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THE MONTI BERICI: GUIDE OF THE FIELDTRIP

ABSTRACT: SAURO U., *The Monti Berici: Guide of the fieldtrip.* (IT ISSN 1724-4757, 2005).

The Monti Berici plateau is the most southern karst morpho-unit of the Southern Alps and represents a peculiar type of karst. The analysis of its topography, the identification of a «morphostratigraphy» based on the relicts of planation surfaces and on the different types of fluvial forms, the recognition of the few elements of chronological significance present in this context, allow for the delineation of a preliminary model of the geomorphological evolution of this mountain group. The main geomorphological types are of fluvial origin and have been influenced not only by the climatic changes, but also by the tectonic uplifting and/or by changes of the base level. The karst landforms have mostly evolved on the relict fluvial forms or in the context of relatively inactive fluvial forms. The age of the main forms extends over a very long time span, probably in the order of 15 millions years. The preservation of very old forms can be explained by the peculiar geomorphological environment, which was not affected by glacial erosion during the Pleistocene. The comparison between the evolution models of several karst morpho-units in the Southern Alps helps to understand the differences in their geomorphological styles.

KEY WORDS: Morphostratigraphy, Relict fluvial forms, Karst morphogenesis, Venetian Prealps.

RIASSUNTO: SAURO U., *I Monti Berici: guida all'escursione* (IT ISSN 1724-4757, 2005).

L'altopiano dei Berici è l'unità morfocarsica più meridionale di tutte le Prealpi e rappresenta un particolare tipo di «carso». L'analisi della sua topografia, l'identificazione di una «morfostratigrafia» basata sui relitti di superfici di spianamento e su diversi tipi di forme fluviali, il riconoscimento dei pochi elementi di significato cronologico presenti nel contesto del rilievo, permettono di delineare un modello preliminare dell'evoluzione di questo gruppo montuoso. I principali tipi geomorfologici sono di origine fluviale e sono stati influenzati non soltanto dai cambiamenti climatici, ma anche dal sollevamento tettonico e/o dai cambiamenti del livello di base. Le forme carsiche si sono per lo più evolute nell'ambito di relitti di forme fluviali o nel contesto di forme fluviali relativamente inattive. L'età delle forme principali comprende un ampio intervallo di tempo, probabilmente dell'ordine di 15 milioni di anni. La conservazione di forme molto vecchie può essere spiegata con il particolare ambiente geomorfologico, che non è stato interessato dall'erosione glaciale durante il Pleistocene. Il confronto tra unità morfocarsiche diverse delle Prealpi aiuta a comprendere analogie e differenze nella loro evoluzione e nei loro stili geomorfologici.

TERMINI CHIAVE: Morfostratigrafia, Forme fluviali relitte, Morfogenesi carsica, Prealpi Venete.

TYPES OF KARST IN THE SOUTHERN ALPS

The Southern Alps consist of a large number of very different karst morpho-units, each characterized by a complex history, difficult to be reconstructed in detail. While it is relatively easy to describe their forms and to define their main geomorphological styles, i.e.: tectokarstic, fluviokarstic, glaciokarstic, typically karstic (mainly characterized by dolines), it is difficult to recognize the morphogenetic events preceding the last ones and, in general, to delineate the morphological evolution during the Neogene and the Quaternary.

One of the main problems is that many of the morpho-units consist mostly of erosional landforms only partially covered by scattered deposits, relatively recent in age; older deposits, lower Pleistocene and Pliocene in age, are nearly completely missing or difficult to be identified.

The best strategy to understand the evolution of the Southern Alps is, as a first step, to focus the research on the most recent morpho-units, made of relatively young rock formations. Here, the average thickness of marine rocks worn away after the emersion is not so big and the erosional forms are relatively recent. According to the modest elevation of these young morpho-units, part of their erosional surfaces are gentle sloping and are sometimes partially covered by relatively old sediments deposited after the emersion. These characters make it easier to recognize the interrelations between the different erosional forms and the types and ages of the deposits located on the same forms.

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This helps to establish a «stratigraphy» of the forms and to delineate a history of the relief. If we apply such a procedure to some karst morpho-units, we will be able to discern that each is unique in some of its characteristics or events, being the expression of a complex environmental history. An interesting example of a recent karst morpho-unit is the Montello plateau developed on a late Miocene conglomerate (Ferrarese & *alii*, 1997). Here, an attempt to try to delineate a «morpho-stratigraphic» model of the Monti Berici mountain group (Sauro, 2002; 2003), the most southern karst morpho-unit of the Southern Alps, is presented.

THE MONTI BERICI

The Monti Berici group is a kind of mountain isle surrounded by the Venetian Plain. It is a small karst plateau with an area of about 200 km^2 extending to the SE of the Monti Lessini (fig. 1). The highest point is 444 m a.s.l. The main plateau area, only 2-4 km wide and about 10 km long, is on the east side. A south-eastern, lower plateau is gently sloping to the western plain. Systems of branched ridges originate from this plateau, some with the aspects of narrow plateaux or gently rounded hills. The south-eastern scarp of the main plateau is higher and steeper than the north-western.

From the morphotectonic point of view Monti Berici is a tabular structure made up by an uplifted block consisting in a sequence of sedimentary formations mostly of Cretaceous and Paleogenic ages. The block is delimited by normal faults (Mietto, 2003).

The asymmetry of the plateau, also expressed by the much steeper southeastern slope than that of the north-western one, is the effect of the presence on the eastern side of less erodible reef limestone than the softer limestone outcropping on the western side.

Spectacular cliffs rich in weathering forms and caves cut the reef limestone. Some are utilised by free climbers for training.

On the plateau, beside the marine sedimentary rocks, volcanic rocks and discontinuous covers of continental deposits also outcrop. In particular, pebbles and boulders of exotic rocks are widespread. Former Authors considered them as relicts of old glacial deposits (Da Schio & *alii*, 1947; Dal Piaz, 1947).

The landforms of the Monti Berici are both of karst and fluviokarstic type. Some plateaus are typical doline areas; others show assemblages of dry valleys, uvalas and dolines; pocket and canyon-like valleys are entrenched in the outer belt of the plateau. At the head of the pocket valleys, springs feed small creeks utilised in the past to feed chains of mills.

A peculiar feature inside the main plateau is the depression of Pozzolo, a wide trench cutting the plateau with a NW-SE direction and hanging on both the SE and NW ends. It is the relict segment of an antecedent valley crossing the relief and cut by a river during the first uplifting phases of this morpho-unit.

PROBLEMS IN THE RECONSTRUCTION OF THE GEOMORPHOLOGICAL EVOLUTION OF MONTI BERICI

The reconstruction of the geomorphological evolution of Monti Berici is a puzzle, which may be partly solved on the basis of the available data. Some chronological elements are supplied by the literature and in particular by Dal Piaz (1947), Albertini (1952), Bartolomei (1958), Giulini & *alii* (1981), Masini & *alii* (1995), Mietto & Sauro (2000), Dal Molin & *alii* (2000), Mietto (2003), Sauro (2002, 2003).

The «morpho-chronological» sequence of the main erosional features recognized on the base of a morphographical analysis, and organized from the oldest to the youngest is:

1. summit plateau, extending between 400 and 250 m a.s.l. (plus the south-western plateau which extends at a lower altitude), that may be interpreted as a planation surface only partly controlled by the bedding of the sedimentary formations; in fact it is a sub-structural planation surface (Castiglioni & *alii*, 1988);
2. top-surfaces of the northern ridges ranging in elevation between 150 e 180 m a.s.l. (Valmarana, Arcugnano-M. Berico, M. Bisortole and Villa Brunello), that may be interpreted as the relicts of a lower planation surface;
3. the segment of the antecedent valley of Pozzolo, entrenched in the plateau and hanging more than 100 m above the level of the plain; its bottom is between 150 and 170 m a.s.l.;
4. the relicts of a planation surface corresponding to the top of some eastern ridges extending from the foots of the large eastern scarp (ridge north of Castagnero, Mossano-S. Pancrazio ridge, isolated hilly groups of Monticello and Albettone); the elevation range of this surface is 70-100 m;
5. canyon like valleys converging in wide, flat bottom, fluvial sedimentation valleys open towards the surrounding plain.

From a careful analysis of the topography it is possible to recognize that the Pozzolo depression is part of an entrenched meander continuing with the Val Liona depression; the lateral contour of another meander is recognizable in the Brendola area; both these relict forms show nearly the same bending radius (about 1.2 km), similar to that of the Po river in the Po plain near Piacenza.

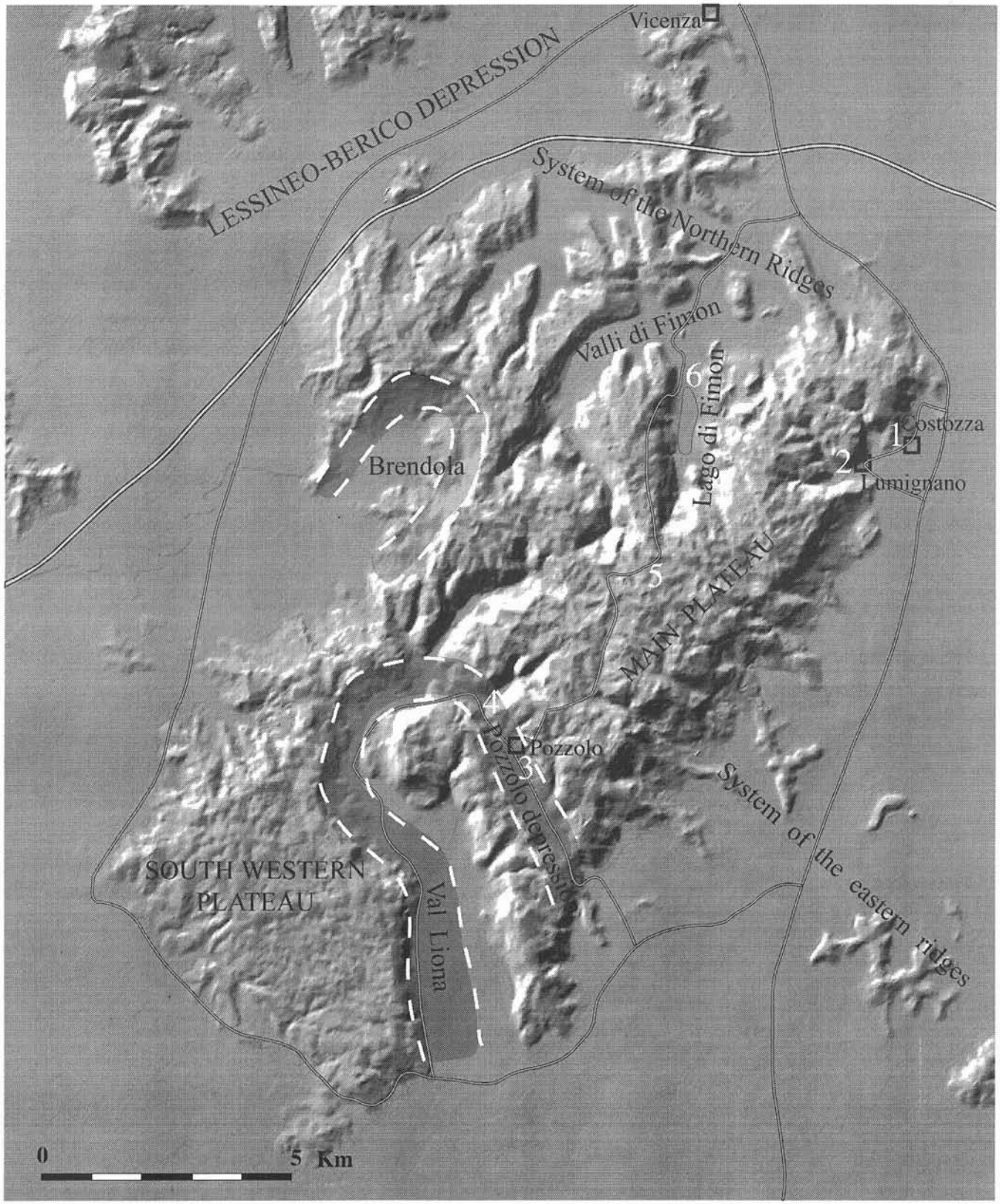


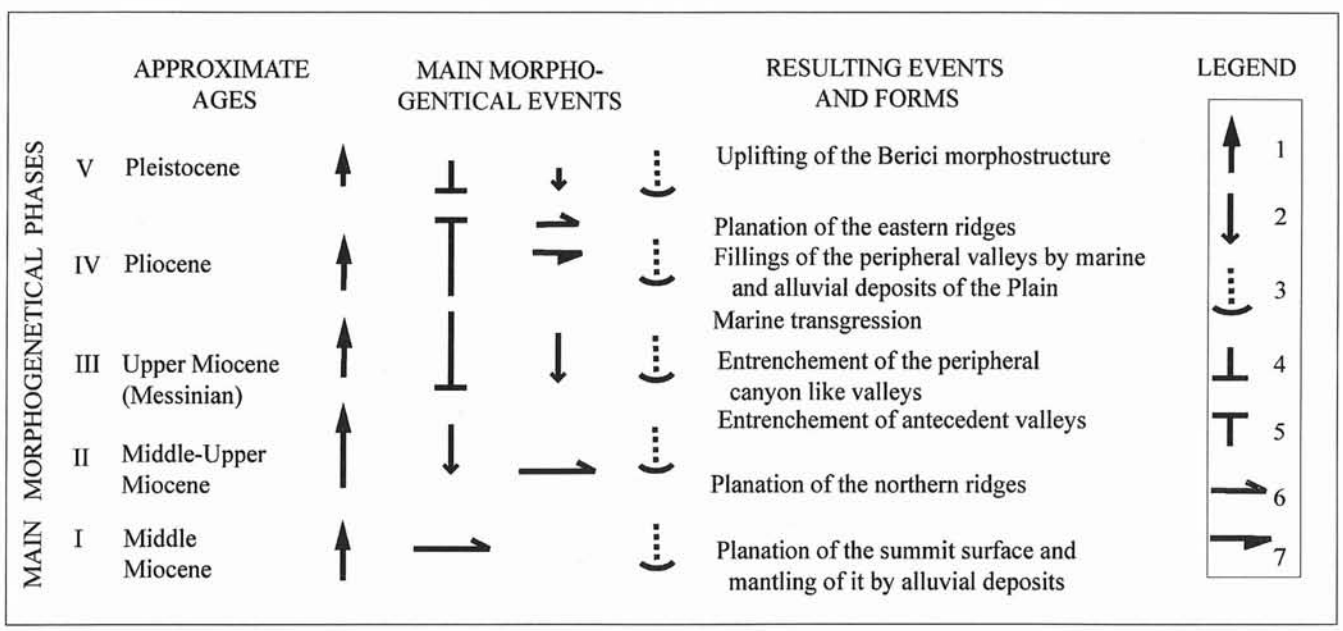
FIG. 1 - Digital elevation model of the Monti Berici with indicated the main stops of the fieldtrip. The supposed outlines of the entrenched meanders of Pozzolo - Val Liona and of Brendola are sketched.

The sedimentary units related with these main features are:

- mostly scattered exotic pebbles and sands (locally as covers) on the summit plateau;
- sediments of sands, peat and soil sediments containing pollens and vegetal remains of an undefined age, between late Miocene and Pliocene, trapped inside the Pozzolo depression (Giulini & *alii*, 1981) and the S. Rocco doline (karst depression entrenched in the n. 2 surface) (Bartolomei, 1958);
- clastic sediments trapped in karst shafts containing animal bones attributed to the early lower Pleistocene (Masini & *alii*, 1995) related with the south-western margin of the n. 1 surface.

The morphogenetic events organized in a chronological sequence on the base of the interrelations between the main erosional forms and the terrigenous sedimentary units could be (fig. 2):

- uplifting and emersion of the morfostructure; after the marine regression, development of a planation surface (surface 1) by river abrasion (pebbles of crystalline rocks transported by rivers may have exerted a strong erosion over softer rocks, as marly limestones);
- sedimentation of alluvial sediments mantling most of the erosional surface; these sediments including pebbles of alpine rocks are widespread over the whole plateau and are found in a geomorphological environment which is completely lacking in any glacial form, and, so, can not be explained as till sediments;
- slow uplifting phase with development of a lower planation surface (surface 2), and entrenchment of the rivers in the summit plateau (if we consider that a large river has been able to incise inside the plateau, the uplifting speed should have been moderate; so, the entrenched meanders of Pozzolo-Val Liona and Brendola developed);
- abandonment of the Berici relief by the large river caused by an uplifting phase and/or a lowering of the base level;
- important fall of the base level and subsequent entrenchment of the local rivers; these rivers, fed by the hanging aquifer hosted inside the alluvial deposits mantling the main plateau, excavated canyon like valleys with bottoms extending below the present day sea level (probably this phase took place in the late Miocene, during the Messinian stage, between 6 and 5 millions of years ago, when the Mediterranean sea par-



Legend: 1. uplifting, 2. linear fluvial downcutting, 3. lowering of the surface by karst solution, 4. lowering of the base level, 5. rising of the base level, 6. marine and fluvial planation, 7. burying of the relief by marine and fluvial deposits

*FIG. 2 - Sketch of the main morphogenetic phases of the Monti Berici.

tially dried); also the depression of Vicenza, between the Berici and the Lessini Mountains, could represent an old relict valley, entrenched in this phase;

- marine ingression inside the Po basin (lower Pliocene) following the reopening of the communication between the Mediterranean and the Atlantic; the planation surface of the eastern ridges (n. 4) could perhaps represent the relict of a wide marine terrace linked with the level of the Pliocene Sea.

After their development, the relict forms, as the plateau surface and the entrenched meanders, have been modified by different weathering processes. In particular, the plateau surface has been firstly interested by local fluvial morphogenesis, with the development of a network of small valleys, and later by karst morphogenesis with the evolution of uvalas, dolines (mostly of the type «cover doline») etc., in correspondence with the fluvial segments.

The bottom of the Pozzolo relict valley was lowered by the karst solution operated by the water hosted in the sediments trapped in the depression. This segment is now evolving as a large uvala, which widens more rapidly in the middle sector than at the extremities. The strike and dip of the trapped sediments has changed as a consequence of the differential lowering of the rocky bottom.

Old authors understood that the relief of the Monti Berici had been partially buried by the alluvial deposits of the Venetian Plain. Albertini (1952) called this phenomenon as *sovralluvionamento* («overalluviation») and explained it as the consequence of a tectonic subsidence of all the southern sector of the Venetian Prealps. In fact, there are no evidencex of such a subsidence and now the burying of the relief is explained as the consequence of the Messinian event and of the Pliocene transgression of the Mediterranean sea.

ITINERARY OF THE FIELDTRIP

The proposed fieldtrip will articulate in the following itinerary and stops (fig. 1):

Padova, Grisignano, Montegalda, Costozza (1), Lumignano (2), Toara, Pozzolo (3, 4), Monte Lungo (5), Lapio, Lago di Fimon (6), Padova.

1. Costozza is famous for its limestone called «Pietra di Costozza» (a soft calcarenite) and for the related quarries consisting mostly in large artificial caves. Between the 16th and the 17th centuries the owners of the Venetian *Ville* of Costozza realized conditioning systems, using the cool air of the caves. A memorial tablet mentions the visit of Galileo to the *Villa Trenta-Da Schio* during the summer of 1606. The scientist enjoyed the fresh air of the caves.
2. In the Lumignano square there is a fountain fed by a karstic spring; along the eastern border of the Berici there are several of such springs. In the area of Lumignano there are the most spectacular cliffs in reef limestone of Oligocene age. Some tracks allow to visit the main cliffs with many caves and shelters containing deposits rich in archaeological prehistoric remains and also utilized as hermitages by monks during the Middle Age.
3. Pozzolo is a village located in the relict segment of a dead valley, entrenched in the Berici plateau and hanging with its extremities on both sides; this segment is part of a large paleo-meander continuing in the Val Liona depression.
4. The western end of the Pozzolo segment hangs above the head of the pocket valley (spring valley) of Calto, where the water of the karst springs was used for the functioning of mills.
5. The main plateau of the Berici is characterized by large karst depressions, by chains of dolines of different sizes and by dry valleys. It is evident that most of the karst forms have developed as «cover type forms», by karstification of the limestone buried by a mantle of alluvial sediments. Relicts of such covers are exotic pebbles scattered all over the plateau.
6. The Lago di Fimon is a semi-natural lake, strongly modified by human activity, hosted inside the Fimon Valley, a kind of «fiord» of the alluvial plain insinuated inside the Berici relief. The lake is originated by the damming activity of the rivers of the plain, with their alluvial deposits (phenomenon called *sovralluvionamento*).

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