Il Quaternario
*Italian Journal of Quaternary Sciences*
***18**(1), 2005 - Volume Speciale, 93-101*

# THE MAIN GEOMORPHOSITES IN UMBRIA

**Lucilia Gregori, Laura Melelli, Silvia Rapicetta & Andrea Taramelli**
Dipartimento di Scienze della Terra, Università degli Studi di Perugia, Piazza Università
06123 Perugia; email: Lucilia@unipg.it

ABSTRACT: L. Gregori *et al.*, The main Geomorphosites in Umbria. (IT ISSN 0394-3356, 2005).
The Region of Umbria region is characterised by highly different geological and geomorphological environments, giving the territory a "geomorphodiversity" as well as considerable variability among its ecosystems. The identification of potential geomorphosites is interesting, and is aimed not only at protecting them, but also at an appropriate management and use of the territory as well.
This work attempts to provide a preliminary analysis by identifying common parameters within those numerous environments that best correspond to the "geomorphosite" model, based on their historical, geomorphological and landscape characteristics. Therefore a review of the Umbria's environments has been prepared.

*RIASSUNTO: L. Gregori* et al.*, Principali Geomorfositi in Umbria. (IT ISSN 0394-3356, 2005).*
*La regione Umbria è caratterizzata da ambienti geologico-geomofologici profondamente diversi tra loro che conferiscono al territorio una "geomorfodiversità" e, ovviamente, una profonda variabilità anche nell'ambito degli ecosistemi. L'identificazione dei potenziali geomorfositi è interessante e finalizzata non solo alla loro tutela, ma anche alla corretta gestione e fruizione del loro territorio.*
*Questo lavoro tenta una preventiva analisi individuando, attraverso parametri comuni, quei numerosi siti che, per caratteristiche storiche, geomorfologiche e paesaggistiche, meglio rispondono al modello di "geomorfosito". Si redige pertanto una rassegna dei siti umbri identificabili in tale ambito. I siti individuati sono estremamente rappresentativi ed in buona parte unici nel loro genere. Alcuni hanno un livello di valenza scientifica mondiale, come la "foresta fossile di Dunarobba", o il sito di Pietrafitta, noto sia i suoi reperti fossili (gli elefanti di Pietrafitta) che per il ruolo chiave nella ricostruzione paleogeografia del territorio regionale. Altri siti, come il "colle di Perugia", importante centro culturale ubicato al top di un paleoconoide, o Civita / Bagnoregio "la città che muore", sono stati selezionati per la presenza, oltre che di forme o associazioni di forme di indubbia qualità didattica e scientifica, anche per la compresenza di alti valori storico-artistici e culturali.*

Key words : Geomorphology, Geomorphosites, Landscape, Environment, Umbria, Italy.

*Parole chiave: Geomorfologia, Geomorfositi, Paesaggio, Ambiente, Umbria, Italia.*

## 1. INTRODUCTION

Central Italy is characterized by many "geological and geomorphological peculiarities" described in scientific literature as landforms, with high scientific or cultural value (Fig. 1).

To this end, recent research has developed a new insight that defines these areas as geosites or geomorphosites (BRANCUCCI & BURLANDO, 2000; PANIZZA, 1992; PANIZZA & PIACENTE, 2002a,b; POLI, 1999). Many research groups (Working Group of the I.A.G. "Geomorphological Sites" and the Italian Research project COFIN 2001-2003 "Geosites in the Italian landscape" with the UNESCO Working Group) are working on the identification, management and protection of geomorphosites and are organizing workshops to discuss and develop this issue (in example the "Geomorphological Sites: research, assessment and improvement" workshop in Modena, June 2002).

Based on the approaches currently available, the aim of this paper is to make an inventory of geomorphosites in and near the region of Umbria.

Some features, well known in literature (CARTON *et al*., 1994), are used to identify the value of the "natural resources." Others (scientific, cultural and social economic) are assessed to define the importance of the sites from a world, national, regional and local perspective (CARTON *et al*., 1994). Furthermore, there are limitations in the current approaches in describing and analy-

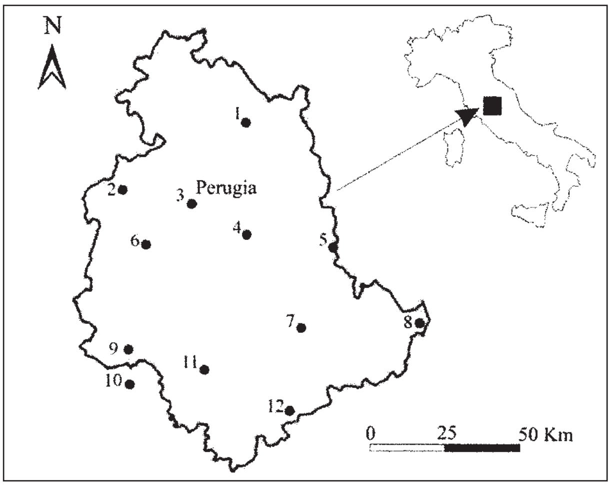


Fig.1 - Location map: main geomorphosites in the Umbria region: 1) Gubbio Basin; 2) Trasimeno Lake; 3) Perugia Paleo-Delta; 4) Subasio Mountain; 5) Colfiorito Polye; 6) Pietrafitta Mine; 7) Clitunno Springs; 8) Sibillini Mountains / Pian Grande Polye; 9) Orvieto "Mesa"; 10) Civita di Bagnoregio; 11) Dunarobba; 12) Marmore Falls.

*Localizzazione dell'area di studio: principali geomorfositi in Umbria: 1) il Bacino di Gubbio; 2) il Lago Trasimeno; 3) il Paleo-Delta di Perugia; 4) il Monte Subasio; 5) il Polye di Colfiorito; 6) la Miniera di Pietrafitta; 7) le Fonti del Clitunno; 8) i Monti Sibillini / il Polye del Pian Grande; 9) la Mesa di Orvieto; 10) Civita di Bagnoregio; 11) Dunarobba; 12) la Cascata delle Marmore.*

sing the degree of hazard and the ex-post recovery and fruition activities. Thus there is a need to improve existing methods and to develop new approaches. For each geomorphosite, some aspects, in addition to the literature (Brancucci *et al*., 1999), are described as conditions of hazard/risk situations. A better understanding of the mechanics and statistics of the geological and geomorphological processes involved, along with increased attention to the cultural heritage, has facilitated the individuation of several geomorphosites already known as important tourist resources in Umbria (Gregori & Rapicetta, 2001).

Geomorphosites are divided into two groups. In the first group, morphological characteristics are given together with cultural/historical and scenic values, for example medieval villages near or over landforms; in the second, scientific values are predominant. In this group the principal attributes are the peculiarities of the geomorphologic processes or the special nature of the landforms and its conditions.

## 2. GEOMORPHOSITES AND TOWNS

### 2.1 The hill of Perugia: an example of a paleodelta

Perugia is an excellent example of a town built over a fluvial paleodelta (Fig. 2). In the Plio-Pleistocene the paleo-Tiber flowed into the ancient Lake Tiberino near Perugia. The ancient town centre is built over the Tiber paleodelta top set (Cattuto & Gregori, 1988).

Sand and conglomerate strata in a horizontal setting (top set) are found at the top of the hill along the main roads of the town. Going downward toward the new part of the town, clays, mud/sands and sands outcrop in the middle part of the slope (foreset beds). At the bottom of the hill, these deposits are composed instead of finer particles (mud and clays) in horizontal strata. The lobes of the paleodelta are recognisable from different observation points. The Perugia paleodelta is of both scientific and cultural interest. According to this hypothesis the hill of Perugia is considered an erosional residue of Lake Tiberino. The recognising of the delta brings to light different neotectonic conditions linked to the evolution of Lake Tiberino and the paleo-Tiber flow direction. Furthermore, Perugia is one of the most important cultural and historical towns in central Italy. It is not the only example of a town situated on a fluvial paleodelta, but what makes it particular is the good state of preservation of the landform and the large number of points of observation along the hill recognisable, from top to bottom set beds (Fig. 3).

Some of the points of observation of paleodelta outcrops are situated near important historical sights in Perugia. Interesting outcrops are found at the Volumni Hypogeum (2nd century BC), an Etruscan chamber tomb, belonging to the Velimna family.

Another particular paleodelta outcrop sight is at the Etruscan well (2nd- 3rd cent. BC), a marvel of engineering skill. The many connections between urban development and geological-geomorphological evidence are the main grounds for defining the Perugia paleodelta as a good example of a geomorphosite.

### 2.2 The Orvieto "mesa"

The town of Orvieto is an important tourist attraction in Umbria. It is situated on a mesa derived from morpho-selection processes (Fig. 4).

During the Middle Pleistocene/Holocene, erosion processes separated the "mesa" from the Alfina high plain that was the northern part of the Vulsino Apparatus. The Orvieto mesa is an erosional "relic".

The sequence outcropping on these structures is in the upper part the pyroclastic series (tuffs) from vol-

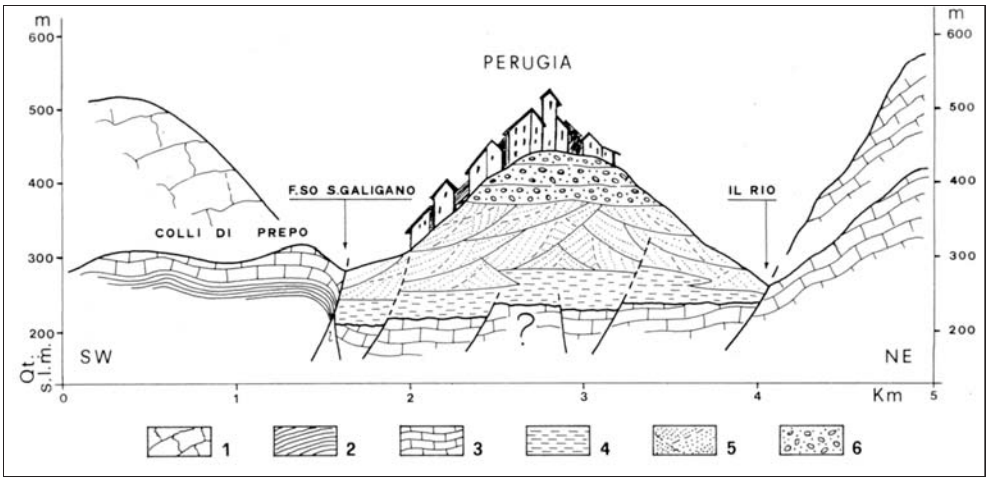


Fig. 2 – Perugia geological section: 1) calcareous bedrock; 2) marly bedrock; 3) arenaceous/marly bedrock; 4) clayey deposits; 5) sandy deposits; 6) gravel deposits (in Cattuto & Gregori, 1988).

*Sezione geologica del Colle di Perugia: 1) substrato roccioso a composizione calcarea; 2) substrato roccioso a composizione marnosa; 3) substrato roccioso a composizione arenaceo/marnosa; 4) depositi argillosi; 5) depositi sabbiosi; 6) depositi conglomeratici (in Cattuto & Gregori, 1988).*

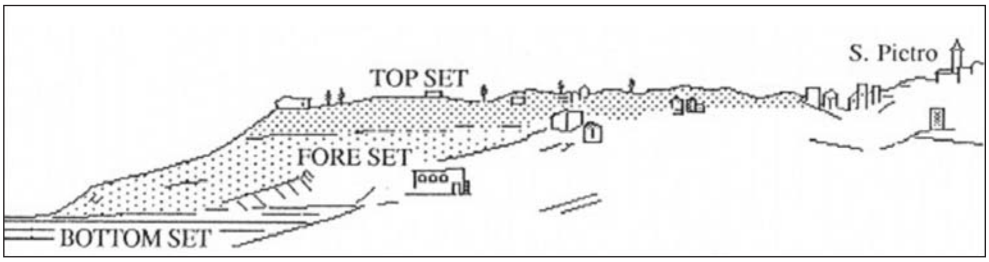


Fig. 3 - Perugia cross section with the three delta sets (in Cattuto *et al.*, 1995).

*Sezione longitudinale del colle di Perugia con la ripartizione dei tre sets del delta (in Cattuto* et al.*, 1995).*

canic events during the Pleistocene, and in the lower part of the slope are the Pliocene clays (Fig. 5).

Fluvial erosion and mass movement phenomena produced the development of pyroclastic covering with collapse in the upper part of the slope (where the pyroclastic sequence outcrops) and landslides in the lower part (Fig. 6).

In ancient times, local populations chose to build the village on the upper part of the rocks, due to the good geomechanics and morphological conditions of the tuff. Quarries, dovecotes, and reservoirs were dug out of the rock. Many of these can be visited. Near Orvieto, during an archaeological expedition an important site was unearthed, dating from the 6th cent. BC to the 14th cent AD. This site, located in Campo della Fiera, is very interesting for its relationships between geomorphology and archaeology (Fig. 7).

The paleogeographic evolution of this area was reconstructed from the geologic, geomorphologic and photogeologic study of the site (Cattuto *et al*., 2002). It was possible to reconstruct an Etruscan building ("Tempio Federale") located near a small lake.

Fig. 6 - Aerial photograph of the Orvieto area. Mass movements can be observed along the slopes. (Region of Umbria; scale: 1:33,000; photo date September - October 1977; SMA permission no. 38: 01/02/1978 execution. Photo by: Compagnia Generale Riprese aeree - Parma).

*Foto aerea dell'area di Orvieto. Si possono osservare movimenti di massa lungo i versanti (Regione dell'Umbria; scala 1:33.000; foto datata Settembre – Ottobre 1977; SMA permesso n. 38: data di acquisizione 01/02/1978; foto della compagnia Generale Riprese aeree – Parma).*

Fig. 4 - Orvieto "mesa" with a skyline of the Cathedral (photo by Gregori L.).

*La "mesa" di Orvieto con la vista panoramica della Cattedrale (foto di Gregori L.).*

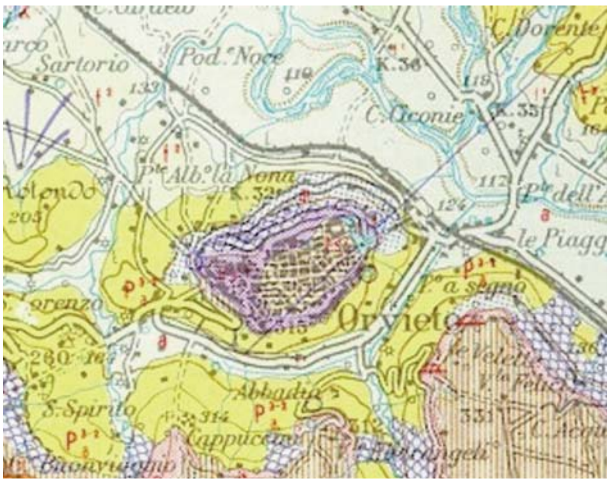


Fig. 5 - Geological map of Orvieto with the pyroclastic sequence outcropping at the town of Orvieto (Sheet 130 - Geological Map of Italy).

*Carta geologica del territorio di Orvieto con la sequenza piroclastica affiorante in corrispondenza della città di Orvieto (Foglio 130, Carta Geologica d'Italia).*

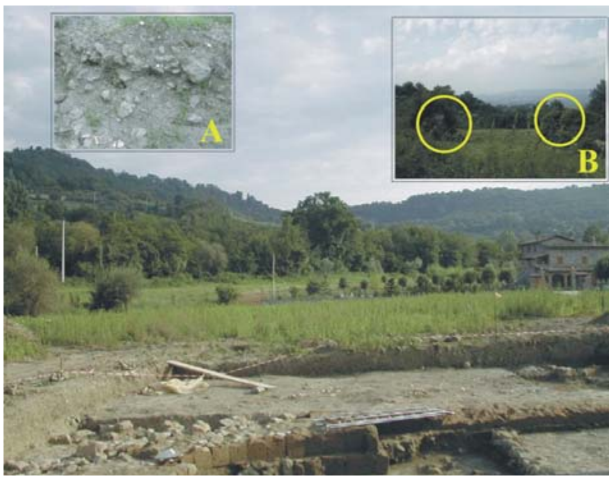


Fig. 7 - Archaeological site at Campo della Fiera, Orvieto (in Cattuto *et al*., 2002). A) Pliocenic clay with tuff fragments, B) basaltic blocks along the slope.

*Sito archeologico al Campo della Fiera - Orvieto (in Cattuto* et al*., 2002). A) Argille plioceniche con frammenti tufacei, B) blocchi basaltici lungo il versante.*

### 2.3 Civita: "The Dying Town"

The wonderful landforms observable in Orvieto, Bardano, Lubriano, Civita and Bagnoregio are the consequence of morphogenetic processes (Fig. 8).

From different observation points one can admire the wonderful argillaceous crests of the Calanchi Valley (Fig. 9, Fig. 10), and the fascinating erosion-shaped mountains with their high cliffs (Cattuto et al., 1995).

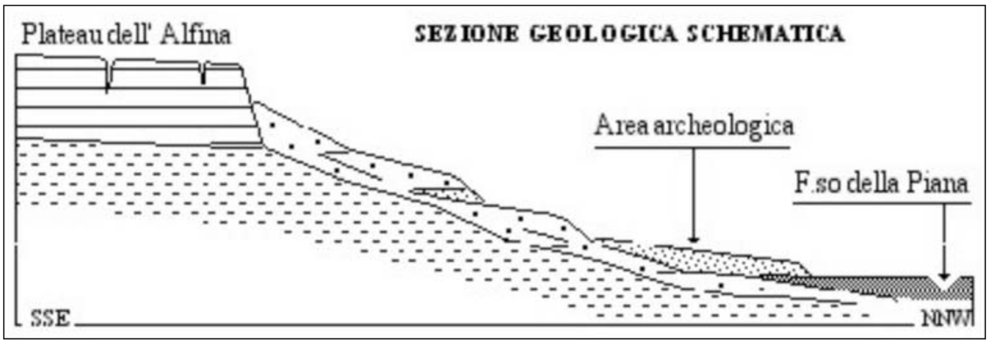


Fig. 8 - Alfina Plateau cross section (in Cattuto *et al.*, 2002).

*Sezione longitudinale dell'Altopiano dell'Alfina (in Cattuto* et al.*, 2002).*

Landslide and erosion processes cause the cliff to recede, bringing about slope degradation but creating unique landscapes such as that of Civita - Bagnoregio, "the dying town".

The cliff of Civita - Bagnoregio is composed of a sequence divided into two parts: the lower part is a clay unit, the upper part is a pyroclastic unit subdivided into an ignimbrite layer overlying tuff. This sequence is the cause of the mass movement phenomena constituting the risk for Civita. In addition, surface clay erosion processes create badlands. Consolidation activities have lessened the badlands in the landscape, but a compromise is necessary to preserve both the town's infrastructures and the badlands as a typical landscape (Gregori, 2003).

### 2.4 The morphological evidence of the "Gubbio Basin Master Fault"

The town of Gubbio is known all over the world for its Corsa dei Ceri ("Candles" Race) and for its landscape. Gubbio is located at the foot of a very high anticline limb (Fig. 11). River erosion cuts this fault scarp into a number of triangular facets (Fig. 12). These landforms are clear evidence of an important normal fault. This master fault bounds a tectonic basin, with various morphological indications. The new part of Gubbio is built on an alluvial fan derived from Camignano River sedimentation. The Camignano River cuts the anticline and models a beautiful diaclinal valley (Cencetti, 1990).

## 3. GEOMORPHOSITES: MORPHOSITES AND MORPHOGENETIC PROCESSES

### 3.1 Syn-rift Basins

Many basins are present in Umbria as the "Gubbio Basin". In central Italy such basins are very frequently grabens (Cattuto *et al.*, 1992). Several of these vast depressions are frequently called "polye": this is due to the tectonic evolution of the area that is characterized by the activity of an extensional stress field superimposed on an earlier Upper Miocene contractional stage.

The interplay between these processes, weathering and the karstic process, are the main factors controlling the stratigraphic and structural architecture of the active basins. The basin geometry of the Sibillini mountains suggests this interpretation of tectonic evolution and brought to light the unique morphotypes of significant scenic value.

It is possible to make a scenic tour along some basins, from Gubbio-Gualdo to the Colfiorito plains (Gregori, 1990) and as far as the Norcia basin and the Sibillini mountains (Fig. 13).

Fig. 9 – Civita di Bagnoregio and in the background the badlands landscape at the bottom of the Alfina Plateau (photo by Gregori L.).

*Civita (Bagnoregio) e sullo sfondo il paesaggio a calanchi al bottom dell'Altopiano dell'Alfina (foto di Gregori L.).*

Fig.10 - Outcast from erosion processes, shown in the circle (photo by Gregori L.)

*Un testimone (contrassegnato dal cerchio) relitto di morfoselezione (foto di Gregori L.).*

### 3.2 Trasimeno Lake

Lake Trasimeno (Fig. 14) is a tourist attraction in Umbria which has enjoyed renewed popularity in recent years. Many poets and writers have described the landscape around Lake Trasimeno.

It is one of the laminar lakes in Italy, and is quite shallow (almost 6 meters at the centre). Even though Lake Trasimeno is undergoing a dry period, it is still an important resource for fishing and for irrigating the surrounding farmlands.

Historically it has been defined as an alluvial lake; however, there is evidence that it is a tectonic lake. It is the oldest tectonic lake in Italy (AMBROSETTI *et al.*, 1989; CATTUTO & GREGORI, 1993; CATTUTO *et al.*, 1995) whose genesis is tied to the tectonic stretching that has involved central Italy since the Pliocene, developing an old drainage system which widens toward the north (Fig. 15).

In particular, the tectonic system and its anti-Apennine activity confirm the model of the basin as a tectonic depression for the drainage lines of secondary water.

The morphologically articulated sides may hide interesting historical-geological and/or floral-faunal particularities and peculiarities. To this end a number of scenic trails have been made: hiking trails, bicycle paths around the lake, the routes and sites of Hannibal, guided visits to the castles on Maggiore Island and Polvese Island.

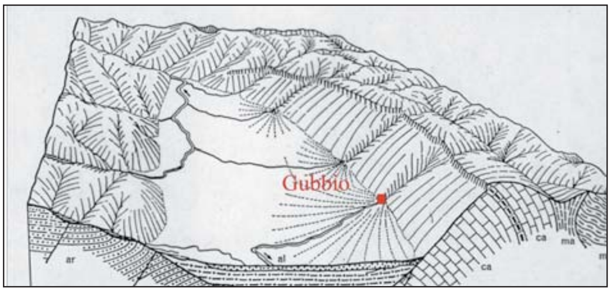


Fig. 11 – Block diagram of the Gubbio basin (original in Sestini A., in Castiglioni, 1979).

*Block diagram del bacino di Gubbio (originale modificato tratto da Sestini A. in Castiglioni, 1979).*

Fig. 12 - Triangular facets on the anticline limb near Gubbio (photo by Cencetti C.).

*Faccette triangolari lungo il fianco dell'anticlinale di Gubbio (foto di Cencetti C.).*

Fig. 13 - Foreground view of the Mt. Sibillini polye, in winter season (photo by Paoletti A.).

*Vista del polye dei Monti Sibillini durante la stagione invernale (foto di Paoletti A.).*

### 3.3 Marmore falls

The far northeastern area of the Rieti plain, called the "Piano delle Marmore," is cut off by a 160-meter high escarpment coming from the southeast, joining the valley at the Nera River. In this area the Velino River flows to the end of the Rieti depression before "escaping" toward the Marmore gorge.

Marmore falls (Fig. 16) is a spectacular example of an active morphogenetic process, and is one of the highest waterfalls in Italy. Besides, knowledge of the waterfall's inland, shows interesting geological-geomorphological characteristics.


Fig. 14 - Geological map of the Trasimeno Lake region (Sheet 122 - Geological map of Italy).

*Carta geologica dell'area del Lago Trasimeno (Foglio 122, Carta Geologica d'Italia).*

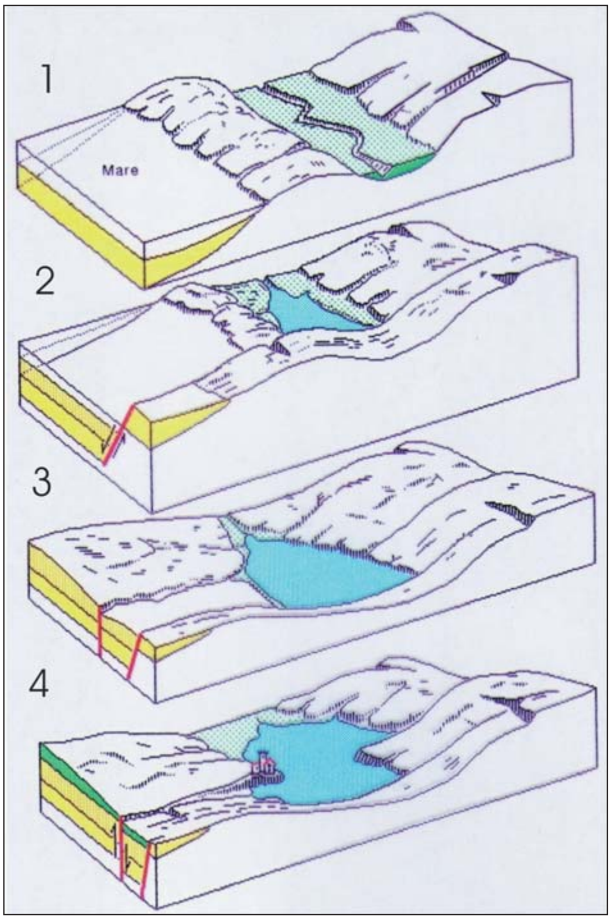


Fig. 15 - Paleogeographic evolution of Trasimeno Lake (in Cattuto & Gregori, 1993); 1) Pliocene; 2) Lower Pleistocene; 3) Middle Pleistocene; 4) Upper Pleistocene.

*Evoluzione paleogeografica del Lago Trasimeno (in Cattuto & Gregori, 1993); 1) Pliocene; 2) Pleistocene inferiore; 3) Pleistocene medio; 4) Pleistocene superiore.*

The source of the Velino river is in a wide travertine plain located at an elevation of 370 m, from whiere the its waters flow down to the Nera river valley.

The falls are essentially of artificial origin, from Roman times; nevertheless, some authors have pointed out that a waterfall existed there before. These geological studies of the falls are mostly related to tectonic activity and lead to the conclusion that the steepness is due to a series of travertine prominences that drop down toward stream in a narrow valley.

There are interesting yet little-known forms along the Plain of Marmore which are called "fosse." These are pseudo-karstic complex landforms: a deep depression with a flat floor surrounded by high slopes named "fosse" or " weel". They look like typically karstic morphotypes (bowl-shaped dolinas).

The structural level is characterized by the presence of numerous dolinas and/or deep "fosse" surrounded by spectacular travertine incrustations, a wonderful example of a pseudo-karstic process (MATTIOLI, 1972; TROIANI, 1996) (Fig. 17, Fig. 18).

### 3.4 The Clitunno Springs

Particularly interesting is the site of the Clitunno springs, near the small village of Campello sul Clitunno (Spoleto). Its springs, light blue width depressions (Fig. 19) and riparian vegetation are a spectacular sight.

The depressions result from underground waters emerging through the detrital cover that covers the

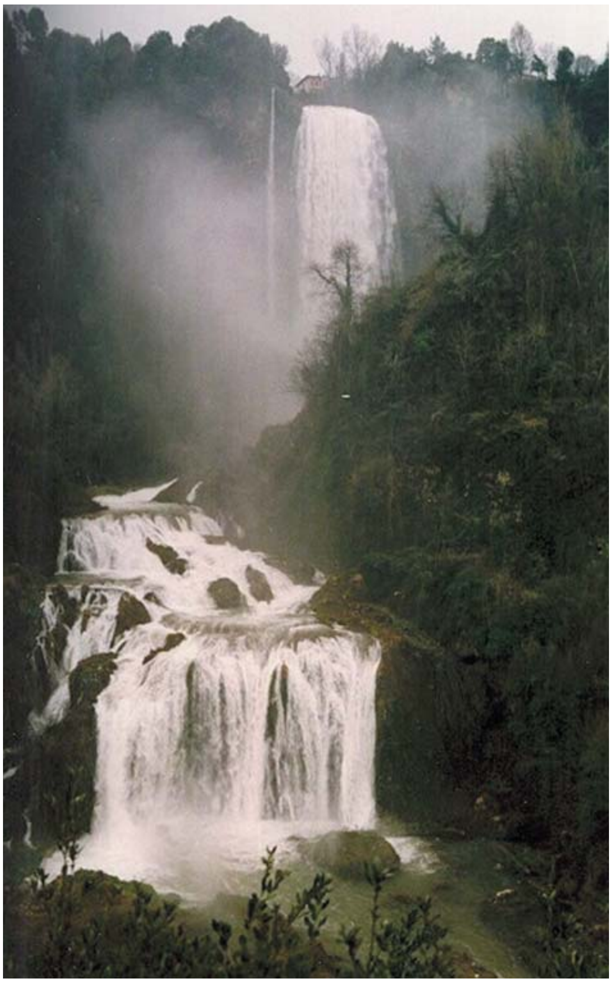

Fig. 16 – Marmore falls (Terni), (photo by Troiani C.).

*Cascata delle Marmore (Terni), (foto di Troiani C.).*

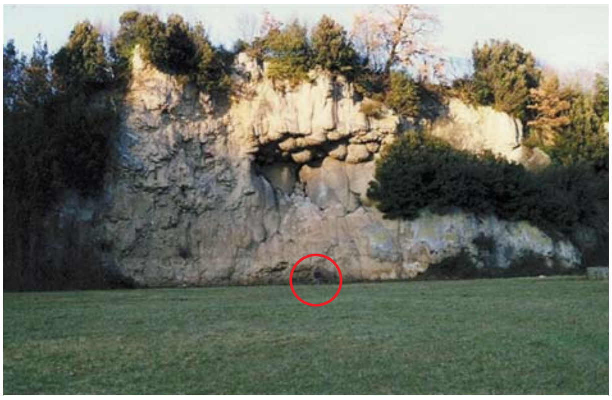

Fig. 17 - "Tiberiana cavity " in the Marmore plain (photo by Troiani C.).

*La Fossa Tiberiana nel Piano di Marmore (foto di Troiani C.).*

base at the side of the Campello mountain (Cattuto *et al*., 1995). The Clitunno springs are located at the base of the relief, sometimes masked by detrital materials. Through them waters open one way to stand out inside "funnel-shaped cavities" covered by flourishing underwater vegetation. These cavities are attributed to karstic dissolution phenomena occurring probably in bedrock limestone. The cavities now function more as "water issue" points than as absorption points.

Fig. 18 – Carbonatic ballstones along the "Tiberiana cavity" edge (photo by Troiani C.).

*Concrezioni carbonatiche lungo la parete della Fossa Tiberiana (foto di Troiani C.).*

Fig. 19 - Surfacing of underground waters at the Clitunno springs (photo by Gregori L.).

*Risorgenza delle Fonti del Clitunno (foto di Gregori L.).*

### 3.5 The Mammalofauna of Pietrafitta mine

The Pietrafitta mine is located south of Lake Trasimeno and is an important fossiliferous site. Since 1960 numerous specimens of Mammalofauna in very good shape have been discovered (Fig. 20) in the Pleistocene lake of Tavernelle/Pietrafitta. This lacustrine depression (Ambrosetti *et al*., 1987) formed near the paleodelta of the Nestore river. In the Plio-Pleistocene this river flowed east to west, emptying into the Pliocene sea near the modern town of Città della Pieve.

The Pleistocene tectonic activity, characterized by a general raising and sliding of the area towards the east, also caused the sliding of the paleodelta and the inversion of the flow direction of the Nestore river (Fig. 21).

Before the complete reversal, tectonic activity "stepped" this site toward the east and brought about the formation of a depression that for approximately one million years created the conditions for a lake evolution and the development of luxuriant vegetation (lignites) and of fauna such as elephants, rhinoceroses, beavers and turtles. (*Archidiskodon meridionalis*, *Dicerorhinus etruscus*, *Castor fiber*, *Emys orbicularis*, *Leptobos*, *Allophaiomys*, etc; Ambrosetti *et al*., 1987).

Students and/or tourists can see many well-preserved fossils in the Pietrafitta mine. This heavily mined site is an exceptional testimonial of a particularly evocative paleoenvironmental scene.

Fig. 20 - Fossil remains (Archidiskodon meridionalis) in the Pietrafitta mine (photo by Gregori L.).

*Resti fossili (Archidiskodon meridionalis) nella miniera di Pietrafitta (foto di Gregori L.).*

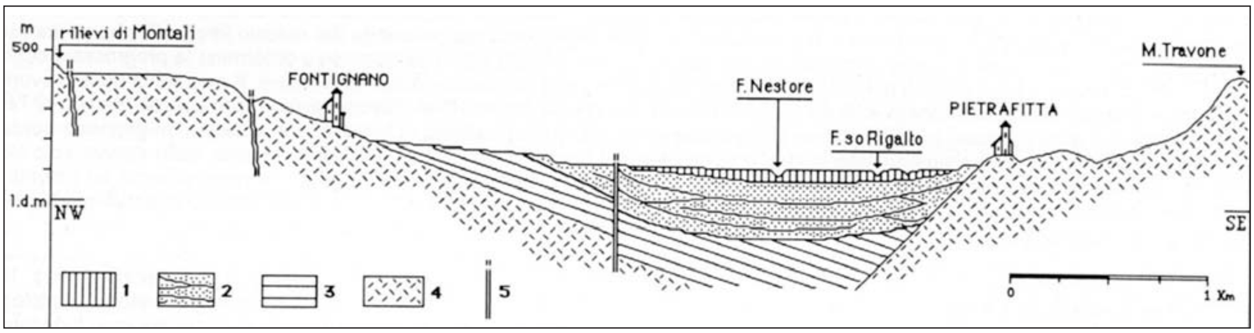


Fig. 21 – Pietrafitta basin cross section (in Ambrosetti *et al*., 1987).

*Sezione trasversale del Bacino di Pietrafitta (in Ambrosetti* et al.*, 1987).*

**3.6 The Dunarobba Fossil Forest**

The Dunarobba Fossil Forest is one of the most representative geomorphological sites in Umbria (Fig. 22, Fig. 23), and certain extraordinary characteristics make it unique in the world.

In early 1970 the remains of a number of trees still standing in a “living position” were discovered in a clay pit near Dunarobba. These were identified as a specimen of an extinct conifer, *Taxodioxylon gypsaceum*, very similar to modern sequoias (Ambrosetti *et al.*, 1992). The trunks have a diameter of approximately 1.5 meters and are 5 to 10 meters tall. The forest was probably located on the shores of the ancient Lake Tiberino and dates from the Pleistocene (the latest dating attributes it to approximately 1 million years ago).

The extraordinariness of the site also depends on the excellent state of preservation of the paleoenvironment existing when the trunks were buried (which probably happened during a landslide and/or flood). In addition to conifer remains, other evidence of the entire ecosystem was also preserved that supports the theory of humid, warm climatic conditions. In addition, the trunks not hardened by a mineralization process are still wooden. In 1990 a monitoring system was set up and an experimental treatment method for the protection and preservation of the trees was activated.

The Dunarobba Fossil Forest is protected as an environmental monument by the Region of Umbria and by the Ministry for Cultural Assets as a site of Paleontological Interest. The site constitutes an important example from both a geomorphologic and a paleogeographic/enivironmental viewpoint.

**3.7 The “mortari” of Mt. Subasio**

Mt. Subasio is formed by an elliptical anticline fault along the western side. The bedrock that outcrops consists of the Umbro-Marche sequence between the Calcare Massiccio formation and the Marnoso Arenacea formation (lower Lias – Middle Miocene). The bedrock outcrops in the old core of the anticline as limestone and as marl in the recent part. The sequence units of Mt. Subasio is a seismogenetic box with a large hinge area in the upper part having a many extensional fracture patterns (Fig. 24).

At the top of the mountain (elevation approx. 1200 meters), some deep dolinas locally known as mortai or mortari (mortars) are visible (Fig. 25).

Fig. 22 - The Dunarobba Fossil Forest (photo by Gregori L.).

*La Foresta Fossile di Dunarobba (foto di Gregori L.).*

Fig. 23 - A tree trunk in the Dunarobba Fossil Forest (photo by Gregori L.).

*Tronchi fossili della Foresta Fossile di Dunarobba (foto di Gregori L.).*

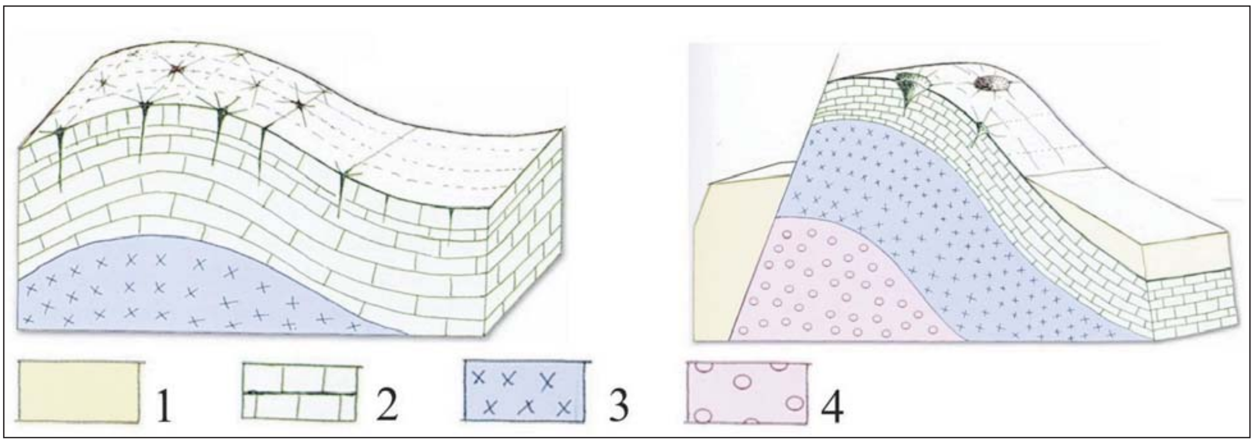


Fig. 24 – Geological section of M. Subasio. 1) Alluvial deposit; 2) Scaglia rossa formation; 3, 4) Lias formations. (figure in Venturi & Rossi, 2003).

*Sezione geologica del M. Subasio. 1) Depositi alluvionali; 2) Formazione della Scaglia rossa; 3, 4) Formazioni del Lias (figura tratta da Venturi & Rossi, 2003).*

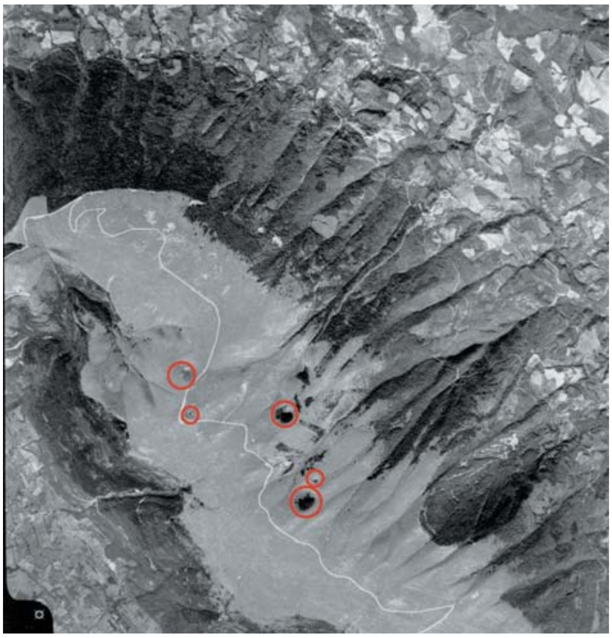

Fig. 25 - Aerial photograph of the Mt. Subasio area with "mortars" shown by the circles. (Region of Umbria; scale: 1:33.000; photo dated September - October 1977; SMA permission no. 38: 01/02/1978 execution; Photo by: Compagnia Generale Riprese aeree - Parma).

*Foto aerea dell'area del M. Subasio con i "mortari" contrassegnati dai cerchi (Regione dell'Umbria; scala 1:33.000; foto datata Settembre – Ottobre 1977; SMA permesso n. 38: data di acquisizione 01/02/1978; foto della compagnia Generale Riprese aeree – Parma).*

Their shape is that of a mortaro, and popular tradition led to the belief that Mt. Subasio was an extinct volcano (Cattuto *et al*., 1995). These depressions are typical examples of karstic morphogenesis and are also of educational and scenic importance (the "Big Mortar" has a maximum width of 280 m and a depth between 50 and 70 m).

## REFERENCES

Ambrosetti P., Faraone A. & Gregori L. (1987) - *Pietrafitta: un museo di paleontologia in Umbria* - Museologia Scientifica, **4**, (1-2), pp. 99-118.

Ambrosetti P., Cattuto C. & Gregori L. (1989) - *Lineamenti geomorfologici dell'area a sud del L. Trasimeno: bacino di Tavernelle / Pietrafitta* - Il Quaternario, **2**, (1), pp. 57-64.

Ambrosetti P., Basilici G., Gentili S., Biondi E., Cerquaglia Z. & Girotti O. (1992) - *La foresta fossile di Dunarobba* - EdiArt, 90 pp.

Brancucci G. & Burlando M. (2000) - *La salvaguardia del patrimonio geologico. Scelta strategica per il territorio. L'esperienza della Liguria* - Franco Angeli Ed., 96 pp.

Brancucci G., Carton A. & Pavia G. (1999) - *Scheda inventario geositi* - Geoitalia, n. 4 Novembre 1999.

Carton A., Cavallin A., Francavilla F., Mantovani F., Panizza M., Pellegrini G.B. & Tellini C. (1994) - *Ricerche ambientali per l'individuazione e la valutazione dei beni geomorfologici - Metodi ed esempi* - Il Quaternario **7**, 1, pp. 365-372.

Castiglioni G.B. (1979) - *Geomorfologia* - UTET, 436 pp.

Cattuto C. & Gregori L. (1988) - *Il colle di Perugia: note di geologia, idrogeologia e geomorfologia* - Boll. Soc. Geol. It. **107**, pp. 131-140.

Cattuto C. & Gregori L. (1993) - *Origine ed evoluzione del Lago Trasimeno* - Conferenza Auditorium Urbani, 15 Marzo. (Assessorato alla Cultura - Passignano S.T. Università degli Studi di Perugia).

Cattuto C., Cencetti C. & Gregori L. (1992) - *Il Plio-Pleistocene nell' area medio-alta della valle del F. Tevere : possibile modello morfotettonico* - Studi Geologici Camerti - Vol. spec., **1**, pp. 103-108.

Cattuto C., Cencetti C. & Gregori L. (1995) - *Guida all'escursione Perugia-Spoleto-Todi-Orvieto* - Assemblea/Escursione del Gruppo Nazionale Geografia Fisica e Geomorfologia, Perugia 27/29 Aprile.

Cattuto C., Gregori L., Rapicetta S., Bizzarri C., Giontella C. & Stopponi S. (2002) - "*GIS e geo-archeologia in località Campo della Fiera presso Orvieto (TR )*" - 6a Conferenza Nazionale ASITA Geomatica per l'ambiente, il territorio e il Patrimonio Culturale 5 - 8 novembre 2002, Perugia. Atti, **2**, pp. 705-714.

Cencetti C. (1990) - *Morfogenesi fluviale, tettonica ed evoluzione del paesaggio appenninico nel Plio-Pleistocene* - Tesi di Dottorato di Ricerca - Dipartimento di Scienze della Terra II Ciclo, Università degli Studi di Perugia.

Gregori L. (1990) - *Geomorfologia e neotettonica dell'area di Colfiorito (Umbria)* - Geogr. Fis. e Dinam. Quat., **13**, pp. 43-52.

Gregori L. (2003) - *Le caratteristiche geologico-geomorfologiche: risorsa nello sviluppo turistico* - Giornate del turismo 2003, 7/9 maggio, Novara.

Gregori L. & Rapicetta S. (2001) - *Rappresentazione divulgativa di cartografie tematiche per la tutela dei beni ambientali* - Atti Workshop " GIS per la tutela e valorizzazione dei beni ambientali e storico-culturali", Firenze 25 Maggio 2001.

Mattioli B. (1972) - *Fenomeni speleogenici nei travertini di Marmore* - L'Universo (I.G.M.) Anno 52, Marzo-Aprile 1972, **2**, pp. 411-426.

Panizza M. (1992) - *Sulla valutazione dei beni ambientali* - Mem. Descr. Carta Geol. d'It., **42**, pp. 479-484.

Panizza M. & Piacente S. (2002a) - *Geositi nel paesaggio italiano. Ricerca, valutazione e valorizzazione. Un progetto di ricerca per una nuova cultura geologica* - Geologia dell'Ambiente, SIGEA, 2002, **2**, pp. 3-4.

Panizza M. & Piacente S. (2002b) - *The geomorphosites between scientific research, cultural integration and artistic suggestion* - Workshop Geomorphological sites: research, assessment and improvement, Modena (Italy) 19 -22 June 2002.

Poli G. (1999) - *Geositi testimoni del tempo. Fondamenti per la conservazione del patrimonio geologico* - Regione Emilia-Romagna, Ed. Pendragon, 258 pp.

Troiani C. (1996) - *La cascata delle Marmore* - Itinerari Didattici, Collana diretta da Pompeo De Angelis. Assessorato alla Pubblica Istruzione-Comune di Terni.

Venturi F. & Rossi S. (2003) - *Subasio. Origine e vicende di un monte Appenninico* - Porzi Ed., 112 pp.