ISTITUTO DI GEOLOGIA DELL'UNIVERSITA' DI NAPOLI

PUBBLICAZIONE N. 272

Università
di Siena
Centro di
GeoTecnologie

B11680

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The Position of the Basic and Ultrabasic Rocks in the Tectonic Units of the Southern Apennines

Estratto dagli « Atti » dell'Accademia Pontaniana
Nuova Serie - Volume XXI

1971-72

The Position of the Basic and Ultrabasic Rocks in the Tectonic Units of the Southern Apennines *

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RIASSUNTO

Nell'Appennino meridionale si rinvengono rocce basiche e ultrabasiche appartenenti a differenti unità tettoniche, sia « interne » che « esterne ». Scopo di questo lavoro è distinguere le varie unità contenenti tali rocce, e fornire i caratteri petrografici essenziali dei vari tipi presenti. Nonostante siano stati scritti numerosi lavori sull'argomento, infatti, esiste una grande confusione sull'età e sulla posizione stratigrafica di queste rocce, segnatamente riguardo le ofioliti: frequentemente sono stati comparati elementi tra loro non comparabili sia per età che per posizione tettonica. Un lavoro di riordinamento ci sembra pertanto primario rispetto ad ogni altra specifica analisi.

Nell'Appennino calabro-lucano le unità « esterne » sono costituite dal basso in alto dall'unità del M. Alpi, dalle unità lagonegresi e dalle unità di Timpone Pallone, del Pollino-Campotenese e di Verbicaro. Le unità « interne » finora riconosciute sono costituite dal flysch metamorfico del Frido, dalle ofioliti, dall'unità delle radiolariti e delle filladi del Torrente Bagni (Terme Luigiane), dal cristallino dell'unità dioritico-kinzigitica, dal flysch del Cilento e dal complesso delle argille varicolori. Le relazioni tra queste unità non sono ancora del tutto chiarite: non sono noti i rapporti geometrici tra il cristallino dell'unità dioritico-kinzigitica e il flysch del Cilento, nonché le relazioni (contatto stratigrafico discordante o contatto tettonico?) tra quest'ultimo e il sottostante flysch metamorfico del Frido. Nella tabella 1 sono poste le corrispondenze tra le unità paleogeografiche e le unità tettoniche, relativamente alle zone esterne dell'Ap-

* This work has been supported financially *pro parte* by the Italian Consiglio Nazionale delle Ricerche.

pennino. Per le zone interne le unità tettoniche sono ancora mal definite e uno schema delle unità paleogeografiche, di conseguenza, non è ancora tracciabile. Nella tabella 2 sono riassunte le sequenze delle singole unità tettoniche e sono forniti i caratteri essenziali delle rocce basiche e ultrabasiche, nonché delle tufiti in esse contenute.

In Calabria settentrionale le unità « esterne » immergono sotto le unità « interne » lungo un'importante linea tettonica trasversale, la linea di Sangineto, per riaffiorare poi in una serie di finestre tettoniche (Cetraro, Terme Luigiane, Grimaldi, M. Cocuzzo, Bagni di Caronte ecc.).

Nella tavola 1 sono schematizzati i rapporti geometrici tra le varie unità tettoniche.

Nella tavola 2 sono indicati i principali affioramenti di rocce basiche e ultrabasiche, nonché di tufiti, descritte nel testo.

1. — *Introduction.*

Many outcrops of basic and ultrabasic rocks that belong to several tectonic units — both « internal » and « external » — of the Apennine chain exist in Southern Italy (Campania, Lucania and Calabria). Here we shall not discuss the existing literature [1], as we shall do this in another work. Our purpose in this short note is to distinguish the different tectonic units containing basic and ultrabasic rocks, as well as tuffites, and to give their main petrographic characters. We believe a work of rearrangement is propaedeutic to other specific analyses, as it is a matter of primary importance to eliminate the great confusion concerning age and stratigraphic or tectonic position of the Southern Apennine basic igneous rocks, mainly in the ophiolites. Often, in fact, elements different in age or in tectonic position, which are not comparable, have been compared (Quitzow 1935; Bousquet 1962b, 1963b; Ghezzi & Bayllis 1964; Vezzani 1968, 1970; Hoffmann 1969, 1970; Ogniben 1969; Dubois 1970).

In the Calabria-Lucania Apennines the « external » units are represented by several carbonate thrust sheets, by the underlying Lagonegro units and by the Monte Alpi unit. The carbonate thrust sheets are: the Verbicaro unit, corresponding in Campania to the Bulgheria unit; the Campotenese-Pollino unit, corresponding in Campania to the Alburno-Cervati unit; the Timpone-Pallone unit, perhaps corresponding in Lucania to the Monte Foraporta unit

[1] Some of the works are: Cortese 1895; De Lorenzo 1896; Novarese 1931; Quitzow 1935; Lucini, Masperoni & Spada 1957; Cotecchia 1959; Bousquet 1961-1972; Caire, Glangeaud & Grandjacquet 1961; Grandjacquet 1961-1967; Grandjacquet, Glangeaud, Dubois & Caire 1962; Grandjacquet & Grandjacquet 1962; Ippolito 1962; Selli 1962; Dubois 1967-1970; Bousquet & Grandjacquet 1969; Vezzani 1968-1970; Hoffmann 1969, 1970; Ogniben 1969; Piccarreta & Zirpoli 1969b; Colonna & Zanettin Lorenzoni 1970, 1972; Scandone 1971, 1972; Grandjacquet, Haccard & Lorenz 1972.

(BOUSQUET & GRANDJACQUET 1969, SCANDONE 1972). The Lagonegro nappes disappear in Southern Lucania, plunging below the « internal » units, and do not outcrop in Calabria. The Monte Alpi unit is comparable in Campania to the Matese-Maggiore unit (D'ARGENIO & SCANDONE 1970, ORTOLANI & TORRE 1971).

North of our area the most « external » units outcrop in the Molise region (Frosolone).

In Table 1 we indicate all the « external » tectonic units and their respective paleogeographic belts.

TABLE 1 - TECTONIC UNITS AND CORRESPONDING PALEOGEOGRAPHIC BELTS IN THE EXTERNAL ZONES OF THE LUCANIA-CALABRIA APENNINES.

Paleogeographic belts	Tectonic units
Campania-Lucania platform	*Verbicaro unit* (corresponding in Campania to the Bulgheria unit)
	Campotenese-Pollino unit (corresponding in Campania to the Alburno-Cervati unit)
	Timpone Pallone unit (probably corresponding in Lucania to the Monte Foraporta unit)
Lagonegro basin	*Lagonegro unit II*
	Lagonegro unit I
Monte Alpi platform (corresponding in Campania to the Abruzzi-Campania platform)	*Monte Alpi unit* (corresponding in Campania to the Matese-Maggiore unit)
Molise basin	——— (in Molise Frosolone unit)
Apulia platform	*Murge zone*, foreland of the Southern Apennines

The vertical succession of the tectonic units follows the original arrangement of the paleogeographic belts from E to W.

The « internal » tectonic units known up to now are represented by the « argille varicolori » unit, by the Cilento Flysch unit, by the « formazione dioritico-kinzigitica » (NOVARESE 1931), by the Bagni River radiolarite-phyllite unit (SCANDONE 1971), by the ophiolitic units, and by the Frido unit.

Relationships among these « internal » units are not completly clear: geometrical relations between the crystalline rocks of the « formazione dioritico-kinzigitica » and the Cilento Flysch are not known, and connections (unconformity or tectonic contact?) between the Cilento Flysch and the metamorphic Frido pre-flysch are still to be found out.

With regard to the internal domains OGNIBEN 1969 suggests the following palinspastic pattern (from E to W):

— Sicilide domain (flysch and deep water pelitic sediments). According to this Author this belt represents the connection between the Panormide « miogeoanticline » (Campania-Lucania platform) and the Liguride « eugeosyncline ».

— Liguride domain (ophiolites and associated sediments, and overlying Cilento Flysch).

— Calabride domain (crystalline pre-Triassic rocks and Mesozoic shallow or deep water sediments).

From the information received up to date, we can neither refuse nor accept such a scheme as the analytical data are insufficient, and they may be used for different and contrasting interpretations. The « internal » tectonic units are still not well defined, and the corresponding paleogeographic belts are therefore vague.

The « external » units plunge, in Northern Calabria, below the « internal » ones along a very important line called the Sangineto line. The meaning of this big transversal tectonic element of the Apennine chain is not made clear. South of the Sangineto line the « external » units outcrop in some tectonic windows (Cetraro, Terme Luigiane, Grimaldi, Monte Cocuzzo near Amantea, Bagni di Caronte near Nicastro etc.).

The geometrical relationships among the « internal » and « external » tectonic units outcropping in the studied area are put schematically in Plate 1.

The sequences relative to the tectonic units and the main characters of the basic and ultrabasic rocks, and also of the tuffites, are briefly described in Table 2.

The main basic and ultrabasic rock, and tuffite outcrops, described here, are represented in the schematic map of Plate 2. To locate the outcrops exactly, we refer to the official geological maps 1:100000 (199 Potenza, 209 Vallo della Lucania, 211 S. Arcangelo, 220 Verbicaro, 221 Castrovillari) and to the new official maps 1:25000 covering the whole of Calabria.

North of our area some basic rocks have been found in drills (Molise and Western Puglie) in the most « external » units of the Apennine chain (MIGLIORINI 1952, PIERI 1966). They will not be the subject of this note. In the next paragraphs we shall discuss the basic and ultrabasic rocks, as well as the tuffites, beginning from the Lagonegro units.

2. — *Lagonegro units.*

IETTO & COCCO 1965 report some outcrops of diabases in the Lagonegro terrains near Tito (Potenza). These Authors state that the diabases lie in a primary position within black shales belonging to the upper part of the sequence (Lower Cretaceous).

We visited these outcrops and we did not see any magmatic contact with the surrounding sedimentary rocks. Moreover the rocks outcropping near the diabases are siltstones and claystones of the Monte Facito formation (lower part of the Lagonegro unit II, of Middle Triassic age). In the same region we also found some blocks probably belonging to the Monte Facito formation, made up of conglomerates containing pebbles of basic rocks. These pebbles consist of diabases of intersertal structure (dimension of the plagioclases less than 1 mm) and of fragments of variolitic pillow lavas showing arborescent plagioclases (dimensions 0.2-0.8 mm). The main mineral assemblage is made up of acid plagioclases, calcite, chlorite, epidote minerals, sphene, apatite and ore minerals.

Therefore it seems probable that basic rocks exist in the Middle Triassic terrains of the Lagonegro nappe II. The existence of a Middle Triassic volcanism in the external domains of the Southern Apennines is proved in Northern Calabria (prasinites of the Campotenese-Pollino nappe).

A sure evidence of volcanism in the Lagonegro sequence is represented by Upper Triassic (Carnian) tuffites that occur in a clayey level (*Halobia superba* level) present in the middle-lower part of the Cherty Limestone formation. These tuffites consist of thin (5-15 cm) green graded beds intercalated with green claystones containing pelagic pelecypods (*Halobia* and *Posidonia*).

Under the microscope feldspars (sanidine and plagioclase), calcite, quartz, chlorite, apatite, zircon and ore minerals were recognized.

The Upper Triassic tuffites are distributed in the whole area in which the terrains of the Pignola-Abriola facies (SCANDONE 1968, 1972) outcrop, that is, between the Higher Agri Valley and the Pignola-Abriola mountains.

3. — *Campotenese-Pollino unit.*

The basic rocks belonging to this unit consist of diabases (flows or sills) intercalated with phyllites of Middle Triassic age. The shape of these bodies is of flattened lenses, with a max. thickness of about 10 metres.

In the thin section, the rock appears as a prasinite, composed of albite, amphiboles (hornblende and actinolite), epidote minerals, zoisite, calcite, chlorite, sphene, apatite, ore minerals.

The few outcrops lie along the S. Donato di Ninea-Acquaformosa-Lungro band.

4. — *Verbicaro unit.*

The basic rocks of this unit consist of « limburgites » in the form of massive lavas, pillow lavas and dykes in Mesozoic carbonates (Triassic dolomites, Jurassic cherty limestones and reef limestones, Upper Cretaceous calcirudites). At Monte Cerviero we found some flows stratigraphically covered by Maastrichtian calcarenites and calcirudites. Therefore in this outcrop the basic rocks are not younger than the uppermost Cretaceous. Since near Colle Trodo the same rocks are intrusive in Upper Cretaceous calcirudites [2], it appears without doubt that the « limburgites » are uppermost Cretaceous in this area. We believe this volcanism is connected with the Maastrichtian tectonic phase.

These rocks were studied by QUITZOW 1935 who recognised that they belong to the calcareous Apennine.

Under the microscope the rock appears to be formed of roundish aggregates (max. 1 mm) of serpentine minerals and calcite representing, after QUITZOW 1935, transformed olivine, lying in a ground-mass made up of pyroxenes, plagioclases, calcite, sphene, ore minerals.

A description of the main outcrops, in the Northern part of the Calabrian Coastal Chain, is in GRANDJACQUET & GRANDJACQUET 1962.

5. — *Ophiolitic units.*

It is possible to distinguish two ophiolitic units: the ophiolitic unit I, consisting of serpentinites, greenschists and glaucophane rocks, associated with phyllites and calcareous schists; the ophiolitic unit II, consisting of diabases (often pillow lavas) stratigraphically covered by radiolarites and *Calpionella* limestones.

The rocks of unit I are comparable with the Piemonte ophiolites, those of unit II with the Liguria ophiolites. Both units tectonically overlie a slightly metamorphosed pre-flysch sequence (Frido formation VEZZANI 1969, or « flysch à quartzites » GRANDJACQUET 1962, or « argille scagliose » *pro parte*) of Lower Cretaceous age. The tectonic superimposition: Frido complex-ophiolitic unit I-ophiolitic unit II exists only around the Sangineto line. South of this line, the ophiolitic unit II tails off, disappearing between the ophiolitic unit I and the gneisses belonging to the « formazione dioritico-kinzigitica ». The most Southern outcrops are between Cetraro and Acquappesa.

North of the Sangineto line the relationships between the Frido complex and the two ophiolitic units become more and more chaotic. Finally in the

[2] C. GRANDJACQUET showed this outcrop to one of us (P. SCANDONE) in 1968. Afterwards during the rebuilding of the road Mormanno-Scalea this fine contact was destroyed.

Higher Sinni Valley a mélange of Frido terrains, ophiolites and crystalline rocks outcrops. This mélange was called « flysch ofiolitifero » or « argille scagliose ofiolitifere » by former Italian geologists. The main outcrops of ophiolites lying in the Frido complex are in the Latronico-Castelluccio-Episcopia-S. Severino Lucano region, W of Terranova di Pollino (VEZZANI 1968, 1970) and in the Lao Valley from Papasidero to Scalea.

5.1. — *Ophiolitic unit I.*

From the Northern to the Southern part of Central Calabria the sequences show a wide variability. The discontinuity of the outcrops and the differences in the metamorphic facies suggest the possibility that this unit consists of more sub-units. For these reasons we give a description preliminarily of three sequences that may be considered typical here: the Diamante-Terranova da Sibari, the Fuscaldo-Rose and the Monte Reventino-Gimigliano sequences.

Diamante-Terranova da Sibari. — The sequence consists of glaucophane rocks, locally strongly schistose (e.g. La Guardiola near Diamante), locally less foliated and rich in pillows (Terranova da Sibari).

The glaucophane schists appear as layered rocks with alternating blue and green laminae a fraction of a centimetre thick. The blue laminae are made up especially of glaucophane (max. diameter of the crystals is of some millimetres), the green ones chiefly of epidote, chlorite and pumpellyite.

The main mineral assemblage consists of glaucophane (also crossite), albite, relictic clinopyroxene, lawsonite, calcite, pumpellyite, epidote minerals, chlorite, muscovite, sphene, apatite, ore minerals.

The foliation is less strong in the pillow lavas, where it is possible to observe only a flattening of the pillows, whose dimensions vary from some decimetres to one metre. The rock has a uniform bluish colour, is generally finely grained and only seldom shows porphyric structure.

The age of this sequence is unknown. Presumably it is Jurassic-lowermost Cretaceous. The Jurassic attribution of the French geologists, based on *Calpionella* spp. from Terranova da Sibari, is inconsistent, as the *Calpionella* limestones belong to the tectonically overlying ophiolitic unit II.

The main outcrops of the Diamante-Terranova da Sibari sequence are in the Tarsia-Spezzano Albanese-Terranova da Sibari region and in the environs of Diamante. Some other small outcrops exist along the Sangineto line (e.g. SE of Saracena).

The thickness of the greenstones is not more than 100 m. The glaucophane rocks are stratigraphically overlain by calcareous schists and phyllites (more than 100 m). Glaucophane rocks are also interbedded in the calcareous schists as flat lenses conformable to the general foliation, having a max. thickness

of some metres (e.g. the Torrente Corvino Valley between Diamante and Buonvicino). The main mineral assemblage is the same as in the glaucophane schists outcropping at La Guardiola near Diamante.

Going Southwards in the ophiolitic unit I the Diamante-Terranova da Sibari sequence is replaced by the Fuscaldo-Rose sequence. The petrological relationships between these two sequences have not yet been studied.

Going Northwards the ophiolitic units I and II lose their individuality. Some Klippen of glaucophane rocks and of associated calcareous schists and phyllites outcrop between Castrovillari and Mormanno. In the Lao Valley (from Papasidero to Scalea) and in the Higher Sinni Valley (Seluci, Frido) scattered blocks of glaucophane rocks lie in the Frido complex.

Fuscaldo-Rose. — The sequence consists of alternating chlorite-epidote schists without traces of original volcanic structures, massive diabases, pillow lavas and breccias.

The chlorite-epidote schists are strongly foliated layered rocks showing an alternance of green-violet laminae. The green laminae are made up of chiefly epidote, the violet ones of chlorite.

The breccias consist of fragments of lavas, flattened according to the general foliation, lying in a green-violet matrix. In the field it is possible to see all the intermediate types from the chlorite-epidote schists (typical greenschist structures) to the volcanic breccias.

The massive diabases, corresponding to original lava flows or sills, form almost regular beds of about 10 m thick. The deformation is generally not pronounced and consists of a flattening of the porphyroblastic plagioclases.

The pillow lavas may occur in every part of the sequence. In the Rose sequence porphyric pillows form the last 50 m of the greenstones. The pillows are flattened everywhere according to the general foliation; their diameter may vary from some decimetres to one metre.

The main mineral assemblage is made up of acid plagioclase, amphiboles (actinolite and rare relictic hornblende), calcite, lawsonite, epidote minerals, chlorite, pumpellyite, muscovite, sphene, apatite, ore minerals. In a few thin sections also glaucophane has been found.

The total thickness of the greenstones is more than 200 m.

The greenstones are stratigraphically overlain by more than 200 m of phyllites and calcareous schists.

The age of the sequence is unknown; presumably it is Jurassic-lowermost Cretaceous.

The main outcrops are E of Rose, in the Guardia Piemontese-Mongrassano-Paola-Gesuiti region, around Terme Luigiane, at Serra Varrone E of Cetraro, near S. Agata d'Esaro. In this last zone the terrains of the Fuscaldo-Rose sequence are tectonically overlain by the ophiolitic unit II (Eastern foot of Serra la Penna; at the end of the Esaro Gorge near Malvito).

Atti Acc. Pontaniana
Nuova Serie, vol. XXI, 1971-72

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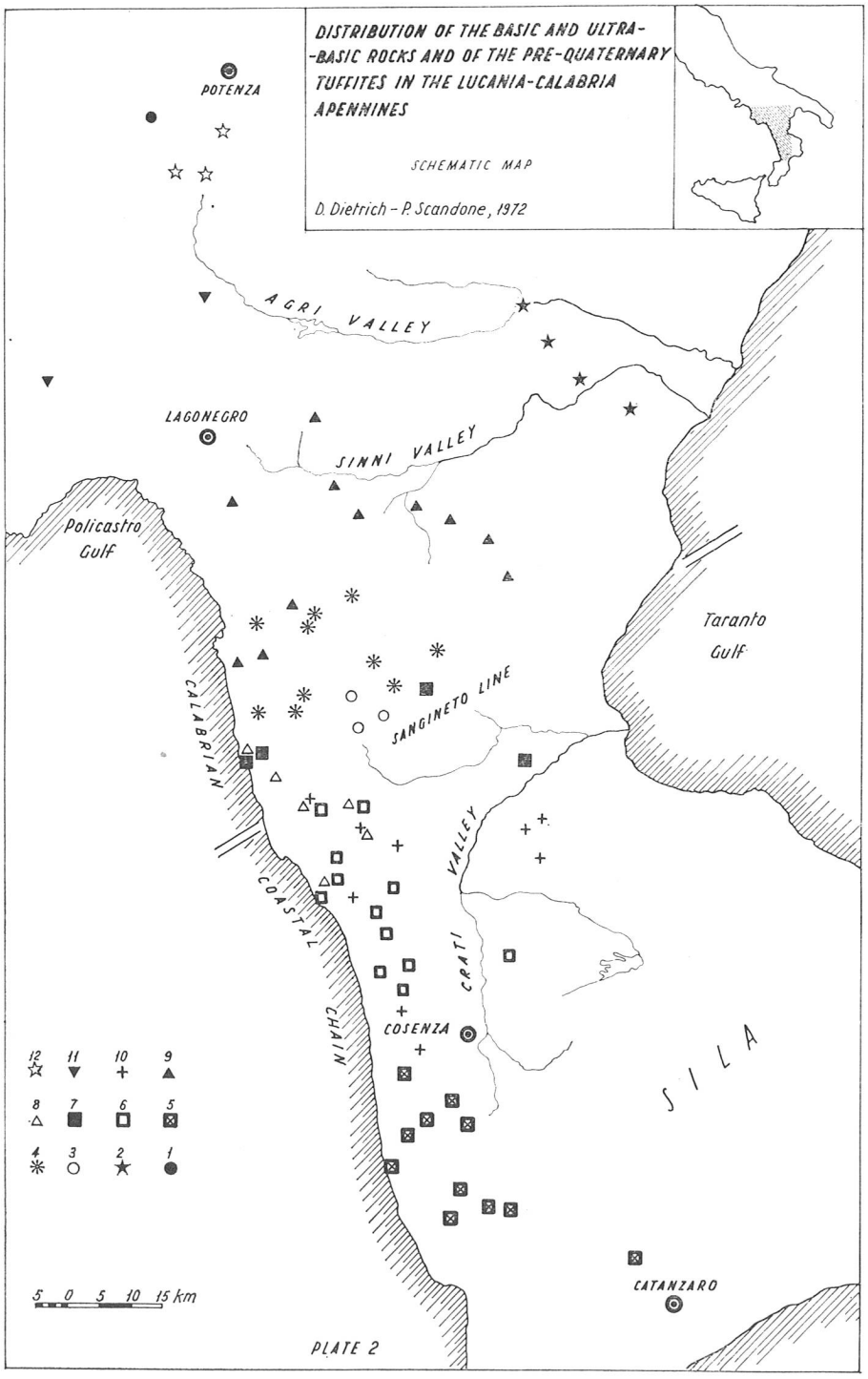

Going Northwards in the ophiolitic unit I the Fuscaldo-Rose sequence is replaced by the Diamante-Terranova da Sibari sequence. Going Southwards the Fuscaldo-Rose sequence passes into the Monte Reventino-Gimigliano sequence.

Monte Reventino-Gimigliano. — The sequence consists of serpentinites (some tens of metres) followed by a monotonous succession of greenschists (max. thickness about 200 m), in which we did not recognize any definite volcanic structure. The serpentinite-greenschist contact is tectonic everywhere, and locally (e.g. Corace Valley SE of Gimigliano) the serpentinites are squeezed within the greenschists along the foliation surfaces.

The greenschists appear as layered homogeneous rocks, often strongly foliated, formed mainly of albite, chlorite and epidote. Locally layers show an alternation of green and violet millimetric laminae, consisting of epidote and chlorite respectively.

The mineral assemblage, similar to that of the Fuscaldo-Rose sequence, consists of acid plagioclase, relictic clinopyroxene, amphiboles (actinolite, hornblende), calcite, epidote minerals, chlorite, muscovite, sphene, apatite, ore minerals. In a few thin sections also glaucophane has been found. Recently PICCARRETA (1972) reports pumpellyite and lawsonite in the greenschists outcropping between Falerna and the Monte Reventino.

The greenschists in the Gimigliano section are stratigraphically overlain by quartzites, microconglomerates, chlorite-sericite schists, marbles and calcareous schists (70-80 m) followed by black phyllites (some hundred metres). According to COLONNA & ZANETTIN LORENZONI 1972 the whole section is reversed. The Authors attribute a Permo-Carboniferous age to the phyllites and a Permian-Triassic age to the calcareous and clastic member between the phyllites and the greenstones.

The main outcrops are near Gimigliano, in the Monte Reventino zone and in general in the whole Nocera Tirinese-Falerna-Martirano Lombardo region, at Coreca S of Amantea, in the environs of Lago and of Monte Cocuzzo.

In the whole region, wherever any contact can be seen, the ophiolites tectonically overlie the Frido complex [3].

5.2. — *Ophiolitic unit II.*

The unit consists of diabases (max. 200 m) stratigraphically overlain by radiolarites (from zero to some tens of metres) and *Calpionella* limestones (from some tens of metres to 150 m). Black slates, clayey limestones and siltstones follow (some tens of metres) (BOUSQUET 1962a, SCANDONE 1971).

[3] During an excursion to the environs of Gimigliano and to the Monte Reventino region led by V. COLONNA, E. ZANETTIN LORENZONI and G. PICCARRETA (Bari University), they very kindly showed us extremely good contacts between the Frido complex and the ophiolites. We are indebted to them for their invaluable help during this trip.

The diabases appear as green or reddish rocks, massive or in the form of pillow lavas. Pillow breccias are frequent too. The structure of the rock is often intersertal; sometimes it is porphyric, with plagioclase crystals more than 1 cm long.

The main mineral assemblage is made up of plagioclase, pyroxene, amphiboles (actinolite, hornblende), epidote minerals, zoisite, pumpellyite, chlorite, muscovite, calcite, quartz, ilmenite, sphene, apatite, ore minerals.

The age of the *Calpionella* limestones is Neocomian. Some calcareous microbreccias interbedded within the radiolarites near Diamante contain *Protopeneroplis striata* and *Trocholina* spp. of Upper Jurassic (Malm) age. The age of the basic rocks, underlying the radiolarites and/or the *Calpionella* limestones is therefore not younger than Upper Jurassic.

The main outcrops of the ophiolitic unit II form a discontinuous band from Diamante to Malvito, including Monte Milioso, Serra la Vriglia, Serra la Penna. Other outcrops, prevalently made up of *Calpionella* limestones are in the Tarsia-Terranova da Sibari-Spezzano Albanese region, and in the environs of Fagnano Castello, Mongrassano and Acquappesa.

The ophiolitic unit II disappears South of a line joining Intavolata and Cerzeto.

Going Northwards the ophiolitic units I and II lose, as we have described, their individuality, and scattered rocks comparable with the litho types of both units lie in the Frido complex.

6. — « *Formazione dioritico-kinzigitica* ».

The « formazione dioritico-kinzigitica » includes basic and ultrabasic rocks like amphibolites and pyroxenites, as well as serpentinites.

Amphibolites appear as dark layers intercalated in the garnet-sillimanite gneisses. The rock commonly is laminated according to the general foliation and often shows an irregular alternance of segregation bands consisting of millimetric laminae of light minerals (plagioclases) and dark minerals (pyroxenes and amphiboles). Outcrops are very common in the Coastal Chain between the Sangineto line and Guardia Piemontese. Outside the Coastal Chain fine outcrops exist e.g. near S. Demetrio Corone. Sometimes the rock does not show foliation, the contents in plagioclases are very low, and the rock is made up chiefly of amphiboles and pyroxenes. One can find excellent examples of these types near S. Marco Argentano and S. Demetrio Corone. Processes of serpentinisation also occur (e.g. Fagnano Castello). In some localities, as near S. Marco Argentano and S. Demetrio Corone, masses of serpentinites are present as lenses in garnet-biotite gneisses. Macroscopically they appear layered in parallel bands of one or more centimetres. We do not know if this banding is parallel or not to the general foliation of the garnet-biotite gneisses.

7. — *Cilento unit.*

Cocco & Di Girolamo 1970 report a hawaiitic magmatism of Eocene-Oligocene age in the Cilento Flysch. They describe a body of ophiolites at Monte Centaurino (Salerno), interpreting it as submarine flows interbedded in the flysch conglomerates of the S. Mauro formation (upper part of the Cilento Flysch). In a cross section these Authors show the volcanic vent, apophyses and flows.

We visited this important outcrop which would seem to represent an unusual example of ophiolites in a primary position within flysch conglomerates. Our conclusions are that the ophiolites at Monte Centaurino have no magmatic contact with the Cilento conglomerates, but slid into them during sedimentation. These olistostrome phaenomena are also frequent below and above the main ophiolite body (olistostromes and mud flows containing basic rocks).

Another outcrop of ophiolites which also lie in the Cilento Flysch was recognised by Migliorini 1944 near Tramutola (Higher Agri Valley). In this outcrop too the ophiolites are contained in an olistostrome which is not older than Middle Eocene, as we found some boulders inside it containing large nummulites of Middle Eocene age.

The petrographical characters of these ophiolites at Monte Centaurino and at Tramutola are comparable with those of the rocks of the ophiolitic unit II.

8. — « *Argille varicolori* » *unit.*

The upper part of the « argille varicolori » complex is chiefly made up of tuffites, studied by Ogniben (1964, 1969) in Sicily and in the Southern Apennines.

The thickness of these tuffites is of about 250 m in the studied area. They consist of greenish graded beds (the thickness of one bed varies from some decimetres to some metres), with occasional intercalations of calcareous microbreccias made up mainly of foraminifera and algae, and of calcilutites.

According to the microfacies the age is Upper Eocene.

Under the microscope the rock appears to consist of fragments of lava (andesite according to Ogniben 1964, 1969), and of plagioclases, quartz, biotite, muscovite and chlorite.

These tuffites, connected with island arc volcanism, are supposed by Ogniben 1964, 1969 to be penecontemporaneous of the « limburgites » belonging to the Verbicaro unit, and the material of the tuffites is supposed to have been derived from the « limburgites ». The age of the latter, on the contrary, is Maastrichtian, at least at Monte Cerviero, that is quite different from the tuffites of the Upper Eocene age. Moreover we did not find « limburgite » fragments in the tuffites.

The main outcrops of the tuffites in the studied area are between Colobraro and Monticchio (Agri Valley), and between Rotondella and Nova Siri.

9. — *Conclusive remarks.*

The purpose of this note is to distinguish the different tectonic units containing basic and ultrabasic rocks, as well as tuffites, giving preliminary their main petrographic characters. The conclusions are summarized in Table 2.

In any case, here we will try to fix some salient moments of the magmatic activity during the Alpine history of the Calabria-Lucania Apennines before the Burdigalian age, which marks the first orogenic phase in the external zones.

In the external domains of the Apennine geosyncline the earliest magmatic activities occur during the Middle and Upper Triassic. They are represented by diabases and by acid tuffites. The Triassic activity, also known in other chains (e.g. the « Porphyrit-Hornstein » formation of the Southern Yugoslavia, ČIRIĆ 1966), can be connected with the large Triassic taphrogenesis which concerns the whole Mediterranean area.

During the Maastrichtian another important moment of magmatic activity occurs in the external zones. « Limburgites », in fact, cross the carbonates of the internal side of the Campania-Lucania platform which is in this moment being dissected by large tension faults (SCANDONE & BONARDI 1968).

In the internal domains the earliest magmatic activity, represented by the ophiolites, is connected with the Jurassic opening of the ocean floor. These ophiolites are then metamorphosed during an early tectonic phase, which is of Lower Cretaceous age according to GRANDJACQUET, HACCARD & LORENZ 1972.

During the Upper Eocene volcanic island arcs occur in the internal zones, witnessed by andesitic tuffites.

The ophiolites found in the Cilento Flysch do not prove a magmatic activity in this basin, as they are arrived there, sliding from an internal cordillera during the sedimentation of the upper part of the flysch sequence.

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