Il Quaternario
Italian Journal of Quaternary Sciences
***12**(2), 1999, 141-148*

WEATHERING PATTERNS IN THE SILA MASSIF (NORTHERN CALABRIA, ITALY)

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ABSTRACT - *Weathering patterns in the Sila massif (northern Calabria, Italy).* In Northern Calabria a deep and mature weathering profile has developed from Late Miocene to Pleistocene within the granitic and metamorphic rocks which form the main mountains and massifs. The Sila massif crystalline rocks are characterized by deep and variable weathering profiles, which represent a fossil and eroded mantle. In this paper the regional pattern of the weathering profile in Sila Massif is described. The wide variability of weathering conditions of the Sila weathered rocks required the use of weathering classifications; the mapping of weathering profiles and grades permitted a general and comprehensive overview of the effect, intensity and distribution of weathering processes.
In the study area two sectors with different weathering profiles have been recognized. The development of the weathering profiles in Sila could have occurred between the Late Miocene and the Pleistocene under various climatic conditions. Under the current temperate and Pleistocene glacial climatic conditions the erosional processes, as activated by tectonic uplifting, prevail over the weathering processes, although not enough to completely remove the exposed, deeply weathered mantle.

RIASSUNTO - *Caratteri dei profili di alterazione nel massiccio della Sila (Calabria settentrionale).* Le rocce metamorfiche e granitiche che costituiscono i principali rilievi della Calabria settentrionale sono caratterizzate da profili di alterazione profondi e maturi legati a processi di degradazione meteorica. In particolare le rocce cristalline affioranti nel massiccio della Sila si presentano profondamente ed intensamente alterate; i processi di alterazione si sono probabilmente sviluppati a partire dalla definitiva strutturazione ed emersione del massiccio cristallino, in un intervallo di tempo compreso tra il Miocene superiore ed il Pleistocene.
L'ampia variabilità delle condizioni di alterazione delle rocce cristalline silane, costituite prevalentemente da graniti e gneiss, ha indotto ad utilizzare per la raccolta e la sintesi cartografica dei dati una classifica del grado di alterazione. Tale approccio metodologico è ampiamente diffuso in letteratura e consente di analizzare in maniera completa e di sintetizzare in maniera ottimale i dati relativi agli effetti, all'intensità ed alla distribuzione spaziale dei processi di degradazione meteorica.
Nell'area studiata sono stati riconosciuti due settori distinti, caratterizzati da un differente andamento dei profili di alterazione. Nel settore di altopiano della Sila, caratterizzato da un'ampia paleosuperfice sommitale del Pleistocene inferiore, affiorano graniti e subordinatamente gneiss, filladi e rocce sedimentarie. Le rocce cristalline si presentano in condizioni di elevata degradazione meteorica, cosicchè lungo la paleosuperfice si rinvengono coltri di suoli residuali e saproliti granitiche spesse da decine ad alcune centinaia di metri, localmente ricoperte da depositi lacustri pleistocenici ed alluvioni terrazzate. I graniti sono notevolmente alterati ed esibiscono un profilo di alterazione semplice e maturo, caratterizzato da potenti orizzonti di saprolite e terreno residuale che includono massi sferoidali di granito poco alterato. Nel settore del versante occidentale silano degradante verso la valle del fiume Crati, l'andamento topografico si presenta molto irregolare e affiorano gneiss, scisti, filladi e graniti alterati. Le condizioni di degradazione delle rocce cristalline variano da moderate a complete, mentre la roccia poco o per nulla alterata affiora solo lungo le profonde incisioni torrentizie. I terreni residuali sono quasi del tutto assenti, mentre, a causa degli attivi processi morfodinamici che caratterizzano il versante, sono molto diffusi i terreni colluviali, i detriti di versante e di frana. Nell'insieme lo spessore del profilo di alterazione è dell'ordine dei 70 m; esso risulta inferiore rispetto a quello riconosciuto nel settore sommitale, in quanto il profilo è stato parzialmente eroso.
Nel complesso le rocce cristalline del massiccio silano sono caratterizzate da profili di alterazione profondi e maturi variabili da semplici a complessi. Nel settore sommitale, lungo la paleosuperfice pleistocenica, affiorano in prevalenza regoliti costituite da saprolite e terreni residuali e colluviali ed il profilo di alterazione si presenta semplice e potente almeno un centinaio di metri, mentre nel margine occidentale del massiccio il profilo di alterazione è ereditato e parzialmente eroso, cosicchè presenta spessori di circa 70 m ed in affioramento si ritrovano in prevalenza rocce da parzialmente a completamente alterate.

Key words: weathering pattern, weathering profile, weathering grade map, Sila Massif, Calabria, Italy.
Parole chiave: caratteri della degradazione meteorica, profili di alterazione, carta del grado di alterazione, Massiccio della Sila, Calabria settentrionale.

1. INTRODUCTION

In Northern Calabria granitic and metamorphic rocks form the bulk of the main mountains and massifs and mature weathering profiles have developed within these rocks from Late Miocene to Pleistocene (Novarese, 1908; Crema, 1908; Ducci, 1949; Ippolito, 1962a, 1962b; Guzzetta, 1974; Ietto, 1975).

In particular the Sila massif crystalline rocks are characterized by a deep weathering profile (Montella, 1955; Carta Geologica della Calabria, 1968; Nossin, 1972; Verstappen, 1977), which Guzzetta (1974) hypothesized to be due to an ancient tropical weathering. Today Calabria has a mediterranean type of climate, but the observed decomposition and degradation characteristics of the weathered rocks result from the accumulation of the weathering effects which have been produced under the climatic conditions from the Sila massif emerging time (i.e. Late Miocene) to the present time. The currently available data about weathering various aspects (geochemistry, pedology, geomorphology, geology, etc.) do not permit to recognize the contribution to the weahering increase due to the different climate conditions in the Sila Massif. The data about phisical condition and intensity, distribution and deepness of the wetahering of crystalline rocks are even very deficient.

The aim of this paper is the description of the regional patterns of the weathering profile in the Sila Massif with reference to degradation and lithological features of the rock masses. For this purpose we have carried out weathering field surveys at various scales, formulated some hypotheses about the weathering profiles and plotted a weathering map of the Sila western sector. This paper bases also on lithological, geomorphological, geotechnical, and petrographical data which have been collected during a research project about the landsliding of weathered gneiss in a study area of the Sila Grande Massif (Cascini et al., 1992, 1994; Critelli et al., 1991; Cascini & Gullà, 1993; Matano & Tansi, 1992).

2. GEOLOGICAL AND MORPHOLOGICAL OUTLINE OF THE SILA MASSIF

The geology of Northern Calabria is characterized by crystalline allochthonous nappes which overthrusted Apennine sedimentary formations in the Miocene. From the Messinian to the Quaternary they were covered by evaporitic and terrigenous sediments (Amodio Morelli et al., 1976). In the Plio-Pleistocene a tectonic uplifting produced normal fault systems which are still active and give the general shape to the mountainous massifs, so that tectonics is the most important factor of relief construction. In particular the crystalline rocks are affected by widespread jointing and faulting so that granites and gneiss are very prone to weathering.

The geomorphology of the territory of Northern Calabria is very complicated, presenting evidence of new forms due to active processes and ancient inherited forms, which have been greatly modified. The main landforms are morphostructures generated by spatially and temporarily discontinuous tectonic uplifts which produced the mountain massif and highlands alternating with lowlands (Sorriso Valvo, 1990). The present Calabrian climate is of Mediterranean type with warm summers (Csa), but it is apparent that the climatic differences in the Holocene and in older glacial times have influenced the rates of morphodinamic processes.

The Sila massif emerged after the Upper Miocene and its morphological evolution is at a very advanced stage; indeed remnants of a "peneplane" can be seen (Fig. 1). The age of this paleosurface is ascribed to the end of Lower Pleistocene (Dramis et al., 1990). The surface is truncated by several erosional episodes, including glacial

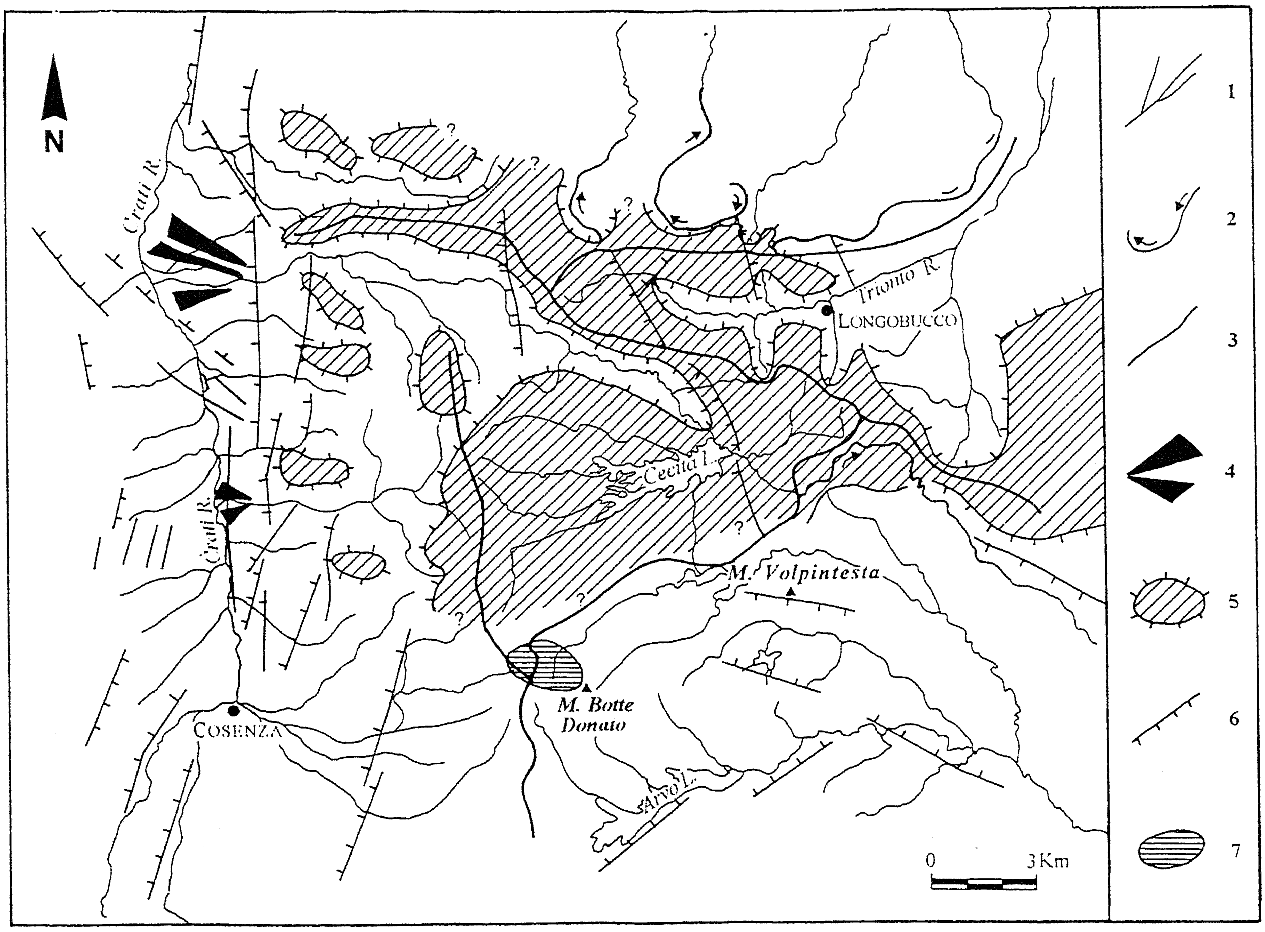

Figure 1. Geomorphological scheme of the western area of the Sila Massif, Northern Calabria, Italy (modified by Dramis et al., 1990). Legend: 1. Hydrographic network; 2. River capture; 3. Divide; 4. Fan; 5. Lower Pleistocene paleosurface; 6. Normal fault; 7. Moraines.

Carta geomorfologica schematica della porzione occidentale dela Massiccio della Sila (modificata da Dramis et al., 1990). Legenda: 1. Reticolo idrografico; 2. Cattura fluviale; 3. Spartiacque; 4. Conoide; 5. Paleosuperfice sommitale del Pleistocene inferiore; 6. Faglia normale; 7. Depositi morenici.

events whose scarse and faint evidences have been found on the highest tops of Sila (Boenzi & Palmentola, 1975). The highlands are characterized by forest covers, whereas badlands dominate those slopes affected by intensive landlsiding. A large number of non-active alluvial fans can be found at the mouths of canyons where they enter intramontane tectonic valleys. Rapid mass-movement is widespread throughout, with a humid temperate climate in the highlands intensifying soil creep and chemical weathering. Mass-movement phenomena appear as the most effective present factor of slope and stream channel development (Sorriso Valvo, 1988).

3. METHODOLOGY OF WEATHERING ANALYSIS AND MAPPING

The wide variability of weathering conditions of the Sila massif weathered rocks, and particularly of granites and gneiss, has required the use of a weathering classification, described in Cascini et al. (1992) and in Gullà & Matano (1997), as already in use in other countries where deep weathered crystalline rocks crop out (Knill & Jones, 1965; Thomas, 1966; Dearman, 1976; Ollier, 1984; Hall, 1986, 1987). The adopted classification methodology was enhanced by suggestions contained in G.C.O. (1984, 1988), I.A.E.G. (1981), I.S.R.M. (1978) and G.S.E.G.W.P. (1995). The classificative scheme is based on qualitative and semiquantitaive observations of lithological kind and is useful for both detailed and large scale studies on the field; it has been already used and tested in the study of the relationships between weathering condition and landsliding of gneiss and granites in Northern Calabria (Cascini et al., 1992, 1994; Gullà & Matano, 1994; Calcaterra et al., 1998).

The adopted methodology for the analysis and survey of the weathering grade consists of a detailed survey in the field, which is based on a careful analysis of the outcropping rocks and soils through the observation of strength, discolouration and texture of the regolith and the results of Schmidt Hammer tests. Six weathering classes have been adopted: fresh (class I), slightly weathered (class II), moderately weathered (class III), highly weathered (class IV) and completely weathered (class V) rock, and residual and colluvial soils (class VI). In order to have more data on the thickness and the geometrical characteristics of the weathering horizons, the field surveys can be integrated with a detailed cuttings analysis (Gullà & Matano, 1994, 1997).

The characteristics of the different weathering classes for gneiss are summarized in Tab. 1; the criteria are

CLASS	ROCK MATERIAL	ROCK MASS
I - Fresh	Rock unchanged from original state or only slightly stained along major joints	Behaves as rock; 0 % soil
II - Slightly weathered	Rock discoloured along discontinuities and slightly weakened; strenght approaches that of fresh rock; greenish grey colour and brown colour only along discontinuities; N value more than 50.	Strenght, stiffness and permeability affected; less than 10% saprolite and residual soil
III - Moderately weathered	Rock with penetrative discolouration and considerably weakened but large pieces cannot be broken by hands; greenish grey colour in mass and reddish brown in discontinuities; does not slake in water; N value: 25-50	Rock framework still locked and controls strength and stiffness; matrix controls permeability; 10-30% saprolite and residual soils; moderately to highly weathered rock with slightly weathered to fresh corestones and with saprolite and residual soils in discontinuities
IV - Highly weathered	Rock completely discoloured but largely weakened so that large pieces can be broken by hands; greyish to reddish brown colour; does not slake readily in wayer; N value: 10-25	Rock framework contributes to strength while soil controls permeability and stiffness; 30-50% saprolite and residual soils; highly weathered rock with rare less weathered corestones and more weathered rock and soil in discontinuities
V - Completely weathered	Rock wholly decomposed and disintegrated having soil consistency but original texture apparent and structural discontinuities relict; reddish to greyish brown colour; sandy gravel to gravelly sand grain size; slakes in water; considerably weakened; N value: 0-15	Weak grades with control behaviour; more than 50% saprolite and residual soils with corestones of less weathered rock
VI - Residual and colluvial soil	Soil derived by in-situ weathering, which have lost original texture and fabric, and soil reworked and trasported by colluvial processes; yellowish, reddish or greyish dark brown colour; from gravelly sand to sandy silt grain size	Behave as soil altough relict fabric may still be significant; about 100% colluvial and residual soils with random saprolite relicts and very rare disordered corestones

Table 1. Weathering classification adopted for gneiss rocks; N is the Schmidt Hammer test index (G.C.O., 1984; Mc Carroll, 1984).

Classifica del grado di alterazione adottata per le rocce gneissiche; N rappresenta l'indice ottenuto mediante il test con il Martello di Schmidt secondo la procedura descritta in G.C.O. (1984) e Mc Carroll (1984).

the same for granites and others crystalline rocks. The term "soil" is used to indicate loose deposits of residual and colluvial nature, without reference to pedogenetical processes (G.C.O., 1984, 1988; G.S.E.G.W.P., 1995).

The mapping of weathering grades permits a general and comprehensive overview of the effect, intensity and distribution of weathering processes and profiles. On the basis of the described methodology of weathering field analysis and classification, it is possible to survey and map the weathering condition of gneiss, or of other crystalline rocks, at different scales (Di Nocera & Matano, in press).

4. RESULTS

In the western sector of the Sila massif, between the Crati river and the Trionto river, three main morpho-structural sectors have been identified (Fig. 1): i) the Sila highland, ii) the western Sila slope, and iii) the Crati river valley bottom. Figure 2 shows the weathering patterns which have been identified in the area. Crystalline rocks do not outcrop in the Crati river valley bottom sector, which has developed along an asymmetrical graben bordered by several active faults (Figg. 1-2). The tectonic valley is filled by silico-clastic deposits of Pliocene and Pleistocene ages and by Quaternary terraced alluvial deposits.

In the other two sectors the crystalline rocks show different weathering patterns.

The Sila highland sector lies between 1200 m and 1900 m a.s.l.; the top plateau is the relict of a wider Lower Pleistocene paleosurface (Dramis et al., 1990) and is bordered by steep slopes (Fig. 1). Some Wurmian moraine deposits and glacial cirques have been described near Botte Donato Mt., on the plateau, where the Wurmian snow line lay at 1650 m a.s.l. (Palmentola et al., 1990).

Granites and subordinately gneiss, slates and sedimentary rocks crop out in the highlands; granitic saprolite and residual soils widely crop out across the paleosurface, where they are covered with Pleistocene lacustrine and alluvial terraced deposits (Calderoni et al., 1989) and by Holocene alluvial deposits in the topo-

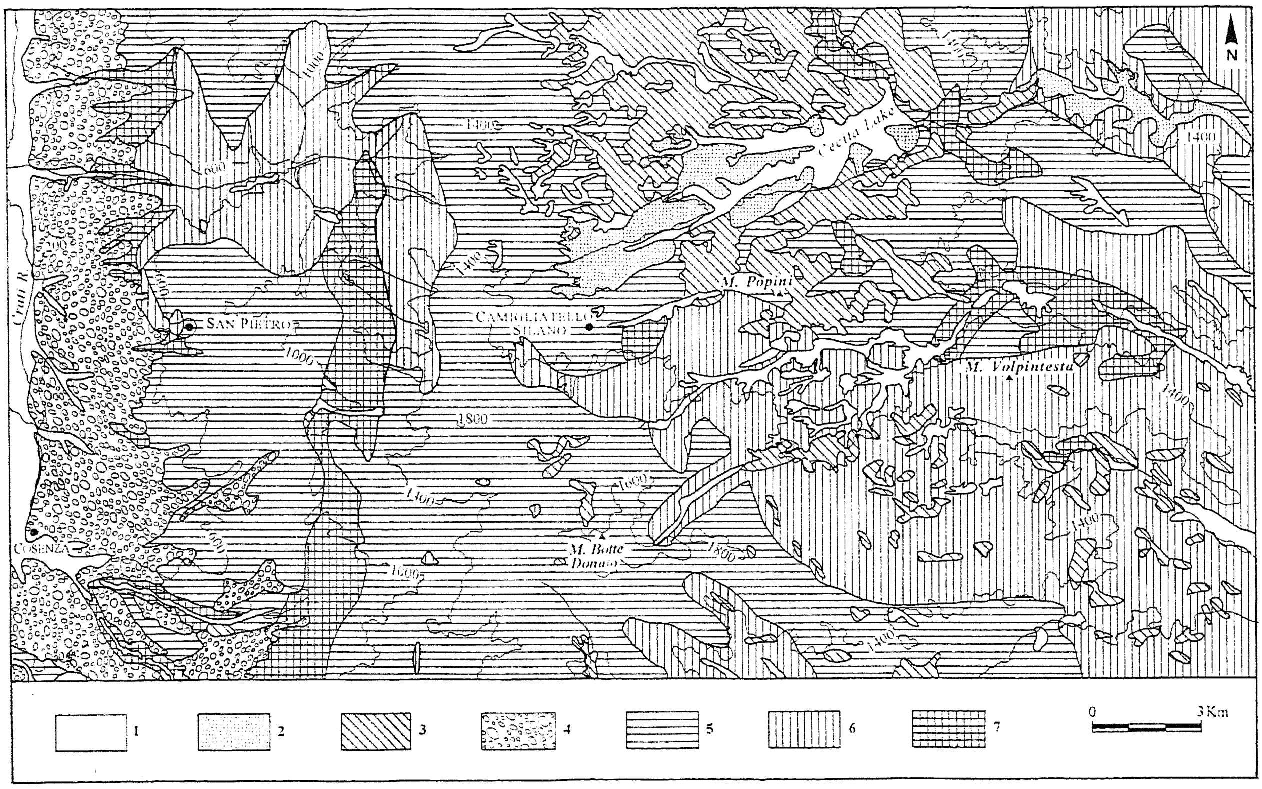

Figure 2. Weathering patterns and geo-lithological schetch-map of a sector of the western area of the Sila Grande Massif, Northern Calabria, Italy. Legend: 1. Current and Holocene alluvial deposits; 2. Pleistocene terraced alluvial and lacustrine deposits; 3. Continuous and deep covers of colluvial soils, residual soils and saprolite (classes V and VI) with local strips of alluvial deposits and few fresh or weathered crystalline rock outcrops; 4. Sedimentary rocks (silty clays, conglomerates and arenites) of Pliocene and Upper-Middle Miocene age; 5. Deeply weathered crystalline rocks (classes IV and V) with few partially weathered rock outcrops; 6. Variously weathered crystalline rocks with pockets of deep weathering and isolated fresh rock outcrops (classes II to V); 7. Generally fresh and moderately weathered crystalline rocks (classes I to III) with rare pockets of deep weathering. For classes see table 1.

Carta schematica geo-litologica e delle condizioni di alterazione di una porzione del settore occidentale del massiccio della Sila Grande in Calabria settentrionale. Legenda: 1. Depositi alluvionali attuali ed olocenici; 2. Depositi lacustri ed alluvionali terrazzati del Pleistocene; 3. Coperture continue e spesse di terreni residuali e colluviali e di saprolite (classi V e VI) con rari affioramenti di rocce cristalline da alterate a non alterate e con locali accumuli di depositi alluvionali; 4. Rocce sedimentarie (argille siltose, arenarie e conglomerati) del Pliocene e del Miocene medio-superiore; 5. Rocce cristalline profondamente alterate con rari afffioramenti di rocce parzialmente alterate (classi IV e V); 6. Rocce cristalline variamente alterate con bande di intensa alterazione ed affioramenti isolati di rocce non alterate (classi da II a V); 7. Rocce cristalline da non alterate a moderatamente alterate (classi da I a III) con rare tasche di profonda alterazione. Per la definizione delle classi si faccia riferimento alla Tabella 1.

graphic lows (Fig. 2). In some localities, such as near lake Cecita and "Piano del Barone", saprolite and residual soils, which have been produced by the in-situ weathering of the granites, crop out and are tens of meters thick (Fig. 3).

The granites are extremely weathered and usually exhibit deep simple and mature weathering profiles, which are characterized by thick horizons of saprolite and residual soil with rounded corestones (spheroidal weathering). Weathering profles are tens to some hundreds of meters deep (Guzzetta, 1974), and are typically characterized by an upper horizon of organic sandy colluvial and residual soil, which overlies completely decomposed rock of a sandy texture within which the original discontinuities are still preserved (saprolite). A horizon of spheroidally weathered rock boulders, surrounded by sandy saprolitic soil, underlies the saprolite horizon, while in the lowest part of the profile there is jointed weathered rock and then fresh rock with discolouration along the major joints at depth (Fig. 4).

The western slope sector of the study area is characterized by an uneven topography with a criss-cross pattern of second-order morphological highs and lows (Fig. 1).

Weathered gneiss, granite, schist and slate crop out along the slope (Fig. 2). They are mainly characterized by moderate to high weathering grades, while fresh and slightly weathered rocks crop out only along deeply incised streams. Residual soils are only some centimetres thick, while colluvial soils, slope debris and landslide debris are widespread and meters to decameters thick because of the very active morphodynamics of the slopes.The weathering profile is usually complex (sensu Baynes et al., 1978, and G.C.O., 1984) and results partially eroded. In Fig. 5 some examples of complex weathering profiles studied in some gneiss cuttings near Altavilla are shown.

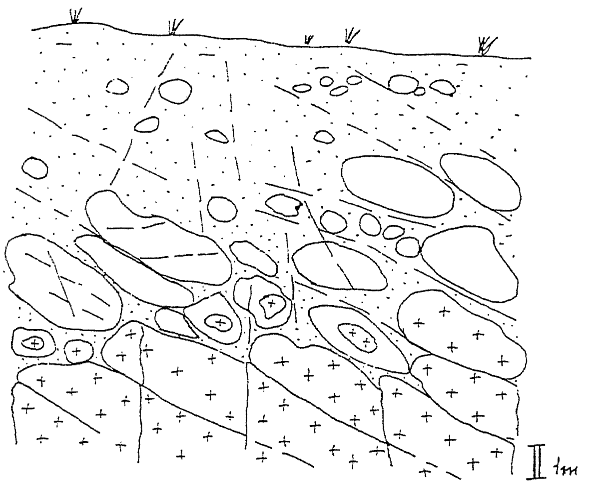

Figure 3. Example of a simple weathering profile cropping out in granites cuttings near Cecita Lake, Sila highlands (Legend: dotted, residual soil and saprolite; white, moderately to higly weathered corestones of granite; crossed, joint bounded block of discoloured to fresh granite; lines, relict joints).

Esempio di un profilo di alterazione semplice esposto in un taglio in granito ubicato presso il Lago Cecita sull'altopiano silano (Legenda: puntinato, terreni residuali e saprolite; vuoto, nuclei sferoidali di granito da altamente a moderatamente alterato; crocette, granito fratturato non alterato o decolorato; linee, fratture relitte).

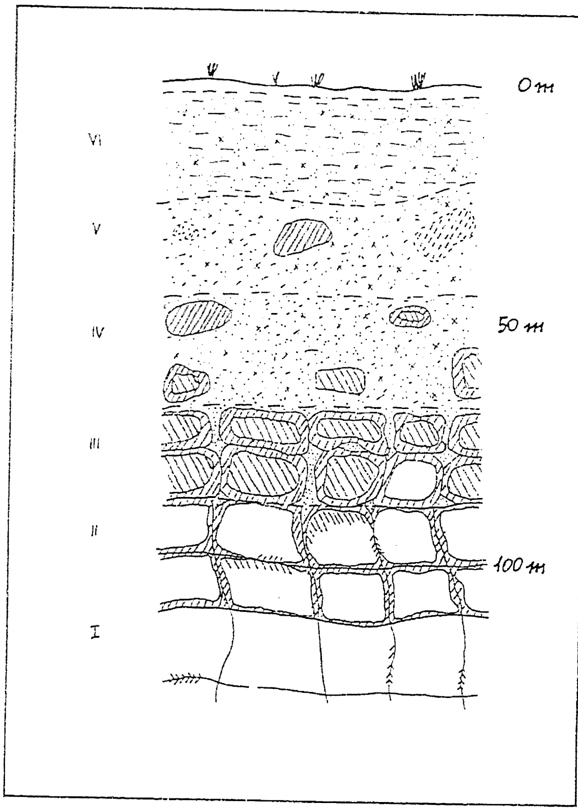

Figure 4. Scheme of the simple weathering profile of the granites cropping out in the Sila highland. Legend: VI, organic sandy colluvial and residual soil; V, saprolite; IV-III, spheroidally weathered rock boulders, surrounded by sandy saprolitic soil; II, jointed weathered rock; I, fresh rock with discolouration along the major joints.

Rappresentazione schematica del profilo di alterazione semplice che caratterizza i graniti affioranti nell'altopiano silano. Legenda: VI, colluvioni sabbiose con sostanza organica e terreno residuale; V, saprolite; IV-III, massi rocciosi sferoidali di roccia alterata inglobati in un terreno sabbioso saprolitico; II, roccia fratturata ed alterata; I, roccia non alterata con decolorazione lungo le discontinuità principali.

In recent years a multidisciplinary research has been carried out on the weathering and landsliding of the gneissic rocks in the western slope foothills of the Sila Massif (Cascini et al., 1992, 1994). The studied area is characterized mainly by the outcropping of gneiss of the Paleozoic, which has undergone a complex metamorphic history. Veins of aplite and pegmatite are interbedded with gneiss; migmatite gneiss and mylonite gneiss have also been found on the field. The compressive and extensional tectonic events have induced an intense state of fracturing in the rock mass.

Surveys of the weathering grade on the field (Cascini et al., 1992; Di Nocera & Matano, in press) and on the cuttings of the slopes (Gullà & Matano, 1994, 1997) integrated with an analysis of the stratigraphs of continuous core boreholes allowed us to estimate the total thickness of the gneiss which has been involved by the weathering processes (corresponding to ca. 70 m), and to disclose

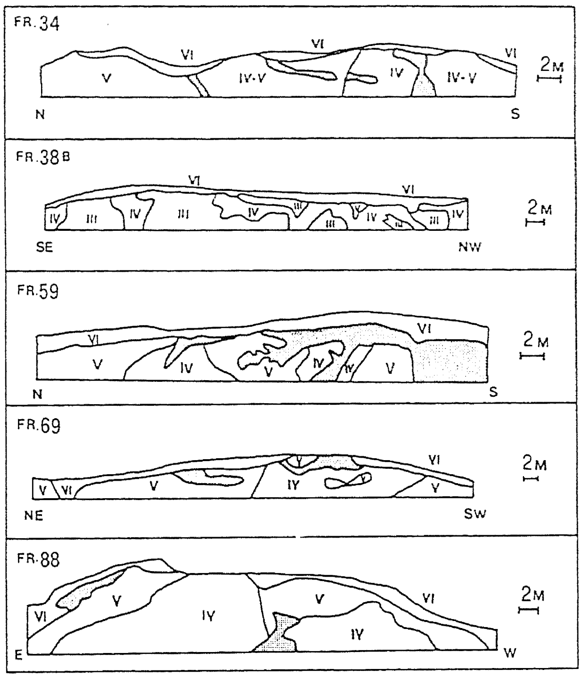

Figure 5. Some examples of complex weathering profile cropping out in gneiss cuttings near Altavilla, Cosenza (Legend: dotted: aplite and pegmatite veins; roman numbers: weathering grades).

Alcuni esempi di profili di alterazione complessi esposti in alcuni tagli in gnaiss affioranti nei pressi dell'abitato di Altavilla, presso Cosenza (Legenda: puntinato, filoni di pegmatite ed aplite; numeri romani, grado di alterazione).

the vertical sequence of the various weathering horizons, which is complex and variable from site to site (Cascini et al., 1992). This may be related to several factors, i.e. the compositional heterogeneity of the gneiss, the diffuse veins or the elevated state of fracturing.

The profile schematically assumes the trend indicated in Fig. 6. The weathering profile presents a complex vertical trend which is variable from site to site. The complexity of the weathering profile makes it difficult to locate well-defined horizons of a determined weathering class. The various lithological horizons that may be schematically singled out present extremely variable and articulated thicknesses and geometric relationships. The weathering grade of the gneiss decreases in relation to depth and it is strongly influenced by the structural elements present in the rock mass. In fact, along a given vertical line one can find out-of-sequence weathering horizons giving rise to a partial, or even complete inversion of the simple weathering profile. Moreover, the lithological horizons do not have a wide lateral continuity; in particular, in correspondence with the main structural discontinuities, bands of soil can be observed.

5. CONCLUSIONS

The regional patterns of the weathering profile in Sila Massif have been described. The wide variability of weathering conditions of the Sila weathered crystalline rocks required the use of weathering classifications, which have been already tested in Northern Calabria (Cascini et al., 1992, 1994; Gullà & Matano, 1994; Calcaterra et al., 1998).

In the study area two sectors with different weathering pattern have been recognized.

The Sila highland sector is formed by the relict of a wider Lower Pleistocene paleosurface bordered by steep structural slopes. Granites and subordinately gneiss, slates and sedimentary rocks crop out in the highlands; granitic saprolite and residual soils (classes V and VI) widely crop out across the paleosurface, where they are locally covered with Pleistocene lacustrine and alluvial terraced deposits. The granites are extremely weathered and show deep simple and mature weathering profiles, which are characterized by thick horizons of saprolite and residual soil with rounded corestones (spheroidal weathering). Weathering profiles develop for tens to some hundreds of meters in depth.

Along the western slope sector weathered gneiss, granite, schist and slate crop out. They are mainly characterized by moderate to high weathering grades (clas-

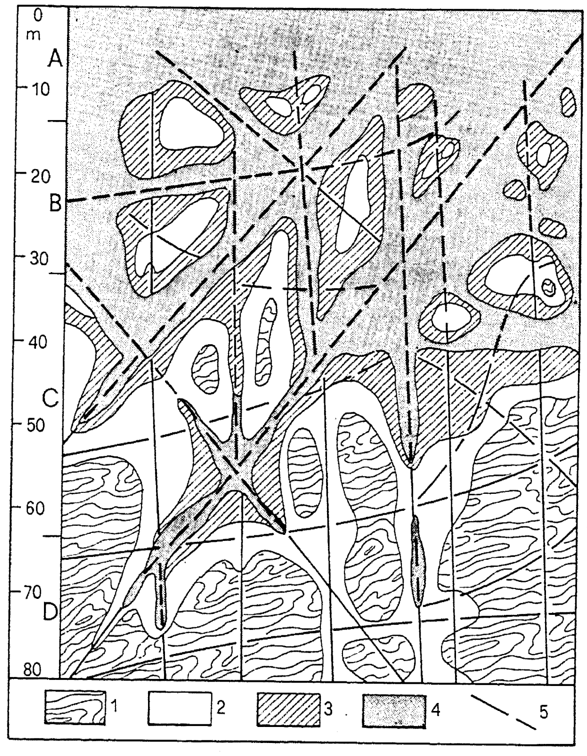

Figure 6. Schematic outline of the complex weathering profile of the gneiss cropping out along the western slope of the Sila Massif. Legend: 1. fresh or discoloured gneiss (classes I and II); 2. weathered gneiss (classes III and IV); 3. saprolite gneiss (class V); 4. residual and colluvial gneissic soil (class VI); 5. joints; A. soil horizon; B. transition horizon; C. weathered gneiss horizon; D. bedrock.

Schema del profilo di alterazione complesso riconosciuto negli gneiss affioranti lungo il versante occidentale del massiccio silano. Legenda: 1. Gneiss non alterati o decolorati (classi I e II); 2. Gneiss alterati (classi III e IV); 3. Gneiss saprolitico (classe V); 4. Terreni residuali e colluviali derivati da gneiss (Classe VI); 5. Fratture; A. Orizzonte dei terreni di alterazione; B. Orizzonte di transizione; C. Orizzonte degli gneiss alterati; D. Roccia madre.

ses III, IV and V), while fresh and slightly weathered rocks crop out only along deep streams. Residual soils are only some centimeters thick, while colluvial soils, slope and landslide debris are widespread and meters to decameters thick because of the very active morphodynamics of the slopes. In the foothills, the complex weathering profile of about 70 m thick is partially eroded.

On the whole, the Sila massif crystalline rocks are characterized by deep and mature weathering profiles. A reliable analysis of the observed decomposition and degradation features of the weathered rocks must them consider a result of the accumulation of the weathering effects produced under varied climatic conditions since the emergence of the Sila massif to the present time. Various cases of deep weathering profiles, which have been recognized inside today's temperate area, are considered to have been developed during the Tertiary and the Early Pleistocene, under different climatic conditions, such as in peninsular Malaysia (Raj, 1982) and in northeast Scotland (Hall, 1985, 1986). Similar phenomena seem to have taken place in Sila massif, so that the deep weathering profiles would represent a fossil, partially eroded mantle (Guzzetta, 1974).

The regional tectonic evolution shows that the Sila massif structural high had already emerged after the Tortonian (Lanzafame & Zuffa, 1976). The development of the weathering profiles in Sila could have occurred between the Late Miocene and the Pleistocene under various climatic conditions. The lack of paleo-climatic data does not permit to well define these climatic conditions; we can only report that, on the basis of petrographical analysis on gneiss, Critelli et al. (1991) consider the weathering profile of the Sila gneiss to have developed through chemical processes under humid climatic conditions, and that Guzzetta (1974) hypothesized an ancient tropical weathering in Calabria.

Under the current temperate and Pleistocene glacial climatic conditions, the erosional processes, as activated by tectonic uplifting, prevail over the weathering processes, although not enough to completely remove the exposed, deeply weathered mantle.

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Ms. ricevuto l'11 ottobre 1999
Testo definitivo ricevuto il 10 gennaio 2000

Ms. riceived: October 11, 1999
Final text received: January 10, 2000