

PLEISTOCENIC BURIED ABRASION PLATFORMS IN SOUTHEASTERN "TAVOLIERE " (APULIA, SOUTH ITALY)

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ABSTRACT - Pleistocenic buried abrasion platforms in Southeastern "Tavoliere" (Apulia, South Italy) - Il Quaternario, 4(2), 1991, p. 303-310 - The stratigraphies of about nine hundred water wells have been analyzed using computer techniques, in order to reconstruct the morphology of the roof of the "Argille subappennine" in the southeastern portion of the Tavoliere plain. In this way it has been possible to recognize nine buried plain surfaces, whose origin can be related to the presence of the sea during the middle-upper Pleistocene. The information collected, together with the first results proceeding from the study of continuous coring show the presence of several sedimentary cycles above the most recent abrasion platforms.

RIASSUNTO - Superfici di abrasione sepolte nella parte sudorientale del Tavoliere delle Puglie (Italia meridionale) - Il Quaternario, 4(2), 1991, p. 303-310 - Con il nome di Tavoliere si indica la pianura alluvionale che occupa gran parte della provincia di Foggia, in Puglia, estesa senza particolari caratteri morfologici tra l'Appennino dauno e il mare Adriatico. Tuttavia, analizzando circa 900 stratigrafie di pozzi per acqua, distribuiti nella parte sudorientale della piana, tra i fiumi Cervaro ed Ofanto, si è potuto individuare la presenza di ben nove spianate di abrasione marina, incise nelle "Argille subappennine", che costituiscono il substrato su cui poggia uno spesso manto alluvionale. Queste superfici sono delimitate verso mare da ripide e ben evidenti scarpate, il cui allineamento originario, NW-SE, ha subito con il tempo una rotazione antioraria fino a raggiungere nella V scarpata la direzione E-W e nella VI quella WSW-E. Successivamente, la linea di riva ha invertito il verso di rotazione tornando ad assumere l'originario orientamento con la IX spianata. L'esame del tetto formazione delle "Argille subappennine" ha altresì evidenziato la presenza di tratti di valli fluviali solo in parte corrispondenti all'attuale reticolo idrografico del Tavoliere.

Key-words: Buried morphology, marine terraces, "Argille subappennine" Formation, Tavoliere (Apulia - Italy)

Parole chiave: Morfologia sepolta, terrazzi marini, "Argille subappennine", Tavoliere (Puglia)

1. PREFACE

Apulian Tavoliere is the widest plain of Italy second only to the plain of the Po river. It has a surface of 4,300 km² and is limited to the North by the Gargano Massif, to

the West by the Mounts of Daunia, to the South by the Murge Highland and to the East by the Adriatic Sea. From the administrative point of view the plain is located in the province of Foggia and stretches along a narrow strip of land to the right of the Ofanto River falling within the borders of the provinces of Bari and Potenza.

From a structural point of view (Fig. 1), Tavoliere was a part of the *Fossa Bradanica* ("Bradanic Trough"), that was formed, starting from the Lower Pliocene until the Lower Pleistocene, between the Southern Apenninic chain and the Apulian-Dinaric foreland. After the basin filling, some terracing phases linked both to glacio-eustatic and discontinuous uplifting phenomena took place: various phases are characterized by the deposition of transgressive marine sediments unconformably over deposits of the Plio-Pleistocene cycle. At present, Tavoliere appears as a plain without morphological peculiarities monotonously degrading toward the Adriatic Sea.

The aim of this study, that is limited to the Southeastern part of Tavoliere from the Cervaro stream to the Ofanto river, was to reconstruct the trend of the top of "Argille Subappennine" Formation and to detect the Pleistocenic abrasion surfaces.

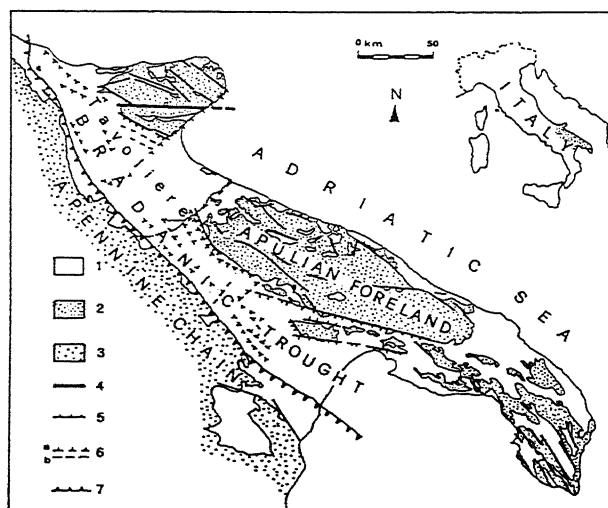


Fig. 1 - Schematic structural map. Legend: 1) post-orogenic units; 2) Apulian-dinaric foreland; 3) Apenninic and late-orogenic units; 4) wrench fault; 5) normal fault; 6) a) normal buried fault, b) inferred buried fault; 7) external thrust.

Carta strutturale sintetica. Legenda: 1) unità postorogeniche; 2) unità apulo-dinariche; 3) unità appenniniche e tardorogeniche; 4) faglie trascorrenti; 5) faglie dirette; 6) a) faglie dirette sepolte, b) faglie presunte sepolte; 7) fronte esterno dell'alloctono.

2. PREVIOUS KNOWLEDGE

The Bradanic cycle sediments, whose thickness reaches even 2,000 m locally, lie on a carbonatic sub-

stratum of the Apulian foreland, that presents a horst-and-graben structure. In the *Tavoliere* area this structure was first put in evidence by Tramonte (1955) and recently confirmed by Casnedi & Balduzzi (1984) by means of reflection shootings.

The Adriatic foredeep was subdivided into four paleogeographical units (Crescenti, 1971): the Teramo, Molise, Apulia and Lucania Basins. In the Molise and Apulian Basin the top of the clayey successions is referred to Late Pliocene, whereas the same lithostratigraphic layer, in Lucania and Teramo Basins, has to be referred to the Early Pleistocene. The shoreline is therefore supposed to have gradually receded eastward starting from the Late Pliocene: it reaches its lowest level during the Early Pleistocene in the Apulia Basins (Follador, 1973; Crescenti, 1975).

The Bradanic deposits form a complete and continuous sedimentary cycle whose transgressive part, along the eastern border of the trough, consists of the "*Calcareniti di Gravina*" Formation passing upwards to the "*Argille subappennine*" Formation; the regressive part of the cycle consists of the marine "*Sabbie di Monte Marano*" Formation, on which the continental "*Conglomerato di Irsina*" Formation is laying; the latter formation is considered, in literature, Sicilian in age.

Detailed stratigraphic studies on the *Tavoliere* area have been carried out by Caldara *et al.* (1979), Balduzzi *et al.* (1982), and Scalera (1986). Hence, it has been possible to attribute the top of the "*Argille subappennine*" Formation to the Early Pleistocene, lower part of the *Globigerina cariacensis* zone (*sensu* Colantoni & Sartori, 1979).

There are less scanty but certainly not abundant data about Quaternary terraced deposits of Apulian *Tavoliere*; the first pieces of information can be found in some old studies, among them Sacco (1911), D'Erasmus (1934), and Stampanoni (1960) must be mentioned.

Various series of terraced deposits both of marine and fluvial origin are reported by Malatesta *et al.* (1967), and with slightly different interpretations by Jacobacci *et al.* (1967). Delano Smith (1978) singles out six order of Quaternary sea terraces starting from a height of 400 m.

Moreover, Ciaranfi *et al.* (1980) report the presence of transgressive terraced marine sediments on the abrasion platforms smoothed over the "*Argille subappennine*" Formation.

Parea (1986) gives another interpretation according to which in the *Tavoliere* plain (namely in its northern part) there is only a series of stream terraces degrading to the Adriatic Sea but cut by slopes dipping toward the Apennine. The Author maintains the apparent absence of slopes toward the sea is probably due to the sediment cover of the present Holocenic plain deposited over the sediments of the alluvial plain of the Middle-Upper Pleistocene, whereas the slopes upstream are supposed to result from erosion.

In addition some submerged shorelines, which are not more than 100,000 years old, are well documented in the literature: their presence can be ascribed to the Wurmian oscillations of the sea level, whose peak in the Adriatic Sea is located at -110-120 m (Van Straaten, 1965), or at -150 m (Fabbri & Gallignani, 1972).

Recent investigations (Caldara *et al.*, 1990) put in evidence that the profile of the continental shelf is characterized by four terraces, at -15 m, -75 m, -90 m, and -110 m b.s.l. from the present sea level.

Finally, it must be observed that cores collected from boreholes drilled offshore Manfredonia, on the shelf at a depth of -127 m, allowed to detect *Cerastoderma lamarky* (Reeve) and *Bittium reticulatum* (Da Costa) faunas suggesting the presence of lagoons during the Wurmian age (Fabbri & Gallignani, 1972; D'Onofrio, 1972).

3. METHODOLOGY

In this first part of the study the southern portion of *Tavoliere* (about 1/3 of the whole plain) has been explored. This area is near the Murge Highland and stretches from the Cervaro stream to the Ofanto river (Fig. 2).

The analysis of aerial photographs along with field survey tried to uncover possible analogies with the data reported by Ciaranfi *et al.* (1988) about Murge. These Authors have detected 16 different slopes thought to be ancient shorelines formed after the Bradanic Trough was filled (Sicilian in age). Our study has enabled to recognize only 8 surfaces considered to be the result of the stoppages of the sea retreat.

The presence of extended alluvial and eluvial deposits over the terraced marine deposits and also the intense farming activity played a major role in determining the present morphology of the plain.

The slopes detected are extremely scattered and therefore they are difficult to correlate to one another with the exception of the most ancient slopes which are continuous for long distances. In conclusion it is possible to recognize (Caldara & Pennetta, 1989): a NNW-SSE shoreline between *Masseria Flamia* and *Posta di Vassallo* at a height of 350 m; a second NW-SE one near Borgo Libertà at a height of 270 m; remains of terraced deposits at *Lagnano da Piede* at a height of 190 m; a slope at the site *Masseria Scarafone* and *Masseria Pignatella di Sopra* at about 130 m; other remains of terraced deposits at *Masseria la Contessa* and at *Grassano delle Fosse* at 100 m, near *Masseria Cafiero* at about 25 m, at *Masseria Angeloni* in the locality *il Monte* at about 13 m, and isolated remains of terraced deposits at the *Masseria de Nittis* at 5 m above sea level.

The analysis of the stratigraphies of 896 wells (Fig. 2) drilled in this area by Boards and Companies

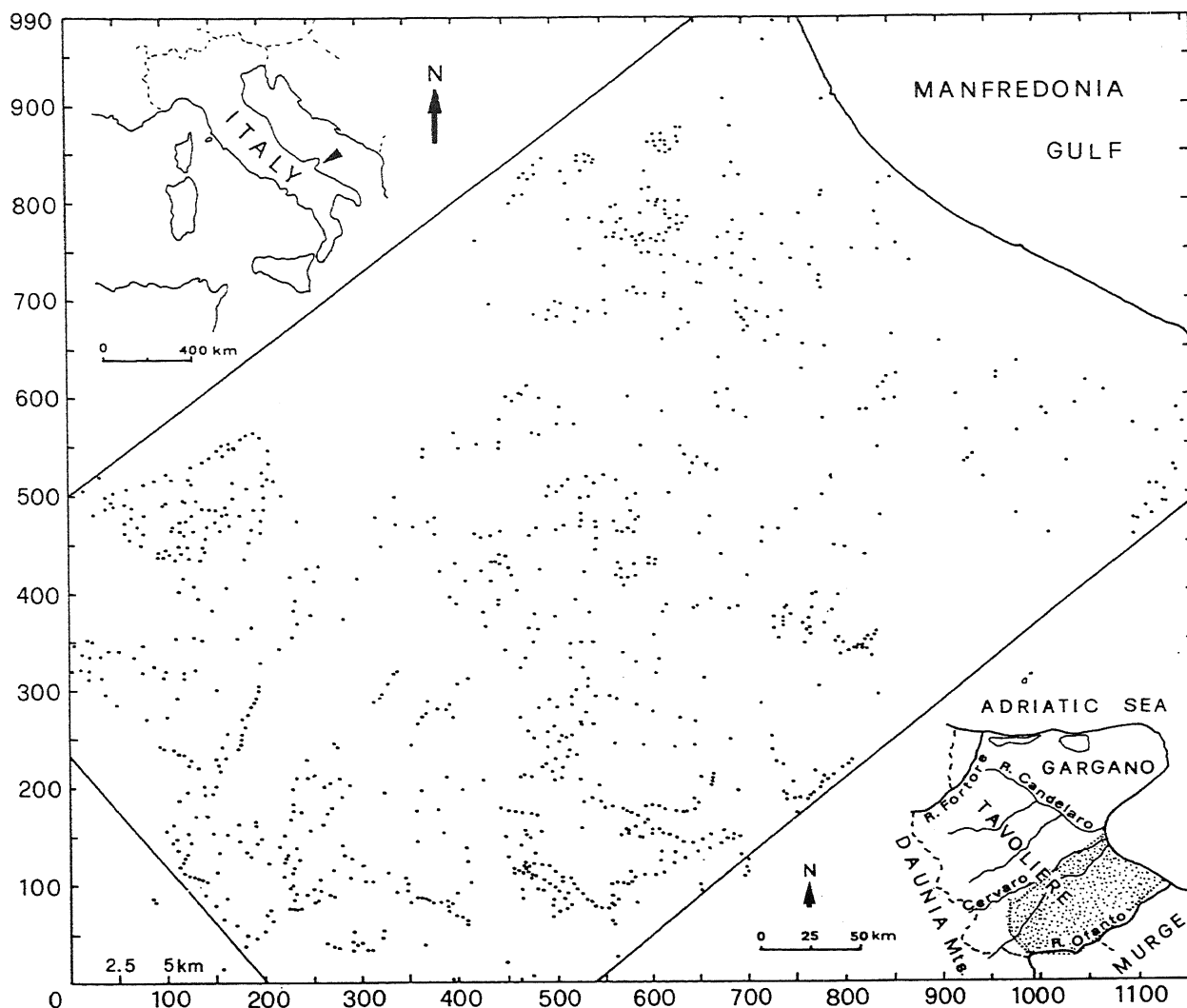


Fig. 2 - Distribution of the used drillings with the relative location of the studied area. The system used is of Cartesian type; it must be taken into account that, as regard the scale, 100 units corresponds to 5 km.

Distribuzione dei sondaggi utilizzati con relativa ubicazione dell'area studiata. Il sistema di riferimento adottato è di tipo cartesiano; per la scala si tenga presente che 100 unità di misura corrispondono a 5 km.

specialized in water drillings has been crucial in the development of this study. Some of these stratigraphies are already part of the literature (Colacicco, 1951; 1953; Tramonte, 1955).

Data have been processed with the aid of a two-dimensional data-interpolation program (Surfer 4.05 of Golden Software Inc.) by means of space vector analysis. Hence, it has been possible to obtain a contour map related to the top of "Argille subappennine" Formation (Fig. 3), where the contour lines are 10 m equidistant, referring to the sea level.

A first interpretation of the map shows a series of sub-plain buried surfaces delimited by slopes. It is obvious that such a method enables to draw only the most evident buried terraces, whereas those resulting from minor events are not pointed out. Actually, in order to detect them, a lot of detailed stratigraphic information

should be available. As a result, the number of terraces recognized is likely to be smaller than in reality.

Moreover, in the areas with sparse or even without drillings the computer made a linear interpolation based on peripheral data led to simple "average situations". In particular, there are two areas with a low density of wells to the NW of Orta Nova and to the E of Cerignola towns.

4. ANALYSIS OF THE RESULTS

The first and most evident outcome of this study has been the reconstruction of the trend of the "Argille subappennine" top. It ranges between 375 m a.s.l. (near Ascoli Satriano) and -115 m near the present-day shoreline.

Data processing shows a concentration of contour

lines in the southwestern area with very marked steepness even on the order of about 200 m (Fig. 3). Some incisions, that can be connected with fluvial activities are very evident. In particular, the first incision (thick line: Fig. 4) corresponds to the paleobed of the Carapelle stream that is presently at the same position over the alluvial cover. The second (triangle line) corresponds to the paleobed of the Ofanto river and is evident outside the area under study too. The third (dotted line), NW-SE in direction, seems connect the two above-mentioned water streams; it corresponds, on the surface, to a dead valley between the Apennines and the *Tavoliere* terraced deposits.

In the central part of the examined area the terraces show a slope with a minor steepness that are characterized by constant northward plunge: the terraced surfaces are wide and subhorizontal.

Finally, in the northeastern part the top of the clays is constantly beneath the sea level and it raises a maximum depth (-115 m b.s.l.) near the present shoreline. The pattern of the contour lines is rather irregular because the large flat surfaces are at random characterized by some small depressions. An incision seems to be evident (dot-and-dash line: Fig. 4) but there is no correspondence with any present-day stream.

The interpretative pattern shown in Fig. 4 is pro-

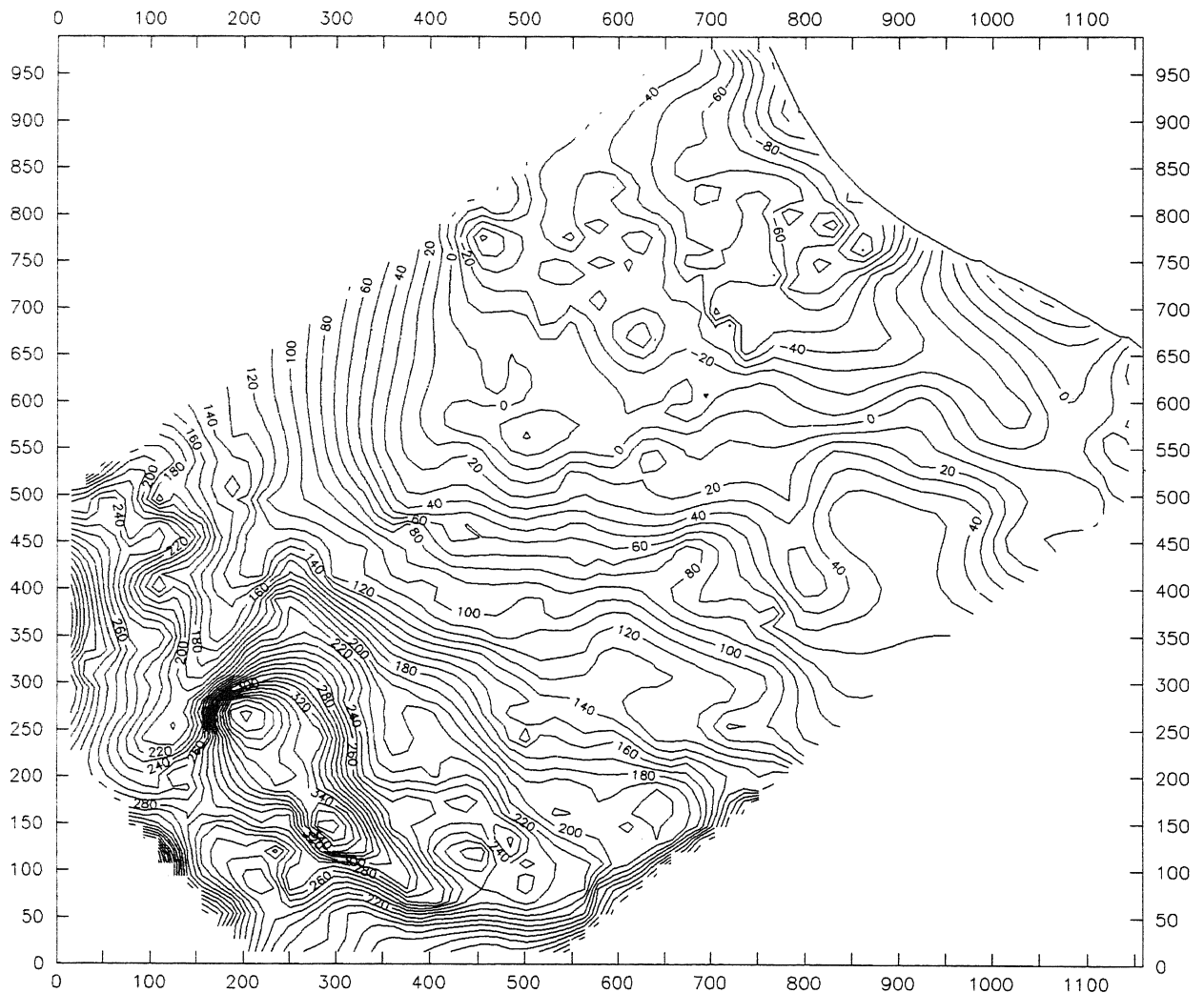


Fig. 3 - Contour map related to the top of the "Argille subappennine" Formation. Isohypsies are 10 metres equidistant. For the scale see Fig. 2.

Carta delle isolinee corrispondenti al tetto delle "Argille subappennine". L'equidistanza è di 10 metri. Per la scala si veda Fig. 2.

posed as a working hypothesis. Moving from SW to NE, a first surface (letter A), placed at the average height of 350 m a.s.l. was recognized: it corresponds to the stratigraphic contact between the "Argille subappennine" and

the "Sabbie di Monte Marano" Formations. This contact can be observed in a natural section near Serra S. Antonio (Ascoli Satriano).

At decreasing heights, ranging from 260 m a.s.l. to

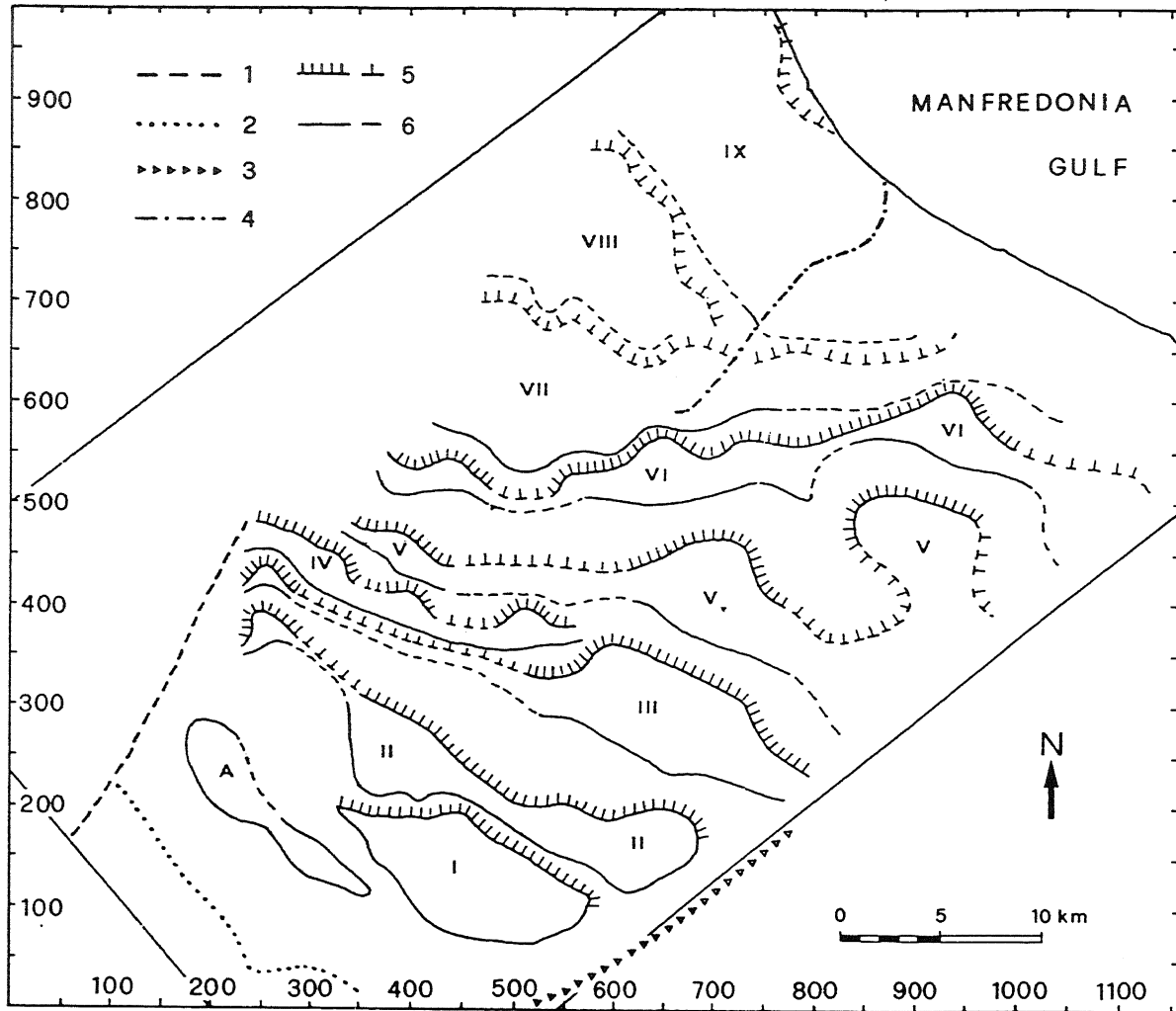


Fig. 4 - Interpretative map of the "flat surfaces" at the top of the "Argille subappennine" Formation. Letter A represents the stratigraphic surface between the "Argille subappennine" and the "Sabbie di Monte Marano" Formations; and the Roman numbers indicate the abrasion platforms situated at more and more decreasing heights. 1) paleobed of the Carapelle stream; 2) dead valley; 3) paleobed of the Ofanto river; 4) "paleocanyon"; 5) external border of the terraces and possible extension; 6) internal border of the terraces and possible extension.

Carta interpretativa del tetto delle "Argille subappennine". Con la lettera A si indica la superficie di contatto fra le argille e le "Sabbie di Monte Marano", mentre con i numeri romani le spianate di abrasione poste a quote via via decrescenti. 1) paleoalveo del T. Carapelle; 2) valle morta; 3) paleoalveo del F. Ofanto; 4) "paleocanyon"; 5) margine esterno del terrazzo, a tratteggio probabile prosecuzione; 6) margine interno del terrazzo, a tratteggio probabile prosecuzione.

-40 m b.s.l. (see Table), a succession of 9 terraced surfaces, that can be considered as abrasion platforms delimited by evident slopes, was recognized. Preliminary stratigraphic analyses of several boreholes continuous cored and field evidences suggest that on the abrasion platforms there are marine deposits: the most ancient deposits form a single sedimentary cycle, instead of the most recent ones which are composed of two or three sedimentary cycles, superposed one upon the other.

Moreover, it must be taken into account that the orientation of the shorelines changed during the Pleistocene: from the oldest trending shoreline NW-SE a counter clockwise rotation towards the W-E direction at the side of the V shoreline is found; afterwards, the orientation is towards WSW-ENE at the VI shoreline, and

Table 1 - Summary scheme taken from Fig. 3 and 4

Schema riassuntivo della situazione emersa dall'analisi della Fig. 3 e 4

Abrasion platforms (orders)	Inside borders (m s.l.)	Sedimentary cycles (number)
I	260	1
II	220-210	1
III	140	1
IV	110	2
V	90	1?
VI	20	2
VII	0	2
VIII	-20	2
IX	-40	3

and subsequently it changes towards the NW-SE direction at the VIII shoreline. It is only at the XI slope that the original position is resumed.

Another morpho-structural element consists in the variation of the longshore inclinations of the abrasion platforms (I-VII) reaching their maximum values in the proximity of the Carapelle stream. This phenomenon must be related to a differential uplift of the Carapelle area: it is consistent with the morphology of the river valleys of *Tavoliere* that are sharply asymmetric, with steeper slopes on the right.

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