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SIGNIFICANCE OF THE PLEISTOCENE CONTINENTAL DEPOSITS CROPPING OUT IN THE BARONIA MTS. IN THE FRAMEWORK OF THE QUATERNARY EVOLUTION OF NORTHERN IRPINIA (SOUTHERN APENNINES, ITALY)

ABSTRACT: MATANO F. & DI NOCERA S., *Significance of the Pleistocene continental deposits cropping out in the Baronia Mts. in the framework of the Quaternary evolution of Northern Irpinia (Southern Apennines, Italy).* (IT ISSN 0391-9838, 1999).

The travertine and reddish gravelly-sandy-silty deposits, cropping out in the Baronia Mts. (Irpinia, Southern Apennines, Italy) and provisionally named *Vallata Unit,* have been studied. The study area is part of the Sannio-Irpinia sector of the Apennines; in this sector the morphology is affected by the cropping out of Late Miocene silico-clastic flysch (*S. Bartolomeo Fm*), Pliocene clastic deposits (*Altavilla and Ariano Units*) and of Meso-Caenozoic basin units (*Lagonegro Units*). The landscape is characterized by some remnants of an old mature suspended morphology (the «*Paleosuperficie*» *Auct.*), the age and genesis of which, have been variously interpreted. The Baronia ridge represents a NW-SE oriented morpho-structural unit, which is defined at the borders by wide normal faults. The morphology is characterized by both some morpho-structural elements (such as fault slopes) and several inherited morphological elements (such as top palaeo-surfaces with remnants of the palaeo-hydrographic network and glacis). The *Vallata Unit* deposits form sandy-gravel lenses up to 40 m thick and up to some square kilometers wide. They are located between the glacis and the top palaeo-surface. The deposits are discontinuously arranged onto the Early-Middle Pliocene alluvial conglomerates and nearshore sands; their age has been referred to the Upper Pliocene and to the Early-Middle Pleistocene. The deposits are variously oxidised and reddish in color due to the intense weathering and local pedogenesis processes. On the basis of their sedimentological and stratigraphic characteristcs a cryonival genesis environment referable to the Pleistocene glacial stages is presumed. If this hypothesis were to be confirmed, these deposits would fill the gap in the evidence of the Quaternary glaciations and cold stages in the Apennines. As a matter of fact, the known glacial evidence are present north of Matese Massif and south of the Alburni Massif but are lacking in the Sannio-Irpinia sector of the Apennines.

KEY WORDS: Quaternary geology, Stratigraphy, Geomorphology, Irpinia, Southern Apennines, Italy.

RIASSUNTO: MATANO F. & DI NOCERA S., *Significato dei depositi continentali pleistocenici dei Monti della Baronia nel quadro dell'evoluzione quaternaria dell'Irpinia settentrionale.* (IT ISSN 0391-9838, 1999).

È stato svolto uno studio dei depositi ghiaioso-sabbioso-limosi rubefatti e travertinosi, affioranti nei Monti della Baronia (Irpinia, Appennino campano-lucano), che sono stati provvisoriamente denominati *Unità di Vallata.* L'area di studio rientra nel settore sannitico-irpino della catena, ove la morfologia è condizionata dall'affioramento di unità terrigene sinorogene tardo-mioceniche e plioceniche e di unità lagonegresi meso-cenozoiche a dominante componente calcareo-pelitica, e risulta caratterizzata da alcuni relitti di un antico paesaggio maturo sospeso (la Palaeosuperficie *Auct.*), la cui età e genesi nel settore campano-lucano dell'Appennino sono state variamente interpretate. La dorsale della Baronia costituisce un'unità morfo-strutturale orientata in senso appenninico, delimitata da faglie marginali che ricalcano l'andamento del fiume Ufita. La morfologia risulta caratterizzata dalla presenza di elementi morfo-strutturali (versanti di faglia evoluti) e da numerosi elementi morfologici ereditati (almeno due ordini di palaeosuperfici e relitti di palaeoidrografie) e non collegati all'attuale livello di base. I depositi in esame si presentano distribuiti in maniera discontinua al di sopra dei termini sabbiosi di ambiente litorale e conglomeratici di ambiente alluvionale del substrato clastico infrapliocenico e sono stati attribuiti ad un intervallo compreso tra il Pliocene superiore ed il Pleistocene inferiore-medio. Essi costituiscono corpi lenticolari, potenti fino a varie decine di metri ed estesi fino ad alcuni km^2, e sono ubicati tra i ripiani del glacis ed i ripiani morfologici sommitali (palaeosuperficie). I terreni in esame risultano interessati da una intensa degradazione, presentandosi ovunque variamente ossidati e rubefatti e localmente interessati da processi di pedogenesi. I caratteri sedimentologici e stratigrafici indicano un ambiente di deposizione criogenico caratterizzato da processi criergici e nivali, ricollegabile agli eventi glaciali del Pleistocene. Se tale ipotesi venisse confermata essi andrebbero a colmare un vuoto nelle testimonianze delle fasi fredde e glaciali quaternarie dell'Appennino centro-meridionale, le quali sono ben evidenti a nord del Matese ed a sud del Massiccio degli Alburni ma mancano nel settore sannitico-irpino della catena.

TERMINI CHIAVE: Geologia del Quaternario, Stratigrafia, Geomorfologia, Irpinia, Appennino campano-lucano.

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INTRODUCTION

A study of the continental Quaternary deposits cropping out in the territory of Sheet nr. 433 «Ariano Irpino» of the new Geological Map of Italy, has been performed. These are made up of alluvial, lacustrine, eluvial and gravitative deposits and travertines, and form widespread covers up to tens of meters thick, lying disconformably on the substrate. They have been mapped according to the criteria proposed by the «Commissione per la Cartografia geologica e geomorfologica» (AA.VV., 1992), the International Stratigraphic Guide (Salvador, 1994) and Baggio & *alii* (1997).

The definition of unconformity-bounded units or of allostratigraphic units has been possibile only for some of those among the outcropping quaternary deposits, such as the alluvial deposits connected to the present hydrographic network and some deposits connected to the palaeohydrography and to wide relicts of inherited palaeomorphologies. In particular, such an approach has been followed in the case of some reddish gravelly-sandy-silty deposits, cropping out widely along the high sectors of the slopes and ridges of the Baronia Mts. and to a lesser degree, on the hills near Ariano Irpino and along the Scampitella ridge (fig. 1). The provisional denomination of *Vallata Allofor-*

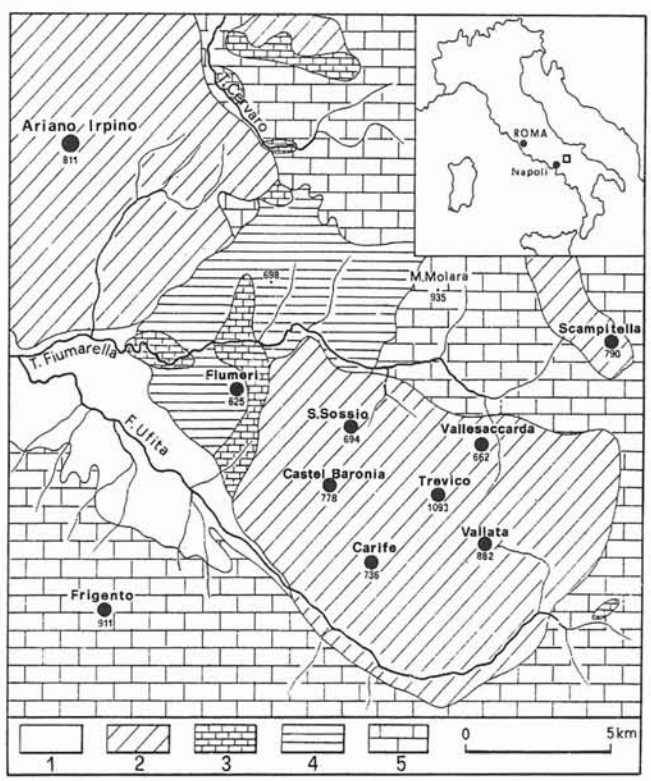

FIG. 1 - Baronia and surroundings geological sketch-map. Legend: 1. Fluvio-lacustrine deposits (Upper Pleistocene- Holocene); 2. Ariano Group (Early-Middle Pliocene); 3. Altavilla Group: «gessoso-solfifera» Fm. and T. Fiumarella Conglomerates (Messinian); 4. San Bartolomeo Flysch (Tortonian- Lower Messinian); 5. Lagonegro Unit and Daunia Unit (Creta-Miocene).

mation has been proposed in the legend of the in progress geological map; as it is not yet definite, in this paper we have used the more general name of *Vallata Unit.*

PREVIOUS DATA OF QUATERNARY GEOLOGY IN THE BARONIA MOUNTAINS

Knowledge of the Quaternary geology concerning the area of the Baronia Mts. and surrounding sectors is poor and incomplete.

The official geological cartography generally lacks data on the Quaternary continental successions (Aiqua, 1993). In particular in Sheet nr. 174 «Ariano Irpino» of the Geological Map of Italy at the scale 1:100.000 (S.G.d'I., 1963; Jacobacci & Martelli, 1967) no deposits referring to the sector of the Baronia of Quaternary age is quoted.

Aprile & *alii* (1976) sketched a neotectonic evolutionary scheme of the study area, according to which this sector of the chain was in a sea domain in the Lower-Middle Pliocene. After the tectonic phase of the Middle Pliocene, the structural high of «Frigento-Mt. Formicoso» and the structural low of «Baronia Mts.-Lacedonia-Daunia Mts.» were formed. The area almost completely emerged so that a diffused attenuation of the relief (peneplanation) and the formation of a primitive hydrographic network occured. In the Lower-Middle Pleistocene a new tectonic phase determined the dismemberment of the previous morphology and the development of normal erosional cycles. The new tectonic phase of the Middle-Upper Pleistocene triggered the differential uplifting and the dismemberment of the flattened top surface. In the Upper Pleistocene other tectonic phases produced little rejuvanations of the main tectonic lines, which allowed the singling out of the Grottaminarda basin and of the «Ufita Valley Fault». The Authors, in particular, put into evidence «*the presence of conglomerates with reddish matrix lying on sea deposits of the Lower-Middle Pliocene cycle, and correlate them to the debris of Upper Pliocene-Lower Pleistocene age which are present along the southern border of the Picentini Mts.*».

Brancaccio & *alii* (1981) recognized in the Baronia Mts. at least two orders of relict erosional surfaces, which are not linked to the current base level, and a fault slope («Ufita Fault»), which has evolved with triangular facets. The Authors define three phases in the neotectonic evolution of the area: a) emersion in Middle-Upper Pliocene; b) a comprehensive uplift over 1000 m, resulting from many uplifting phases; c) recent and current tectonic activity. The intense recent and present tectonic activity is witnessed by some strong historical heartquakes, but also by the current high sismicity of the area, which is characterized by focal mechanisms which put into evidence a distensional regimen in the tectonic movements (Boschi & *alii*, 1994).

Recently some aspects of the Quaternary geology of the high valley of the Ufita river have been studied in detail. In particular Basso & *alii* (1996a) have sketched the Pleistocene evolution of the Grottaminarda fluvio-lacustrine palaeobasin and have briefly described the Quaternary de-

posits and the main morphological and structural elements, while BASSO & *alii* (1996b) have reconstructed the evolutionary picture of the southern slope of the Baronia Mts. between the Late Glacial and the Holocene on the basis of lithological, morphological, structural and archaeological data.

BRIEF OVERVIEW ON THE REGIONAL MORPHO-STRUCTURAL FEATURES

The studied area is part of the southern sector (Irpinia) of the Molise-Sannio segment of the Southern Apennines, near the junction with the Campania-Lucania segment; the area is located about 50 km to the west of the buried front of the chain. The morpho-structural evolution of the Irpinia-Sannio sector of the chain is not yet very clear, but it is presumed that it was affected by compressional deformations up until at least the Upper Pliocene (Cinque & *alii*, 1993; Ortolani & Pagliuca, 1988). From a structural point of view, as a mattter of fact, the area is characterized by a set of thrusts of Late Miocene and Pliocene ages, laterally delimited by tear faults. These structural elements define some juxtaposed tectonic units, which are further dismembered in a set of horst and graben by the distensional Quaternary tectonics.

The landscape is affected by the outcropping of Late Miocene-Pliocene silico-clastic sinorogene units and of Meso-Caenozoic «Lagonegro» basin units with a prevailing calcareous-pelitic component. The morphology of the scenery is characterized by some relicts of an old suspended mature landscape (the «*Paleosuperficie Auct.*»), whose age and genesis in the Campania-Lucania sector of the Apennines have been variously interpreted.

In particular, Brancaccio & Cinque (1988) believe that this surface could be of poly-genic and poly-phased nature and that in the sector located to the east of the campanian limestone massifs it represents the effect of an erosional phase started in the Middle Pliocene. Ortolani & Pagliuca (1988), instead, speculate that the flattened surface, which is developed at a regional scale among the Molise and Basilicata regions, had formed prevalently for marine abrasion between the Upper Pliocene and the Early Pleistocene. Cinque (1992b) put into evidence the diacronism and the different palaeo-geomorphological meanings of the different strips of mature landscapes suspended along the southern Apennines; they appear more as independent local palaeomorphologies, both sinorogene (Upper Miocene - Lower Pleistocene) and post-orogene (Pleistocene), than as fragments of a single regional «*Paleosuperficie*». In particular, the modeling of the mature suspended landscape which characterizes the external strip of the Campania-Lucania Apennines would have occured between the high part of the Early Pleistocene and the low part of the Middle Pleistocene (Cinque & *alii,* 1993), since it appears unconformably overimposed on the morpho-tectonic elements linked to the Early Pleistocene compressional tectonics. The erosional palaeomorphologies have been displaced in the Middle-Late Pleistocene by faults with an apenninic trend with a prevailing vertical movement; these faults have controlled the hydrographic network and the origin and distribution of small continental basins (Brancaccio & Cinque, 1992; Cinque, 1992a; Cinque & *alii*, 1993; Basso & *alii*, 1996a).

GEOLOGICAL AND STRUCTURAL FEATURES

The continental deposits (Vallata Unit), which have been examined, exclusively crop out inside or just beside the sector where Pliocene deposits crop out. As a matter of fact, in the studied area a thick clastic succession of the Lower-Middle Pliocene (Ariano Unit) crops out. It was first described by Dessau (1952) and by Chiocchini & *alii* (1971, 1992). More recentely Amore & *alii* (1998) and Matano & Staiti (1998) refer these pliocenic deposits (Ariano Group) to two separate sedimentary cycles. The successions of the Lower Pliocene (MPl4a Biozone) cycle can reach a thickness of 1400 m and have been grouped on a lithostratigraphical basis in the «Baronia formation»; the successions of the Middle Pliocene cycle (MPl4b p.p. - MPl5a Biozones) are at least 700 m thick and have been grouped on a lithostratigraphical basis in the «Torrente Cervaro formation». These Pliocene deposits represent the more recent deposits of marine and transitional environments that crop out in the studied area and lay on calcareous-pelitic deposits (Flysch Rosso Auct. and Argille Varicolori Auct.), siliciclastic turbidites (San Bartolomeo Flysch, Crostella & Vezzani, 1964) and clastic-evaporitic deposits (T. Fiumarella Conglomerates, Basso & *alii*, 1996c), which form the Palaeogene to Messinian aged substrate (fig. 1).

The deposits of the Ariano Group are deformed with a set of folding structures with sub-parallel NW-SE oriented axes, which are slightly displaced by transversal normal or strike-slip faults and truncated by moderate thrustings.

The geological structures record the existence of a compressional or transpressive tectonic phase that lasted up until at least the high part of the Middle Pliocene or to the low part of the Upper Pliocene (after the MPl5a Biozone). The tectonic phase deformed the youngest marine deposits which crop out in the area; these deposits are at least Middle Pliocene in age for the presence of *Globorotalia bononiensis* (Amore & *alii,* 1997). The Quaternary tectonics has differentially uplifted the various sectors of the Baronia Mts., and has produced a NW-SE lengthened structural high, inside of which minor transversal horst and graben are present.

OUTLINES OF THE BARONIA MTS. MORPHOLOGY

The Baronia Mts. ridge forms an apenninically oriented morpho-structural unit which is delimited by great normal faults on the southern border. The morphology is characterized by the presence of evolved fault slopes and of numerous inherited morphological elements (palaeosurfaces

and palaeohydrografy) which are not linked to the present erosional base level (fig. 2).

In the uppermost topographical position some residual portions of an suspended ancient and very evolved landscape (the *Paleosuperficie Auct.*) are present; this landscape has been modeled after the Middle Pliocene when generalized emersion of the area took place. The palaeosurface appears to dip towards NW, passing from an elevation of 1000-1100 m a.s.l. to about 700 m a.s.l.; it unconformably truncates the stratal trend of the upper parts of the Pliocene succession, which is mainly formed of conglomerates.

The central sector of the uppermost palaeosurface is deeply cut (for about 100-150 m) by a well hierarchized hydrographic network, formed from the high parts of the streams «Vallone San Nicola» and of the «Vallone Alvanello». The high parts of these torrents are NW-SE orientated and are at an angle of 90° with respect to the lower portions (fig. 2). We hypothesize that the capture of some high tracts of a palaeohydrographic network with a NW trend, probably flowing in the palaeo-Fiumarella torrent, has occured and that it was caused by the action of Ufita river tributary streams.

The palaeosurface is subdivided by the valley of the S. Nicola torrent in two NW-SE oriented relict strips (fig. 2), which are represented by the ridges of «Montagna di Carife» (to the SW) and «Trevico» (to the NE).

The sector of «Montagna di Carife» is characterized by various strips of flat or weakly wavy surfaces, which develop degrading towards NW with an elevation between 775 m and 975 m a.s.l.

The northern sector of the palaeosurface, located between «Dietro il Castello» and «S. Stefano», presents some hollows which are interposed among sub-rounded ridges;

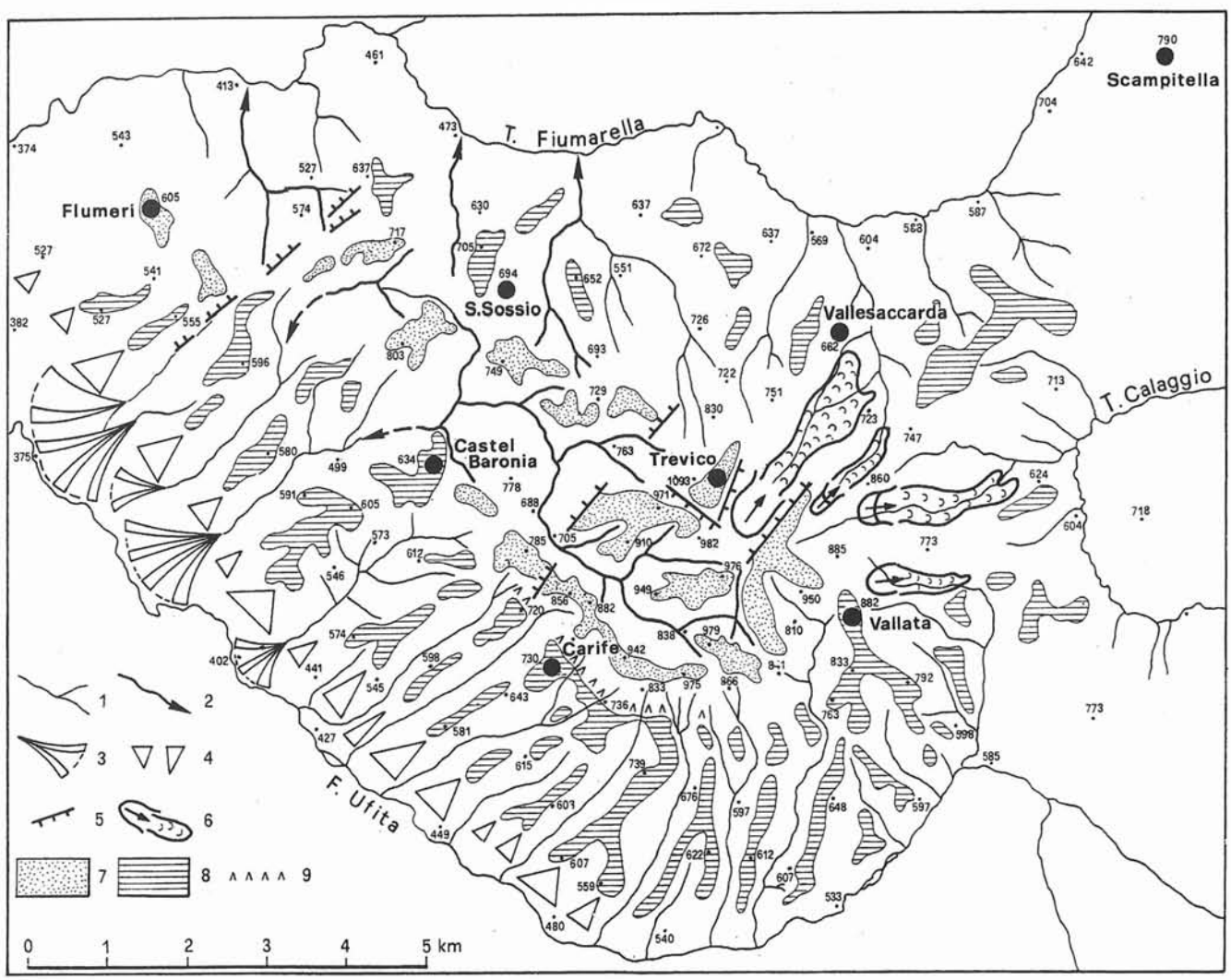

FIG. 2 - Geomorphological sketch-map of Baronia. Legend: 1. hydrographic network; 2. segments of the palaeo-hydrographic network, the arrows show the capture areas; 3. alluvial cone; 4. triangular facet; 5. morphological scarp of tectonic nature; 6. wide landsliding phenomena; 7. top old suspended mature landscape (palaeo-surface); 8. glacis; 9. grèzes litées.

this sector reaches an elevation of 1100 m a.s.l. with the structural high of Trevico. The slope facing towards NW which delimits this sector presents a stair-like morphological trend. At its base, at an elavation of about 650-700 m a.s.l., near «Piano delle Vacche», a 300 m wide and 1 km long secondary valley is present, which is cut in the Pliocene conglomerates with a concave section and is partially filled by 10 m thick gravel debris and sandy-silty reddish-brown colluvial deposits; these deposits are being cut by the present torrent for a depth of about 2-3 m.

On the south-western slope of the Baronia Mts., there are relict portions of a flat morphological surface slightly dipping towards valley. This surface is at an elevation between 550 m and 700 m a.s.l., suspended at about 150 m of elevation with respect to the present valley-bottom. It is about 10 km in length and about 2-3 km in width along the slope (fig. 2). It has been defined as an erosional glacis (Basso & *alii*, 1996a). Some linear subparallel torrents cut the glacis, and are set in it with about 100 m deep valleys; they orthogonally flow together into the Ufita River.

The sector of the slope which develops between the two described erosional surfaces (glacis and top palaeosurface) presents a gradient of 30°-35° in correspondence to the outcropping of the sandy-conglomerates portion of the Pliocene succession.

The glacis is divided from the present valley-bottom of the Ufita river by a slope-fault, which is linked to a neotectonic normal fault with an apenninic trend («Ufita Fault», Brancaccio & *alii,* 1981); this fault is considered to be still active on the basis of morphological, stratigraphical and seismical considerations (Basso & *alii*, 1997; Pantosti & *alii*, 1990).

The fault slope forms in soft rocks (clays and sands) and develops to triangular facets; these are lined up in apenninic direction (NW-SE) for about 13 km and are characterized by a height of 100-150 m from the base to the top (fig. 2). The fault has been reactivated since the Middle Pleistocene and has displaced the junction between the glacis and the ancient valley-bottom, so that it has uplifted its fluvial deposits up to + 150 m with respect to the present river talweg and has triggered the erosional processes along the valley which cut the glacis. At various heights, along the triangular facets and in the valley-bottom, terraced alluvial deposits are present; they are distributed in at least six orders of fluvial terraces (Basso & *alii*, 1996b).

The north-western sector of the Baronia (fig. 2), developing to the west of the Alvanello torrent, is like an isolated body with respect to the rest of the Baronia Mts.; it reaches with the Toppola hill an elevation of 803 m a.s.l..

The north-eastern slope of the Baronia Mts. develops between the towns of Vallata and Vallesaccarda, and presents an uneven and irregular topographic trend. A set of deep river cuttings put into evidence a continuous and thick stratum of debris-colluvial and pyroclastic covers; the latter are generally reworked and are probably associated to the volcanic activity of the Vulture due to the geographical exposure.

The slope is transversally crossed by a set of NNE-SSW oriented horst and graben; the graben are partially filled up by debris covers, which are affected by gravitative remobilization processes (fig. 2). Among these the widest one is located in the area between Trevico and Vallesaccarda, where between the elevations of 850 m and 1050 m a.s.l. a 0,6 km wide and 1,9 km long concavity is present; this is affected by striking active and quiescent gravitative phenomena.

The hydrography of the whole sector reflects the described articulate morpho-structural situation; as a matter of fact, the area of the slope can be subdivided in three different hydrographic basins (T. Calaggio, T. Fiumarella and R. Ufita). The river streams are oriented according to the main transversal structural elements, but some phenomena of river capture are present and these alter the fundamentally centrifuge pattern of the hydrographic network (fig. 2).

CONTINENTAL PLEISTOCENE DEPOSITS OF BARONIA MTS (*VALLATA UNIT*)

The examined clastic deposits appear to be distributed discontinuously above the Pliocene clastic substrate (fig. 3), of sandstone and conglomerate composition of littoral and alluvial environments, respectively (Matano & Staiti, 1998; Amore & *alii*, 1998). They make up lens-shaped bodies up to tens of meters thick that extend for a few square km. They are located on the the glacis surface, on the uppermost palaeosurface, and along the slope which separates the two orders of surfaces (fig. 4). These deposits are lacking at elevations lower than that of the glacis.

The deposits generally lie between unconformities. The lower surface is of erosional type and is cut into the conglomerate-sandy deposits of the Pliocene substrate (Baronia formation); it is characterized by an irregular geometry and is generally concealed by these Quaternary deposits of which it is the depositional surface. The upper surface, generally represented by the topographic surface, is of erosional type and is locally concealed by a thin layer of pyroclastic deposits sometimes reworked by colluvial and gravitational processes.

The examined deposits, provvisionally referred to as Vallata Unit, have been divided on the basis of their lithostratigraphic and morphostratigrafic features, which are explained below.

Trevico Gravel

The term «Trevico gravel» refers to the reddish and mostly gravel deposits that crop out along the strips of the uppermost palaeosurface (fig. 3 and 4).

Particularly along the ridges near «Montagna di Carife», heterometric gravel with sharp edged pebbles are present. These are immersed in a sometimes abundant reddish sandy-silty matrix which locally darkens along mostly lens-shaped levels and have an estimated thickness of about 10 meters. The pebbles are frequently broken with sharp edges and often appear to be weathered, reddened or even blackened, especially for marly lithotypes, which are often

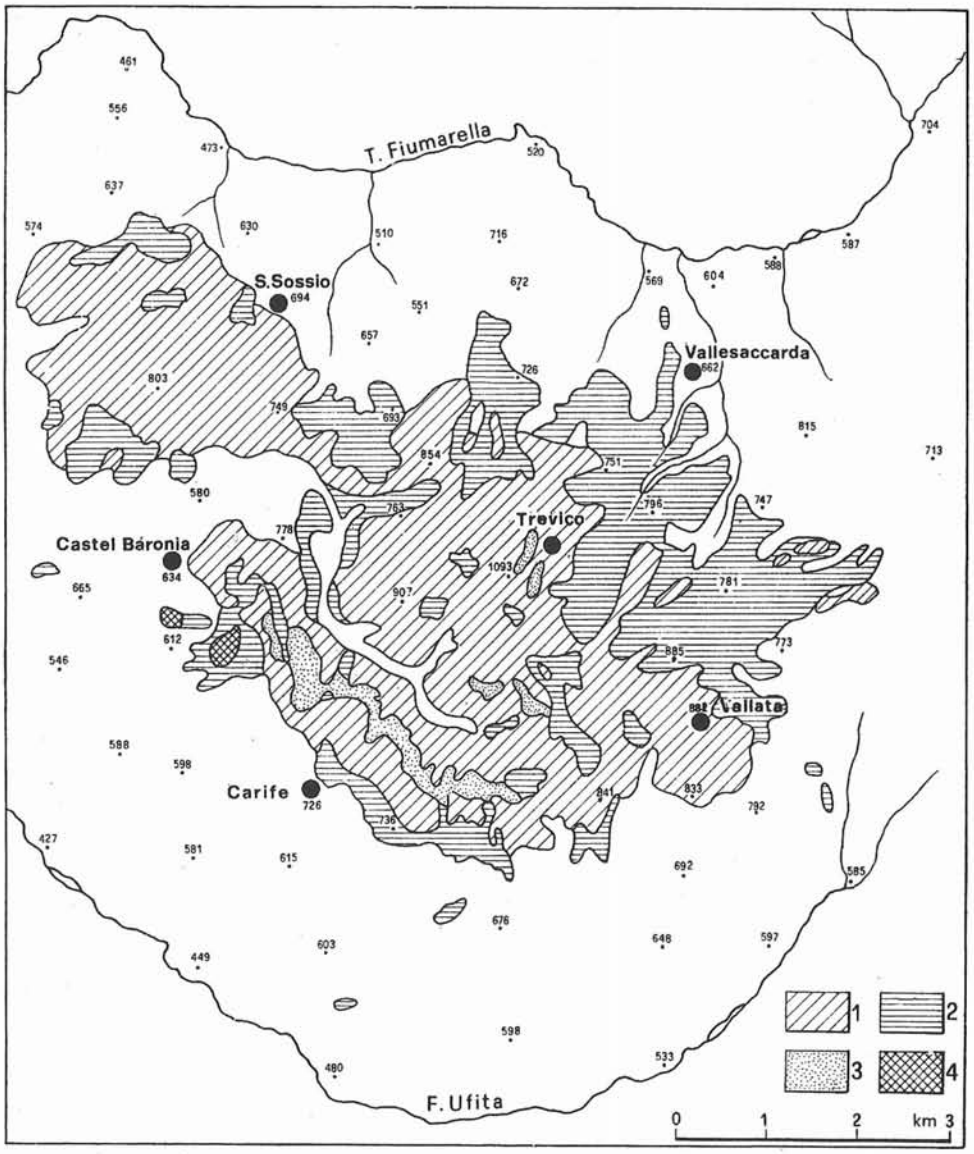

FIG. 3 - Baronia Mts. covers map, which shows the distribution of the clastic deposits of the Vallata Unit with reference to the Pliocene conglomerates outcropping areas. Legend: 1. Early Pliocene alluvial conglomerates (Baronia Fm); 2. Carife pebbles and silty sands; 3. Trevico gravels and pebbles; 4. Sorgente Tufara travertines.

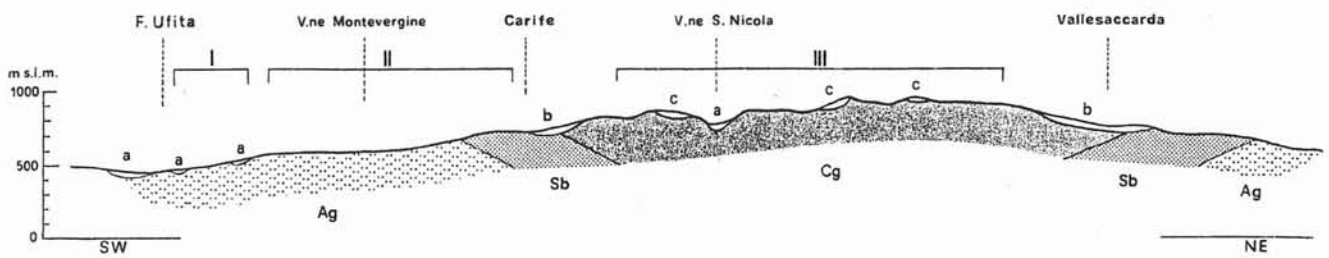

FIG. 4 - Geological and morphological section of the Baronia Mts (Scale ratio 1:1). Legend: I, triangular facet; II, glacis; III, top old suspended mature landscape (palaeo-surface); a, present, terraced and suspended alluvial deposits of the river Ufita; b, Carife pebbles and silty sands; c, Trevico gravels and pebbles; Ag, sandy clay member of the Baronia Fm.; Sb, silty sand member of the Baronia Fm.; Cg, sandy conglomerate member of the Baronia Fm.

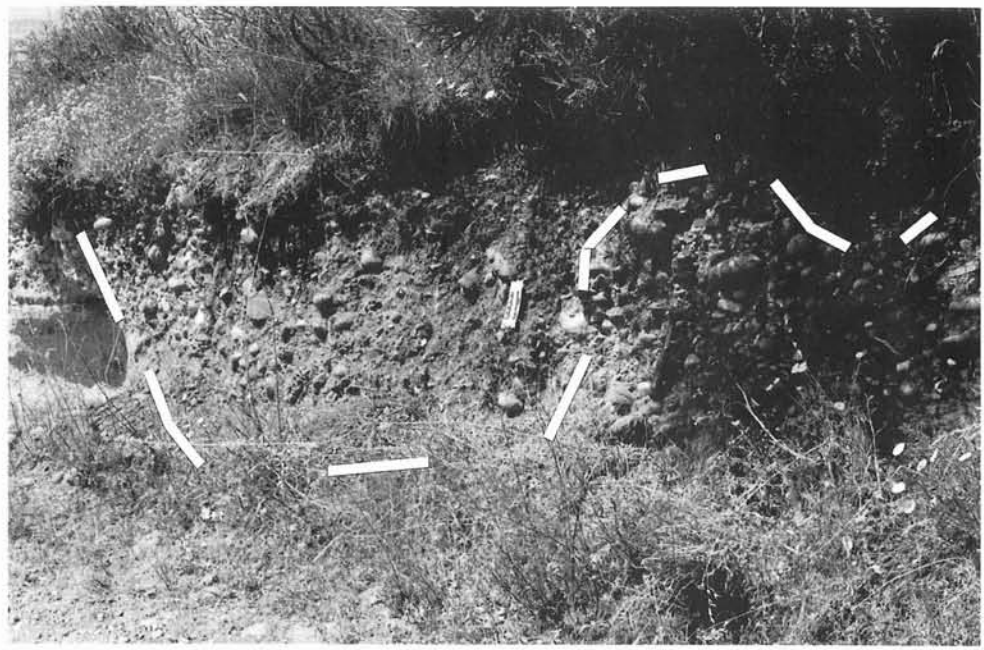

FIG. 5 - Irregular basal buried erosional contact between the Trevico gravels and pebbles and the Early Pliocene conglomerates of the Baronia fm.

decalcified; they are the result of the reworking of Pliocene conglomerate clasts of the substrate which are made up of spherical to tabular well rounded polygenic pebbles.

At a distance of hundreds of meters from the town of Carife, there are some small caves where fresh cuts allow to observe the articulation of the buried erosional contact between these deposits and the underlying Pliocene conglomerates (fig. 5). Furthermore, it is possible to distinguish in the reddish gravel, massive or laminated, subhorizontally laid, coarse grained lens-shaped sands with small scattered pebbles. The gravel deposits are covered by reworked and pedogenetized brownish pyroclastic deposits, up to 6 m thick, rich in small rearranged pumices, small augite crystals and small rounded quartz pebbles.

At the base of the gravel locally there is a discontinuous level of yellowish marls about 20-30 cm thick and here, no sedimentary structures are observed. Open wedge-shaped fractures about 2-3 m deep are present in the Lower Pliocene conglomerates of the substrate, near the contact with the upper gravel. These fractures are filled with sharp edged clasts made up of stone fragments, set in a brownish and reddish sandy silty matrix (fig. 6).

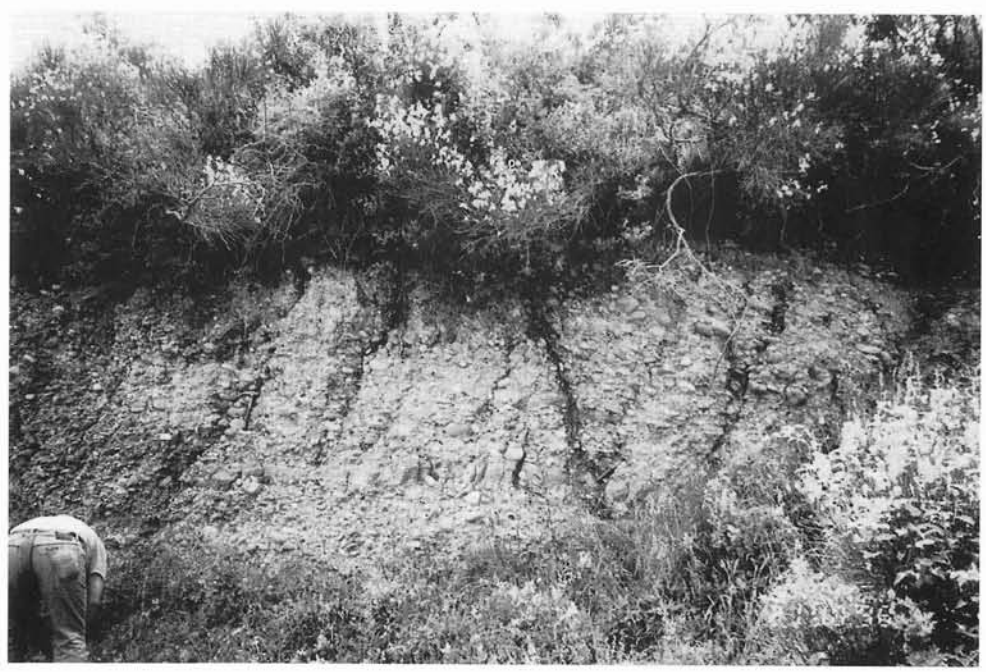

FIG. 6 - Open fractures in the Early Pliocene conglomerates are locally present under the contact with the Trevico gravels and pebbles. The wedge-shaped fractures are 2 or 3 m in depth and are filled by angular elements with a reddish and brownish sandy-silty matrix. The elements are fragments of previous pebbles of Pliocene age.

Some torrent deposits made up of gravel set in a slightly reddish sandy microconglomerate matrix and of lens shaped strata of slightly reddish and laminated sands crop out in correspondence to the uppermost palaeosurface of the Baronia Mts. The pebbles present sharp edges probably due to cryoclastism processes. These features indicate deposition in an alluvial environment and probable reworking in a cryogenic environment.

Conglomerates and Sandy silty gravel of Carife

At the top surface, at the borders of the «Trevico gravel» deposits, and along the upper and middle sectors of the slope of the Baronia Mts. (fig. 3 and 4), there are sandy pebbly and conglomerate deposits, which differ from those described above in their age and genesis environment. These deposits present variable features in the different sectors examined.

Along the southern slope, between Castelbaronia and Vallata, there are strips of gravel with sharp edged pebbles in a sometimes reddish sandy silty matrix. These deposits lie with an irregular unconformity surface of either erosional or depositional nature, on Pliocene deposits of the Baronia formation. Two types of gravel deposits are evident: slope deposits with cryoclastically worked pebbles, and transport deposits, which are placed by gravitational or tractive mechanisms (grain flow, alluvial cones, etc.).

At the bottom of the upper sector of the slope over the glacis at a height of about 700-800 m, there are base-slope debris and some small coalescent cones with a radius of about 100-200 m that make up a discontinuous stratum, at the foot of the mountain, lying on the upper part of the glacis. In some exposures, it is possible to observe cross-bedded conglomerates (fig. 7), dipping at an angle of

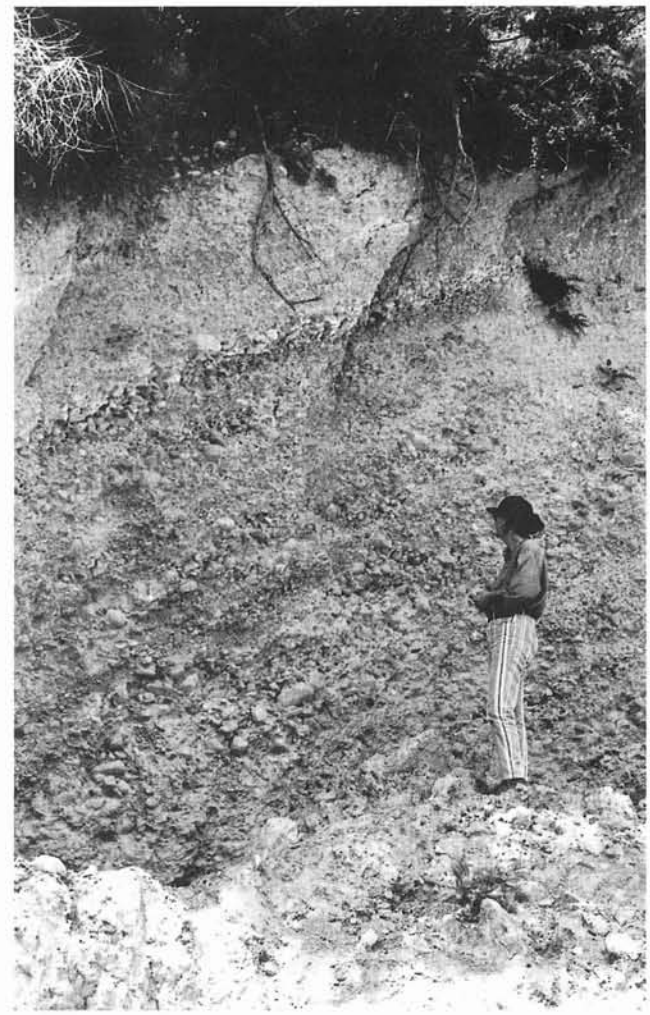

FIG. 7 - Carife conglomerates and silty-sandy pebbles view near Carife city. Along the national road n° 91 a debris talus (grèzes litées) is present. It is formed by pebbles without matrix beds alternating with sandy gravels beds. The cross-bedding is towards the bottom of the valley.

about 25-28° towards the valley, made up of alternating layers of fragmented sharp edged pebbles that lack a matrix and thinner levels of gravel with a sandy matrix. The clasts are generally made up of sharp broken fragments of calcareous-clastic, arenitic and calcareous-marly pebbles which derive from the underlying Lower Pliocene conglomerates of the Baronia formation. These deposits make up a stratum of bedded debris (*grèzes litées*), which develops for about 3 km starting from the city of Carife towards SE (fig. 2). They are about 40 m thick, and can be observed along the national road 91. They are cut and eroded by the present hydrographic network (fig. 2). Towards the top and to the side, the deposits become reddish brown sandy-silty colluvial deposits with stone lines.

Along the glacis there are subhorizontally laying deposits made up of gravel with sharp edged broken pebbles in a reddish silt-sandy matrix with lens shaped layers of massive sandy silt. They make up a few isolated strips in the middle and lower parts of the glacis, like for example near the Area della Croce, where a small residual hill made up of reddish gravel sand with stone lines about 30 m thick is observed.

In this area there are hollow palaeovalleys filled by silty sands and gravel lenses (fig. 8), thus indicating the existence of phases of both erosional modeling and filling of hollow forms along the glacis.

On the northern slope of the Baronia Mts. (fig. 3), on the sector east of S. Sossio Baronia and S. Nicola Baronia, at a height of 650-800 m, two more strips of reddish slope debris can be observed. They make up a strip that marks a stratigraphic transition between Pliocene conglomerates and sands. Along the head of «Vallone di Suosso» valley, the torrents cut some palaeo-hollows, filled with gravel in a reddish soil and with reddish sandy colluvial deposits with stone lines.

At a height of about 650-800 m, over the town of Vallesaccarda, extended reddish sandy gravel covers are observed. These are often related to surface landslide phenomena or soil creep movements that have obliterated previous internal structures. The latter deposits form a rather continuous 10 m thick cover that is cut by various torrents which run down the slope. In the talweg of the torrents a Pliocene sandy conglomerate substrate crops out. In the sector east to the town of Trevico (fig. 2-3), there is a deep and wide, structurally lowered, concavity, inside of which a complex, morphologically articulate landslide phenomenon has developed. It is characterized by small depressions, hills and scarps. Among the reddish gravel sandy debris covers, mobilized by landslides, in this area there are tilted and dislocated blocks of Pliocene conglomerates and sands.

The eastern slope develops to the north and east of Vallata and is characterized by extensive reworked pyroclastic covers many meters thick. These conceal both the Pliocene substrate and the reddish gravel debris. To the north of Vallata (loc. Piano delle Rose) there is a broad valley, partially filled by 20 m thick gravel-sandy deposit that is both chaotic and organized in lens-shaped levels of deposits of different grain size, sometimes tilted; there are also orange and reddish sands with pebble, conglomerate blocks and arenaceous strata fragments. These deposits can be observed in some excavations and along the cutting of the torrent; otherwise they are concealed by pyroclastic and colluviali deposits. In this area gravel deposits lay on clayey sandy deposits of the T. Cervaro formation of Middle Pliocene age.

FIG. 8 - Buried hollow located along the high sector of the «S. Nicola» torrent valley. The fillings are formed by reddish silty sands and gravelly pebbles lens, which belong to the «Carife conglomerates and silty-sandy pebbles».

The «Conglomerates and sandy-silty gravel of Carife» are always in contact with Pliocene marine deposits and, as the homogeneity of the lithological nature of clasts shows, they rise as a result of the reworking of pebbles of the Pliocene conglomerates along the slopes or top surfaces and are probably also due to cryoclastic and solifluction mechanisms thus indicating a cold environment (nival type climate). The processes responsible for their formation are gelifraction, nivation and displacement of the deposit for surface run-off, alternating or combining with solifluction or gravitational phenomena, during cold periods of the Pleistocene.

Travertines of «Sorgente Tufara»

In the upper part of glacis, about 1 km to the south of Castelbaronia, near Tufara spring and at an elevation of about 670 a.s.l., a 500 m^2 stretch of travertine sits. It is both whole and clastic and is associated to a reddish slope debris (fig. 9). The travertine levels are 6-7 m thick and are made up of both phytoclastic calcarenites and whitish phytothermal travertine. These levels are characterized both by well compacted levels and by porous travertine rich in algae incrustations; there are also porous travertine sands rich of gastropoda shells, travertine massive sandstones with medium-small grain size with rare mollusk shells and reddish sands with parallel lamination (fig. 9). The general features indicate a palustrine type environment with intermittent water flows and slope debris feeding. Indeed, the travertine is spotted with reddish sandy gravel with sharp edged pebbles, that extends over the glacis towards the south-east.

These deposits thus represent a local product of springs, which was related to the stratigrafic contact between the Pliocene conglomerates and the underlying sands and located at the base of a palaeo-slope affected by sedimentation due to gravitational processes.

HYPOTHESIS ON THE QUATERNARY GEOLOGICAL EVOLUTION OF THE BARONIA MTS.

Stratigraphically, the examined deposits lie unconformably on the deposits with *Globorotalia. bononiensis*, which crop out along the the valley of T. Calaggio, and make up the T. Cervaro formation (Amore & *alii*, 1998) of the Middle Pliocene. Furthermore, in various locations near Vallata, they underlie pyroclastic deposits that are probably related to the eruptive center of the Vulture, which was active during the Middle Pleistocene (between 0.8 and 0.5 Ma, Cortini, 1975). On the other hand, the presence of pyroclasts from Vulture on the uppermost Palaeosurface, has been noted in areas south to the Ofanto river valley (Ortolani & Pagliuca, 1998). Based on such considerations and on chronological references provided by the literature (Aprile & *alii*, 1976), the studied deposits may be associated to a time interval between the Upper Pliocene and Early-Middle Pleistocene.

In fact, the tectonic phases of the Middle-Upper Pliocene mark the end of marine sedimentation in this area, which still in a compressional regimen was followed by the emersion of the area and the beginning of subaerial morfogenesis. Starting in the Upper Pliocene and all during the Early Pleistocene, complex morphological evolution processes take place resulting in the formation of some areas of intramountain alluvial planes, where a primitive hydro-

FIG. 9 - Heteropic contact between whitish fitoherma travertine, characterized by very hard beds rich of algae incrustations, as well as travertine sands rich of Gastropoda shells and reddish parallel laminated sands of the «Sorgente Tufara» travertines outcrop, located near Castelbaronia city, about 1 km southward.

graphic network, in line with the anticlinal and sinclinal structures of the Pliocene, can be distinguished. Along these streams gravel in a reddish matrix («Trevico gravel») was deposited, produced from torrent erosion and transport processes of the upper conglomerates of the Baronia formation and in part from cryrogenic reworking.

Following the first phase of differential uplifting, which occured during the neotectonic event of the Early Pleistocene (Brancaccio & Cinque, 1988), various situations take form:

a) an inital dismemberment of the already recognized palaeomorphology (presently detected in the residual strips of the top palaeosurface of the examined area),

b) the cutting of the pre-existent hydrographic network (as can be seen from the higher part of the valley «Vallone Macchioni»), and

c) the partial reworking of reddish deposits, also favored by Pleistocene cold periods in which gelifraction and nivation processes were most active.

It is worth speculating that at such a time, there came to be a structural high characterized by a powerful uplifting corresponding to the Baronia Mts. ridge, separated from the present day sector of the Ufita river valley, by perimeter faults («Ufita Fault»).

The selective erosional processes that occurred on the different lithotypes of variable erosionability, which form the lower part (clays and sands) and the upper part (conglomerates) of the stratigraphical succession cut by the tectonic element, together with rapid evolution of the fault slope, may have caused a differential retreat of the different sectors of the slope. This process was accompanied by the formation of a glacis between the Lower and Middle Pleistocene. The residual strips of the glacis are visible along the middle part of the southern slope of the Baronia, to the right of the the Ufita river (Basso & *alii*, 1996a). The cross-bedded gravel deposits (*grèzes litées*) found in the junction sector between the glacis and the uper part of the slope are cut by torrent and pedogenesized in the exposed parts; they may be related to a cold phase of the Midlle-Late Pleistocene. In correspondence to the stratigraphic contact betweeen the Lower Pliocene sands and conglomerates, new springs have been identified along with the formation of local travertine accumulation intercalated with the «silty sands and gravel of Vallata».

Even in Lucania, Boenzi (1980) brings to attention similar morpho-evolutive situations characterized by Middle Pleistocene stratified debris covers (*grèzes litées*) and glacis.

The described sedimentological and morphological features lead to the assumption that the environment in which the Vallata Unit deposits formed, goes from torrential to mountainous and is characterized by a rather cold climate with cryonival processes. Furthermore, the examined deposits are variably oxidized and reddish and are locally affected by pedogenesis processes. Their intense degradation links the nature of their formation processes to those that «ferretto» type deposits would have generated in Alpine areas.

If the postulated hypothesis regarding the genesis environment and age of the clastic deposits of the Vallata Unit, should prove valid, a missing link in the Quaternary glacial periods of the mid-southern Apennines would be resolved. Evidence of such periods (Boenzi, 1980; Boenzi & Palmentola, 1972, 1975, 1997; Castaldo, 1965; Federici, 1979, 1980; Malatesta, 1985; Palmentola & Acquafredda, 1983; Palmentola & *alii*, 1990; Scandone, 1971) are well apparent north to examined area (Abruzzi and Mt. Matese) and to the south (Mt. Cervati and Mt. Volturino) (fig. 10), but are absent in the Sannio-Irpinia sector of the chain. This is however also due to low grade conservation of the outcropping lithotypes and fairly low altitudes.

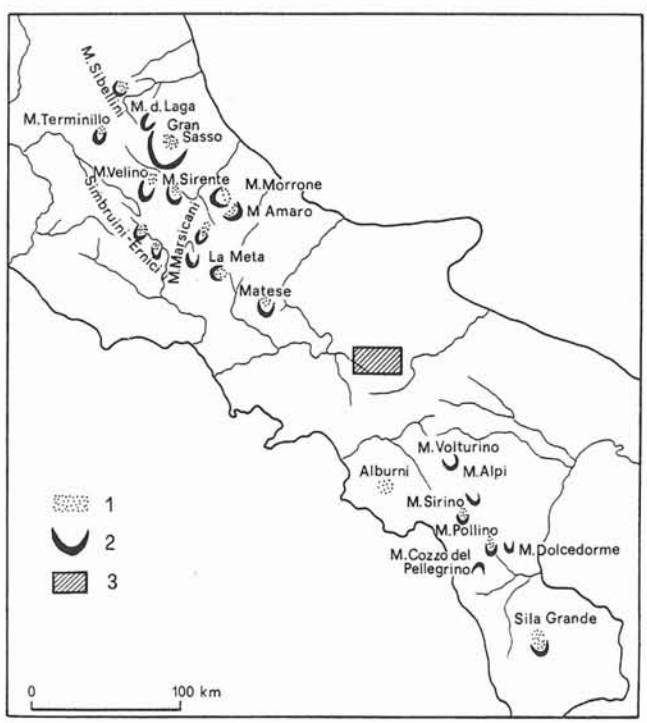

FIG. 10 - Distribution of evidence of the Quaternary glaciations in the central-southern Apennines (Various Authors, see References). Legend: 1. Moraine deposits; 2. Last glacial stages cirques; 3. Study area.

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