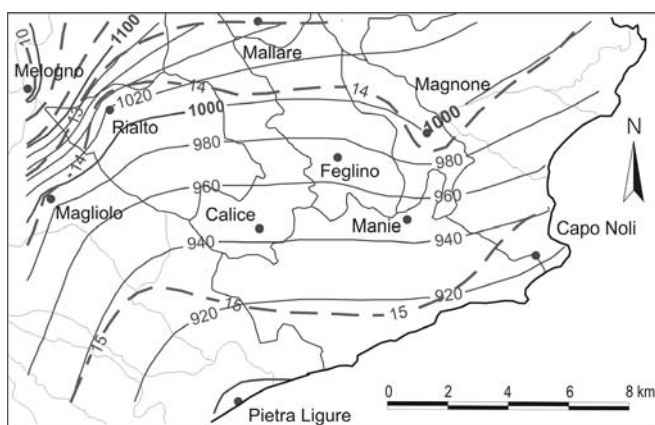
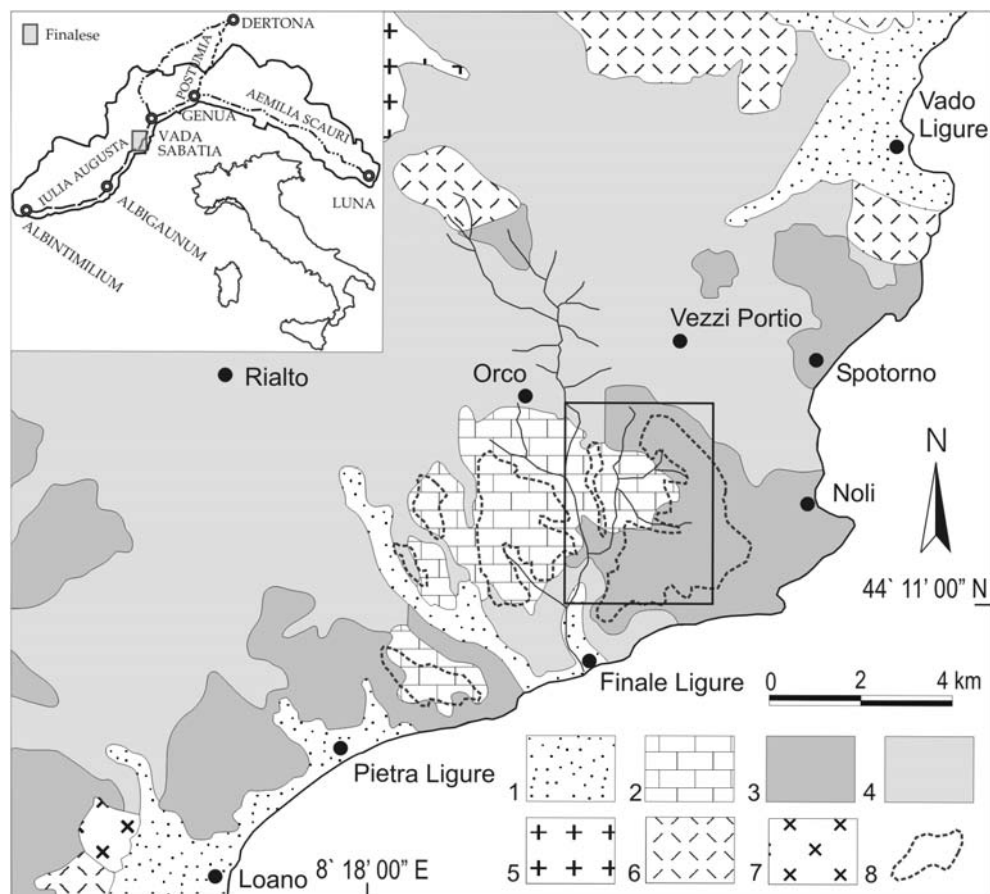


FIG. 2 - Isohyet and isotherm map of Finalese and surrounding area. The map shows the mean annual distribution of rainfall in mm (bold line) and temperature in °C (dashed line).

months rainfall is nonetheless relevant as it exceeds 100 mm. Evapotranspiration is in the 600 mm range: depending on the monthly mean temperatures it ranges between a minimum below 40 mm in winter and a maximum over 200 mm in the three-month summer period, when dryness and outflow deficit occur in July. In this period however

an external supply is provided by condensation phenomena, fostered by winds saturated with water vapour blowing from the south and by the marked contrast of temperatures between soil and air.

Heavy and short precipitations are frequent in autumn when rainfall amounts can reach, in only a few days, half or more than half of the annual value: these occurrences usually represent the factor that triggers geomorphological instability (Brandolini & *alii*, 2008).

GEOLOGICAL OUTLINES

This western Liguria sector is included in the Brianzonese Domain of the Ligurides, which in this area is mainly composed of the external Brianzonese (Mt Carmo-Rialto Unit and its stratigraphic cover). A small *klippe* of external Brianzonese lies to the north (Pamparato-Murialdo Unit); this is made up primarily of metamorphic schists, porphyroids, quartzites, carbonatic rocks and secondarily of clay-limestone schists and conglomerates (fig. 1).

The Ponci Valley features, over two thirds of its length, the outcropping *Pietra di Finale Auct.*, which is a middle Miocene limestone attributed to the Mt Cucco member (Boni & *alii*, 1971). This is a white or pink bioclastic lime-

stone, rich in macrofossil fragments composed of prevalent corals, codiaceae and balanides. The limestone is composed of up to 15% terrigenous components (fine and coarse clasts with quartz-sericitic, quartz-feldspathic, and quartzitic composition). It shows highly fractured and almost subhorizontal layers (5-10°); their main direction is E-W with a dip towards the north in the southern sector and towards the south in the northern sector of the valley.

The *Pietra di Finale Auct.* lies transgressively on the Pre-Tertiary basement, which, in the study area, is mainly composed of dolomitic limestones (San Pietro dei Monti Dolomites) outcropping on the upper and lower basins. Secondary materials in this area consist of quartzites (Ponte di Nava Quartzites), marble-limestones (Val Tanarello Limestones), metandesites (Eze Formation) with associated quartz-sericitic schists and phyllites (Gorra Schists) and porphyroids (Melogno Porphyroids) outcropping on the valley head.

From the tectonic perspective, the *Pietra di Finale Auct.* shows moderate fragile and semifragile deformations that can be referred to folds and faults with preferential directions along two axes oriented E-W and N40-N50 (Marini, 1987). Conversely, the Pre-Tertiary basement is intensely deformed by anticlines and synclines oriented NNE-SSW and displaced by faults oriented NW-SE or NE-SW. Their intersection results in a division of the region into blocks. These geological and structural conditions, featuring two main directrices oriented NE-SW and E-W, dramatically influenced the geomorphological evolution of the valley.

GEOMORPHOLOGICAL SETTING

General features

The Ponci Valley is included in the more extensive Finalese karstic area with various plateaus (i.e. Manie, Camporiundu and Bric dei Frati). These represent the relict remnants of a single karstic plateau that was the consequence of the uplifting, erosion and following dry-up of a more extensive post-Miocenic erosive surface with weak inclination to the south. Its existence is suggested by the correlation of present summit surfaces. The plateau has later been incised by allogenic fluvial valleys and the Ponci Valley is a clear example of this stream evolution (Biancotti & *alii*, 1991).

Thus the Ponci Valley represents the relict of a valley that was more extensive than it is currently and was spread towards the north, past the San Giacomo Saddle, and later captured by the Sciusa and Corealto adjacent streams.

This feature enables one to explain the presence in the Ponci Valley of such an extensive valley floor that is not consistent with the current configuration of the catchment (5.9 km²); it is filled with thick alluvial deposits that formed during a static stage of the region with relative eustatic uplift. When the relative uplift started again it produced the current hanging valley through resumed erosion (Biancotti & Motta, 1989; Biancotti & *alii*, 1991).

From the relief structure perspective, this valley is bounded to the west by tabular relieves similar to a *mesa*, such as Rocca di Corno and Rocca degli Uccelli, and to the east by the Manie Plateau: its margins are mainly characterized by vertical walls and its origin is related to the double action of gravitational and karst processes, with evidences of toppling phenomena, particularly along its orographic right (fig. 3).

As underground flows are prevalent over run off, the Ponci Valley can be considered as a relict and hanging valley and erosion phenomena associated with flowing waters are limited to rare and considerably intense meteoric events. Stream erosion potholes are nonetheless relevant: these are incised in the dolomitic limestones along the final part of the Ponci Stream at the morphological jump where it flows into the Sciusa Stream.

The valley floor seems to be overextended compared to the present basin setting and it involves alluvial deposits extending almost continuously along the Ponci stream from 150 m a.s.l. close to the Ponte delle Fate bridge to nearly 300 m a.s.l. just below the Magnone bridge. Residual materials, originating from carbonate rocks dissolution, are typical here (Rellini & *alii*, 2007): these caused the accumulation of red soils where major karst depressions are found (Ajassa & Motta, 1991).

Owing to the prevalence of carbonate rocks, the valley is mainly characterized by landforms and deposits due to karstic processes. Man-made landforms related to agricultural terraces, quarry activities, and particularly archaeological sites of Roman bridges are also considerably important.

Karst landforms

Karst phenomena developed in this valley and are witnessed by several examples of shallow landforms such as cockpits, dolines and uvalas in the north-western sector of the Manie plateau, as well as caves, swallow-holes, and springs mainly along the contact between the dolomitic limestones and the *Pietra di Finale Auct.* (fig. 3).

Swallow-holes and caves surveyed in the upper catchment are relevant for understanding the geomorphological evolution and underground water flow: these are located along the Ponci Stream (about 210 m a.s.l.) slightly downstream of the Ponte dell'Acqua and along the Landrazza Stream (about 245 m a.s.l.). These represent the absorption spots of shallow waters and the consequent fossil valley.

Underground water flow is fostered by fracture permeability of the *Pietra di Finale Auct.*: the karst network is particularly developed along the contact with the pre-Tertiary bedrock that is permeable and could become karstic, although to a lesser degree compared to the *Pietra di Finale Auct.*. The underground water flows in an E-W direction, determining a line of karstic springs in the adjacent Sciusa Valley. The Acquaviva spring in particular is the resurgence that drains most of the waters of the Ponci Stream catchment, highlighting the difference between the superficial and hydrogeological catchment (Maifredi & *alii*, 1972).

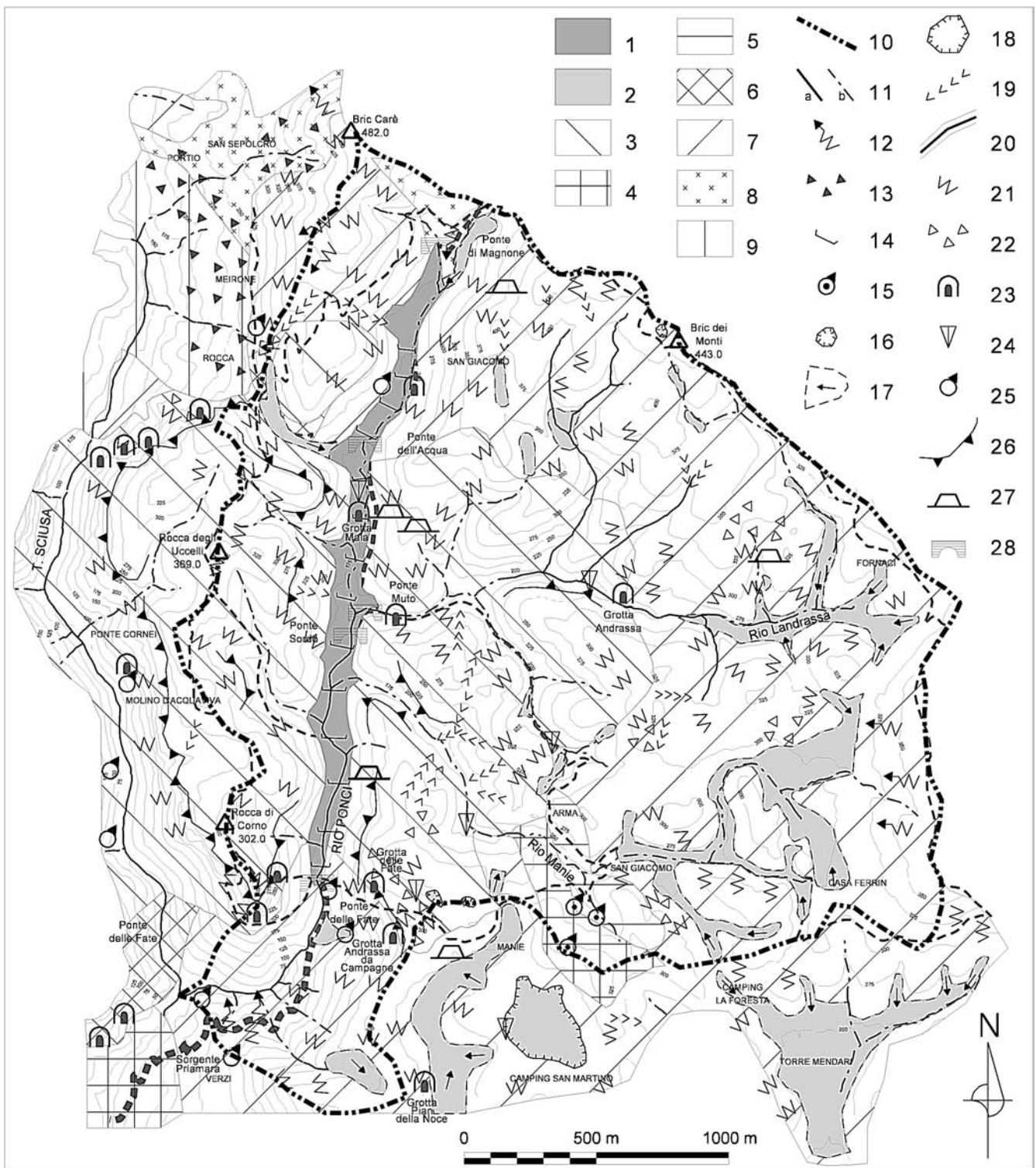


FIG. 3 - Geomorphological map of Ponci Valley. Lithological data: 1) alluvial deposit; 2) red soil deposit; 3) bioclastic limestone (*Pietra di Finale Auct.*); 4) conglomerate and polygenic sand; 5) marly and arenaceous limestone, clayey shales; 6) limestone; 7) dolomitic limestone; 8) quartzite; 9) meta-andesite. Geomorphological data: 10) watershed ridge; 11) water course: perennial (a), intermittent (b); 12) sheet and rill erosion; 13) cemented colluvial deposit; 14) oversized fluvial valley; 15) spring; 16) doline; 17) cockpit; 18) uvala; 19) karst valley; 20) karst canyon; 21) karren; 22) haystack field; 23) cave; 24) swallowhole; 25) karst blowout; 26) edge of karst scarp with rock fall. Man made landform: 27) quarry site; 28) Roman bridges location.

In the Ligurian Speleological Inventory, 34 karstic hollows have been listed, but only in part explored, related to three main directrices of hydrogeological flow corresponding to as many karstic systems and relative springs (Delegazione Speleologica Ligure, 2006): a) Manie Plateau - Acquaviva; b) Pian della Brera - Pian dei Meli; c) Pian della Noce - Priamara.

In the karstic system of the Manie plateau the Mala Cave, Andrassa Cave (or Cane Cave), Ingriv Cave and Contatto Cave (according to unpublished information, Maifredi A.; this cave is not listed in the above Inventory) are interesting for their peculiar landforms and deposits.

The Mala Cave in particular, also known as the Ponci Stream swallow-hole, located at about 200 m a.s.l., was discovered and explored in the early 1970s to -60 m and for a length of 250 m. In the early 1990s the cave has been further explored to -100 m and for a total length of 1,200 m. Hollows, columnar calcite concretions and thick clay deposits can be observed inside.

The Contatto Cave, also dubbed Finalese Grotta Nuova, located at about 250 m a.s.l., is about 400 m long and about 40 m deep. It exhibits two wide falling halls: one features several columnar structures, partly displaced and re-concreted (fig. 6D). The Manie plateau karst area resurgence (karst blowout) is located close to Mulino dell'Acquaviva at about 70 m a.s.l. (fig. 6B).

The Pian della Brera karstic system includes the homonymous swallow-hole (not listed in the inventory): its flow has been documented by a tracer (Maifredi & alii, 1972) and surveyed at the Pian dei Meli resurgence; presumably the Andrassa da Campagna Cave also belongs to this system.

The Pian della Brera swallow-hole is represented by an old drainage borehole covered with dry stones, currently obstructed. After heavy rainfall events a temporary lake is formed.

The Pian della Noce karstic system includes the homonymous swallow-hole and its resurgence, the Superiore Cave of the Priamara spring.

The Pian della Noce swallow-hole, located at 255 m a.s.l., is composed of a drainage bore-hole covered with stone, about 7 m deep.

The Superiore Cave of the Priamara spring, located at about 160 m a.s.l., was discovered and explored in the early 1970s for a length of about 500 m and up to +40 m from its entrance. In the late 1980s the final trap, which was plugged by sand deposits, was crossed and the cave extended to about 1,700 m length and to an altitude of about +100 m. One of the cave branches is considerably wide with stalagmite structures and a number of aragonite concretions. Several occurrences of toppled stalagmites and re-concretions can be observed.

Man-made landforms

The Ponci Valley includes the *Via Iulia Augusta*, along which five single-arch bridges (dated 13-12 B.C.) can be found (Barocelli, 1930; 1934; Lamboglia, 1954; 1976).

These bridges, together with embankment protection structures and some remains of road parts, represent the most important and monumental evidence of Roman communication routes in Liguria. Their technical and construction characteristics can be considered to be state-of-the-art for the Roman period and represent a peculiar example of management of stone materials in relation to the lithological features and geomorphological conditions.

Going uphill from the valley, between 150 m and 300 m of elevation, remains and structures of the following Roman bridges can be observed (fig. 5A):

– Ponte delle Fate. The best preserved bridge. This 5.8 m wide bridge, which is still used today, was built with a single round arch whose base is 6.6 m wide. The arch is 3.8 m high. It was built almost entirely with bioclastic limestone (*Pietra di Finale Auct.*) ashlar and very rare ashlar of dolomitic limestone and quartzite. The biggest imposts, which are built on gravel and pebble alluvial deposits, are in the metric range. Both upstream and downstream tracts of the ancient containment walls of the *Via Iulia Augusta* can be observed; these were also used as riverbank protection (fig. 5D).

– Ponte Sordo. Evidence of this bridge is provided by the vestiges of its abutments, particularly those on its orographic left, and ramps. A road tract of the *Via Iulia Augusta* was unearthed on its orographic right a few years ago by archaeological excavations nearby (Bulgarelli, 2003). Artefacts can still be seen and are almost entirely represented by small rectangular blocks of bioclastic limestone (*Pietra di Finale Auct.*).

– Ponte Muto. This bridge, 5.5 m wide, is fairly well preserved and crosses the Landrazza riverbed slightly upstream of its confluence with the Ponci Stream. This bridge is composed almost completely of *Pietra di Finale Auct.* blocks and only secondarily of dolomitic limestone and quartzite.

– Ponte dell'Acqua. It is 3.65 m wide at the base and 2.05 m high. It rests directly on the rocky limestone and dolomitic bedrock and contains neither piers nor containment structures.

– Ponte di Magnone. Its remains show traces of the decorated arch, without an arched lintel, and a small section of the ramp containment wall. The ashlar are composed primarily of quartzite and secondarily of dolomitic limestone as well as schists of various types.

The vestiges of the ancient quarries where bioclastic limestone blocks and ashlar have been mined could still be observed along the valley both on the surface and underground.

Agricultural terraces represent further examples of the utilization of natural resources in the Ponci Valley. In particular, the lower slopes sectors have been modified by human action for the construction of terraces. The dry stone walls dating back to medieval age, mainly made of bioclastic limestone ashlar, sustain colluvial and alluvial deposits that have been planated so as to obtain level surfaces mainly used in the past for wheat cultivation and currently for growing vineyards.

GEOTOURISM

Favourable climatic conditions throughout the year, together with the valuable landscape and environmental aspects, led to a growing interest in terms of tourism and sport and the consequent creation of hiking and mountain bike trails, in addition to the well-known practices of speleology and climbing. These aspects play a particular role in the Finalese because this area is a natural environment that is also of great value in scenic-landscape terms. This landscape has scarcely been modified by human activity and its location, close to the seaside tourist resorts of the Riviera di Ponente (western coast), enables tourist pressure along the coast to be reduced by attracting a large and heterogeneous public.

Based on the geological, geomorphological and environmental features that have been described above and also taking into account the geoarchaeological value of this site, a geotouristic sketch map of the Ponci Valley has been compiled with the purpose of easy identification of

the most interesting aspects, enabling their enhancement and use for different types of hiking such as educational, scientific, sport, and tourist-cultural hiking (fig. 4).

Specific symbols highlight the main features of the valley and some geopanoramic points overlooking the surrounding area, especially cultural geomorphology as well as geoarchaeology in relation to the existing network of trails.

The main communication route runs along the valley floor: one can drive along the first short sector, but the second part, between the Ponte delle Fate bridge and the San Giacomo Saddle, is only pedestrian; secondary paths wind along small tributary valleys of the Ponci Stream and along most of the eastern ridge (fig. 5A, 5D).

Significant geomorphological hazards have not been identified along the trails network, except for sudden floods of the main water course caused by heavy rainfalls.

Among geomorphological attractions, karst landforms are mainly highlighted, such as the cave close to the Ponte delle Fate bridge, a couple of swallow-holes located on the

FIG. 4 - Geotourist sketch map of Ponci Valley: 1) drainage basin; 2) trail network: dirty road (a), main trail (b), secondary trail (c); 3) drainage network; 4) karst cave; 5) swallow-hole; 6) stream erosion pothole; 7) rock scarp; 8) Roman bridge; 9) historical quarry site; 10) geopanoramic point.



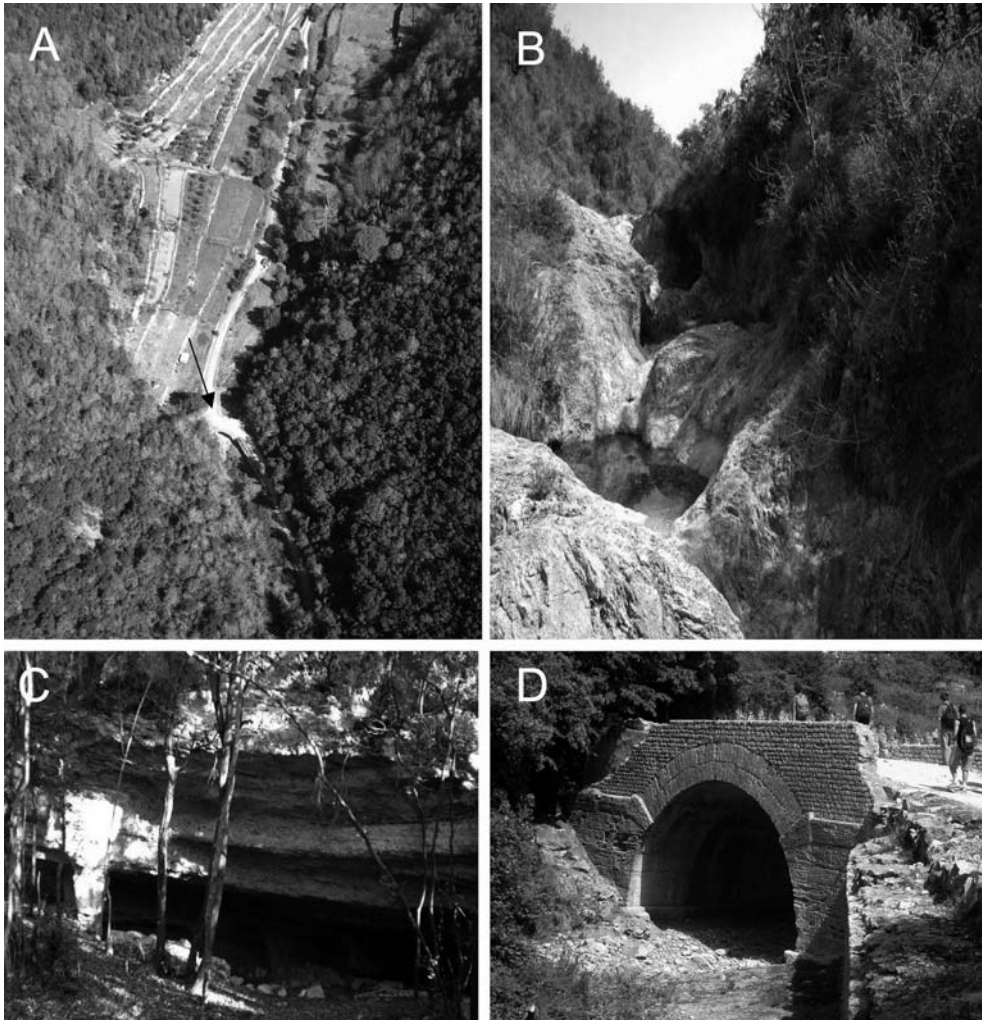


FIG. 5 - Aerial panoramic view of the lower sector of Ponci Valley showing the location of *Ponte delle Fate* bridge (black arrow) along the ancient Roman road *Via Iulia Augusta* (5A). Stream erosion pothole in dolomitic limestone bedrock (5B). Entrance of a former underground quarry of *Pietra di Finale Auct.*, located in the upper sector of the valley (5C). *Ponte delle Fate* bridge almost entirely built with bioclastic limestone (*Pietra di Finale Auct.*) ash-lars and secondarily with ash-lars of dolomitic limestone and quartzite (5D).

main valley floor, and the swallow-hole of the Landrazza Stream (fig. 6C). Furthermore a typical stream erosion pothole can be observed just downhill of the Ponte delle Fate bridge (fig. 5B). In this sector a high cliff referred to the *Pietra di Finale Auct.* can also be found: its current aspect, moreover karst phenomena, is certainly influenced by gravity processes such as rock fall, evidenced by blocks found at its base.

In such an environmental scenario of considerable value, the rocky cliffs tens of metres high play a key role in geotouristic terms as these are used by free-climbers thanks to the remarkable geological and structural features of the rock and, at the same time, these are geosites typical of the *Pietra di Finale Auct.* (fig. 6A); obviously in the first case their use is limited to a small group of well-trained specialists, whereas in the second case these are appreciated universally and particularly by the lovers of earth sciences.

From this perspective, the visits to underground karst environments are also nowadays limited to speleologists or to an expert public who must be accompanied by guides when visiting the caves (fig. 6C).

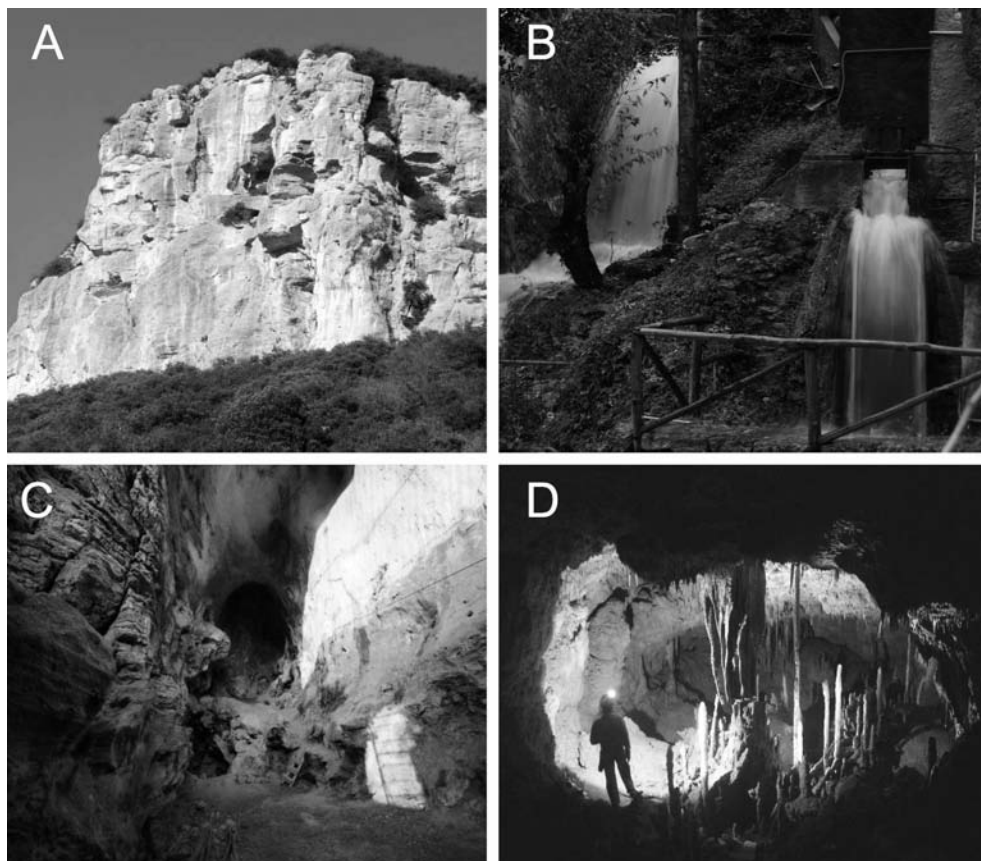
The quarry sites of the *Pietra di Finale Auct.* are considered of geomine interest. These quarries were abandoned decades ago: at first they were open-cast mines and later they became underground mines as witnessed by the quarry, dating back to Roman and medieval age, located in the central-upper part of the basin, on the orographic left between the Ponte Muto and the Ponte dell'Acqua bridges (fig. 5C).

In this natural scenario the five Roman bridges have a special geoarchaeological value, being the most relevant and monumental vestiges of the Roman communication routes in Liguria: the *Via Iulia Augusta*. These bridges are located along the Ponci Stream and in one case along the Landrazza Stream. These are single-arch bridges: three are still entirely preserved and two are witnessed by some vestiges of their abutments and ramps.

FINAL REMARKS

The Ponci Valley represents a geological heritage of great interest and scientific, cultural, socio-economic and landscape value.

FIG. 6 - Rocca di Corno cliff (302 m) is a representative outcrop of *Pietra di Finale Auct.*, used by free-climbers (6A). The Manie Plateau and Ponci Valley karst area resurgence (karst blowout), located close to Mulino dell'Acquaviva at about 70 m a.s.l. in the adjacent Sciusa Valley (6B). Entrance of Fate cave, located to the orographic left just uphill of the *Ponte delle Fate* bridge (6C). Contatto Cave showing several columnar structures, partly displaced and re-concretioned (6D) - (Photos by A. Maifredi).



Lithologies of different ages and origins can be observed over a surface of less than 6 km²: Miocene bioclastic limestones lying on a Pre-Tertiary basement that is composed mainly of dolomitic limestones in the medium and lower sectors of the valley and secondarily of quartzites, marble-limestones, and metandesites with associated quartz-sericitic schists as well as phyllites and porphyroids outcropping on the valley head.

Owing to the prevalence of carbonate rocks, the valley is characterized mainly by karstic landforms and deposits and secondarily by gravity and running water phenomena and anthropogenic activities.

Several scientific aspects, which also have an educational value and are very interesting, enable the observation of geomorphological evolution models related to various past morpho-climatic conditions, also associated with human presence.

The cultural value of this area is related to the presence of five Roman bridges, embankment protection structures, and some remains of roads that represent one of the best evidences of the *Via Iulia Augusta*, a remarkable example of the ancient Roman roads system that can still be observed in western Liguria. Agricultural terracing also represents a model of lithology applied to the construction of dry stone walls for soil conservation and slope stability.

Various types of tourism have recently developed, also due to the proximity of the coast; this tourism is related to

the geological, geomorphological, and geoarchaeological aspects of this area and is frequently associated with sites of sport hiking and enogastronomical interest.

The habitual visiting of all the environmental attractions mentioned above can be enhanced through the creation of guided trails of various types according to their geodiversity value: one has already been planned and implemented along the ancient Roman road network. More trails can be proposed for taking advantage of all the aspects related to the several geo-themes described above.

Another possible trail of scientific value, taking into account that the karst phenomena are the main geomorphological processes, goes along the Landrazza Stream and enables observation of micro and macro karst landforms and a possible access to underground landforms through the creation of an equipped trail in the Andrassa Cave.

The historic-cultural aspect can be appreciated along the trail of the ancient *Via Iulia Augusta*, which enables five Roman bridges and an old kiln as well as the *Pietra di Finale Auct.* quarries to be crossed.

Between Rocca degli Uccelli and Rocca di Corno a ridge trail is found with scenic-landscape value featuring a geopanoramic view for observing the general morphological setting of the Ponci Valley and the adjacent Sciusa Valley towards the west. Furthermore the position at altitude and favourable slope aspect enable the frontal observation of the Landrazza valley and the hanging valley in the final

part of the Ponci Stream, downhill of the first Roman bridge (Ponte delle Fate).

Finally, socio-economic aspects can be appreciated along the wine landscape trails so as to highlight the relationship between the geological and geomorphological conditions and the vineyard cultivations that are spread over two hectares (Pigato, Rossese, Vermentino and Vinaccia). The related accommodation facilities are located on geosites such as the case of the Società Agricola Val Ponci and its vineyards covering terraces along the valley floor in the red soils, or the typical cuisine of the area proposed by the facility built in the Arma delle Manie, one of the biggest caves of the Finalese area, which enabled palaeo-climatic and palaeo-environmental data to be collected.

Thereby the Ponci Valley has geomorphological, environmental, and archaeological value and in all it can be acknowledged as a geosite of Mediterranean importance. It represents an asset of high cultural and landscape value for which protection and enhancement measures must be undertaken so as to preserve it and, at the same time, to promote sustainable tourism by the creation of a protected area.

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