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An Itinerary through Proterozoic to Holocene rocks in the North-Eastern Peloritani Mts. (Southern Italy)

Italian Geological Society - Young Section
1st National Congress - Geology, Culture and Flavors of Sicily

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An Itinerary through Proterozoic to Holocene rocks in the North-Eastern Peloritani Mts. (Southern Italy)

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Informations

Excursion notes

Itinerary

Safety

The individuals or groups can make the excursion in autonomy or ask for a specific guide to the Crystalline Geology research Unit of the University of Messina, which belong to the Authors of the present guidebook.
Safety in the field is related to specific potential difficulties. All participants should know the following indications.
- The itinerary can be made in one day by car and minibus (max 11 people) and in two days on foot.
- The tour starts from Dinnammare top (1.127 m a.s.l.), which is the limit of the NE Peloritani Ridge, sited between Tyrrhenian and Ionian Seas. After a trip of about 50 km it ends in Peloro Cape beach (on the sea level), in front of the encounter of the Ionian and Tyrrhenian Seas.
- Dinnammare Mt. is far away about 13 km from Messina rail-station. It is not accessible by public transport.
- The itinerary develops on asphalt roads: from Dinnammare top (Stops 1-2) to Marmora Torrent mouth (Stop 4) along the sinuous and steep 50 bis, 50 and 51 Provincial Roads (SP); from Marmora Torrent mouth to Tono Torrent mouth (Stops 5-6) along the 113 dir Main Road (SS), which continues still sinuous developing at about 100 m a.s.l.; from Tono Torrent mouth to Strada Panoramica dello Stretto (Stop 7) along the 49 and 45 Provincial Roads; from Strada Panoramica dello Stretto to Peloro Cape (Stop 8) along the 48 Provincial Road, Consolare Pompea Street, 43 and 46 Provincial Roads.
- The outcrops of Stops 1 to 3 are reachable through a pleasant walk at high level on the Ridge, among luxuriant vegetation, with spectacular landscapes on the Tyrrhenian Sea and Ionian Sea ending in the NE with the Messina Straits.
- At the Stops 7 and 8, a magnificent panorama of the Messina Straits can be observed.
- It is preferable to make the excursion in the period from the end of August to the first half of November, when the weather is mild and the panoramic views are sharp. In spring, when the Territory is covered by an indescribable flowering, the landscapes of the Messina Straits are masked by a peculiar haze, called "Lupa". In the remaining period, the Territory is subject to heavy rainfall.
- In all seasons an adequate waterproof coat/jacket is useful.
- All participants require comfortable walking boots.
- A rucksack is necessary to carry a waterproof, a spare T-shirt (or a fleece/sweater), a bottle of water and snacks.

- During August and September sun protection, hats or headscarves are useful, because the insolation phenomena are common.
- In spring and summer the viper bite is a possible danger.
- Each vehicle will carry one basic first aid kit.
- Mobile/cellular phone coverage is good although in some places it can be absent.
- The emergency telephone number for ambulance is 118.
- The emergency telephone numbers for police are 112 and 113.
- The State Corps of Forester - Colle San Rizzo Detachment - telephone number is + 39 090 360979.

Hospitals

South Messina (far away from the area of the itinerary)

- ***Azienda Ospedaliera Universitaria Policlinico "G. Martino"***

Address: Via Consolare Valeria - 98122 Messina. Tel. + 39 090 2211

Centre and North Messina

- ***Azienda Ospedaliera Ospedali Riuniti Piemonte e Papardo***

Centre of Messina - Address: Ospedale Piemonte, Viale Europa, 45 - 98123 Messina. Tel. + 39 090 2221

North Messina (area of the itinerary) - Address: Ospedale Papardo, Contrada Papardo - 98158 Messina. Tel. + 39 090 3991.

Other first-aid stations

- Azienda Usl 5 Messina - Guardia Medica Messina Sud. Address: Via Giuseppe La Farina, 263 - 98124 Messina. Tel. +39 090 2932510
- Guardia medica. Address: Viale Giostra, 98145 Messina. Tel. +39 090 59606
- Guardia medica. Address: Via Giuseppe Garibaldi, 249, 98143 Messina. Tel. +39 090 45077
- Guardia medica. Address: Via dei Mille, 98100 Messina. Tel. +39 090 2932510
- Azienda Sanitaria Provinciale di Messina Guardia Medica. Address: Via Principe di Castelnuovo, 87 - 98049 Villafranca Tirrena (ME). Tel. +39 090 334536
- Municipio Guardia medica. Address: Via Mezzasalma, 15 - 98043 Rometta (ME). Tel. +39 090 9962575
- Azienda Sanitaria Provinciale di Messina Guardia Medica. Address: Via Roma Venetico Marina - 98040 (ME). Tel. +39 090 9920093

Place of food & beverage

From Stops 1 to 4 two characteristic places with typical Sicilian products are:
- Ritrovo Don Minico characterized by bread with Calabria-Peloritani spicy sausages and typical preserves
Address: locality Quattro Strade - Colle San Rizzo, SS 113 road
-Bar Ritrovo Portella Castanea with typical Messina rotisserie, such as "pidoni", "arancini", "focacce", etc.
Address: at the intersection between SP 50 and SP 51 roads
Along the remaining part of the itinerary there are:
- Bar Pasticceria e Tavola Calda Spartà Filippo
Address: Viale Principe Umberto - 98122 Salice (ME)
- Bar Pasticceria Arena Santo
Address: Via Nazionale Gesso, 82 - 98100 Spartà (ME)
- Bar Pasticceria La Lumachina
Address: Via Circuito - 98164 Torre Faro (ME)
Fountains with spring water
Locality Musolino - SP 50 bis road
Locality Quattro Strade - Colle San Rizzo, SS 113 road
Locality Salice (ME)

Cultural heritage

- Madonna of Dinnammare Sanctuary (1899), Dinnammare top
- Ferraro Fort (1889-1890), Locality Colle San Rizzo - SP 50 bis road
- Monte dei Centri Fort (1892-1892), Locality Salice (ME)
- Ganzirri and Faro Lakes, Oriented Natural Reserve Lagoon of Peloro Cape
- Torre Faro locality with the monumental complex known as "Torre degli Inglesi" (dating from the 12th century restructured in the 19th century)

Service stations

From Stops 1 to 4 there are not fuel distributors.
From Stops 4 to 8 there are the following fuel distributors:
Stazione di Servizio IP
Address: Strada Panoramica dello Stretto, Sant'Agata - 98100 Messina
Distributore AGIP
Address: Via Consolare Pompea, Contrada Granatari - 98100 Torre Faro (ME)

Accommodation

Near the Messina rail-station
- Hotel Sant'Elia, Via I Settembre, 63 - 98123 Messina. Tel. e Fax +39 090 6010082 e 090 6783750
- Hotel Gran Commercio, Via I Settembre, 67 - 98123 Messina. Tel. +39 090 6010082
- Hotel NH Liberty, Via I Settembre, 1 - 98123 Messina. Tel. +39 090 6409436; Fax:+39 090 6409340

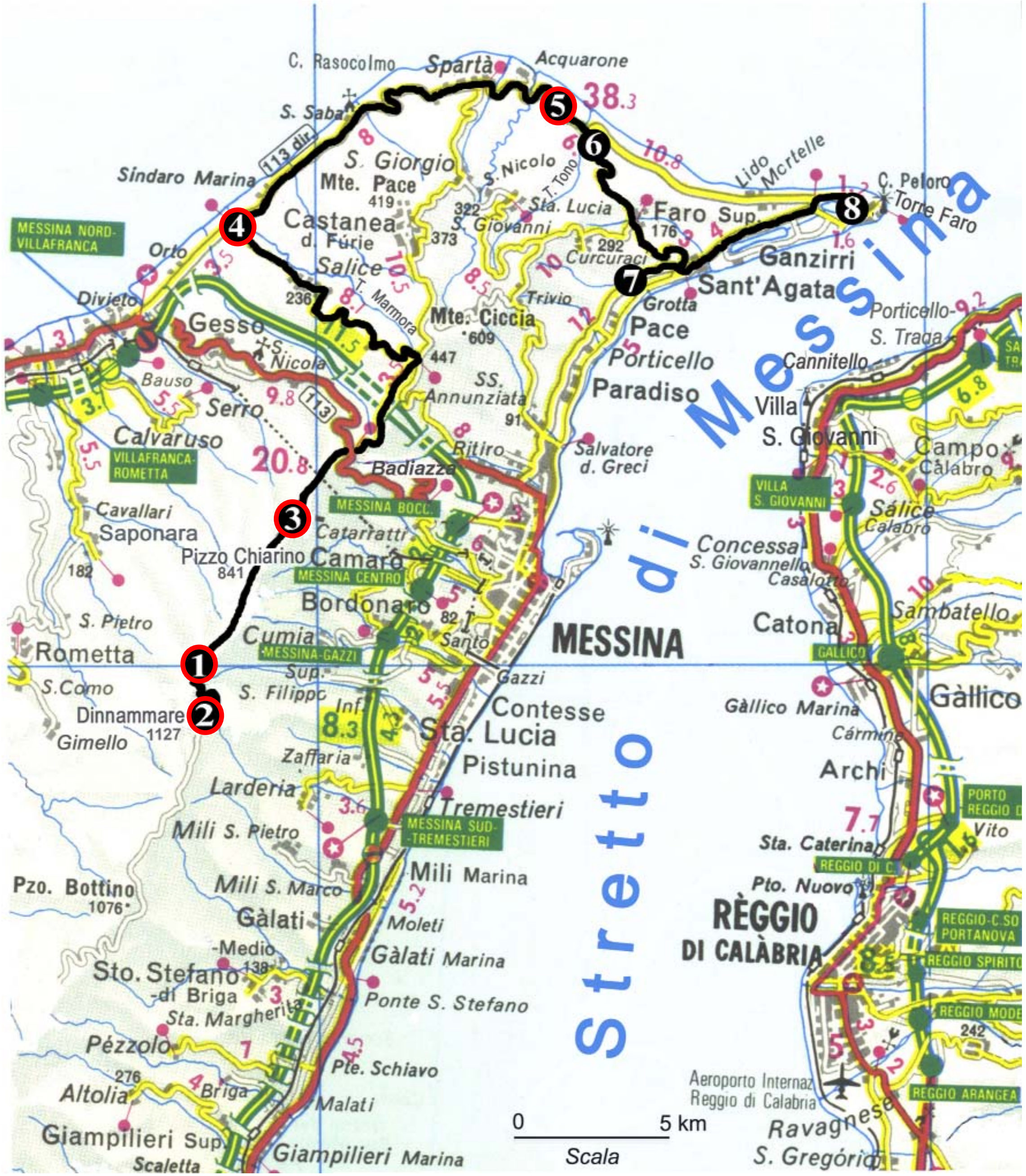
Near Peloro Cape and Mathematician, Physics and Natural Sciences Faculty of the University of Messina
- Grand Hotel Lido di Mortelle, SS 113 dir - 98164 Mortelle (ME). Tel. +39 090 321017; Fax +39 090 321666
- Hotel Villa Morgana, Via Consolare Pompea, 1965 - 98168 Ganzirri (ME). Tel. and Fax +39 090 325575
- Hotel Donato, Via C. Caratozzolo, 8 - 98165 Ganzirri (ME). Tel. +39 090 393150 - 090 9430180; Fax +39 090 9433462
- Capo Peloro Resort, Via Circuito - 98164 Torre Faro (ME). Tel. + 39 090 3223613; Fax +39 090 325511

Program Summary

The tour develops, through Geosites and Geotopes, along the North-Eastern Peloritani Mts. (NE Sicily, Italy) and includes eight Stops, in the framework of a scenic and spectacular geo-morphological landscape. It starts from Dinnammare top (1.127 m a.s.l.), corresponding to the NE limit of the Peloritani Ridge, and continues along the Tyrrhenian coast, from the mouth of the Marmora Torrent up to that of the Tono Torrent. It ends in Peloro Cape, on the Ionian coast (NW Messina Straits; fig. 27).

Part one

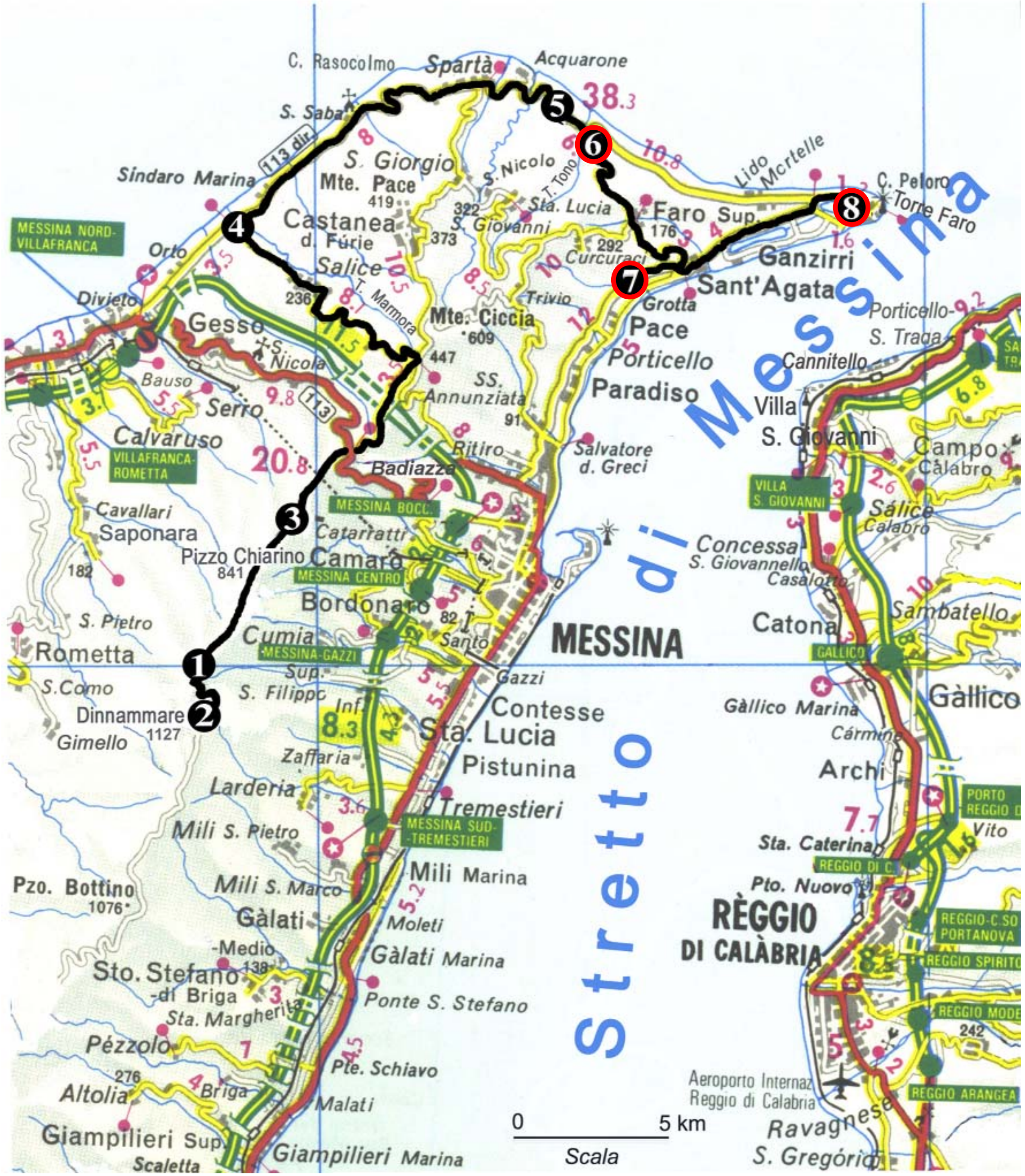
The first five Stops (Stops 1 to 5) illustrate different in age, genesis and composition plutonic and metamorphic rocks. The rocks belong to the Aspromonte Unit basement of the Alpine Peloritani edifice (Calabria-Peloritani Arc). The characterized Geosites testify a Palaeo-Proterozoic to Late Oligocene evolutive history, including three plutonic (Palaeo-Meso-Proterozoic, Late-Pan-African and Late-Variscan) and three metamorphic (Pan-African, Variscan and Alpine) processes.



The most important geo-petrological features are related to: Pan-African granulites, after Palaeo-Meso-Proterozoic intraplate tholeiitic ultramafics; Variscan migmatites, after Pan-African acidic and mafic granulites; Variscan augengneisses, after Late-Pan-African peraluminous plutonics; Late-Variscan peraluminous plutonics; Alpine overprinted Pan-African, Variscan and Late-Variscan rocks.

Part two

The remaining Stops (Stops 6 to 8) focus on some Pliocene to Modern sedimentary deposits, unconformably covering the Alpine Peloritani building. Among them, the typical Middle Pleistocene Messina Gravels and Sands Formation is included.



Riassunto

In occasione del "*I Convegno della Società Geologica Italiana - Sezione Giovani*" (Messina, maggio 2008), è stato realizzato un geo-percorso sui Monti Peloritani nord-orientali, attraverso Geositi e Geotopi che testimoniano una storia geologica dal Proterozoico all'Olocene.
Il presente lavoro costituisce la guida all'itinerario suddetto.
Nella prima parte sono stati ricostruiti e illustrati i caratteri geo-morfologici e geologici del territorio scelto, inquadrato nel contesto dei Monti Peloritani e, in quello più ampio, delle catene alpine del Mediterraneo centro-occidentale.
I Monti Peloritani rappresentano l'estremo lembo meridionale della complessa struttura nota come Arco Calabro-Peloritano, posta al centro del sistema orogenico alpino mediterraneo Africa-Adria vergente. Strutturatisi nell'Oligocene superiore, essi risultano costituiti da una pila di nove unità tettono-stratigrafiche che, geometricamente dall'alto verso il basso e geograficamente da Nord verso Sud, risultano essere: le unità dell'Aspromonte, Mela, Piraino, Mandanici, Alì, Fondachelli, San Marco d'Alunzio, Longi-Taormina e Capo Sant'Andrea. L'edificio alpino così strutturato è stato poi ricoperto, in maniera discordante, da depositi sedimentari differenti per tipo e età, a partire dal flysch di Capo d'Orlando dell'Oligocene superiore-Miocene inferiore fino ai depositi alluvionali e di spiaggia dell'Olocene.
L'itinerario, che si snoda lungo un percorso ricco di una spettacolare paesaggistica, comprende otto soste, partendo da Dinnammare (1.127 m), limite nord-orientale dei Monti Peloritani, per poi proseguire lungo il versante tirrenico, dalla foce del Torrente Marmora fino a quella del Torrente Tono, completandosi a Capo Peloro, sulla costa ionica.
Nei primi cinque Stop, rocce cristalline di composizione diversa, appartenenti all'unità dell'Aspromonte, documentano, geologicamente e petrologicamente, la storia più complessa dei basamenti dell'Arco Calabro-Peloritano. I siti caratterizzati testimoniano processi plutonici e metamorfici di età compresa dal Paleo-Proterozoico all'Oligocene superiore (plutoniti ultramafiche di tipo tholeiiti intraplacca, del Paleo-Meso-Proterozoico; metamorfiti pan-fricane in facies granulitica del Neo-Proterozoico; plutoniti tardo-pan-africane calc-alcaline intermedio-acide del Neo-Proterozoico-Cambriano; metamorfiti varisiche di tipo-bosost in facies da granulitica di B-T a anfibolitica di B-T del Carbonifero superiore; plutoniti tardo-varisiche calc-alcaline intermedio-acide del Carbonifero superiore-Permiano; metamorfiti alpine con riequilibrazione di tipo-barroviano, da pervasiva a blanda, in facies da scisti verdi di A-T a anfibolitica di B-T, dell'Oligocene superiore).
I rimanenti Stop focalizzano depositi sedimentari dal Pliocene fino all'Attuale (marne e calcari marnosi tipo

Trubi, del Pliocene inferiore; formazione delle ghiaie e sabbie di Messina, del Pleistocene medio; depositi di spiaggia, dell'Olocene).
Questo geo-percorso, ricostruibile in tutto l'Arco Calabro-Peloritano solo nei due versanti dello Stretto di Messina, consente di conoscere i caratteri delle storia più antica dei basamenti del settore meridionale di detto orogene, sulla base delle macro-, meso- e microstrutture, in aggiunta alle caratteristiche petrologiche ricostruite su dati bibliografici (prevalentemente degli stessi Autori) e inediti, rappresentativi delle rocce osservate.
La forte similitudine, strutturale e compositiva, tra le metamorfiti interessate da una parziale riequilibrazione alpina dell'unità dell'Aspromonte e quelle dell'unità di Torrox-Sayalonga (Alpujarride Superiore – Cordigliera Betica centro-occidentale, Spagna) a esse comparate è indicativa di un'analoga evoluzione pre-alpina e alpina dei due basamenti messi a confronto. Tale similitudine fornisce nuovo supporto all'ipotesi della provenienza delle unità di crosta continentale dell'Arco Calabro-Peloritano e delle unità interne della Cordigliera Betica da un unico dominio paleogeografico, riconosciuto nella cosiddetta Microplacca Mesomediterranea di età giurassico-cretacica, deformata a partire dall'Oligocene-Miocene.

Parole chiave: *Catene alpine del Mediterraneo centro-occidentale; Arco Calabro-Peloritano; Monti Peloritani; Geo-itinerario; Geositi e Geotopi; Caratteri geologici e petrologici; Evoluzione dal Paleo-Proterozoico all'Olocene.*

Abstract

During the "1st National Congress of the Italian Geological Society - Young Section" (Messina, May 2008), a geo-itinerary in the North-Eastern Peloritani Mounts, through Geosites and Geotopes testifying a Proterozoic to Holocene geological history, has been organized.
The present work is a field trip guidebook of the above defined itinerary.
In the first part the geo-morphological and geological characteristics of the chosen Territory, seen in the context of the Peloritani Mts. and in the wider background of the Central-Western Mediterranean Alpine Chains, have been reconstructed and illustrated.
The Peloritani Mts. constitute the southern part of the complex structure known as Calabria-Peloritani Arc, located in the middle of the Mediterranean Alpine Africa-Adria vergent Orogenic System. Structured in Late Oligocene, they are made up of a pile of nine tectono-stratigraphic units which, going geometrically to the bot-

tom and geographically to South, are: the Aspromonte, Mela, Piraino, Mandanici, Alì, Fondachelli, St. Marco d'Alunzio, Longi-Taormina and Capo St. Andrea Units. The Alpine edifice has been subsequently unconformably covered by different in type and age sedimentary deposits, from the Upper Oligocene-Lower Miocene Capo d'Orlando Flysch to the Holocene alluvial and beach deposits.

The tour, which develops along a route with spectacular landscapes, involves eight Stops. It starts from Dinnammare top (1.127 m), which represents the North-Eastern limit of the Peloritani Ridge, continuing along the Tyrrhenian versant, from the Marmora Torrent mouth to the Tono Torrent mouth. It ends in Peloro Cape, on the Ionian coast.

In the first five Stops, different in composition Aspromonte Unit crystalline rocks, with their geological and petrological features, document the most complex history of the Calabria-Peloritani Arc basements. The characterized sites testify Palaeo-Proterozoic to Late Oligocene plutonic and metamorphic processes (Palaeo-Meso-Proterozoic tholeiitic intraplate ultramafic plutonics; Neo-Proterozoic Pan-African granulite facies metamorphics; Neo-Proterozoic-Cambrian Late-Pan-African calc-alkaline intermediate-acidic plutonics; Late Carboniferous Variscan Bosost-type L-T granulite to L-T amphibolite facies metamorphics; Late Carboniferous-Permian Late-Variscan calc-alkaline intermediate-acidic plutonics; Late Oligocene Alpine, from pervasive to soft, Barrovian-type H-T greenschist to L-T amphibolite facies metamorphics).

The remaining Stops focus on some Pliocene to Modern sedimentary deposits (Early Pliocene Trubi-type marls and marly limestones; Middle Pleistocene Messina Gravels and Sands Fm.; Holocene beach deposits).

In the whole Calabria-Peloritani Arc this geo-itinerary can be reconstructed only in the two sides of the Messina Straits. It allows to know the features of the oldest geological history of the Southern Sector basements of this orogen, on the basis of the macro-, meso- and microstructures, in addition to bibliographic (mostly by the same Authors) and unpublished petrological features, representative of the observed rocks.

The strong structural and compositive similarities between the Aspromonte Unit Alpine partly overprinted metamorphics and the Torrox-Sayalonga Unit ones (Upper Alpujarride – Central-Western Betic Cordillera, Spain) are indicative of an analogous Pre-Alpine and Alpine evolution of the two compared basements, providing a new support to the hypothesis of the provenance of both the Calabria-Peloritani Arc and Betic Cordillera (internal units) continental crust units from a single palaeogeographic domain, recognized in the Jurassic-Cretaceous Mesomediterranean Microplate, deformed since Oligocene-Miocene.

Keywords: *Central-Western Mediterranean Alpine Chains; Calabria-Peloritani Arc; Peloritani Mts.; Geo-itinerary; Geosites and Geotopes; Geological and Petrological features; Palaeo-Proterozoic to Holocene Evolution.*

Foreword

It is particularly interesting to know origin, structure and composition of a magnificent Territory, but it results more charming to be able to reconstruct these characteristics, after having recognized and assembled all mosaic tesserae of its geo-history.
The emotion of this experience is very strong if this Territory exhibits, concentrated in a small surface, seas, lakes, islands, peninsulas, beaches, cliffs, hills, mountains, volcanoes, torrents, valleys and a scenic straits. These elements are the results of an articulated and fascinating geological evolution.

In NE Sicily (Italy), the Peloritani Mts. (from Greek, *pelorios or peloros* – gigantic) constitute a very important Mediterranean scientific pole, because of their geographic, morphological and geological features. These mountains, together with the Calabrian *Costal Chain* and *Sila, Serre* and *Aspromonte Massifs*, form the orogenic domain known as the *Calabria-Peloritani Arc*.
This guidebook introduces to the geology of this Territory, framed in the context of the Peri-Mediterranean Alpine geodynamics, documenting and illustrating through geo-emergences, as geosites and geotopes, peculiar stages of its complex evolutive history.
The considered area is located in the NE Peloritani Mts., where the Geological and Geomorphological Heritage represents a peculiar Italian resource, promoter of innovative conservation and management models.
Along the tour, geological and petrological features are shown, documenting a particular Palaeo-Proterozoic to Modern geo-history, which in all the Calabria-Peloritani Arc is reconstructable only in the nearby and specular Calabrian area.
The journey starts from one of the most panoramic site of the Peloritani Mts., which allows to observe the Ionian Sea in the NE, E and SE, with the spectacular Messina Straits (fig. 1); the Etna Mt. in the SW, the Tyrrhenian Sea in the N, with the Aeolian Islands in the background. The tour ends in the extreme and mythical NE corner of Sicily, showing the minimum length of 3.250 m from Calabria, where the encounter of the two seas come true, accompanied by complex and typical hydrodynamic phenomena.
Grateful for the present opportunity, the young co-Authors and I invite the readers to the following field trip through the Calabria-Peloritani Arc.

Antonia Messina

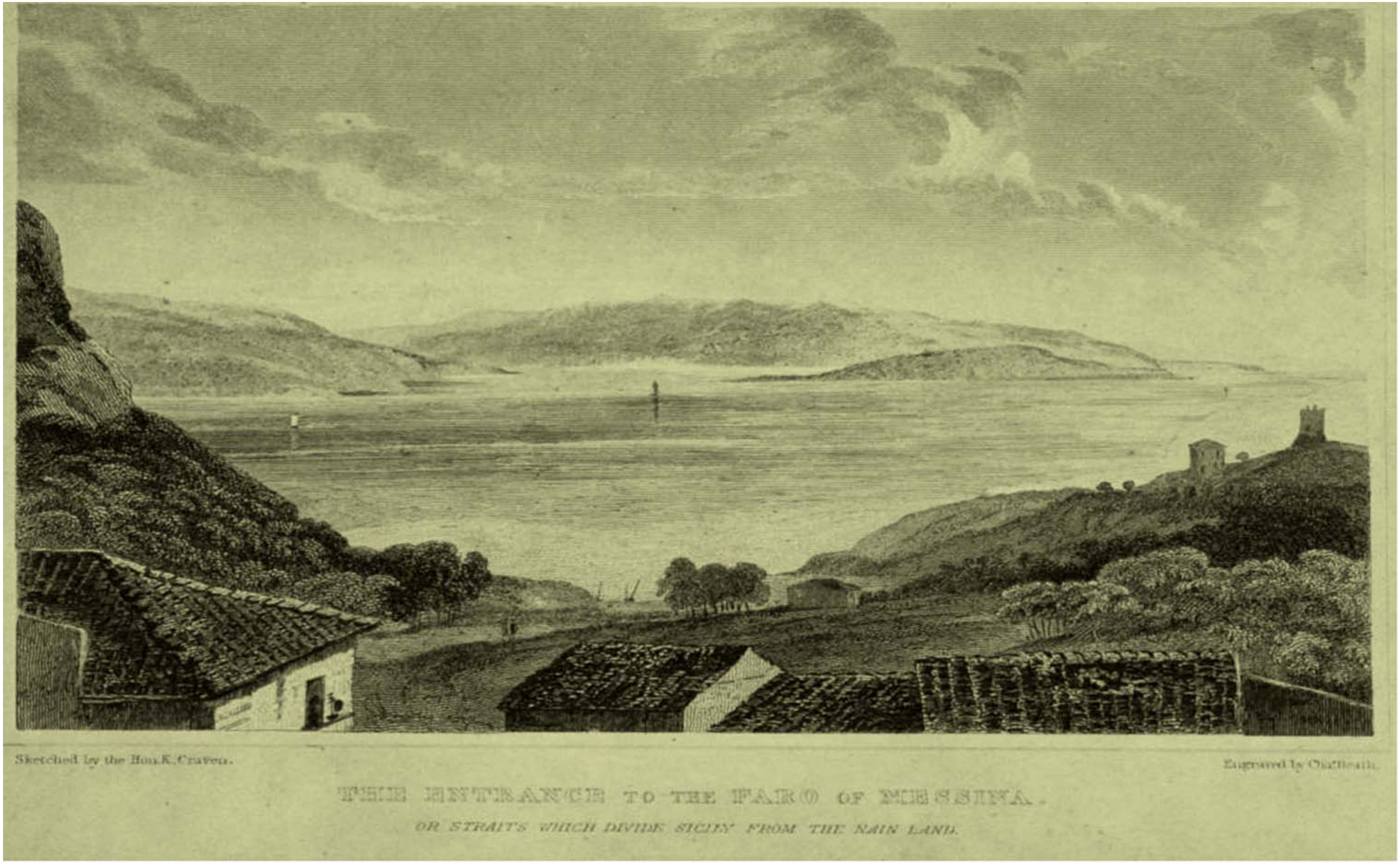


Fig. 1 - Historical Map "*The entrance to the Faro of Messina. Or Straits which divide Sicily from the main land*" (after Hon. Craven K., 1821). Property: Regional University Library of Messina.

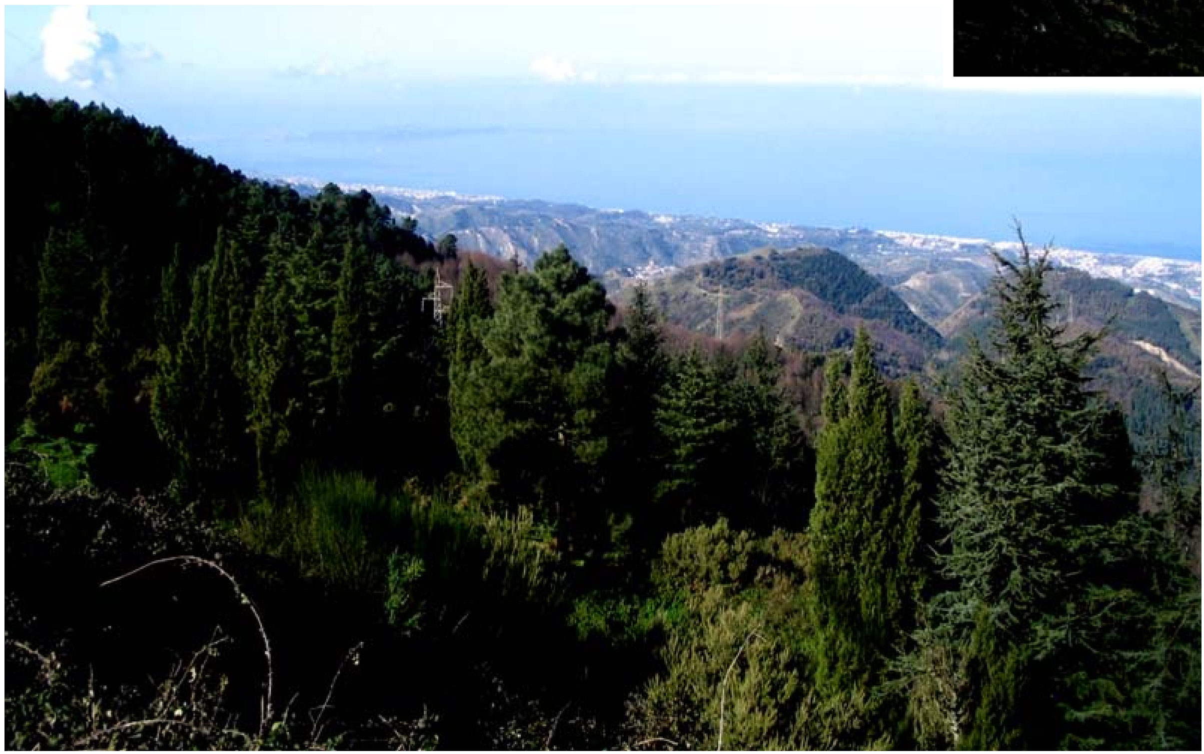
Introduction

With the characteristic triangular form, the Peloritani Mts. (fig. 2) extend from Peloro Cape in the NE, to the Taormina-St. Agata di Militello boundary (Taormina tectonic Line – fig. 22) in the S, separated from the Italian Peninsula by the Messina Straits.

Fig. 2 - Geographic Map "*Territorio dello Stretto*", at 1:500.000 scale: detail of the Peloritani Mts. area (Glimas I.G.M., Firenze - 1885). Property: Museum of Petrography – University of Messina.

Its strongly articulated morphology involves Ionian and Tyrrhenian coasts and a Proterozoic to Palaeozoic crystalline hilly to mountainous inland, unconformably covered by Lower Miocene to Modern sedimentary deposits and cut by deep valleys, where an intersected fluvial network develops.
The Ridge, with an average altitude of 1.000 m, extends with NE-SW direction, from Dinnammare (or Antennammare, 1.127 m) to Montagna Grande (1.374 m), defining the watershed (fig. 3). It continues with E-W trend, up to the joint with the Nebrodi Mts..

Fig. 3 - North-Eastern Peloritani Ridge. Loc.: Dinnammare Mount (1.127 m). NE Peloritani Mts.



It is delimited by Tyrrhenian (figs. 2 and 4) and Ionian Seas (figs. 2 and 5) in the N and E, respectively, and by the Alcantara Valley, in the S, which separates the Peloritani Mts. from the Etna Mt. (fig. 6).

Fig. 4 - North-Eastern limit of the Peloritani Mts.. On the background the Tyrrhenian Sea. Loc.: Dinnammare. NE Peloritani Mts.

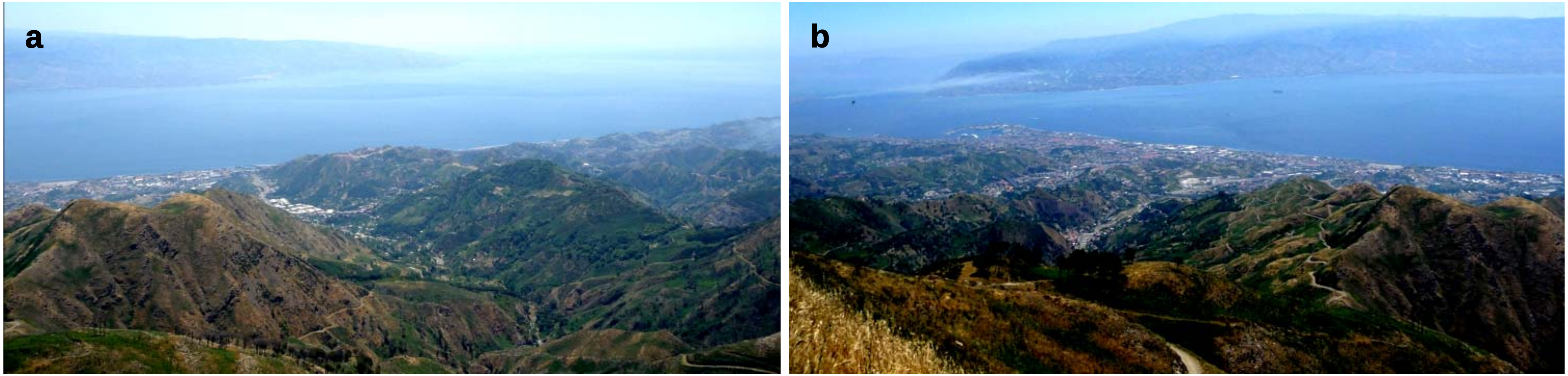


Fig. 5 - E (a) and NE (b) Ionian Peloritani versants, with the Messina Straits. In the background the Calabrian coast is evident. Loc.: Dinnammare. NE Peloritani Mts.

Fig. 6 - South-Eastern limit of the Peloritani Mts.. Beyond the Alcantara Valley the smoking peak of Etna Mt. is also evident. Loc.: Forza d'Agrò. SE Peloritani Mts.

Fig. 7 - View of Peloritani steep crystalline reliefs.
Loc.: Ridge of the hydrographic right versant of the Mela Torrent. Central-Eastern Peloritani Mts.

The landscape is characterized by steep reliefs (fig. 7), very deep valleys, acute peaks (fig. 8) and hierarchized hydrography made up of short, seasonal and torrent-like water courses (*fiumare* and torrents). At different sea levels marine and alluvial terraces are very common (fig. 9).

Fig. 8 - View of Peloritani acute peaks (1.200-1.400 m of altitude) and deep valleys. In the background the smoking Etna Mt. (3.350 m) is evident.
Loc.: hydrographic right versant of St. Venera *Fiumara*. Central Peloritani Mts.

Among the most elevated tops, going westward and southward, we report the Poverello (1.279 m), Scuderi (1.253 m, fig. 9), Pizzo Croce (1.214 m), Polo (1.286 m), Vernà (1.286 m), Rocca Novara (1.259 m, fig. 10), Croce Mancina (1.324 m), Punta dell'Inferno (1.480 m, maximum top) Mountains (fig. 2 and/or fig. 25).

Fig. 9 - The Scuderi Mt. (1.253 m), which is made up of a Palaeozoic crystalline (*Mela Unit Variscan two mica-almandine marbles after Eo-Variscan eclogite facies marbles*), ends with an Upper Pleistocene alluvial terrace. Loc.: Central-Eastern Peloritani Mts.

Fig. 10 - The Rocca Salvatesta Mt. (1.253 m), consisting of a Mesozoic deposit (*Fondachelli Unit - Upper Jurassic – Tithonian grey-whitish limestones of the Rocca di Novara succession*). Loc.: Central Peloritani Mts.

Fig. 11 - View, from S, of the Novara Torrent tract (Mazzarrà-Novara-Paratore Torrent). The two versants consist of a Neo-Proterozoic-Cambrian crystalline (*Aspromonte Unit Variscan biotite-sillimanite orthogneisses, prevailing augengneisses, after Late-Pan-African plutonics, locally re-equilibrated into Alpine phengite-kyanite-almandine leuco-orthogneisses*). The frontal spur is made up of an Upper Oligocene-Lower Miocene deposit (*Capo d'Orlando Flysch*). In the background, from right to left, shapes of Vulcano, Lipari, Santa Maria Salina and Stromboli islands are well delineated.
Loc.: Central Peloritani Mts.

Among rivers exceeding the length of 10 km, we mention Mazzarrà-Novara-Paratore (fig. 11, as T. Mazzarrà in figs. 2 and 25), Patrì-Fantina-Fondachelli (fig. 12, as T. Fondachelli in fig. 1 and T. Patrì-Fantina in fig. 25) and Mela Torrents, in the Tyrrhenian versant; Fiumedinisi, Pagliara Torrents (fig. 13) and d'Agrò *Fiumara* (fig. 14) in the Ionian versant (figs. 1 and 25).

Fig. 12 - View from SW of the low tract of the Patrì-Fantina-Fondachelli Torrent. In the hydrographic right versant an Upper Cretaceous deposit (*Antisicilide Complex Variegated Shales)* extends. At the background, hills of Upper Pliocene-Lower Pleistocene deposits (*prevailing calcarenites*) are also present.
Loc.: Northern Peloritani Mts.

Fig. 13 - View of the luxuriant middle-low tract, with meanders, of the Pagliara Torrent. The two versants are made up of a Palaeozoic crystalline (*Mandanici Unit Variscan chlorite to biotite-garnet phyllites*).
Loc.: Eastern Peloritani Mts.

Fig. 14 - View, from W, of the d'Agrò *Fiumara* middle-low tract. In both versants, prevalently covered by Mediterranean scrub flora, a Palaeozoic crystalline (*Piraino Unit Variscan graphite biotite-garnet phyllites, metarenites and quartzites*) crops out. In the background the Ionian Sea.
Loc.: SE Peloritani Mts.

The Peloritani Mts., from the high peaks, with their spurs, slope down up to the sea, ending with the scenic cliffs, from SE to NW, such as the Taormina (fig. 15), St. Alessio, Alì, Peloro, Rasocolmo, Tindari, d'Orlando and Calavà Capes. The cliffs are alternated with small and beautiful beaches and coastal plains, formed by alluvial deposits.

Fig. 15 - View, from S, of the Taormina Promontory, in the Ionian Sea, prevalently made up of a Mesozoic deposit (*Longi-Taormina Unit - Lower Jurassic - Hettangian-Sinemurian whitish limestones and dolostones*) (after Messina et al., 2010).
Loc.: Northern Giardini Naxos. SE Peloritani Mts.

Fig. 16 - Morphology of Marinello Lagoon System in the Tyrrhenian coast.
Loc.: Tindari Promontory (with Tyndarion Greek-Roman archaeosite). Northern-Central Peloritani Mts.

The morphology of coasts is also characterized by the brackish Lagoon Systems (Oriented Natural Reserves) of Peloro Cape (NE Peloritani Mts.) with the Ganzirri and Faro Lakes sited on the Ionian and Tyrrenian coasts, respectively, and of the Marinello Lakes (fig. 16) located in the Central Tyrrhenian coast.

Fig. 17 - St. Raineri Peninsula, with the Port of Messina. It consists of a crystalline basement (*Aspromonte Unit*) covered by Holocene deposits. This arcuate structure inspired the ancient *Zancle* (sinkle) name of Messina.
Loc.: NE Peloritani Mts.

Other important and scenic morphological elements of coast are the St. Raineri (figs. 17 and 19 – NE Ionian coast) and Milazzo (fig. 18 – Central Tyrrhenian coast) Peninsulas, and the small Isolabella island, near Taormina village (SE Ionian coast).

Fig. 18 - Morphology of the Northern part of the Milazzo Peninsula, in the Tyrrhenian Sea.
Loc.: Northern-Central Peloritani Mts.

Fig. 19 - Historical Map. "*Vue prise à vol d'oiseau de la Ville et du Port de Messine avec une partie du Canal et de Côtes de la Calabre*" (after Despréz, 1829). Property: Regional University Library of Messina.

Geological setting

The peculiar morphology of the defined Territory is strictly correlated to its evolution.
Sicily exhibits a complicate geological architecture involving the Orogenic Domains of the Calabria-Peloritani Arc, the Apenninic-Maghrebian Chain, and the Pelagian-Sicilian Thrust System. The island also includes the Foreland Domain of the Hyblean Plateau and Sciacca area (figs. 20 and 21).

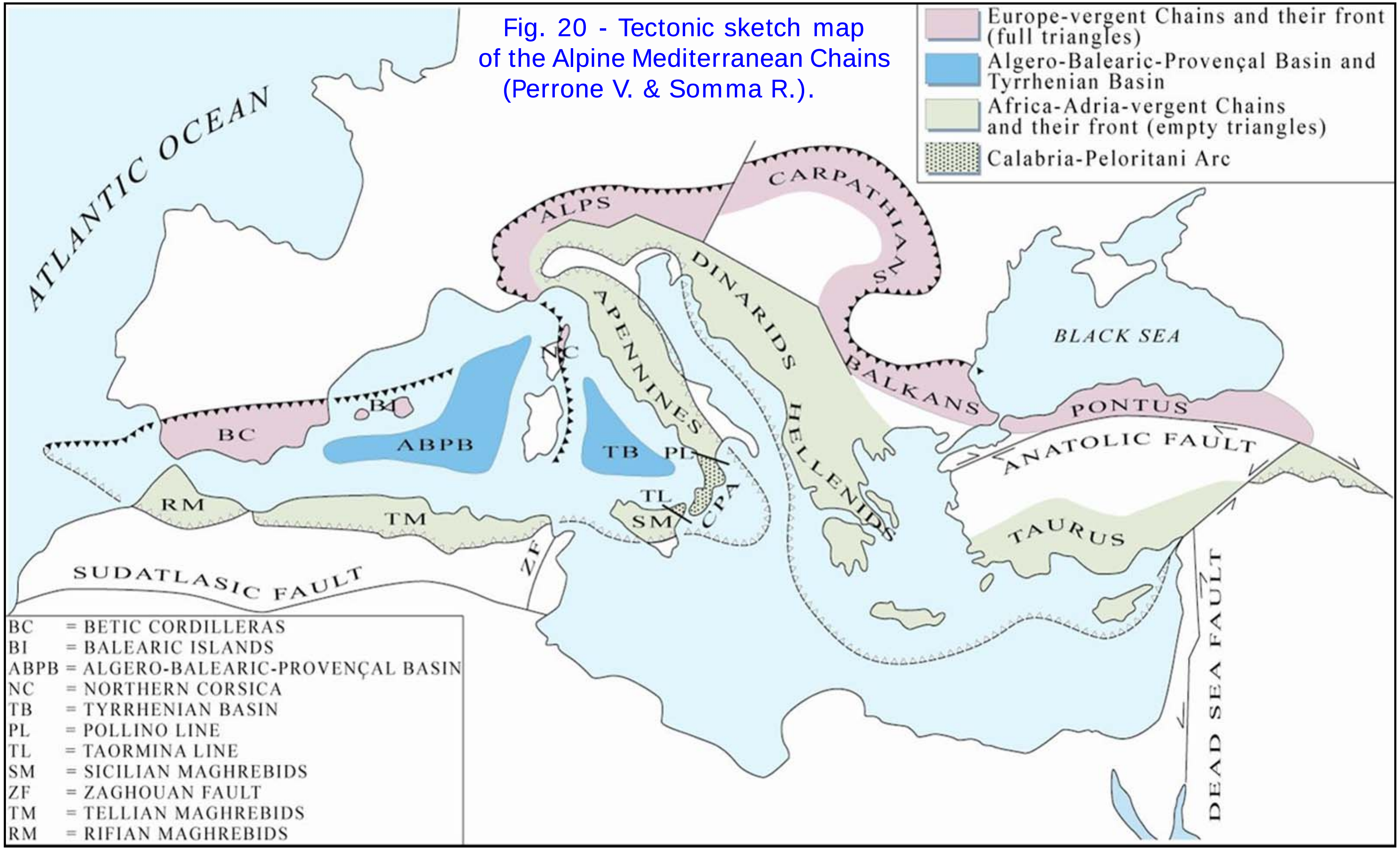


Fig. 20 - Tectonic sketch map of the Alpine Mediterranean Chains (Perrone V. & Somma R.).

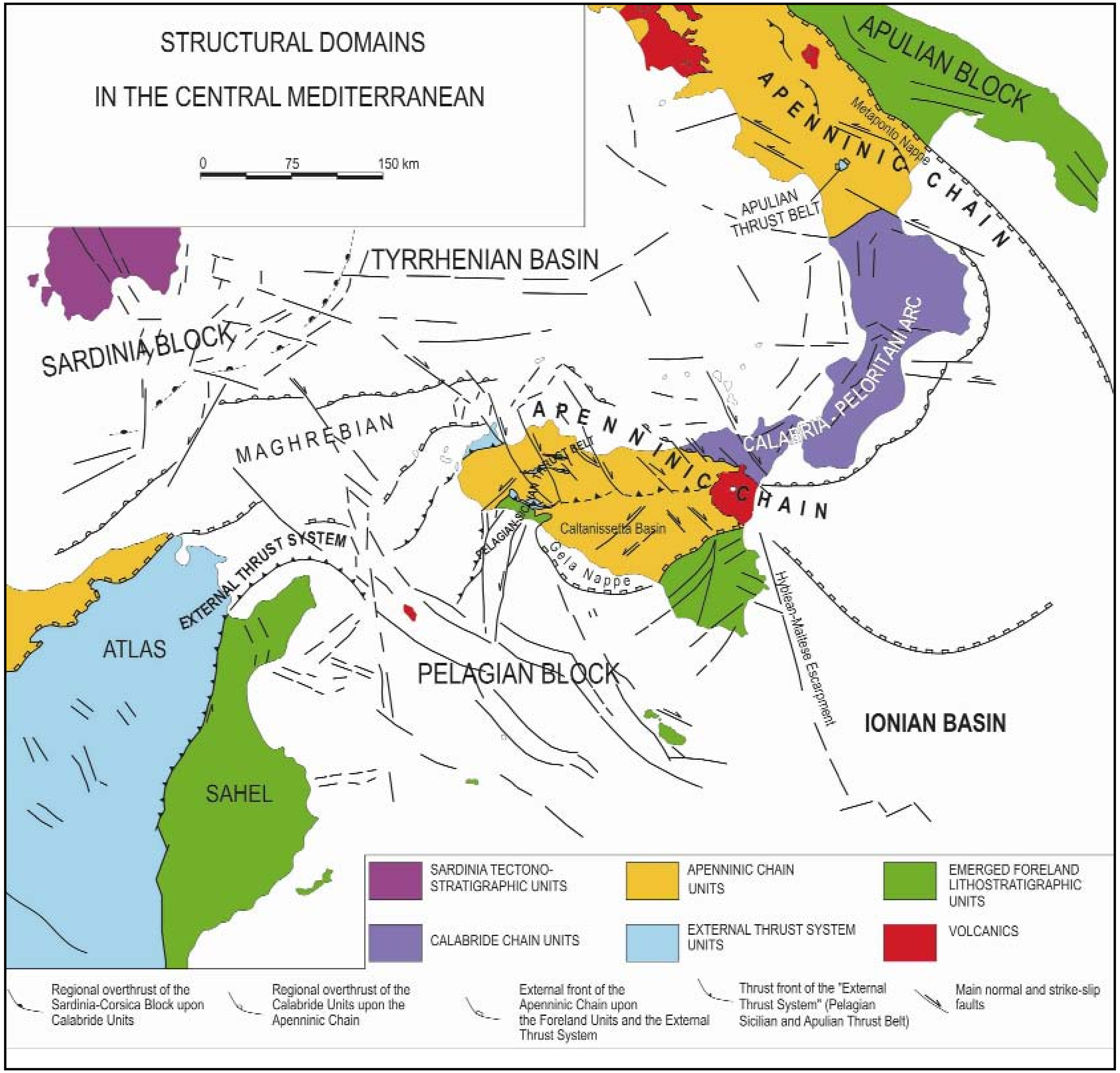


Fig. 21 - Regional Scheme of the structural domains in the Central Mediterranean (after Lentini et al., 1996, modified by Lentini et al., 2009).

The Calabria-Peloritani Arc (CPA) is known as the arcuate structure connecting the NW-SE trending Apennines to the E-W trending Sicilian and African Maghrebids, in the Africa-Adria-verging Mediterranean Alpine Chain (figs. 20 to 22).

The CPA, which represents the innermost tectonic element of the Apenninic-Maghrebian Orogen, extends from N Calabria to NE Sicily, and involves, going S, the *Costal Chain, Sila, Serre* and *Aspromonte Massifs* (Calabria), and *Peloritani Mts.* (Sicily) geographic domains. Traditionally, its tectonic boundaries have been represented by the *Sangineto Line* (Amodio-Morelli et al., 1976) in the N and the *Taormina Line* (Scandone et al., 1974) in the S. Recently, the Northern limit has been discussed, and placed in the Maratea region (Perrone, 1996, Perrone et al., 2006), along the *Pollino Line* (fig. 22).
The CPA, structured in the Tertiary during the last collisional phases between Europa and Africa Plates, is formed by a stack of continental and oceanic crust units (Amodio-Morelli et al., 1976; Bonardi et al., 1976a, b, 1996, 2001, 2004; Messina et al., 1996a).

According to the current opinion, the continental units derived from the Jurassic-Cretaceous *Mesomediterranean Microplate* which, originally located between the European and Africa Plates together with the other microplates (Ragusa, Apulia, Adria), divided the Western Tethys Ocean in the Piemontese-Ligurian-Nevado-Filabride branch to the N and the Lucanian-Maghrebian branch to the S (Guerrera et al., 1993; Bonardi et al., 2002, 2003, 2008; Careri et al., 2004; Iannace et al., 2005; Somma et al., 2005a, b; Perrone et al., 2006, 2008). The oceanic crust units originated from the Tethys Ocean branches (Amodio-Morelli et al., 1976; Bonardi et al., 1976a, b, 1996, 2001 and references therein).
At the Mediterranean scale (fig. 23), the CPA shows compositional, structural and tectono-metamorphic correlations only with Central-Western Mediterranean internal tectonic units (Internal Zone) exposed in North Africa (Kabylias and Rif) and in South Spain (Betic Cordillera), also considered originated from the Mesomediterranean Microplate (Frizon de Lamotte et al., 2000; Martin-Algarra et al., 2000; Michard et al., 2002; Bonardi et al., 2003; Careri et al., 2004; Iannace et al., 2005; Somma et al., 2005a, b; Perrone et al., 2006, 2008).

The CPA does not exhibit a unitary structure, but the *Northern* and *Southern Sectors,* diversified for the Alpine evolution, have been recognized, become kinematically independent in the Cretaceous-Paleogene. The boundary between the two Sectors corresponds to the Soverato-Mesima Valley alignment (fig. 20), which crosses the Serre Massif, in Calabria (Bonardi et al., 1996; Messina et al., 1996a).
The Calabria-Peloritani Arc Southern Sector (CPASS) forms the bulk of the Serre Massif, the Aspromonte Massif and the Peloritani Mts. (figs. 22 and 24).
It consists of a stack of twelve genetically not correlated continental crust units (Messina & Macaione, 2010) that, going to bottom, are: *Stilo, Aspromonte, Cardeto, Africo Units* in Calabria; *Aspromonte, Mela, Piraino, Mandanici, Alì, Fondachelli, St. Marco d'Alunzio, Longi-Taormina, Capo St. Andrea Units* in Sicily (fig. 24).
The units involve Pan-African and Variscan basements, and remnants of originally Meso-Cenozoic sedimentary covers. The Oligo-Miocene orogenesis was responsible for the present stacking of units, implying, both in the basements and in the covers, cataclastic effects to localized metamorphic re-equilibrations, which strongly modified Pre-Alpine features (Bonardi et al., 1992, 1996, 2008; Messina et al., 1990, 1992, 1996a, 2004a, b; Platt and Compagnoni, 1990; Atzori et al., 1995).
Upper Oligocene-Lower Miocene siliciclastic turbidites of the Capo d'Orlando Flysch unconformably covered and sealed the Southern Sector Alpine units (Carbone et al., 2008; Carbone et al., *in press*; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008; F° 587 Milazzo - F° 600 Barcellona Pozzo di Gotto, *in press*).

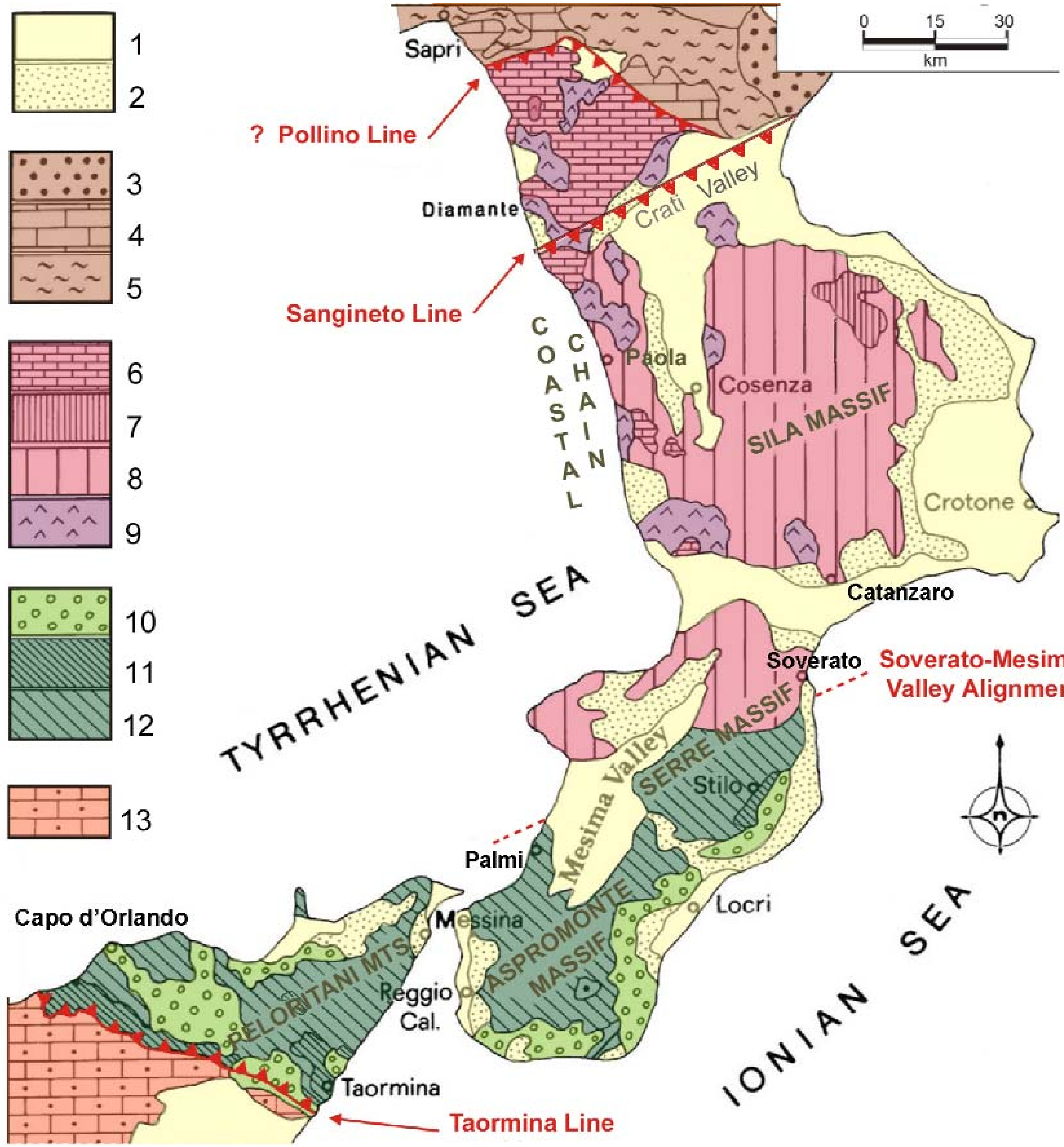


Fig. 22 - Tectonic sketch map of the Calabria-Peloritani Arc (after Messina & Macaione, 2010, modified). **Legend**: 1. Alluvial and beach deposits (Holocene); Etna volcanics (Middle Pleistocene-Holocene). 2. Clastics and evaporites (Upper Tortonian-Pliocene). 3-5. Apenninic Chain: 3. Clastics of the Cilento Group (Langhian-Lower Tortonian); 4. External mainly carbonate Units (Upper Triassic-Serravallian); 5. Lucanian oceanic Units (Upper Jurassic-Burdigalian). 6-9. **Calabria-Peloritani Arc, Northen Sector. Continental crust Units**: 6. Lungro-Verbicaro and Cetraro Units (Middle Triassic-Aquitanian); 7. Paludi Fm. (Upper Oligocene-Lower Miocene) and Sila Unit sedimentary cover (Upper Triassic?-Lower Cretaceous); 8. Sila (Pre-Palaeozoic and Palaeozoic), Castagna (Pre-Palaeozoic and Palaeozoic) and Bagni (Palaeozoic) Units basements; **Oceanic crust Units**: 9. Diamante-Terranova, Monte Reventino-Gimigliano and Malvito (Upper Jurassic-Lower Cretaceous) Units. 10-12. **Calabria-Peloritani Arc, Southern Sector**. 10. Floresta Calcarenites (Upper Burdigalian-Langhian), Antisicilide Complex (Upper Cretaceous-Lower Miocene) and Capo d'Orlando Flysch (Upper Oligocene-Lower Burdigalian). **Continental crust Units**: 11. Stilo (Calabria - Upper Triassic?-Aquitanian), Fondachelli (Sicily - Upper Jurassic-Oligocene?), St. Marco d'Alunzio (Sicily - Lower Jurassic-Eocene), Longi-Taormina (Sicily - Lower Jurassic-Upper Eocene-Oligocene?) and Capo St. Andrea (Sicily - Lower Jurassic-Lower Eocene) Units sedimentary covers; 12. Stilo (Calabria-Palaeozoic), Aspromonte (Calabria and Sicily - Pre-Palaeozoic and Palaeozoic), Cardeto, Africo (Calabria - Palaeozoic), Mela, Piraino, Mandanici, Alì, Fondachelli, St. Marco d'Alunzio, Longi-Taormina and Capo St. Andrea (Sicily - Palaeozoic) Units basements. 13. Maghrebian Chain Flysch Basin Units (Upper Jurassic-Burdigalian).

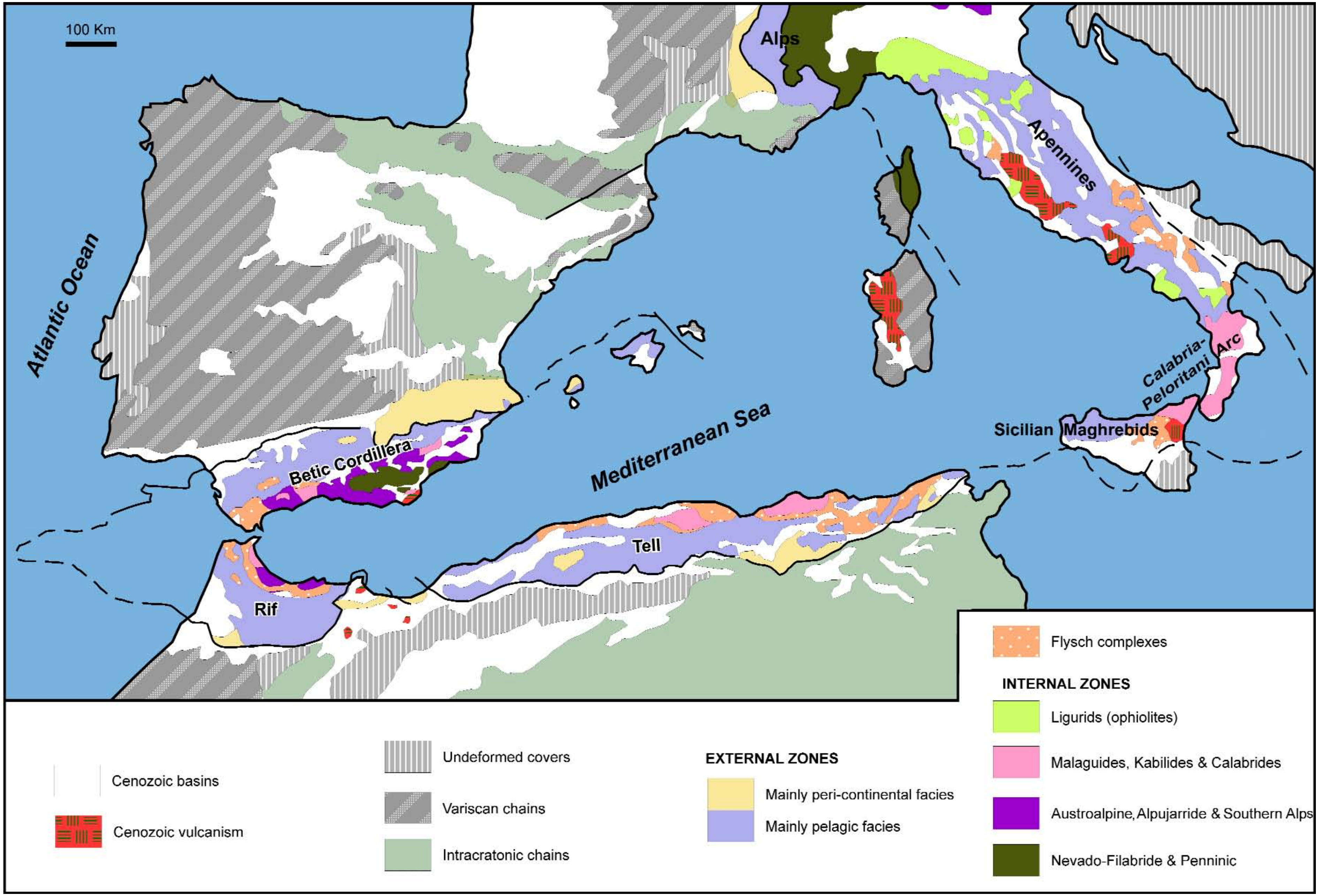


Fig. 23 - Geological sketch map of the Western segment of the Alpine Peri-Mediterranean Orogen (after Geologia de Espana, J.A. Vera - Ed. SGE-IGME, 2004, modified).

This flysch can be interpreted as a thrust top basin deposit developed after the main emplacement of the CPASS units, and subsequently involved in further tectonic phases.
Additional tectonic activity (Post-Burdigalian folds and thrusts) has affected the CPASS since Late Burdigalian, during the orogenic transport onto the Apenninic-Maghrebian Chain, and since Middle Miocene, as consequence of the Tyrrhenian opening.
The Burdigalian to Plio-Pleistocene tectonics was responsible for Middle Miocene to Recent sedimentary deposits, that unconformably covered the CPASS units (Lentini et al., 2000a, b, 2008; Carbone et al., 2008; Carbone et al., *in press*; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008; F° 587 Milazzo - F° 600 Barcellona Pozzo di Gotto, *in press*).
On the basis of the evolutive history and composition of each unit, in the CPASS it has been recognized (Messina & Macaione, 2010):
- a Proterozoic *lower crustal segment*, affected by a Proterozoic to Cenozoic evolution, in the Aspromonte Unit, which lacks of Meso-Cenozoic cover;
- Palaeozoic *intermediate to upper crustal segments*, interested by a Palaeozoic to Cenozoic history, in the remaining units, some of them preserving slices of original Meso-Cenozoic covers.

The Peloritani Mts. tectonic edifice, constituting the southernmost part of the CPA (figs. 24 and 25), is characterized by the above defined nine units, of which only the *Aspromonte Unit* is also present in Calabria (Messina et al., 2004a, b; Macaione, 2006; Carbone et al., 2008; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008; Messina & Macaione, 2010).
In the Aspromonte Unit a *Proterozoic lower crustal segment* has been recognized on the basis of the reconstruction of: i) a Palaeo-Meso-Proterozoic ultramafic plutonic event, dated 1562-1771 Ma in the Variscan metahornblendites; ii) a Neo-Proterozoic high grade metamorphic event, dated 600-800 Ma, in the same rocks; iii) a Neo-Proterozoic-Cambrian orogenic intermediate to acidic plutonic event, dated 500-622 Ma, in the Variscan augengneisses, (Table 1).
This complex evolution, which is the most important theme of the present geo-tour, is subsequently documented and illustrated.
In the Palaeozoic sequences of the other units, dated Cambrian to Carboniferous in age in the Longi-Taormina Unit (Truillet, 1969-1970; Lardeaux & Truillet, 1971; Majesté-Menjoulas et al., 1984, 1986; Bouillin et al., 1987; Spalletta & Vai, 1989; Somma et al., 2005b), and Devonian - Early Carboniferous in the Alì Unit (De Stefani, 1911), on the

basis of paleontological data, are commonly made up of prevalent pelitic-arenaceous levels, interlayered by carbonates and basic to acidic volcanics. Particularly, the Mela Unit marbles, which represent the most important CPA Variscan metacarbonates, in terms of thickness and extension, form a large SE-NW belt extending from the Ionian coast to the Tyrrhenian one, in the central portion of the Peloritani Mts.. It reaches a maximum thickness of 900 m (Messina et al., 2004a, b; Carbone et al., 2008). The volcanic intercalations, from Cambrian to Carboniferous in age, are related to different tectonic settings. They consist of both Variscan metabasalt to metandesite series (Ferla & Azzaro, 1978; Ferla, 2000 and references therein) present in all the units (Carbone et al., 2008) excluding the Alì Unit, and Variscan metadacite to metaryolite series, present in the Mandanici (Messina et al., 2004a, b; Carbone et al., 2008), Longi-Taormina (475 Ma, Table 4; Trombetta et al., 2004) and St. Marco d'Alunzio Units (Carbone et al., *in press*; Servizio Geologico d'Italia - F° 587 Milazzo - F° 600 Barcellona Pozzo di Gotto, *in press*).

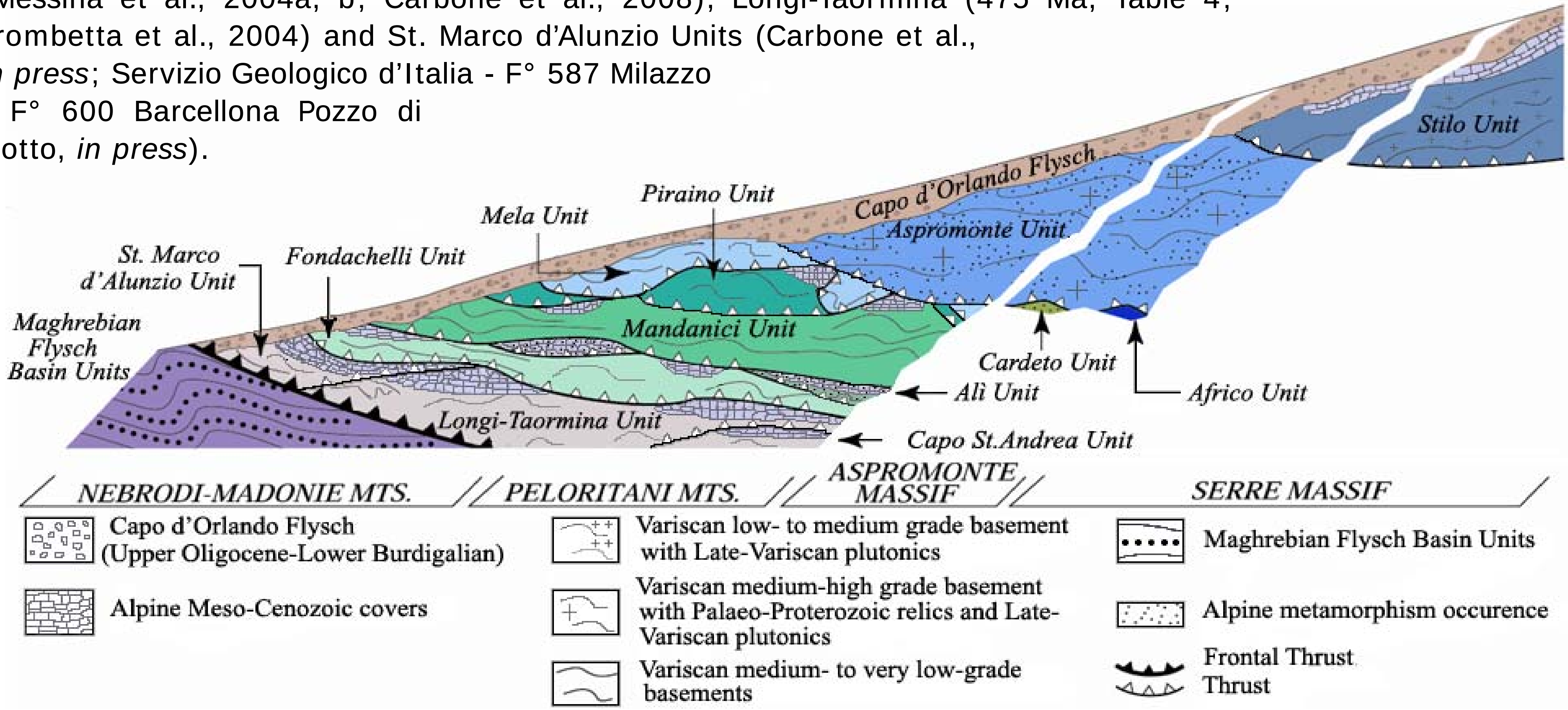


Fig. 24 - Tectonic scheme of Southern Sector of the Calabria-Peloritani Arc (after Messina et al., 2004b, modified).

The Proterozoic crystalline and Palaeozoic sequences were affected by a Variscan metamorphic event, which developed peculiarly in each basement:

- in the Aspromonte Proterozoic low crust, dated 300-340 Ma in amphibolites and 314 Ma in paragneisses (Table 1), it was responsible for a retrograde L-T granulite to L-T amphibolite facies Bosost-type process (Messina et al., 1996a, 2004a, b; Carbone et al. 2008);
- in the Palaeozoic sequences, excluding the Mela Unit, it developed a subgreenschist (Capo St. Andrea and Longi-Taormina Units) to amphibolite (Abukuma-type Piraino Unit) facies prograde metamorphism.

In the Mela Unit the Variscan event was polystage, with an Eo-Variscan eclogite facies condition (Compagnoni et al., 1998) dated 349 Ma (Table 2) in eclogite relics, followed by a retrograde Barrovian-type amphibolite to greeenschist facies second stage (Messina et al., 1997, 1998), dated 310-315 Ma in the Variscan clinopyroxene-metahorblendites after Eo-Variscan eclogites (Table 2).

Tab. 1 - Aspromonte Unit Geochronological data.

Event	Age	Method	Bibliography
Ultramafic Plutonism	1562-1771 Ma Palaeo-Meso-Proterozoic	U/Pb Titanite Age	De Gregorio et al., 2003
Pan-African granulite facies Metamorphism	600-800 Ma Neo-Proterozoic	$^{39}Ar/^{40}Ar$ Amphibole Age	De Gregorio et al., 2003
Late-Pan-African intermediate Plutonism	500-622 Ma 537-572 Ma Neo-Proterozoic-Cambrian	U/Pb Zircon Age	Schenk & Todt, 1989 Micheletti et al., 2007
Variscan amphibolite facies Metamorphism	330-340 Ma 305-314 Ma Late Carboniferous	$^{39}Ar/^{40}Ar$ Amphibole Age Rb/Sr Mica Age	De Gregorio et al., 2003 Bonardi et al., 2008
Late-Variscan intermediate to acidic Plutonism	290 Ma Late Carboniferous-Permian	Rb/Sr Mica Age	Rottura et al., 1990
Alpine greenschist to amphibolite facies Metamorphism	22-28 Ma (metamorphic peak 25 Ma) Late Oligocene	Rb/Sr Mica Age	Bonardi et al., 2008

The Aspromonte basement was also intruded by an orogenic Late-Variscan plutonic series (290 Ma, Table 1) cropping out as different in composition and extension stocks. Syn-tectonic metaluminous to mesaluminous diorite to melatonalite intrusions, very rich of mafic microgranular inclusions, can be found only in Calabria (Palmi-Bagnara Stock). Post-tectonic peraluminous leucotonalite to leucomonzogranite intrusions extend both in Calabria and in Sicily. An intersected network of felsic dykes, cut by rare mafic ones (only in Calabria), form the latest intrusions.

Tab. 2 - Mela Unit Geochronological data.

Event	Age	Method	Bibliography
Eo-Variscan eclogite facies Metamorphism	349 Ma Early Carboniferous	$^{39}Ar/^{40}Ar$ Amphibole Age	De Gregorio et al., 2003
Variscan amphibolite to greenschist facies Metamorphism	310-315 Ma Late Carboniferous	$^{39}Ar/^{40}Ar$ Amphibole Age	De Gregorio et al., 2003

The Palaeozoic sequences preserve a Mesozoic to Cenozoic cover, absent only in the Mela Unit, dated from Middle-Late Triassic to Early Oligocene, which includes Middle-Late Triassic-Hettangian continental to transitional clastic deposits, Early Jurassic carbonate platform deposits and Early Jurassic-Oligocene basinal successions. In the Mandanici and Piraino Units the cover has a thickness ranging from few to ten meters, whereas in the Fondachelli, St. Marco d'Alunzio, Longi-Taormina and Capo St. Andrea Units it reaches 600-800 m (Truillet, 1962, 1969-1970; Montanari & Truillet, 1964; Caire et al., 1965; Atzori, 1968; Lentini & Vezzani, 1975; Bonardi et al., 1976a, 2002, 2003; Grandjacquet & Mascle, 1978; Bouillin et al., 1985, 1992, 1999; Baudelot et al., 1988; Montanari, 1989; de Capoa et al., 1997; Cecca et al., 2002; Carcione et al., 2003; Somma et al., 2005a, b; Somma, 2006; Carbone et al., 2008; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008).

Tab. 3 - Alì Unit Geochronological data.

Event	Age	Method	Bibliography
Mesozoic Cover	26 Ma Late Oligocene	Rb/Sr Mica Age	Atzori et al., 1995

In the Peloritani Mts. the Alpine tectonics started in the Late Oligocene (22-28 Ma, Tables 1 and 3) and finished in the Burdigalian, when the structured chain was covered by siliciclastic turbidites of the Capo d'Orlando Flysch. It developed along shear zones widespread in all the units, both in the basements and in the covers, responsible for cataclasis to mylonisis and localized metamorphic re-equilibrations in the Aspromonte and Alì Units (Messina et al., 1990, 1992, 1996a, 2004a, b; Somma et al., 2005a). The Alpine overprint in both units was polystage. In the first stage, it realized under MH-P Barrovian-type greenschist facies conditions in the Aspromonte Unit, and M-P subgreenschist facies ones in the Alì Unit. In the second stage, it occurred at M-P amphibolite facies conditions in the Aspromonte Unit and L-P subgreenschist facies in the Alì Unit.
The Peloritani units, as the other CPASS units, was unconformably covered by Burdigalian to Modern deposits, and together with them, was deformed by meter- to kilometer Burdigalian folds and thrusts, and by different Plio-Quaternary fault systems (Carbone et al., 2008; Carbone et al., *in press*; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008; F° 587 Milazzo - F° 600 Barcellona Pozzo di Gotto, *in press*).
Mono- and polymetallic (Zn, Cu, Fe, Pb, Sn, Sb, As, W, Ag, Au, etc.) mineralizations are present in all the units. They are ascribable to Proterozoic syn-plutonic (Aspromonte Unit) or to Palaeozoic syn-sedimentary and syn-volcanic (remaining units) deposits, followed by Variscan and Alpine metamorphic remobilizations. Miocene to Actual hydrothermal processes are also largely widespread (Ferla, 1982; Censi & Ferla, 1983; Omenetto et al. 1986, 1988; Saccà & Triscari, 1985; Saccà & Cimino, 1988; Saccà et al., 1992, 1996; De Vivo et al., 1998, 1999; Messina et al., 2004a, b; Messina & Macaione, 2010).

Tab. 4 - Longi-Taormina Unit Geochronological data.

Event	Age	Method	Bibliography
Picritic Na-Alkaline Volcanism	Cambrian	paleontological data in associated rocks	Bouillin et al., 1987
Calk-alkaline Volcanism	475 Ma Early Ordovician	U/Pb zircon age	Trombetta et al., 2004
Alkaline transitional Volcanism	Middle-Late Devonian	paleontological data in associated rocks	Ferla, 1978, 2000; Ferla and Azzaro, 1978
Variscan subgreenschist to greenschist facies Metamorphism	323-330 Ma Late Carboniferous	K/Ar age	Acquafredda et al., 1994; Guerrera et al., 1999

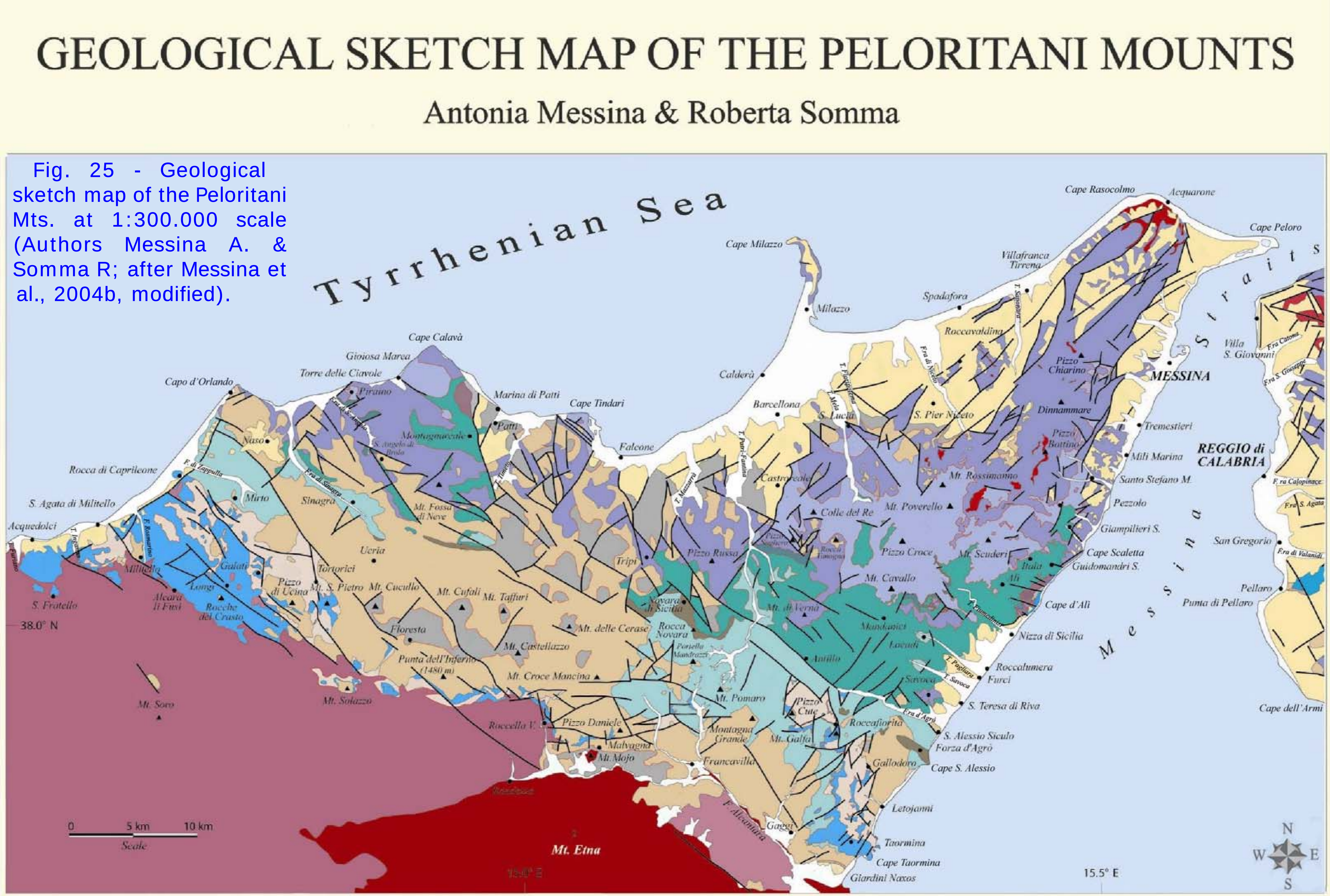


Fig. 25 - Geological sketch map of the Peloritani Mts. at 1:300.000 scale (Authors Messina A. & Somma R; after Messina et al., 2004b, modified).

LEGEND of fig. 25

ALLUVIAL AND BEACH DEPOSITS

Continental and marine terrigenous deposits
Lithotypes - clays, sands and polygenic (mainly crystalline), heterometric and rounded gravels (Holocene).

ETNA VOLCANICS (Middle Pleistocene-Holocene)

MIDDLE MIOCENE-PLEISTOCENE DEPOSITS UNCONFORMABLY ON THE CALABRIA-PELORITANI ARC AND MAGHREBIAN CHAIN UNITS

Continental and marine deposits
Lithotypes - sands, gravels, conglomerates (Messina Gravels and Sands Fm.; Middle Pleistocene); calcarenites, bioclastic sands, clays and sandy clays (Upper Pliocene-Middle Pleistocene); sandy marls, sands and calcarenites (Middle Pliocene); marls and marly limestones (Trubi - Lower Pliocene); evaporites (Gessoso-Solfifera Fm.; Upper Messinian); coralgal limestones and calcareous breccias (Upper Tortonian-Lower Messinian); sandstones, siltstones, marly and sandy-clayey alternations, marls, clayey marls and conglomerates (Middle Serravallian-Lower Messinian).

FLORESTA CALCARENITES

Clastic deposits
Lithotypes - bioclast-rich siliciclastic sandstones and conglomerates (Upper Burdigalian-Langhian).
VARIEGATED CLAYS with megablocks of the Numidian Flysch - Antisicilide Complex (Upper Cretaceous-Lower Miocene).
Lithotypes - polychrome clays, with intercalations of radiolarites and cherty limestones.

CAPO D'ORLANDO FLYSCH

Terrigenous marine deposits
Lithotypes - sandy, sandy-clayey and sandy-conglomeratic turbidites, locally coarse conglomeratic levels; a) olistoliths of metamorphics, neritic limestones and dolostones (Upper Oligocene-Lower Burdigalian).

ASPROMONTE UNIT

Palaeozoic Basement: Late-Variscan calc-alkaline post-tectonic, peraluminous, intermediate to acidic plutonics (Upper Carboniferous-Permian) with a localized Alpine polyphasic Barrovian-type metamorphism.
Lithotypes - Late-Variscan plutonic Basement with Alpine re-equilibration: phengite±almandine±tourmaline leuco-orthogneisses; almandine±kyanite±phengite±pargasite±ripidolite±chloritoid±albite/oligoclase±biotite orthogneisses (Upper Carboniferous-Permian).
- Late-Variscan plutonic Basement: two mica±tourmaline±fluorite±garnet pegmatite, aplite, felsite and porphyrite dykes; muscovite+biotite±sillimanite±cordierite±andalusite±garnet leucomonzogranite to leucotonalite bodies; amphibole±biotite diorite to melatonalite microgranular inclusions (Upper Carboniferous-Permian).

Pre-Palaeozoic Basement: para- and orthoderivates (Palaeo-Meso-Proterozoic) affected by a Pan-African H-T granulite facies metamorphism (Neo-Proterozoic), intruded by Late-Pan-African orogenic intermediate to acidic plutonics (Neo-Proterozoic-Cambrian) and all crystalline interested by a Variscan (Upper Carboniferous) polyphasic Bosost-type L-T granulite to L-T amphibolite facies metamorphism, and by a localized Alpine polyphasic MH-P Barrovian-type greenschist to M-P amphibolite facies re-equilibration.

Lithotypes - Variscan metamorphic Basement with Alpine re-equilibration: almandine±kyanite±phengite±pargasite±ripidolite±chloritoid± albite/oligoclase±biotite gneisses, schists and fels; phengite±garnet±pargasite marbles and metahornblendites; forsterite+enstatite relics Fe-antigorite+clinochlore+tremolite ultramafics (Palaeo-Meso-Proterozoic and Neo-Proterozoic-Cambrian).

- Variscan metamorphic Basement: biotite melatonalite to monzogranite augengneisses, two mica tonalite to monzogranite metaplutonics (Neo-Proterozoic-Cambrian); plagioclase+biotite+hornblende±diopside amphibolites and amphibolite gneisses (Palaeo-Meso-Proterozoic); locally migmatite biotite+sillimanite+garnet+K-feldspar+cordierite±muscovite gneisses; biotite±sillimanite±garnet±cordierite±muscovite±staurolite± andalusite gneisses and schists; hornblende±diopside±garnet±phlogopite±muscovite quartzites, marbles and Ca-silicate fels (Palaeo-Proterozoic).

- Pre-Variscan metamorphic Basement: relics of metaperidotites, metapyroxenites and metahornblendites (Palaeo-Meso-Proterozoic).

MELA UNIT

Palaeozoic Basement: sequence interested by an Eo-Variscan eclogite facies metamorphic stage (Lower Carboniferous), followed by a Variscan polyphasic Barrovian-type amphibolite facies kyanite-staurolite-garnet zone to greenschist facies andalusite-two mica-albite zone metamorphic stage (Upper Carboniferous).

Lithotypes - Variscan metamorphic Basement: garnet-relic two mica+almandine+staurolite±kyanite±sillimanite±cordierite+andalusite gneisses and schists, two mica quarzites; almandine+two mica marbles; porphyroclastic andesine amphibolite gneisses, porphyroclastic orthoclase gneisses, feldspathic leucogneisses.

- **Eo-Variscan metamorphic Basement:** omphacite+garnet+epidote eclogites partially to pervasively re-equilibrated into garnet-relic clinopyroxene metahornblendites.

PIRAINO UNIT

Mesozoic Cover: siliciclatic and calcareous deposits (Upper Triassic-Aalenian).

Lithotypes - limestones, marls, sandstones and siltites (Middle Liassic-Aalenian); dolostones (Jurassic?); continental redbeds (Upper Triassic?-Hettangian).

Palaeozoic Basement: sequence affected by a Variscan polyphasic Abukuma-type greenschist facies chlorite zone to amphibolite facies staurolite-oligoclase zone metamorphism.

Lithotypes - Variscan metamorphic Basement: graphite+white mica±chlorite±albite±chloritoid±biotite±garnet±oligoclase±staurolite phyllites and metarenites, graphite+white mica quartzites; amphibolite schists.

MANDANICI UNIT

Mesozoic Cover: calcareous, evaporite and siliciclastic deposits (Upper Triassic-Cretaceous?).

Lithotypes - limestones, dolostones and cargneules (Upper Triassic-Cretaceous?).

Palaeozoic Basement: sequence interested by a Variscan polyphasic L-P greenschist facies chlorite zone to amphibolite facies garnet-oligoclase zone metamorphism.

Lithotypes – Variscan metamorphic Basement: muscovite±chlorite±albite±chloritoid±biotite±garnet±oligoclase phyllites and metarenites, white mica+chlorite quarzites; paragonite or muscovite±chlorite+albite marbles; chlorite+muscovite±biotite porphyroids, actinolite schists.

ALÌ UNIT

a b **Mesozoic Cover:** carbonate platform and pelagic deposits and continental clastic deposits, interested by an Alpine polyphasic ML-P subgreenschist facies metamorphism (Middle?-Upper Triassic-Cretaceous).
Lithotypes – a) silicified metapelites, metacalcarenites and metamicrobreccias (Middle Jurassic-Cretaceous); Medolo-type cherty metamarly and metalimestones (Domerian); metadolostones and metalimestones (Norian?-Lower Lias?); cargneules (Carnian?); b) continental redbeds (Middle?-Upper Triassic).

Palaeozoic Basement: sequence affected by a Variscan subgreenschist facies metamorphism, followed by an Alpine polyphasic ML-P subgreenschist facies re-equilibration (Devonian-Lower Carboniferous).
Lithotypes - Variscan metamorphic Basement with an Alpine re-equilibration: graphite+chlorite metasiltites and metarenites (Devonian-Lower Carboniferous).

FONDACHELLI UNIT

Mesozoic Cover: calcareous and siliciclastic deposits (Tithonian-Oligocene?).
Lithotypes: turbiditic sandstones, red conglomerate (Upper Eocene-Oligocene?), Scaglia marls (Cretaceous-Eocene); marly limestones (Lower Cretaceous), limestones (Tithonian).
Palaeozoic Basement: sequence affected by a Variscan L-P greenschist facies chlorite zone metamorphism.
Lithotypes - Variscan metamorphic Basement: graphite+chlorite+white mica phyllites, metarenites and quarzites; metalimestones; chlorite+actinolite metadiabases.

ST. MARCO D'ALUNZIO UNIT

Meso-Cenozoic Cover: continental clastic deposits, carbonate platform and pelagic deposits (Lower Lias-Eocene).
Lithotypes – carbonate breccias (Eocene); Scaglia facies pelagic marls and marly limestones (Upper Cretaceous); Rosso Ammonitico facies limestones (Malm); massive limestones (Dogger); Medolo facies cherty marls and limestones (Lias); grey algal limestones, dolomite limestones, crinoidal limestones, brachiopods and ammonites-bearing limestones (Pliensbachian); continental redbeds (Lower Lias).

Palaeozoic Basement: sequence affected by a Variscan polyphasic L-P greenschist facies chlorite zone metamorphism.
Lithotypes - Variscan metamorphic Basement: grey-violet white mica±chlorite±chloritoid±graphite slates and metarenites, grey-pinkish quartzites; pinkish white mica+chlorite metavolcanics, with prevailing porphyroids, grey-bluish metabasites and ochre talc-schists (Palaeozoic).

LONGI-TAORMINA UNIT

Meso-Cenozoic Cover: continental clastic deposit, carbonate platform and pelagic deposits (Hettangian-Lower Oligocene?).
Lithotypes - sandy and sandy-pelitic turbidites (Frazzanò Fm.; Upper Eocene-Lower Oligocene?); Scaglia facies pelagic marls and marly limestones (Upper Cretaceous-Lower Eocene); Biancone facies cherty marly limestones (Tithonian-Neocomian); radiolarites and Rosso Ammonitico facies marls and nodular marly limestones (Lower Lias-Malm); Medolo facies cherty marls and limestones (Pliensbachian); clastic limestones, oolitic limestones and dolostones (Lower Lias); continental redbeds (Hettangian).

Palaeozoic Basement: sequence affected by a Variscan polyphasic L-P subgreenschist facies to greenschist facies chlorite zone metamorphism (Cambrian-Lower Carboniferous).
Lithotypes - Variscan metamorphic Basement: white mica±chlorite±graphite slates, metarenites and quartzites; metabreccias; metalimestones and metamarls; pinkish chlorite+white mica porphyroids, violet metabasalts, metadiabases, dark metabasalts; metaconglomerates (Cambrian-Lower Carboniferous).

CAPO ST. ANDREA UNIT

Meso-Cenozoic Cover: continental clastic deposits and carbonate platform and pelagic deposits (Lower Lias-Lower Eocene).

Lithotypes – Scaglia facies pelagic marls and marly limestones, Biancone facies limestones, Maiolica facies red micritic limestones, Rosso Ammonitico limestones (Upper Jurassic-Lower Eocene); massive grey limestones, Brachiopoda and Pectinidae limestones, grey and red crinoidal limestones (Lower Lias); continental redbeds (Lower Lias).

Palaeozoic Basement: sequence affected by a Variscan polyphasic L-P subgreenschist facies metamorphism.
Lithotypes - Variscan metamorphic Basement: white mica±chlorite±graphite slates and metarenites, metarkoses, metabreccias; metalimestones; violet metabasalts, dark metabasalts.

MAGHREBIAN CHAIN

UNITS OF THE MAGHREBIAN FLYSCH BASIN (Upper Jurassic-Burdigalian)
Lithotypes - turbiditic sandstones and tuffites (Burdigalian); Variegated Clays and carbonate deposits (Upper Cretaceous-Aquitanian); arenites (Hauterivian-Albian); quartzarenites, allodapic limestones and radiolarites (Upper Jurassic-Lower Cretaceous).

Normal and strike-slip fault

Overthrust

Presumed stratigraphic boundary

Stratigraphic boundary

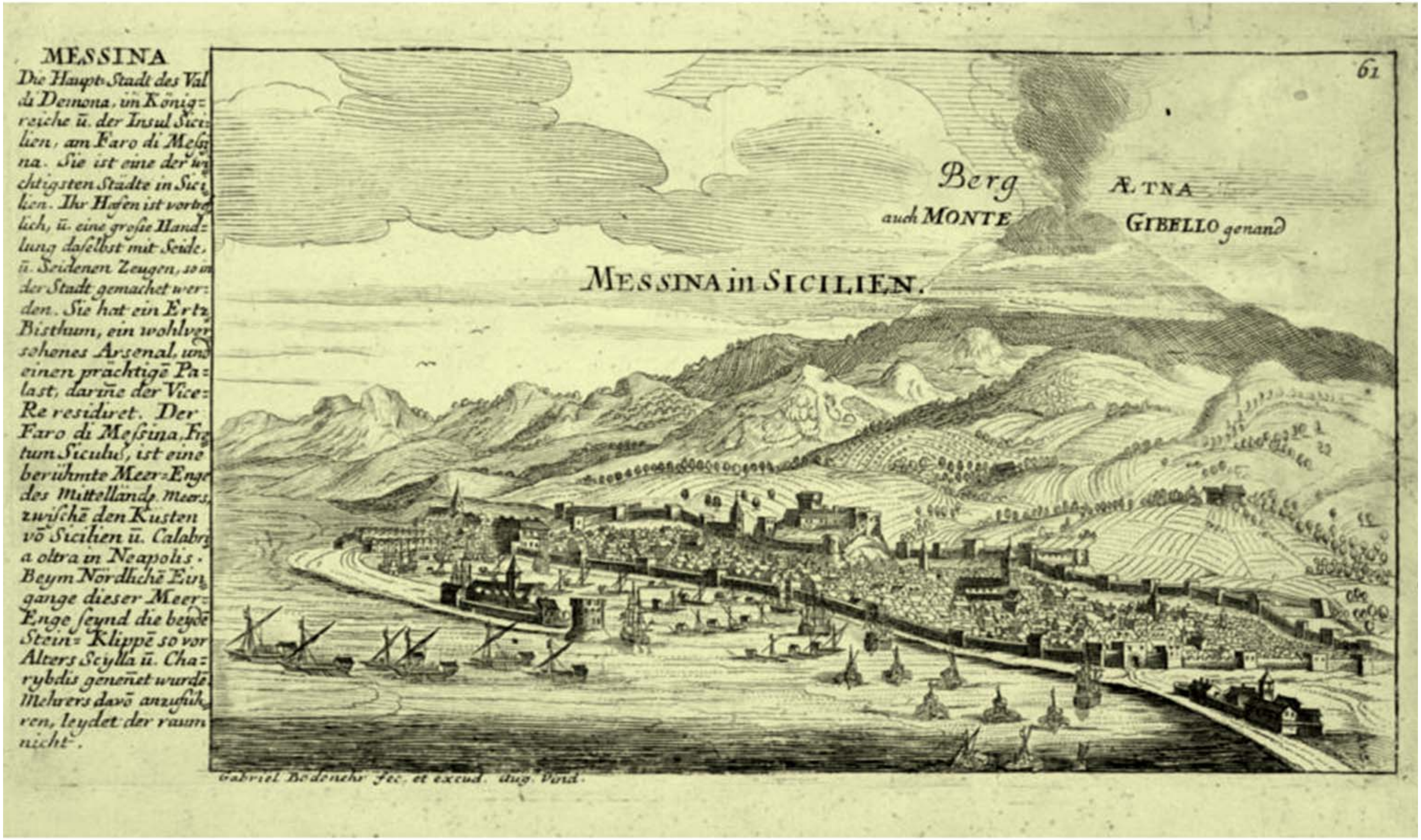


Fig. 26 - Historical Map *"Messina in Sicilien. Berg Aetna auch Monte Gibello genand"* (after Bodenehr G., 1731). Property: Regional University Library of Messina.

Geological Field Trip

The geo-itinerary, aim of the present guidebook, is a journey through time, using Geosites and Geotopes as a document of the Proterozoic to Holocene evolutive history of the Peloritani Mts..
The tour, which involves eight Stops, develops along the extreme NE part of Sicily, starting from Dinnammare top (1.127 m), NE limit of the Peloritani Ridge (figs. 3 to 6 and 27). It continues along the Tyrrhenian versant, from the mouth of the Marmora Torrent, up to that of the Tono Torrent, ending in Peloro Cape, on the Ionian coast (fig. 27).
The first five Stops illustrate different in age, genesis and composition crystalline rocks, belonging to the Aspromonte Unit basement; the other ones represent Pliocene-Quaternary sedimentary deposits (figs. 27b and 28).

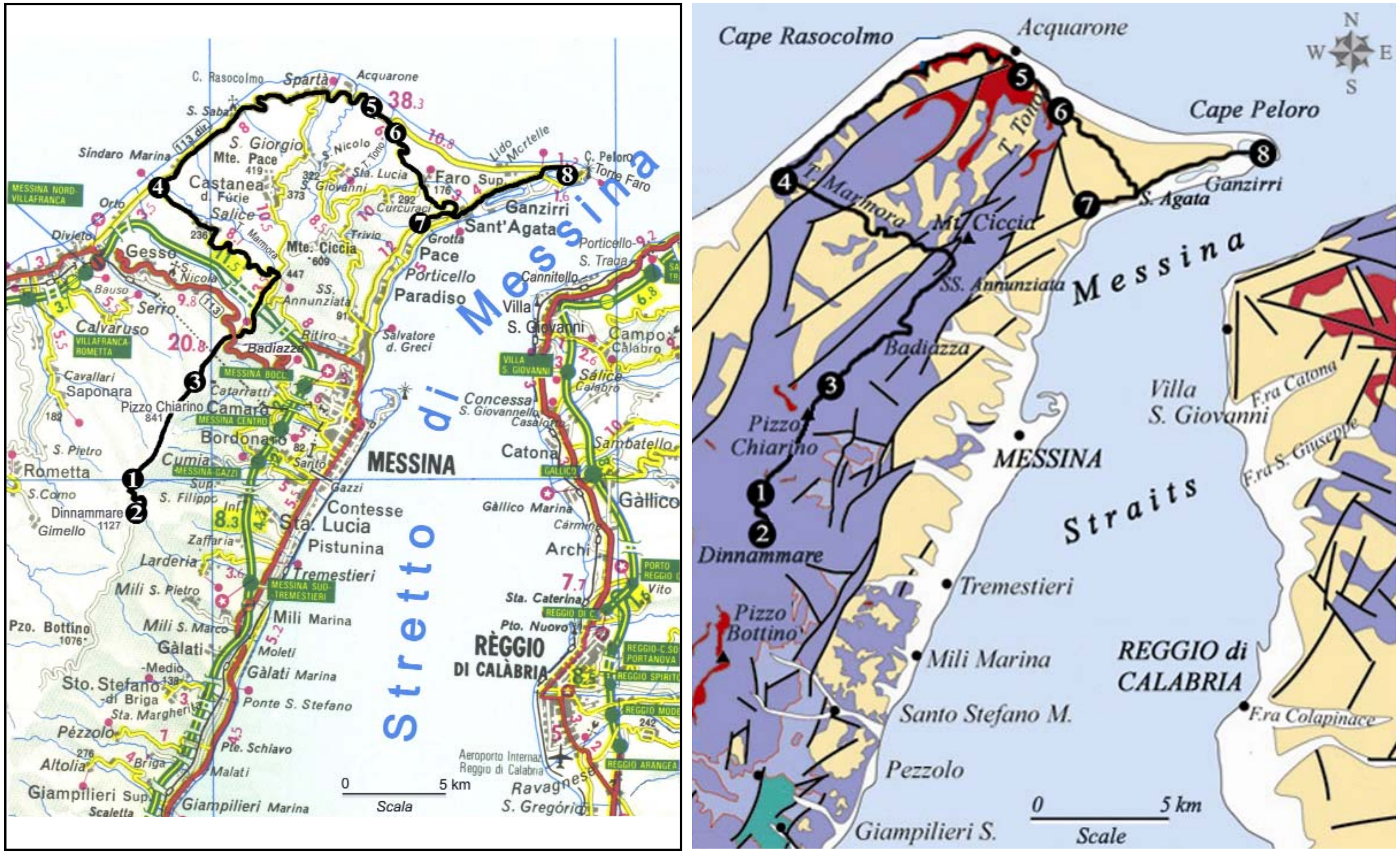


Fig. 27 - Geological itinerary from Palaeo-Proterozoic to Holocene in the North-Eastern Peloritani Mts. The black continuous tract delineates the journey, from Dinnammare to Peloro Cape, along which the eight Stops are signaled: a) detail of the Topographic schematic map of the North-Eastern Sicily, at 1:250.000 scale - Istituto Geografico De Agostini, Novara, 1993; b) detail of the Geological sketch map of the Peloritani Mts., at 1:300.000 scale - Messina A. & Somma R. (legend as in fig. 25).

As above indicated, Peloritani basements commonly consist of different in grade metamorphics. Only the Aspromonte Unit also includes plutonics. Both the Proterozoic and Palaeozoic crystalline and the Mesozoic to Modern deposits exhibit a very large compositive range.

Lithotypes record numerous and different in type processes related to the Peloritani complex evolutive history. Particularly, metamorphics testify: anatectic phenomena in the Aspromonte Unit high grade rocks; up to five deformative phases in the medium grade Mela Unit rocks, three of which accompanied by syn- to post-kinematic metamorphism, characterized by the growth of centimeter porphyroblasts of

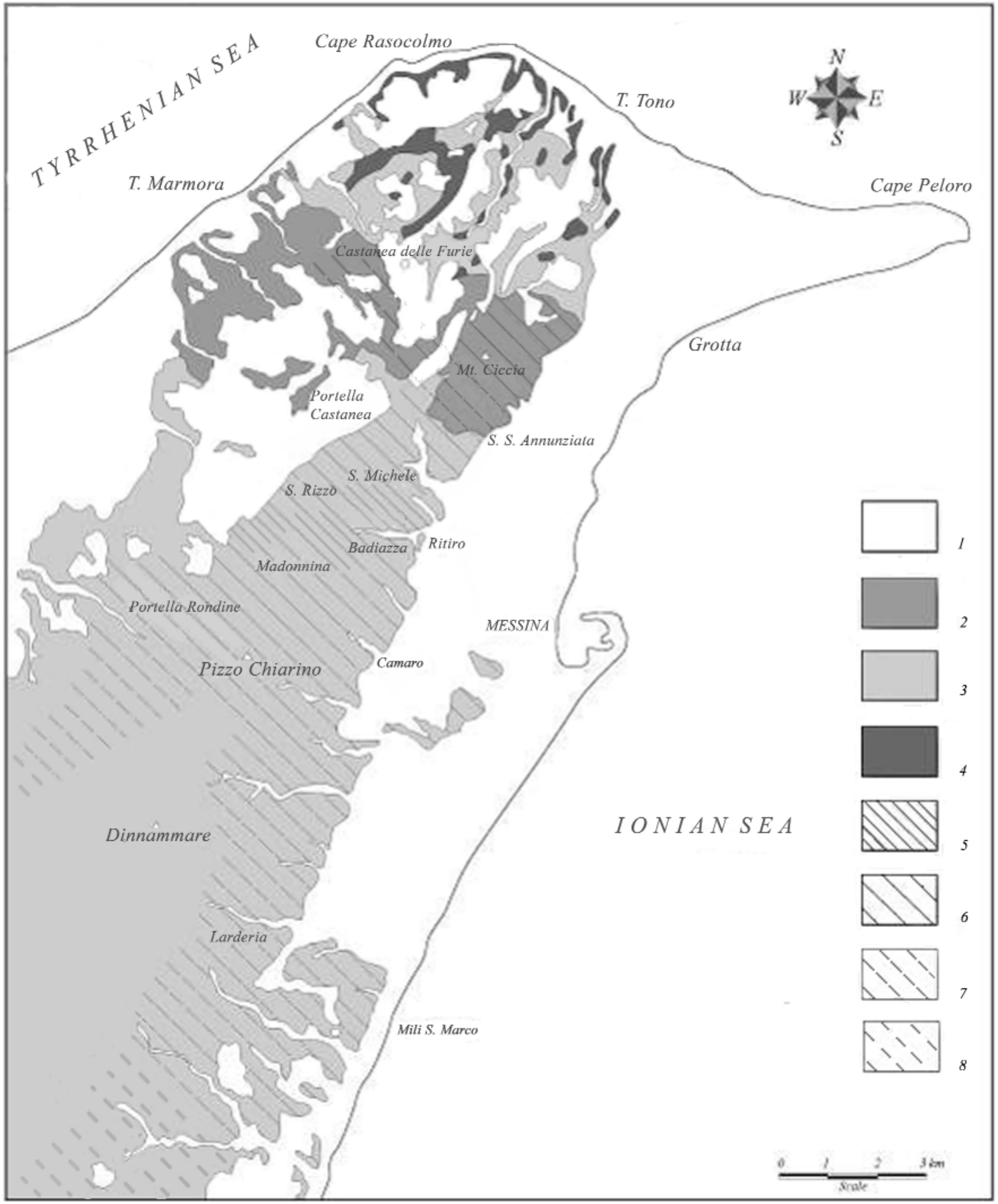


Fig. 28 - Geological sketch map of the North-Eastern Peloritani Mts..
Legend: 1. Tertiary to Quaternary deposits. 2-4. Calabria-Peloritani Arc - Aspromonte Unit: 2. Variscan augengneisses (Neo-Proterozoic-Cambrian); 3. little mobilized Variscan paragneisses and micaschists, with subordinate marbles (Palaeo-Proterozoic), gneissic amphibolites, amphibolites and relics of Pan-African metahornblendites, metapyroxenites and metaperidotites (Palaeo-Meso-Proterozoic); 4. Late-Variscan peraluminous granodiorites to leucomonzogranites (Upper Carboniferous-Permian). 5-8. Areas with the Alpine (Upper Oligocene) pervasive (5), partial (6), weak (7) and soft (8) metamorphic re-equilibration.

typified mineral phases, such as kyanite, staurolite, sillimanite, almandine, cordierite, andalusite; up to four deformative phases in the low grade rocks, where porphyroblasts of chlorite, stilpnomelane, chloritoid and biotite are present. As a whole, metamorphic processes developed under a very large range of T (around 300°C in the Capo St. Andrea and Longi-Taormina Units to 750°C in the Aspromonte Unit) and P (retrograde metamorphisms - from 1.6 GPa in the Mela Unit, or 1.2 GPa in the Aspromonte Unit; prograde metamorphisms, from 0.4 GPa in the Piraino Unit to 0.2-03 GPa in the Capo St. Andrea and Longi-Taormina Units - Messina et al., 2004b; Somma et al., 2005a, b; Carbone et al., 2008; Messina & Macaione, 2010; Carbone et al., *in press*).
The composition of plutonics indicates also a complex evolution, involving mantle magmas, mixings with anatectic crustal magmas, in addition to fractionation, assimilation and commingling processes (Messina et al., 1991a, b; Ayuso et al., 1994 and references therein).
Different in age, genesis and composition sedimentary rocks are very interesting as well, starting from Mesozoic continental clastic, carbonate platform and basinal deposits, to Upper Oligocene-Lower Miocene siliciclastic turbidites, to Middle-Upper Miocene coralgal carbonate and terrigenous covers, to Plio-Pleistocene marine and continental deposits (suggesting the high Peloritani uplift in this period), up to Modern alluvial and beach clastic sediments.

PART ONE
Stops 1-5: Aspromonte Unit

GEOLOGICAL OUTLINES

The Aspromonte Unit (AsU; Bonardi et al., 1979) extends from the homonymous massif in Calabria to the Peloritani Mts. in Sicily.
In Calabria, the unit crops out from Taureana-Antonimina to the N up to Bova Marina to the S, geometrically interposed between the overlying low to medium grade Stilo Unit (Bonardi et al., 1984; Crisci et al., 1983) and the underlying low-grade Cardeto (Bonardi et al., 1980b; Messina et al., 1996a) and Africo (Bonardi et al., 1979) Units. It is also present in the Montebello Ionico tectonic window (Southern Aspromonte Massif).
In Sicily, the AsU is the highest tectonic structural element and crops out in the northernmost part of the Peloritani Mts., N of Guidomandri-d'Orlando Cape alignment, reaching the apparent thickness of 1.000-1.200 m (Carbone et al., 2008; Carbone et al., *in press*; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008; F° 587 Milazzo - 600 Barcellona Pozzo di Gotto, *in press*).

The Unit is commonly unconformably covered by Oligocene-Miocene to Recent deposits and overlays the Mela Unit gneisses, micaschists and marbles (Messina et al., 1997, 2004b) or, rarely, the leaden Piraino Unit garnet phyllites (Messina et al., 2004b), the silvery Mandanici Unit muscovite phyllites (Atzori & Vezzani, 1974; Lentini & Vezzani, 1975), the dark Fondachelli Unit graphite phyllites, metarenites and quartzites (Bonardi et al., 1996), or the grey-violet to pinkish St. Marco d'Alunzio slates and porphyroids. The AsU crops out also in small klippen (Atzori & D'Amico, 1972; Carbone et al., 2008).

The Aspromonte Unit exhibits the most complex evolutive history of the CPA units because, lacking of Meso-Cenozoic sedimentary cover, its basement records three metamorphic and three plutonic events. Precisely, it consists of a Palaeo-Proterozoic plutonics and metamorphic lower crust affected by a Pan-African H-T granulite facies metamorphism and intruded by a Late-Pan-African orogenic peraluminous plutonic suite. This crystalline was, subsequently, interested by a Variscan L-T granulite to L-T amphibolite facies metamorphic re-equilibration, intruded by a Late-Variscan orogenic plutonic series and, locally, affected by an Alpine MH-P greenschist to M-P amphibolite facies metamorphic overprint.
The complex AsU evolution, which records Proterozoic, Palaeozoic and Meso-Cenozoic stages, is the most important theme of this geo-tour. It is documented and illustrated in the 1 to 5 Stops.
The AsU Variscan metamorphic basement is made up of plurimeter layers of paragneisses and micaschists, including meter-thick lenses of metamafics (amphibolites and gneissic amphibolites) and of relics of Pan-African metaultramafics (metaperidotites, metapyroxenites and metahornblendites), with intercalation of silicate marbles, Ca-silicate fels, quartzites, and of several kilometer in extension bodies of intermediate to acidic orthogneisses, where the augengneisses prevail. Variscan ortho- and paraderivates show localized migmatitic phenomena.
The Late-Variscan plutonic basement is composed by several stocks. They involve both syn- (only in Calabria) to post-tectonic bodies, ranging in composition from diorites (Calabria) to leucomonzogranites, and felsic to mafic dykes (the last in Calabria), which represent the latest intrusions.
The Variscan features are often masked, or completely obliterated, by the Alpine overprint, heterogeneous for intensity of deformation and re-crystallization.
The main markers of the AsU basement, not present in the other CPASS tectonic units, are: i) Pan-African metaultramafic relics (metaperidotites, metapyroxenites, metahornblendites); ii) Variscan metaplutonics (prevailing augengneisses); iii) Variscan anatectic mobilization (migmatites); iv) Late-Variscan syn-tectonic plutonics; v) up to medium grade Alpine metamorphic overprint.

GEOSITE Dinnammare

(or Antennammare - 1.127 m) - SP 50 bis

A – Geological features: Proterozoic and Palaeozoic evolution in the Aspromonte Unit basement.

A Palaeo-Meso-Proterozoic plutonic event (1500-1700 Ma, Table 1) is dated in Variscan metahornblendites (after Pan-African metahornblendites), cropping out in hectometer bodies or meter lenses inside Variscan sillimanite+almandine+staurolite+cordierite gneisses or migmatitic gneisses. Pre-Variscan Grt-metapyroxenite (Messina et al., 1996b) and metaperidotite (Messina et al., *in progress*) relics are considered coeval and more preserved. They are partly re-equilibrated in the Variscan event and some of them also in the Alpine event.

The recent data (Macaione & Messina, *submitted*; Messina et al., *in progress*) indicates that metaperidotites and metahornblendites derive from an intraplate tholeiitic mantle magma. For their colour and texture they have been used as ornamental material in religious monuments of the Messina Province, as in the lower order of Messina Cathedral façade (figs. 29-31).

Consequently, these ultramafics represent preserved rock types of a Palaeo-Meso-Proterozoic lower crustal segment originated during a geological distensive tectonic environment.

Fig. 29 - Messina Cathedral (1120, under Ruggero II's domination): a) detail of the lower order of the façade, preserving Norman-Gothic elements in spite of several restorations due to anthropic and natural calamities. Among materials of decorative covering (1320), the green stones - as slabs (1), inlays of mosaics (2), tiles of floor (3), semicolumns (4), capitals (5), blocks for steps (6) - consist of 11 metamafic and metaultramafic rock types.
They include both Aspromonte Unit Dinnammare Variscan metahornblendites (Stop 1, figs. 32 and 33) and Badiazza Valley Alpine partly re-equilibrated metahornblendites (Fig. 30) and metaperidotites (Fig. 31).

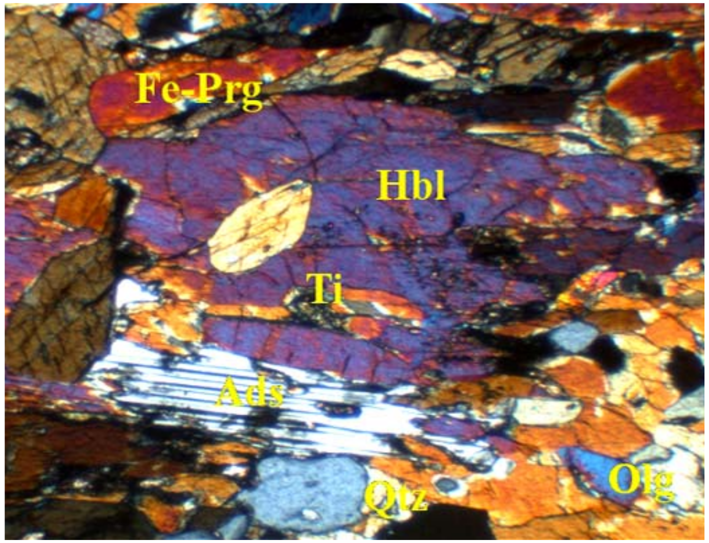
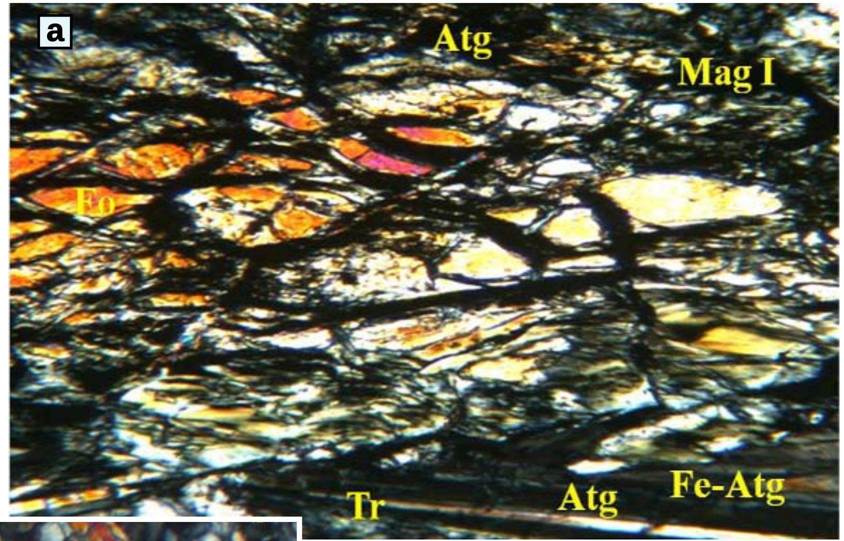


Fig. 30 - Microscopic structure: Variscan hornblende (Hbl) and twinned andesine (Ads) porphyroclasts in an Alpine matrix made up of prevalent Fe-pargasite (Fe-Prg) and rare oligoclase (Olg) and quartz (Qtz). Titanite (Ti) and zircon are the accessories (Sample ASU1B. Crossed Polarized Light, XPL, 45x).



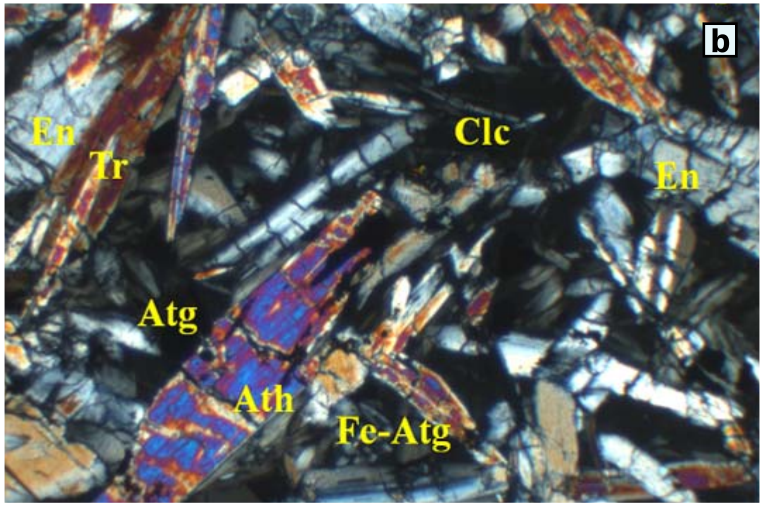


Fig. 31 - Microscopic structures: a) Pre-Variscan forsterite (Fo) relic partly replaced by Variscan antigorite (Atg), in an Alpine matrix made up of tremolite (Tr), Fe-antigorite (Fe-Atg) and clinochlore. Magnetite I (Mag I) is the accessory (Sample MRD1. XPL, 45x; after Macaione & Messina, *submitted*); b) Variscan porphyroclasts of anthophyllite (Ath) after Pre-Variscan enstatite (En), and Variscan antigorite (Atg) plagues after Pre-Variscan forsterite, in an Alpine matrix made up of tremolite (Tr), Fe-antigorite (Fe-Atg) and clinochlore (Clc). Very small magnetite II is also present (Sample ASU2A. XPL, 45x; after Messina et al., *in progress*).

A Neo-Proterozoic (600-800 Ma, Table 1) metamorphic event is also dated in the above defined Variscan metahornblendites. The thermobaric conditions of this event are indicated by the *Opx+Pl=Cpx+Ca-Grt+Qtz* reaction in metapyroxenites, developed under T=750°C and P=1.2 GPa (Messina et al., 1996b), and by the *forsterite* (Fo_{78} to Fo_{79}) – *enstatite* (En_{89} to En_{94}, with X_{Mg} between 0.93 and 0.99) – *magnetite* paragenesis in metaperidotites (Macaione & Messina, *submitted*; Messina et al., *in progress*). These petrological evidences are typical of H-T granulite facies conditions. Other records put down to this event are the very rare An_{35-45} plagioclase cores of some gneisses of the Dinnammare Mt.

Stop 1. GEOTOPE: Variscan Pl-Metahornblendite.

SP 50 bis, about 2 km from Dinnammare top (figs. 27 and 28)

Decameter outcrop of dark green, medium-grained and foliate metahornblendites (fig. 32), which at the microscale are composed of granoblastic to nematoblastic hornblende (90%), andesine/oligoclase and quartz. Accessories are titanite, zircon and magnetite (fig. 33).

As above indicated, this ultramafic rock is polymetamorphic and records the oldest Peloritani history, testifying an ancient magmatic event and two successive metamorphic processes.

Radiometric data realized on the same lithotypes cropping out at Cumia (SE of Dinnammare – in the Aspromonte Unit basement) supply 1500-1700 Ma on titanite, 600-800 Ma on dark green core of hornblendes, and 300–340 Ma on the pale green rim of the same hornblendes (Table 1; fig. 33). The first (Palaeo-Meso-Proterozoic) age is connected to the ultramafic plutonic event in a low crust. The second (Neo-Proterozoic) age is related to the Pan-African high grade metamorphic event, the third (Late Carboniferous) dates the Variscan medium-high grade metamorphic re-equilibration (low-intermediate crust), which is better registered in the metahornblendites than in the other metaultramafics.

Fig. 32 - Variscan Pl-Metahornblendite, after Palaeo-Meso-Proterozoic ultramafite.
Macroscopic structure: decameter body of Variscan medium-grained and foliate metahornblendite.
Loc.: about 2 km from Dinnammare top, North-Eastern Peloritani Mts.

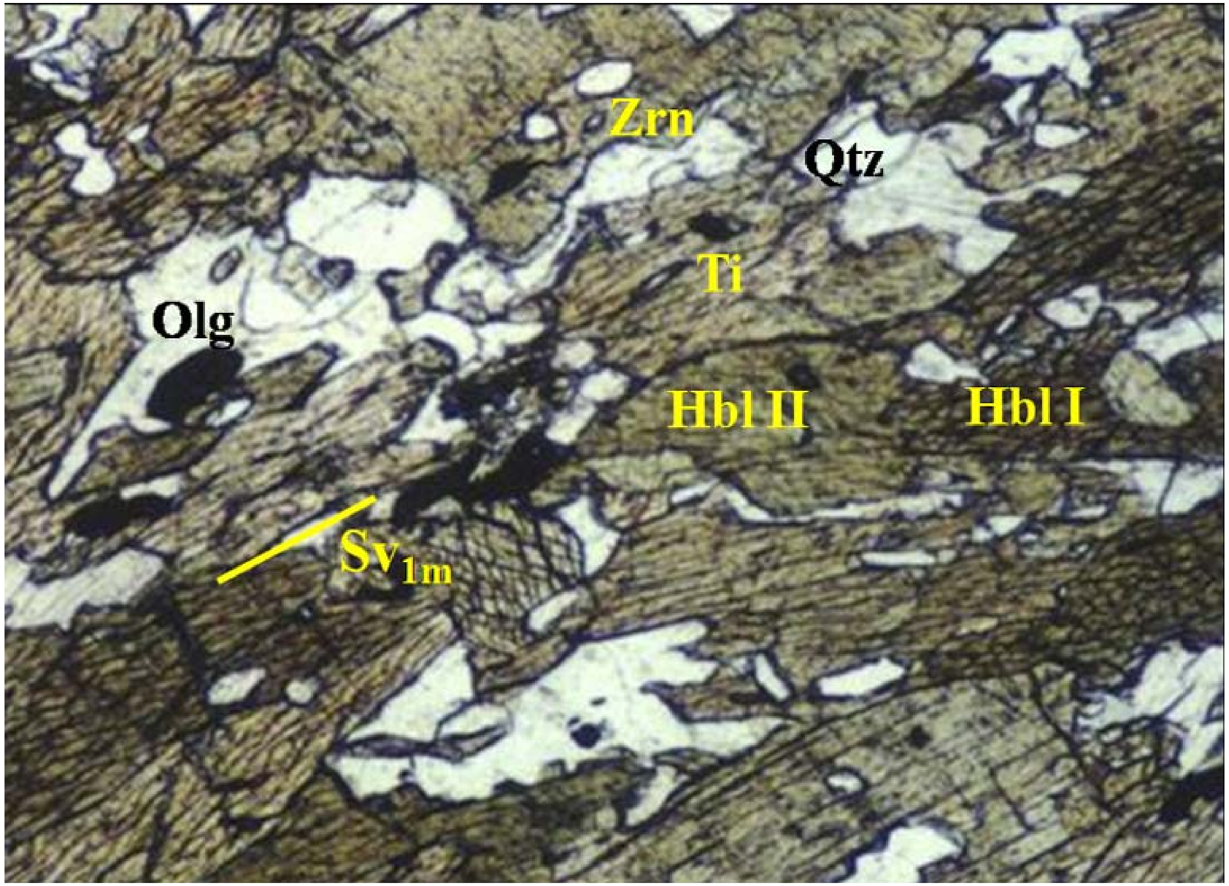


Fig. 33 - Variscan Pl-Metahornblendite.
Microscopic structure: Variscan Sv_{1m} main foliation defined by green hornblende (Hbl II) with preserved Pre-Variscan dark cores (Hbl I), minor oligoclase/andesine (An_{30-35} - Olg) and quartz (Qtz). Accessories are titanite (Ti) and zircon (Zrn). (Sample DM4. PPL, 60x; after Messina & Macaione, 2010).
Loc.: about 2 km from Dinnammare top. North-Eastern Peloritani Mts.

Several studies have been devoted to the Peloritani metamafics. Data of recent analyses on Aspromonte Unit Variscan amphibolites cropping out SW of Messina (Atzori et al., 2004) and Alpine pervasively re-equilibrated metahornblendites of the Badiazza Valley (Messina et al., *in progress*) are here reported (Tables 5 and 6; figs. 34-36). Among the amphibolites of Atzori et al. (2004): the 20 sample, more fractionated than the Badiazza Valley metahornblendites, exhibits the same within plate tholeiitic mantle magma genesis, whereas the 11 sample, which differs for Major and Trace element abundances, shows a MORB character. Tholeiitic distensive tectonic setting has been previously recognized in metamafics of other areas of Peloritani Aspromonte Unit by D'Amico et al. (1972), Gurrieri & Maccarrone (1978), Atzori et al. (1988). These Authors also identified an arc tholeiitic magma origin in not yet dated Aspromonte Unit Variscan amphibolites and amphibolitic gneisses.

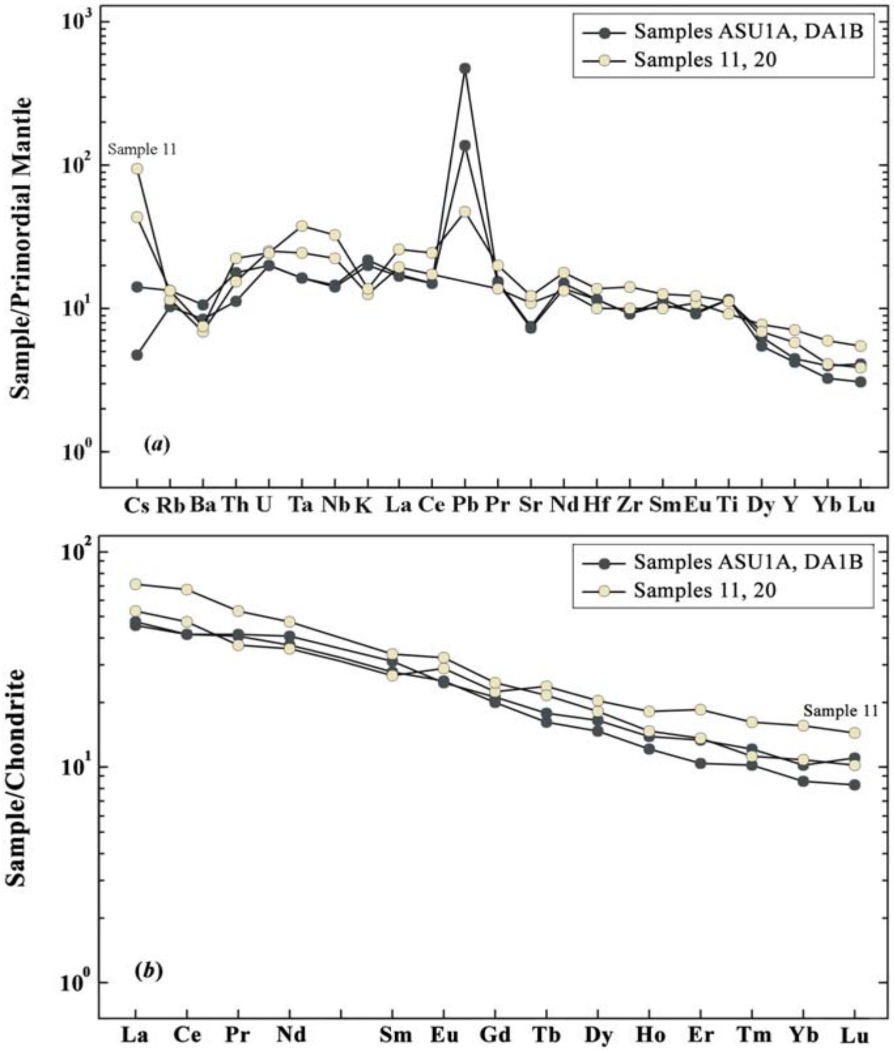


Fig. 34 - a) Primordial mantle-normalized multielement spider diagram (McDonough & Sun, 1995) and b) Chondrite-normalized REE pattern diagram (Sun & McDonough, 1989) for Aspromonte Unit metahornblendites. 11 and 20 samples, after Atzori et al. (2004); ASU1A and DA1B samples, after Macaione & Messina (*submitted*) and Messina et al. (*in progress*).

Table 5 - Representative analyses of Major Elements from Aspromonte Unit metahornblendites.

Sample	ASU1A	20
Element wt%	●	○
SiO_2	36.88	46.17
TiO_2	2.29	2.28
Al_2O_3	10.99	11.39
Fe_2O_3	13.44	12.79
MnO	0.16	0.22
MgO	9.22	11.78
CaO	17.93	10.97
Na_2O	1.15	0.81
K_2O	0.57	0.40
P_2O_5	0.13	0.26
LOI	6.90	1.66
Total	99.66	98.73

● = after Messina et al. (*in progress*);
○ = after Atzori et al. (2004)

Sample	ASU1A	20
Element ppm	●	○
Ag	0.30	<0.50
As	0.60	<5.00
Ba	56.00	49.00
Bi	0.20	0.28
Ce	25.30	40.90
Co	62.80	53.00
Cr	362.68	561.00
Cs	0.10	0.90
Cu	2.10	30.00
Dy	3.71	4.58
Er	1.73	2.27
Eu	1.45	1.86
Ga	22.00	19.00
Gd	4.09	5.07
Hf	3.30	3.90
Ho	0.68	0.83
La	10.80	16.90
Lu	0.21	0.26
Mo	0.20	<2.00
Nb	9.20	21.60
Nd	17.30	22.30
Ni	34.30	298.00
Pb	20.80	7.00
Pr	3.82	5.00
Rb	6.10	8.00
Sb	<0.10	0.20
Sm	4.27	5.10
Sn	2.00	6.00
Sr	145.60	241.00
Ta	0.60	1.40
Tb	0.61	0.81
Th	0.90	1.79
Tl	<0.10	0.13
Tm	0.26	0.29
U	0.40	0.49
V	404.00	323.00
W	1.20	7.00
Y	18.10	24.60
Yb	1.45	1.82
Zn	31.00	99.00
Zr	97.30	150.00

● = after Messina et al. (*in progress*);
○ = after Atzori et al. (2004)

Table 6 - Representative analyses of Trace and Rare Earth Elements from Aspromonte Unit metahornblendites.

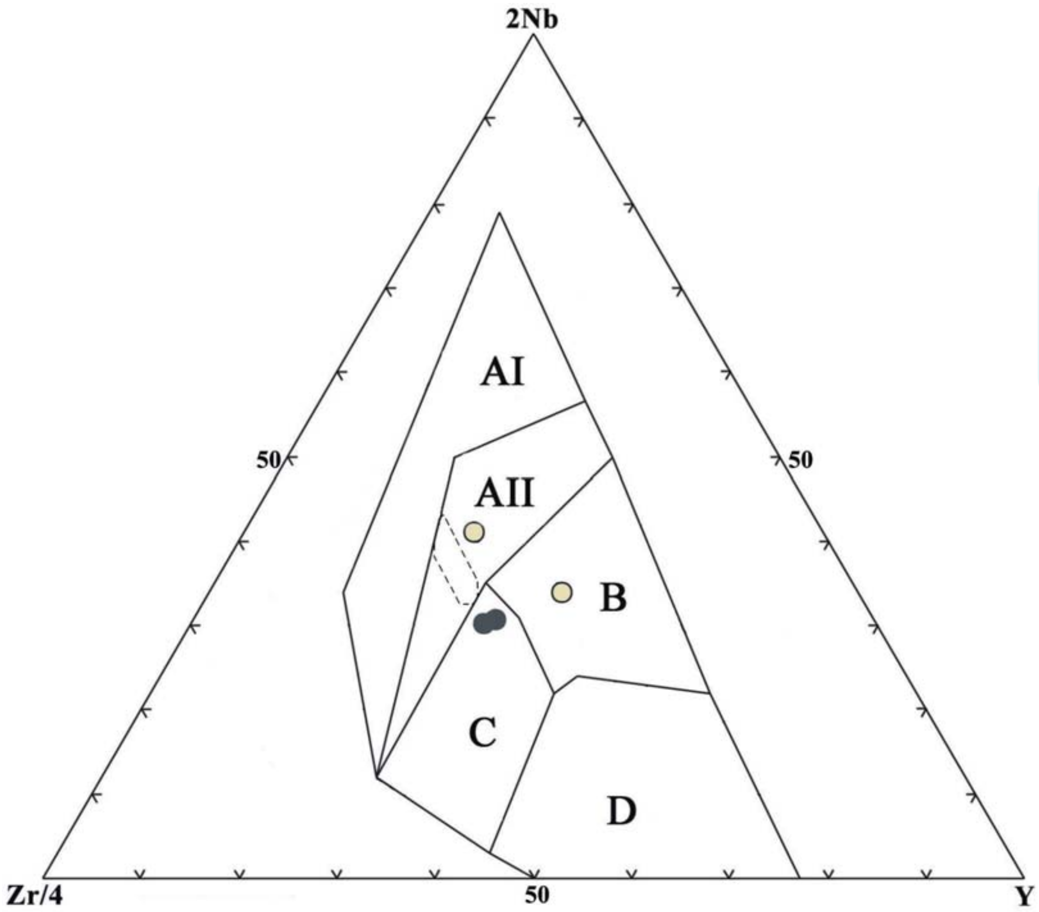
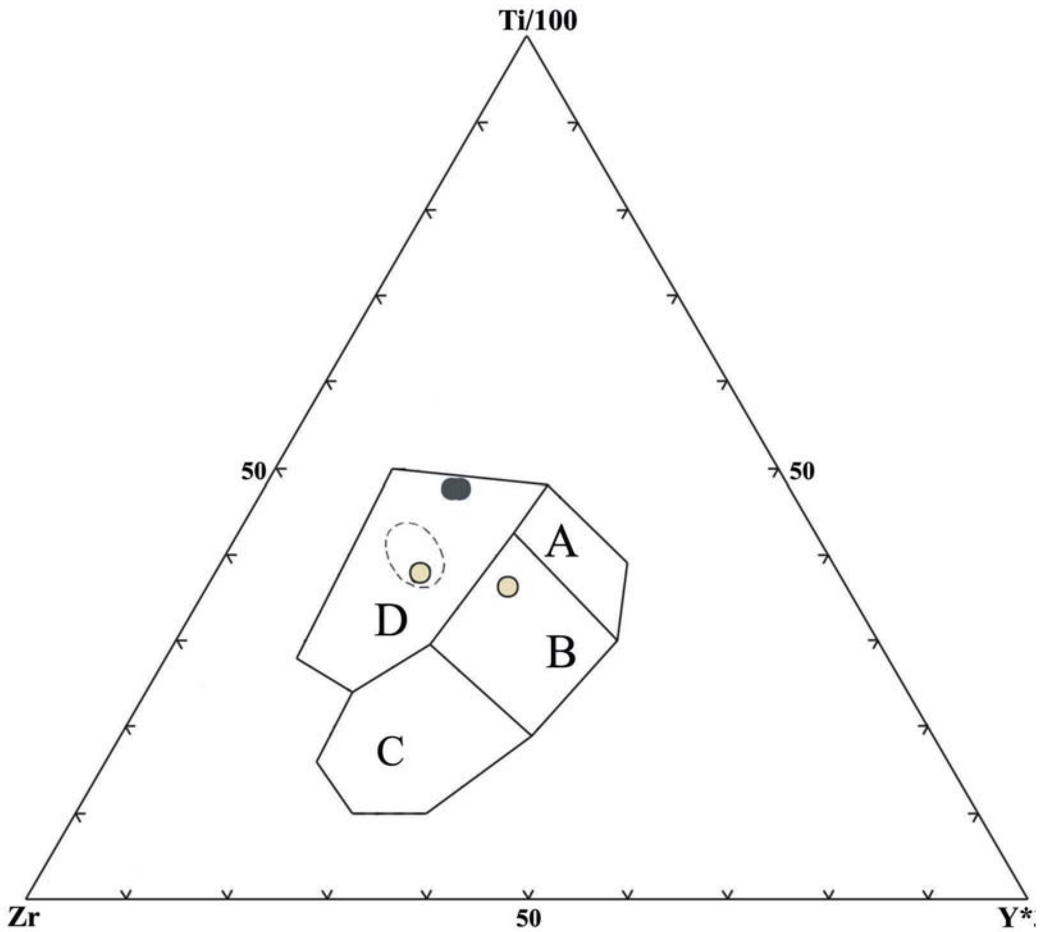


Fig. 35 - 2Nb-Zr/4-Y diagram for Aspromonte Unit metahornblendites (symbols as in fig. 34). In the dashed line area Aspromonte Unit metaperidotites (Messina et al., *in progress*) plot. Legend (Meschede, 1986): AI = Within Plate Alkaline Basalts; AII = Within Plate Alkaline Basalts, Within Plate Tholeiites; B = E-type MORB; C = Within Plate Tholeiites, Volcanic Arc Basalts; D = N-type MORB.

Fig. 36 - Ti/100-Zr-Y*3 diagram for Aspromonte Unit metahornblendites (symbols as in fig. 34). In the dashed line area Aspromonte Unit metaperidotites (Messina et al., *in progress*) plot. Legend (Pearce & Cann, 1973): A = Island Arc Tholeiites; B = MORB; C = Calc-Alkaline Basalts; D = Within Plate Basalts.



B - Geological features: Palaeozoic evolution in the Aspromonte Unit basement.

A Late Carboniferous metamorphic event, related to the Variscan Orogenesis and present in all the CPA basements, is dated 300-340 Ma in the AsU amphibolites of the Peloritani Mts. and 314 Ma in the AsU paragneisses of the Aspromonte Massif (Table 1). It affected Pre-Variscan metamorphics and plutonics, originating a polyphasic (Dv_1-Dv_3, only Dv_1 accompanied by metamorphism) and plurifacial Bosost type-metamorphism, responsible for a ML-P retrograde process, articulated in four zones. In the highest in grade zone, the Variscan metamorphism developed at T=680°C and P=0.5 GPa (thermobaric peak) in biotite-sillimanite-K-feldspar-garnet-cordierite granulite-amphibolite facies transition; in the lowest in grade zone it occurred under T=550°C and P<0.3 GPa, typical of the beginning of oligoclase-staurolite-andalusite amphibolite facies conditions (Messina et al., 1996a, 2004a, b; Carbone et al., 2008; Messina & Macaione, 2010).
Thus the Variscan Aspromonte Unit metamorphic basement consists of high to medium grade para- and orthoderivates, that locally show variable effects of anatectic mobilization and are characterized, at meso- and microscale, by a Sv_{1m} main foliation not very crenulated. The migmatitic process, which originates flebitic-stromatitic to nebulitic structures, is well evident along Sinopoli-Bagnara-Scilla (Calabria)-Rasocolmo Cape (Dinnammare)-Milazzo-Calavà Cape (Sicily) alignment (fig. 25).

Stop 2. GEOTOPE: Variscan little mobilized Paragneisses and Gneissic micaschists.

The Dinnammare top (1.127 m) (figs. 27 and 28)

Kilometer in extension outcrop of Variscan little mobilized paragneisses, passing to gneissic micaschists going to the geometrically lower position of area (figs. 37-39), defines the most elevated zone of Dinnammare Mount. These lithotypes are crossed by discordant Late-Variscan aplo-pegmatitic dykes and cut by Plio-Pleistocene fault systems.
The Dinnammare top, that constitutes the extreme NE limit of the Peloritani Ridge, dominates the whole Territory (figs. 2 to 5). Spectacular landscapes are typified by the presence of the Tyrrhenian Sea, the Milazzo Peninsula and the Aeolian Islands to NW; the Calabrian Scilla to Pizzo Coast to NE; the scenic Messina Straits with the Calabrian Scilla to Reggio Calabria Coast to E; the Sicilian Messina to Taormina Coast to SE. The Montagna Grande-Dinnammare Ridge also represents the last Sicilian tract of the *Sentiero Italia,* which connects the Northern Africa to the Central Europe. It corresponds to a cultural itinerary along ancient routes, mainly on the Ridge, characterized by very important geological-historical-artistic-anthropological traits.

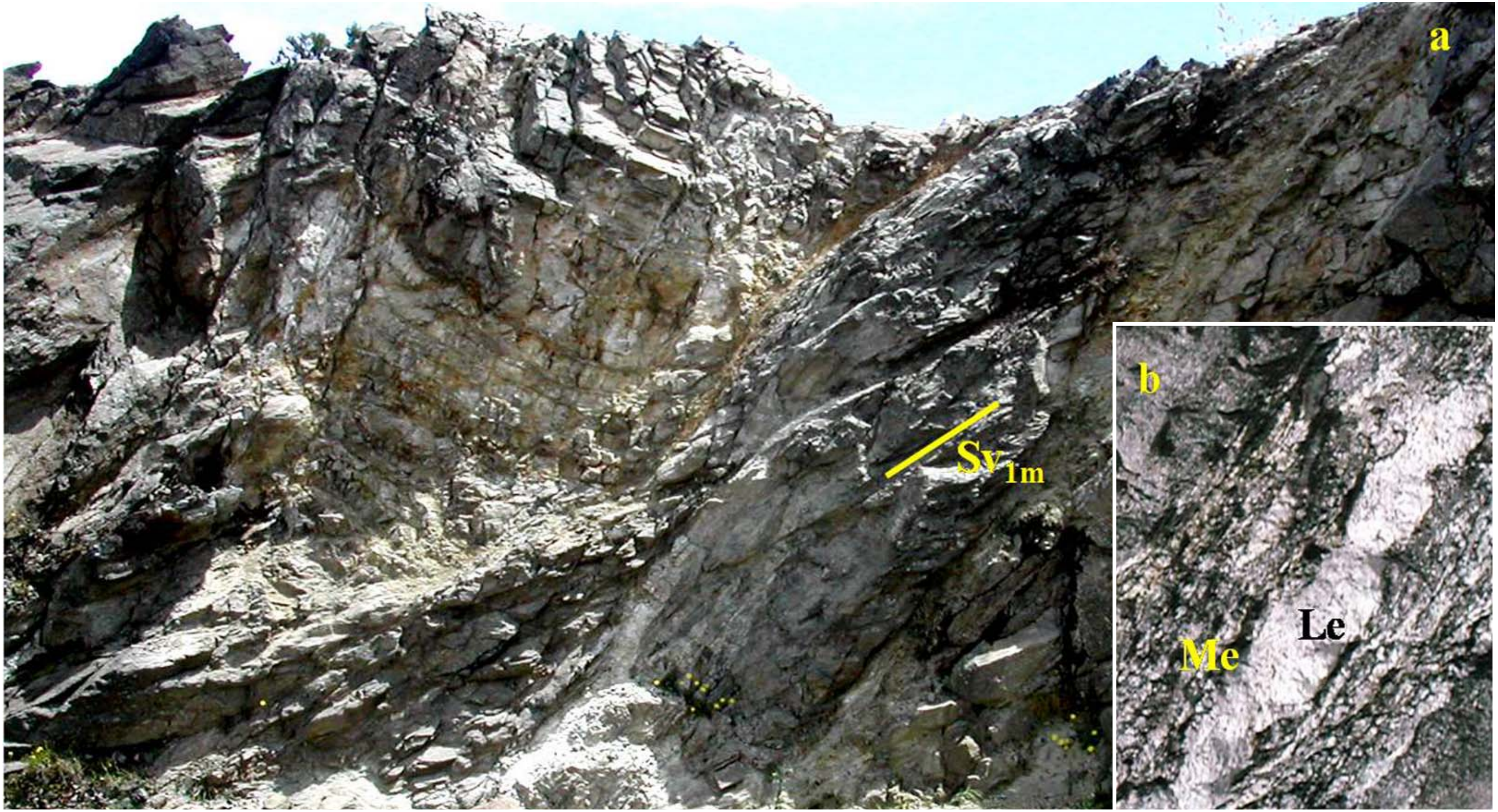


Fig. 37 - Variscan little mobilized Paragneisses crossed by discordant Late-Variscan Aplo-pegmatitic dykes and cut by Plio-Pleistocene fault systems.
Macroscopic structure: detail of kilometer levels of paragneisses (a) showing oriented (Sv_{1m}) texture and localized little mobilized leuco- (Le) and melanosomatic (Me) layers (b). The paragneisses are cut by Late-Variscan pegmatites. A diffuse Alpine cataclasis, emphasized by Plio-Pleistocene faults, is also present.
Loc.: Dinnammare top. North-Eastern Peloritani Mts.

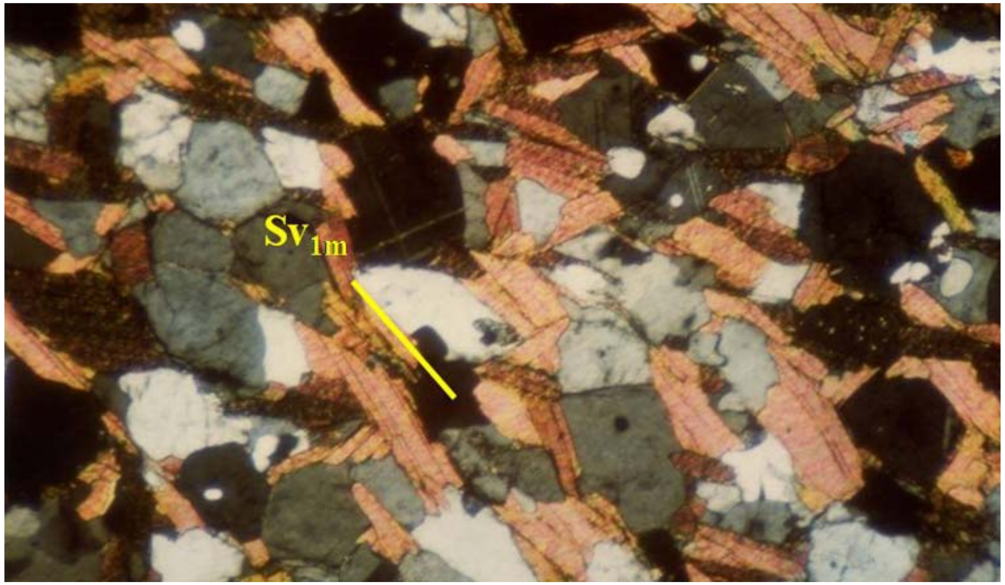


Fig. 38 - Variscan biotite Paragneiss.
Microscopic structure: not very oriented, along the Sv_{1m} main foliation, granoblastic to polygonal quartz and oligoclase, isolated to decussate biotite. (Sample Map 18. XPL, 40x).
Loc.: Dinnammare top. North-Eastern Peloritani Mts.

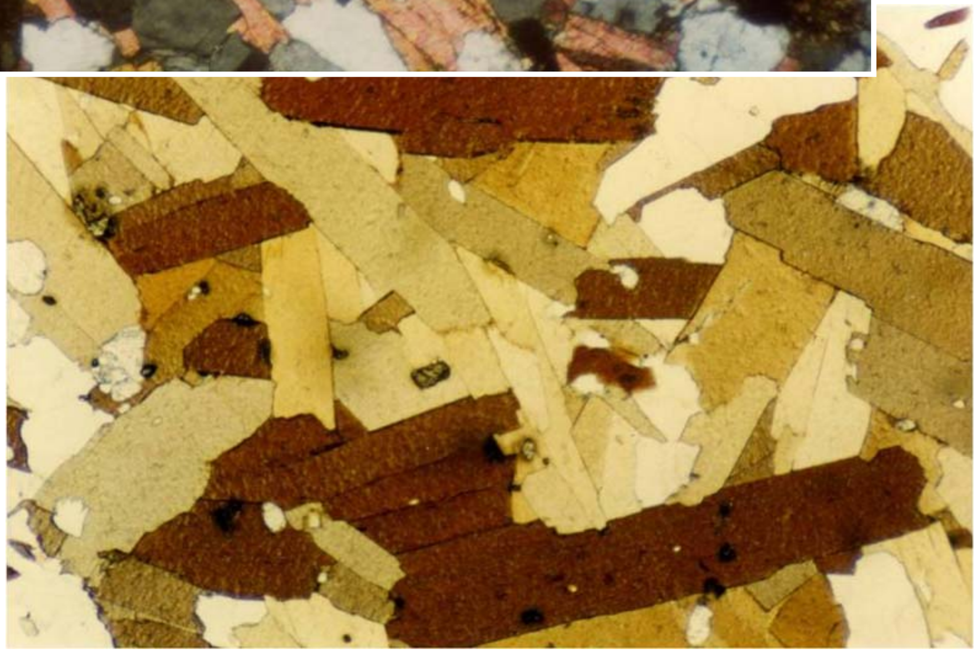


Fig. 39 - Variscan Melanosome.
Microscopic structure: detail of a decussate post-Dv_1 biotite melanosomatic level, in a Variscan mobilized biotite paragneiss. (Sample Map 20. PPL, 60x).
Loc.: Dinnammare top. North-Eastern Peloritani Mts.

The Dinnammare top paragneisses exhibit grey colour, medium-grained and foliate texture defined by the little crenulated main foliation Sv_{1m}. The localized anatectic mobilization originated centimeter-thick leucosomatic quartz-oligoclase veins and thin melanosomatic levels (figs. 37b and 39). Going to the base of the mount, in an area of about 5 kilometers from top including the Stop 1, paragneisses pass to gneissic micaschists. At the microscale they are characterized by the presence of sillimanite+garnet+staurolite+andalusite± cordierite (figs. 40 and 45).
These rocks are interpreted as Pan-African (Neo-Proterozoic) granulites, pervasively re-equilibrated in amphibolite facies conditions during the Variscan age (Late Carboniferous), originating a retrograde zoning. Their protoliths must be older or coeval to the plutonic magmatism of the above defined metaultramafics (Palaeo-Meso-Proterozoic).

Fig. 40 - Variscan sillimanite+garnet+staurolite+andalusite Gneissic micaschist.
Microscopic structure: detail of intergrowth of a syn-kinematic fribolite (Sill) and biotite (Bt) dominion, developing along the Sv_{1m} foliation. (Sample Map 28. PPL, 60x).
Loc.: about 3 km from Dinnammare top. North-Eastern Peloritani Mts.

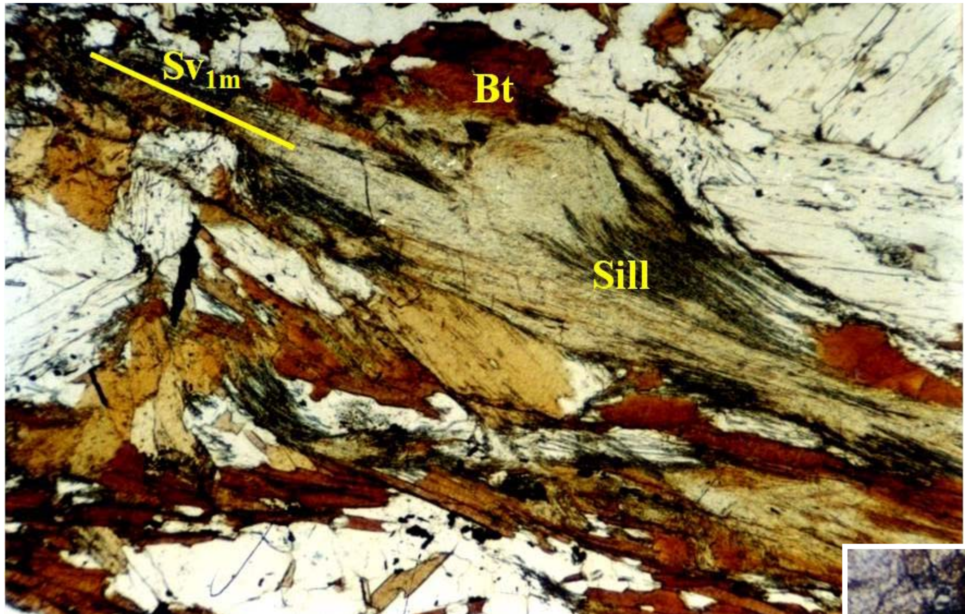
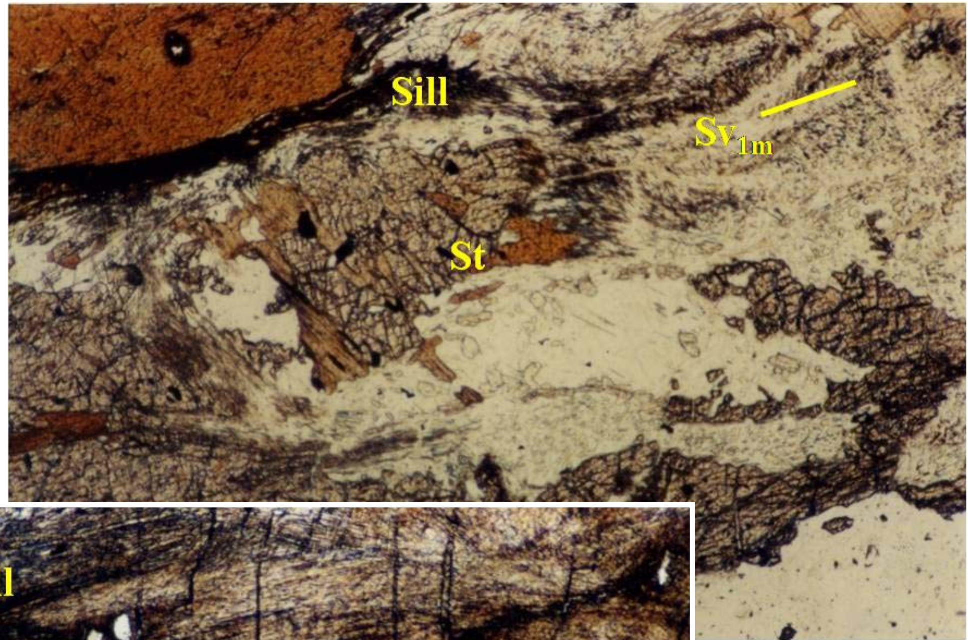


Fig. 41 - Variscan sillimanite+garnet+staurolite+andalusite Gneissic micaschist.
Microscopic structure: detail of late-Dv_1 staurolite (St) growing on syn-Dv_1 fibrolite (Sill) and biotite dominions. (Sample Map 28. PPL, 60x).
Loc.: about 3 km from Dinnammare top. North-Eastern Peloritani Mts.



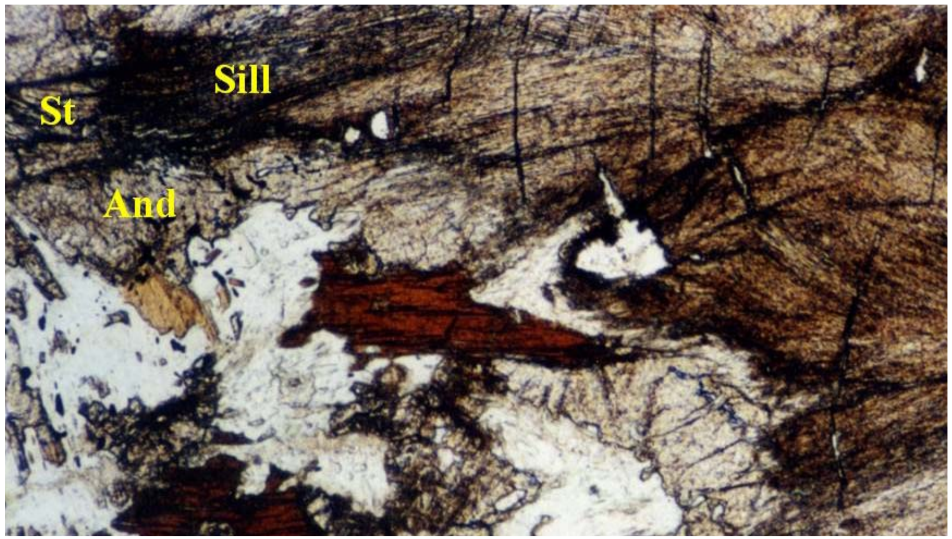


Fig. 42 - Variscan sillimanite+garnet+staurolite+andalusite Gneissic micaschist.
Microscopic structure: detail of relationship among sillimanite (Sill), staurolite (St) and andalusite (And). The last mineral exhibits a post-Dv_1 growth at the expense of the first two, syn- and late-Dv_1, minerals, respectively. (Sample Map 28; PPL, 60x).
Loc.: about 3 km to Dinnammare top. North-Eastern Peloritani Mts.

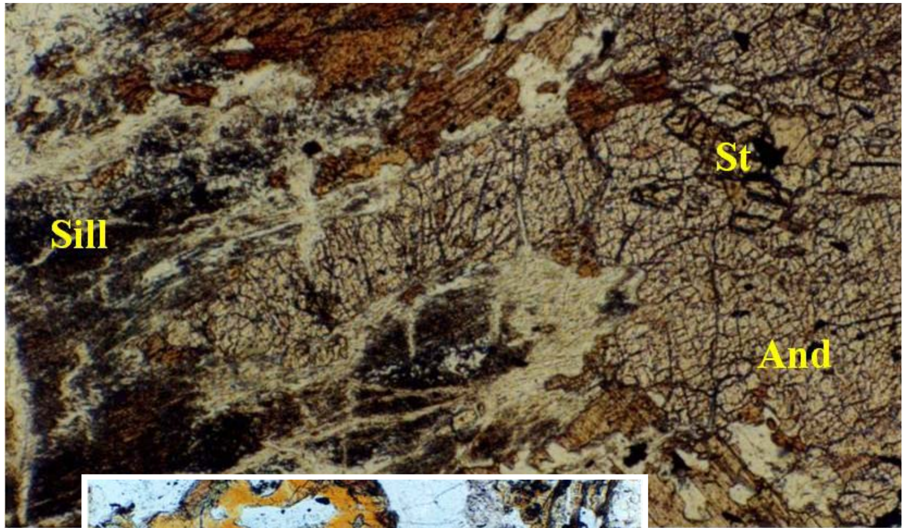


Fig. 43 - Variscan sillimanite+garnet+staurolite+andalusite Gneissic micaschist.
Microscopic structure: centimeter porphyroblastic andalusite (And) growing at the expense of syn- to late-Dv_1 sillimanite (Sill) and late-Dv_1 staurolite (St). (Sample Map 22. PPL, 60x).
Loc.: about 3 km from Dinnammare top. North-Eastern Peloritani Mts.

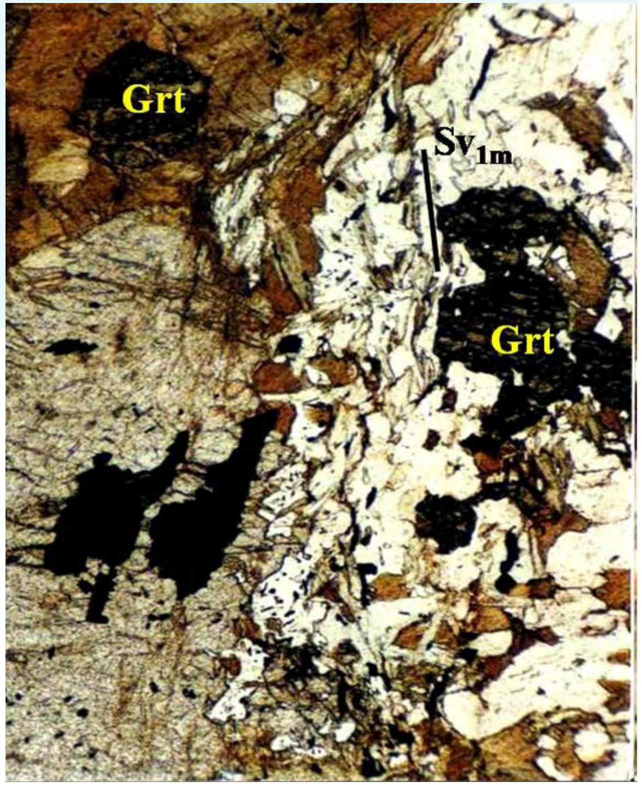


Fig. 44 - Variscan sillimanite+garnet+staurolite+andalusite Gneissic micaschist.
Microscopic structure: quartz, oligoclase, biotite and muscovite developing along the Sv_{1m} foliation. The static rim of syn- to post-Dv_1 garnet (Grt) grows after syn-kinematic biotite. (Sample Map 28. PPL, 60x).
Loc.: about 3 km from Dinnammare top. North-Eastern Peloritani Mts.

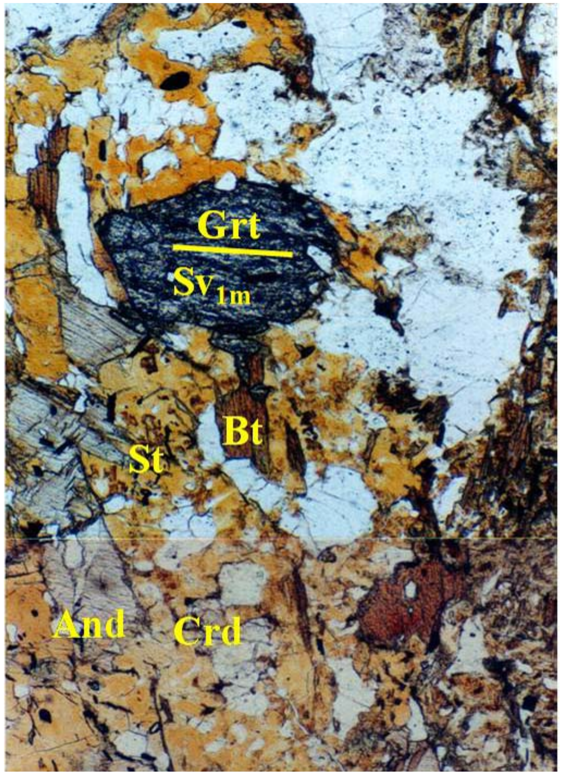


Fig. 45 - Variscan garnet+staurolite+andalusite+cordierite Gneissic micaschist.
Microscopic structure: post-Dv_1 andalusite (And) and later, altered, cordierite (Crd) plagues, develop at the expense of almost obliterated late-Dv_1 staurolite (St) and syn- to late-Dv_1 biotite (Bt). The garnet (Grt) preserves the Sv_{1m} foliation. Its post-Dv_1 rim grows at the expense also of cordierite. (Sample Map 27. PPL, 60x).
Loc.: about 5 km from Dinnammare top. North-Eastern Peloritani Mts.

Table 7 - Representative mineral data and structural formulae of biotite from Aspromonte Unit Variscan gneissic micaschists.

Mineral	BIOTITE		
Sample Site	Map 28 □	Map 27 +	M17 ◊
SiO_2	35.64	36.08	34.94
TiO_2	1.22	1.56	1.58
Cr_2O_3	0.03	0.01	0.03
Al_2O_3	19.84	19.21	19.36
Fe_2O_3	4.63	1.88	0.99
FeO	14.43	16.68	18.70
MnO	0.04	0.04	0.03
MgO	11.05	10.88	9.55
CaO	0.04	0.01	0.04
Na_2O	0.11	0.16	0.26
K_2O	7.48	9.09	9.18
H_2O	4.01	4.00	3.92
Total	98.52	99.60	98.58
Cations calculated on the basis of 11 oxygens and 6 cations +Na+K+Ca			
Si	2.668	2.704	2.675
Ti	0.069	0.088	0.091
Cr	0.002	0.001	0.002
Al	1.750	1.697	1.747
Fe^{3+}	0.261	0.106	0.057
Fe^{2+}	0.903	1.046	1.197
Mn	0.003	0.003	0.002
Mg	1.233	1.216	1.090
Ca	0.003	0.001	0.003
Na	0.016	0.023	0.039
K	0.714	0.869	0.897
OH	2.000	2.000	2.000
X_{Mg}	0.577	0.538	0.476
$Al^{(IV)}$	1.332	1.296	1.325
$Al^{(VI)}$		0.401	0.422

□ = core and + = rim of syn-kinematic lamina;
◊ = post-kinematic lamina

Some new representative mineral chemistry data of biotite, garnet, white mica and staurolite from Dinnammare Variscan gneissic micaschists are here reported, as a contribution to the knowledge of the petrological aspects of this selected Aspromonte Unit area (Tables 7 to 9 and figs. 46-48).

Analyses were determined by a SEM Cambridge Instruments Stereoscan 360 equipped with an EDS Oxford Instruments Energy 200, at the Department of Mineralogical and Petrological Sciences, University of Turin (Italy). Operating conditions were: 15 kV accelerating voltage, 2.59 Å beam current, and 50 s counting time. SEM-EDS quantitative data (spot size = 2µm) were acquired and processed using the Microanalysis Suite Issue 12, INCA Suite version 4.01; the raw data were calibrated on natural mineral standards and the $\Phi\rho Z$ correction (Pouchou & Pichoir, 1988) was applied. Structural formulae were processed using the software of Ulmer (1986), with the exception of staurolite (46 oxygen anhydrous basis with total iron as FeO). X_{Mg} corresponds to $Mg/Mg+Fe^{2+}$.

Biotite (Table 7; fig.46) shows annite-phlogopite composition, with Al^{IV} ranging from 1.19 to 1.35 (a.p.f.u.) and Ti from 0.07 to 0.12 (a.p.f.u.). Differences exist between syn- and post-kinematic laminae: the former have higher Mg cores (X_{Mg} = 0.54-0.58) and the latter are richer of Fe contents (X_{Mg} = 0.48-0.54).

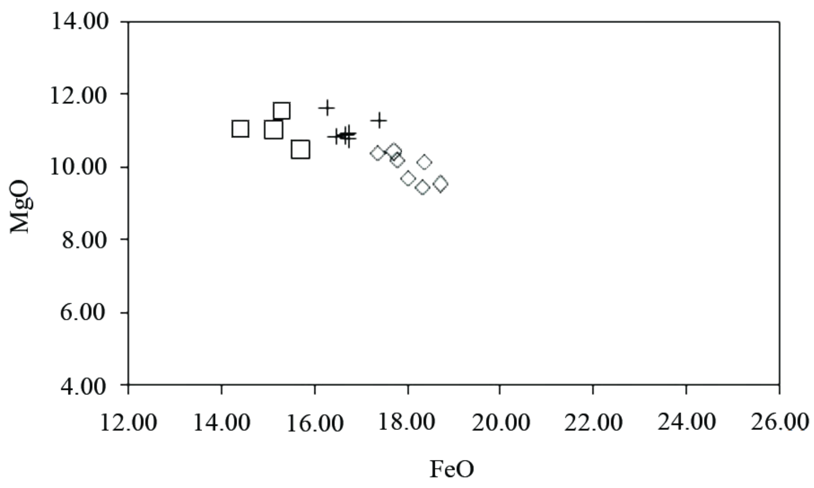


Fig. 46 - MgO vs FeO diagram of biotite from Aspromonte Unit Variscan gneissic micaschists. Legend as in Table 7.

Table 8. Representative mineral data and structural formulae of garnet from Aspromonte Unit Variscan gneissic micaschists.

Mineral	GARNET		
Sample	Map 27	Map 28	M17
Site	□	+	○
SiO_2	36.49	37.22	36.03
TiO_2	0.00	0.01	2.06
Cr_2O_3	0.00	0.01	0.02
Al_2O_3	21.46	22.02	21.61
Fe_2O_3	1.38	0.31	0.13
FeO	31.02	32.95	35.81
MnO	7.63	4.99	3.17
MgO	2.05	2.30	2.75
CaO	0.96	1.86	0.79
Na_2O	0.00	0.00	0.00
K_2O	0.00	0.01	0.00
Total	100.99	101.68	102.37
Cations calculated on the basis of 12 oxygens			
Si	2.940	2.959	2.861
Ti	0.000	0.001	0.123
Cr	0.000	0.001	0.001
Al	2.038	2.063	2.023
Fe^{3+}	0.083	0.019	0.008
Fe^{2+}	2.090	2.190	2.378
Mn	0.521	0.336	0.213
Mg	0.246	0.273	0.326
Ca	0.083	0.158	0.067
Na	0.000	0.000	0.000
K	0.000	0.001	0.000
X_{Mg}	0.105	0.111	0.120
$Al^{(IV)}$	0.060	0.041	0.139
$Al^{(VI)}$	1.977	2.022	1.884

□ = syn-kinematic core;
+ = late-kinematic intermediate zone;
○ = post-kinematic rim

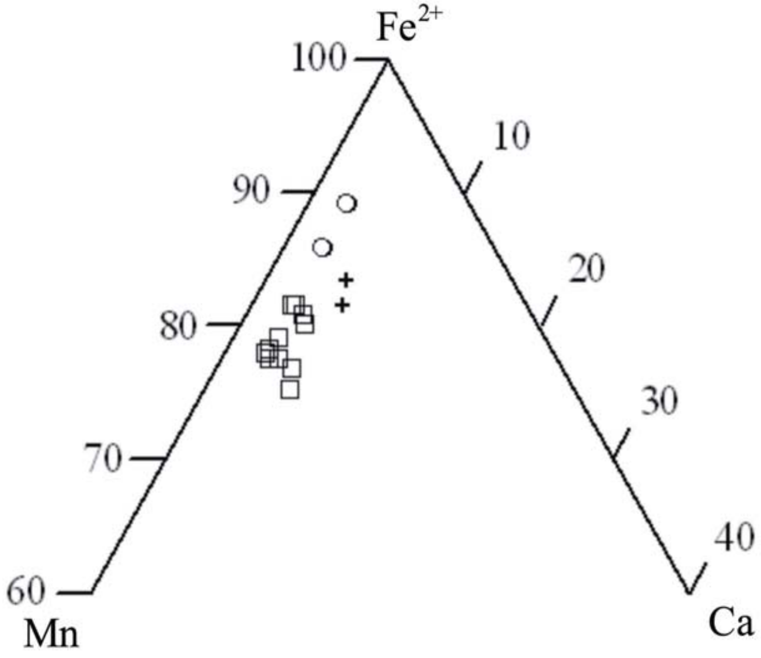


Fig. 47 - Fe^{2+}-Mn-Ca diagram of garnet from Aspromonte Unit Variscan gneissic micaschists. Legend as in Table 8.

Garnet (Table 8; fig. 47), that exhibits syn- to post-Dv_1 growth, has an almandine composition, with a slight increase of Fe and Mg contents from Mn-rich cores (lowest Fe = 2.08, a.p.f.u., and X_{Mg} = 0.09), to intermediate zones (Fe = 2.12-2.19, a.p.f.u.; X_{Mg} = 0.10-0.11), up to rims (highest Fe = 2.38, a.p.f.u., and X_{Mg} = 0.12).

White mica (Table 9; fig. 48), growing in syn- to post-kinematic laminae, independently of different structural sites, is a muscovite (Si = 2.98-3.04, a.p.f.u. and Fe^{2+}+Mg = 0.04-0.06, a.p.f.u.).

Staurolite, that shows a late-kinematic crystallization often appearing almost completely reabsorbed, is very rich in Fe-endmembers exhibiting Fe/(Fe+Mg) = 0.67 (not reported analyses).

For the analyzed area, all data indicate a Bosost-type amphibolite facies metamorphism. It is characterized by a thermobaric peak realized during the late-Dv_1, in the sillimanite-Fe-almandine(intermediate zone)-Fe-staurolite stability field, in presence of muscovite which constrains the baric and thermal limits, not higher than 0.3-0.4 GPa (Wm with Si = 2.98-3.04) and 650°C (minimum melt limit), respectively. Temperature is not lower than 560°C,

Table 9 - Representative mineral data and structural formulae of white mica from Aspromonte Unit Variscan gneissic micaschists.

Mineral	WHITE MICA		
Sample	Map 28	Map 27	M93
Site	△	△	△
SiO_2	44.74	45.13	45.77
TiO_2	0.62	0.76	0.08
Cr_2O_3	0.02	0.04	0.02
Al_2O_3	36.71	36.07	36.43
Fe_2O_3	1.03	1.13	0.99
FeO	0.00	0.00	0.00
MnO	0.00	0.01	0.02
MgO	0.51	0.56	0.48
CaO	0.00	0.01	0.00
Na_2O	0.82	0.93	0.79
K_2O	10.54	9.97	10.61
H_2O	4.50	4.49	4.51
Total	99.49	99.11	99.70
Cations calculated on the basis of 11 oxygens and 6 cations +Na+K+Ca			
Si	2.982	3.011	3.043
Ti	0.031	0.038	0.004
Cr	0.001	0.002	0.001
Al	2.884	2.836	2.854
Fe^{3+}	0.052	0.057	0.050
Fe^{2+}	0.000	0.000	0.000
Mn	0.000	0.001	0.001
Mg	0.051	0.056	0.048
Ca	0.000	0.001	0.000
Na	0.106	0.120	0.102
K	0.896	0.848	0.900
OH	2.000	2.000	2.000
X_{Mg}	1.000	1.000	1.000
$Al^{(IV)}$	1.018	0.989	0.957
$Al^{(VI)}$	1.865	1.847	1.897

△ = large lamina

representing the low limit of sillimanite field at the defined pressure. Metamorphism continues with a very slight decrease of temperature and pressure, according to the post-kinematic andalusite crystallization.
The thermobaric conditions define a specific metamorphic zone (third zone). It is different from that characterizing the near Dinnamare top migmatitic zone (second zone) cropping out, in continuity, going North.

Besides, the gneissic micaschist Map 27 (fig. 45), collected in the southern versant of Dinnammare Mount, about 5 km from the top, is typical, of the fourth zone. It is characterized by the absence of sillimanite and the presence of static cordierite.
In this zone the amphibolite facies metamorphic process realized below the sillimanite stability field, according to both staurolite-garnet-oligoclase late-kinematic association (thermobaric peak) and andalusite-cordierite-garnet rim post-kinematic paragenesis.

The highest in grade Variscan L-T granulite zone (first zone), characterizing the Scilla – Palmi area in Calabria, is present in small outcrops in the Northern Peloritani Mts..

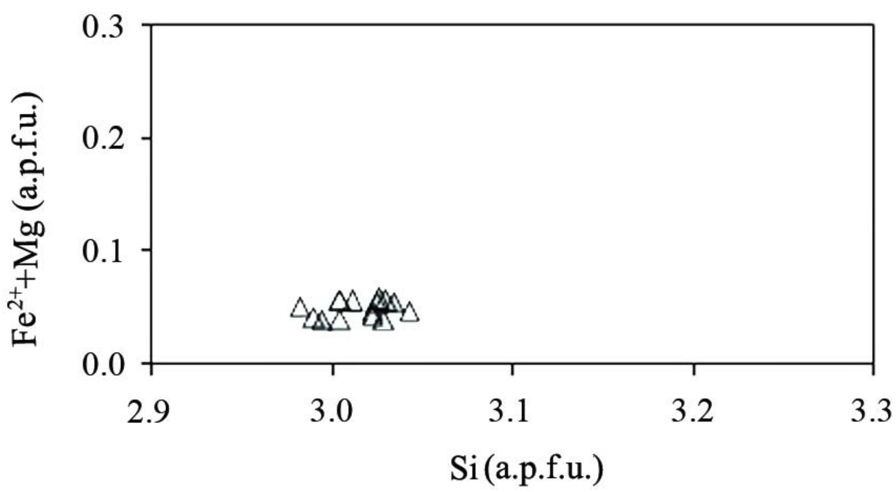


Fig. 48 - Fe^{2+}+Mg vs Si diagrams of white mica from Aspromonte Unit Variscan gneissic micaschists. Legend as in Table 9.

GEOSITE - NE of Pizzo Chiarino (841 m) SP 50 bis; Ferraro Fort – Badiazza Valley Area

Geological features: Palaeozoic and Meso-Cenozoic evolution in the Aspromonte Unit basement.

The Late Oligocene (22-28 Ma, Table 1) metamorphic event, correlated to the Alpine orogenesis, was responsible for a complex tectogenesis.
Widespread meter- to kilometer-thick shear zones, which locally interested both metamorphic and plutonic rocks, produced brittle to ductile deformations. They were responsible for cataclastic to mylonitic phenomena, with variable grade of grain-size reduction and retrocession of minerals up to localized metamorphic re-equilibrations.
In the interested areas, the Alpine overprint gradually increases going to the lowermost parts of the Unit. It proceeds from softly re-crystallized rocks with abundant Variscan mineral relics, to pervasively restructured types, where only some garnet core and/or feldspar relics are preserved, originating four zones at different grade (soft, weak, partial, pervasive) of re-equilibration. These zones locally show a gradual transition: about 100 km around Polsi, in Calabria, and 20 km around Badiazza Valley, in Sicily (Bonardi et al., 1992, 1996, 2008; Messina et al., 1990, 1992, 1996a, 2004a, b; Platt & Compagnoni, 1990; Messina & Macaione, 2010).

In the geometrically lowermost portions of the Unit (Polsi area in Calabria and Badiazza Valley in Sicily), the pervasive re-equilibration was originated by five deformative phases (Da_1-Da_5), three of which accompanied by metamorphism, developed in two different stages.
During syn- to post-Da_1 first stage, MH-P minerals developed at the expense of Variscan mineral phases, such as quartz, albite or paragonite (after Variscan plagioclase), phengite (after biotite), kyanite (after sillimanite), chloritoid (after staurolite), Fe-Ca-almandine (after garnet, biotite, plagioclase and magnetite), pargasite (after biotite and plagioclase), ripidolite (after biotite), zoisite (after plagioclase). This metamorphic stage realized under P=0.8-0.7 GPa (baric peak) and T=500±20°C, typical of greenschist facies almandine-kyanite-chloritoid zone (Messina et al., 1990, 1992; Messina & Macaione, 2010).
The Da_2-Da_3 second stage was responsible for the Sa_2 main foliation and the Sa_3 foliation, both accompanied by the re-crystallization of quartz and growth of lower P and relative higher T minerals, such as oligoclase, biotite (after Variscan biotite, and Alpine phengite or ripidolite), low celadonitic content white mica and clinozoisite.

These minerals show syn- to post-Da_2 and Da_3 crystallization, while chloritoid, amphibole, kyanite and garnet continue to be stable. Garnet exhibits a syn-Da_1 to post-Da_3 crystallization.
The syn-Da_2 to post-Da_3 crystallization occurred at P between 0.5 and 0.4.GPa and T>550°C (thermal peak), conditions typical of the beginning of amphibolite facies.
Da_4 produced a crenulation of previous foliations and Da_5 shear planes.

In the other zones preserving Variscan minerals, the re-equilibration is characterized by the same number of deformative phases. It realized at different thermobaric conditions, that decrease from partly to weakly, up to softly overprinted rocks. During the two stages, the re-crystallization was accompanied by the same above defined minerals, changed in composition. Only kyanite disappears in the two last zones, because they originated at P lower than 0.5 GPa.

Stop 3. GEOTOPE: Variscan Gneisses and Late-Variscan Plutonics affected by an Alpine pervasive metamorphic re-equilibration.

At the beginning of this Stop, Alpine pervasively re-equilibrated Variscan gneisses (fig. 49a) and Late-Variscan peraluminous intrusions (fig. 49b) crop out. They extend nearby the Ferraro Fort, for about 1 km on both sides of SP 50 bis road, reaching one hectometer in thickness. Rocks show a very-fine grained and the Alpine Sa_{2m} main foliation, locally strongly crenulated or transposed in a thin and spaced Sa_3 foliation.
These rocks are characterized by the presence of abundant white mica (phengite and paragonite; figs. 50-52), well evident also at the mesoscale, grown at the expense of Variscan mineral phases (biotite, plagioclase, cordierite, sillimanite, etc.). Several Late-Variscan tourmaline/muscovite/biotite-bearing felsic dykes are transposed along the Alpine main foliation (Sa_m=Sa_1+Sa_2) and converted into centimeter- to meter-thick leuco-orthogneisses (fig. 49). They are characterized by a subgranular recrystallization of the above defined minerals, together with abundant Alpine garnet porphyroblasts (fig. 53).
Going NE up to the Badiazza Valley, the pervasively overprinted zone widely develops. For about 20 km around the Valley, the overprint grades from *pervasively*, to *partly*, to *weakly*, to *softly* re-equilibrated zones (figs. 27-29). The most important microscopic features of this different in intensity Alpine re-crystallization are here illustrated (figs. 54 to 61).

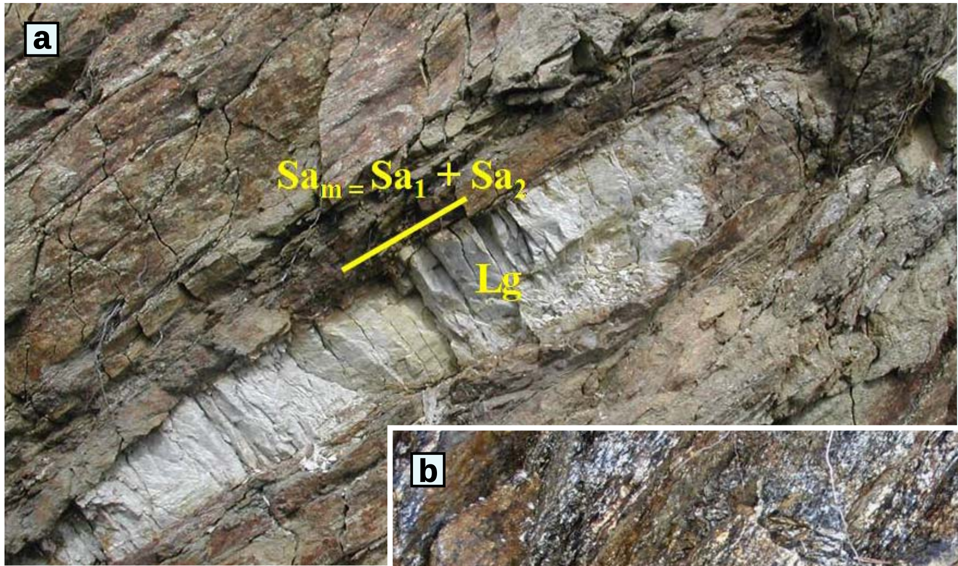


Fig. 49 - Alpine pervasively re-equilibrated Variscan Paragneisses (a) and Late-Variscan Plutonite (b), both intruded by Late-Variscan Felsic dykes.
Macroscopic structures: Variscan sillimanite+garnet paragneiss (a) and Late-Variscan peraluminous intrusion (b) pervasively re-equilibrated into Alpine kyanite+almandine+pargasite+phengite+albite/oligoclase+biotite gneissic micaschist and orthogneiss, respectively. Inside both lithotypes, centimeter-thick Late-Variscan felsic dykes are transposed and folded along the Alpine crenulated main foliation ($Sa_m = Sa_1+Sa_2$) and converted into Alpine garnet-bearing leuco-orthogneisses (Lg).
Loc.: Ferraro Fort. North-Eastern Peloritani Mts.

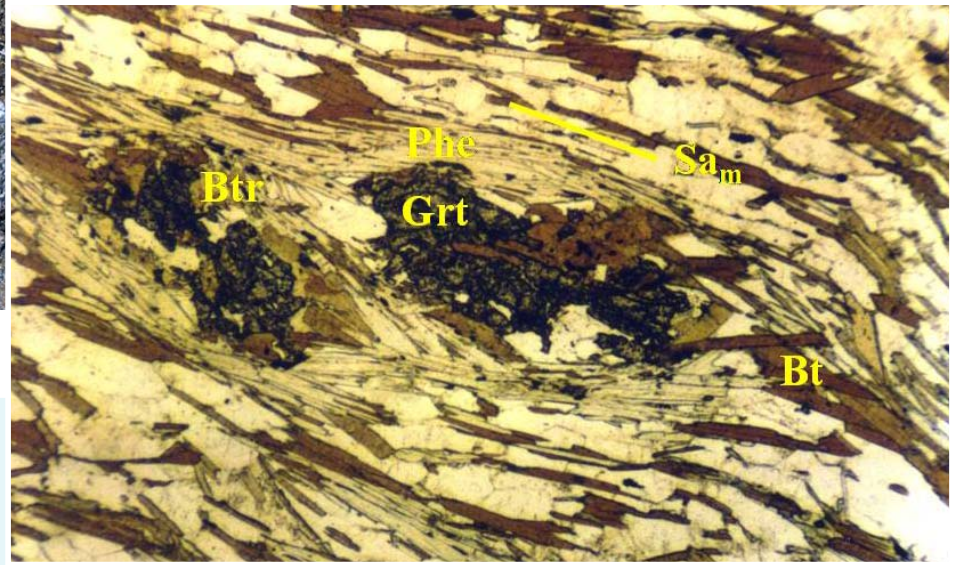


Fig. 50 - Variscan Paragneiss pervasively re-equilibrated into Alpine kyanite+almandine+pargasite+phengite+albite/oligoclase+biotite Gneissic micaschist.
Microscopic structure: crenulated Alpine Sa_{2m} main foliation, defined by phengite (Phe), biotite (Bt), quartz and plagioclase (albite core and oligoclase rim - not well evident in the picture). Variscan biotite dominions (Btr), wrapped up by the main foliation, are almost completely replaced by syn-Da_1 to post-Da_2 garnets (Grt). (Sample Map 5. PPL, 60x).
Loc.: Ferraro Fort. North-Eastern Peloritani Mts.

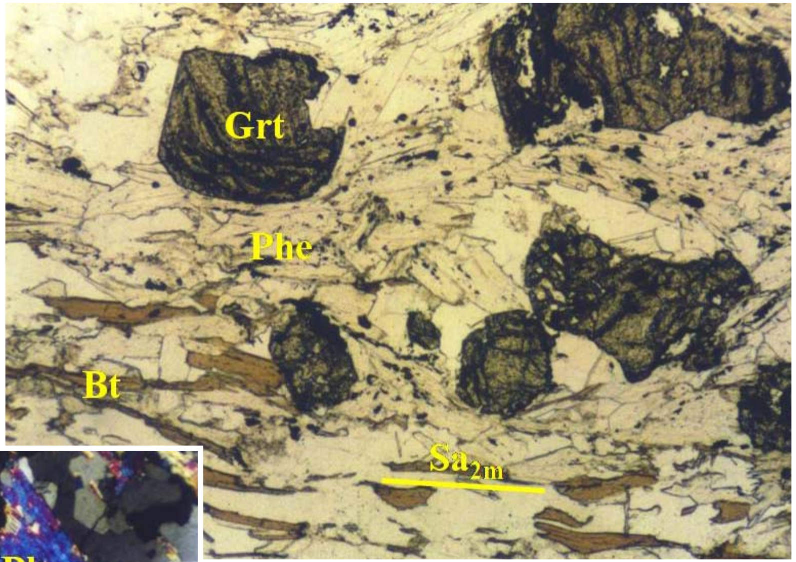


Fig. 51 - Late-Variscan Plutonite pervasively re-equilibrated into Alpine kyanite+Fe-Ca-almandine+pargasite+phengite+albite/oligoclase+biotite Orthogneiss.
Microscopic structure: syn-Da_1 to post-Da_2 Fe-Ca-almandine porphyroblasts (Grt), grown after Variscan biotite and plagioclase, cutting the weakly crenulated Sa_{2m} main foliation, defined by phengite (Phe), biotite (Bt), quartz and plagioclase. (Sample PC 5. PPL, 60x).
Loc.: Ferraro Fort. North-Eastern Peloritani Mts.

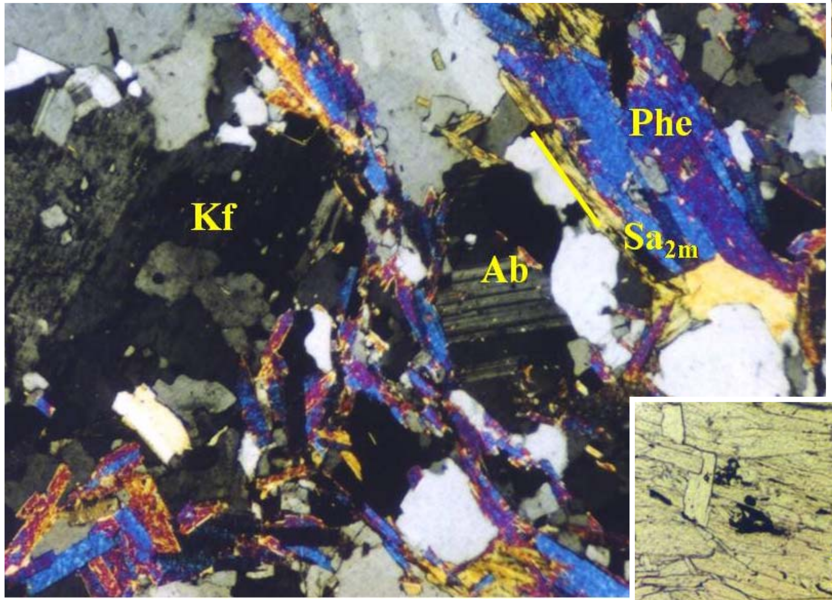


Fig. 52 - Late-Variscan Plutonite pervasively re-equilibrated into Alpine kyanite+almandine+phengite+albite/oligoclase+biotite Leuco-orthogneiss.
Microscopic structure: oriented quartz, twinned albite (Ab) and phengite (Phe) along the Sa_{2m} main foliation. Small peciloclastic K-feldspar (Kf), including magmatic reabsorbed quartz and plagioclase, is also present. (Sample MP21. XPL, 60x).
Loc.: Ferraro Fort. North-Eastern Peloritani Mts.

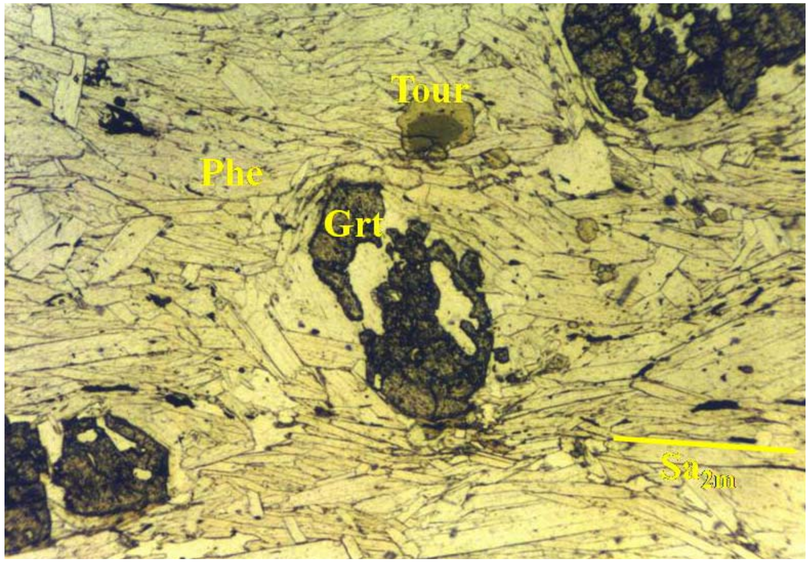
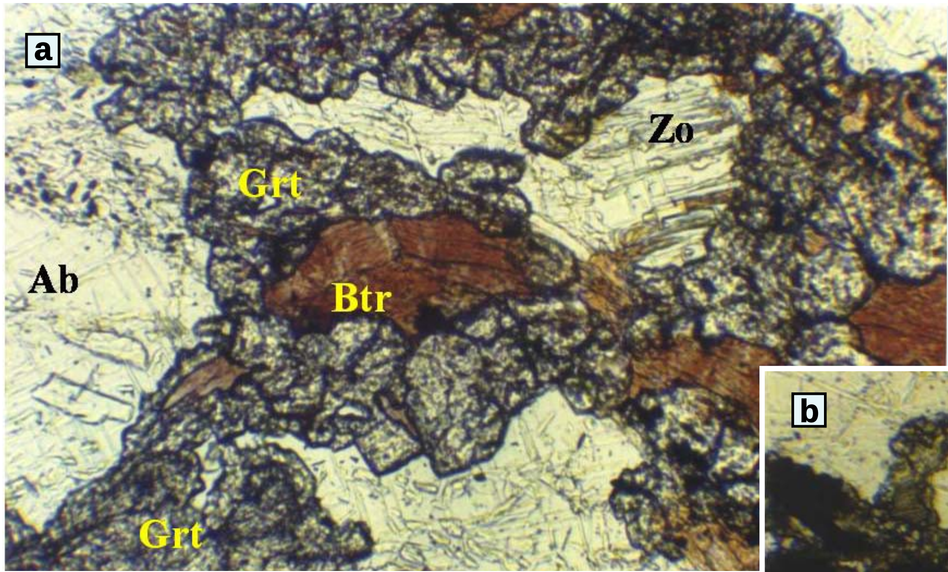


Fig. 53 - Late-Variscan garnet+tourmaline Pegmatite pervasively re-equilibrated into Alpine garnet+phengite+tourmaline Leuco-orthogneiss.
Microscopic structure: syn-Da_1 to post-Da_2 garnet (Grt), including syn-Da_1 quartz crystals, on (or wrapped by) strongly crenulated Alpine Sa_{2m} main foliation defined by phengite (Phe), quartz and albite. Post-Da_2 tourmaline (Tour), around Variscan tourmaline, is also present. (Sample MP3. PPL, 60x).
Loc.: Ferraro Fort. North-Eastern Peloritani Mts.



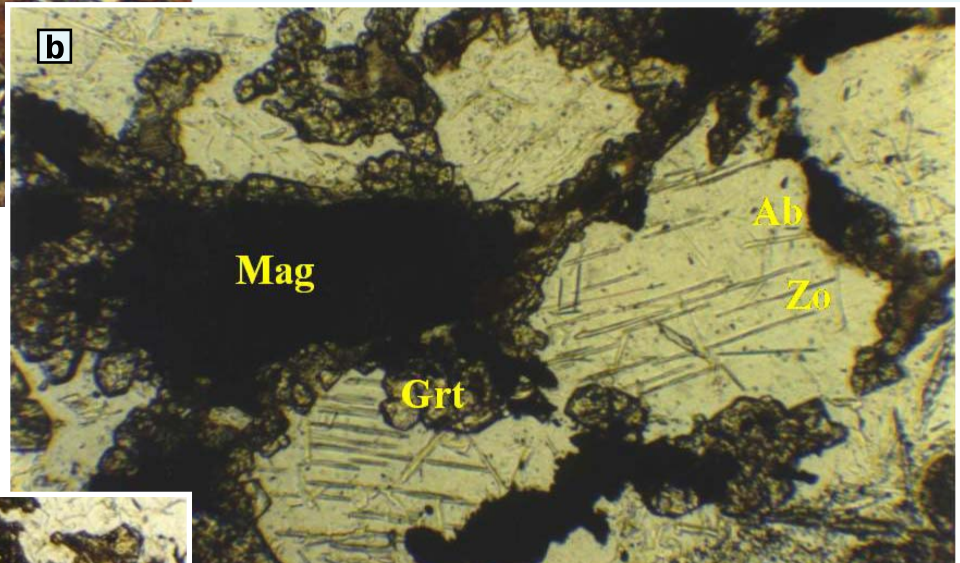


Fig. 54 - Variscan sillimanite+garnet+biotite Kinzigitic gneiss partly re-equilibrated into Alpine kyanite+Fe-Ca-almandine+pargasite+ phengite+albite+biotite Gneissic micaschist.
Microscopic structure: detail of Alpine syn-Da_1 to post-Da_2 almandine (Grt) growing, with coronitic structure, at the expense of both Variscan relict biotite (Btr; a), or magnetite (Mag; b), and plagioclase. This last mineral is also converted into albite (Ab)+zoisite (Zo)+muscovite (a and b - Sample Map 42. PPL, 180x; after Messina et al., 1990).
Loc.: low Badiazza Valley, 4 km from Stop 3. North-Eastern Peloritani Mts.

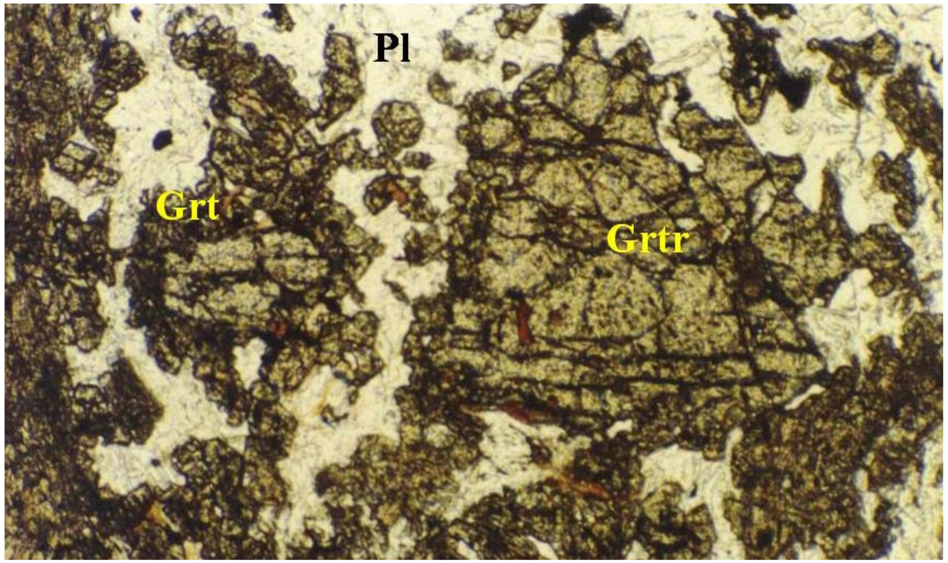
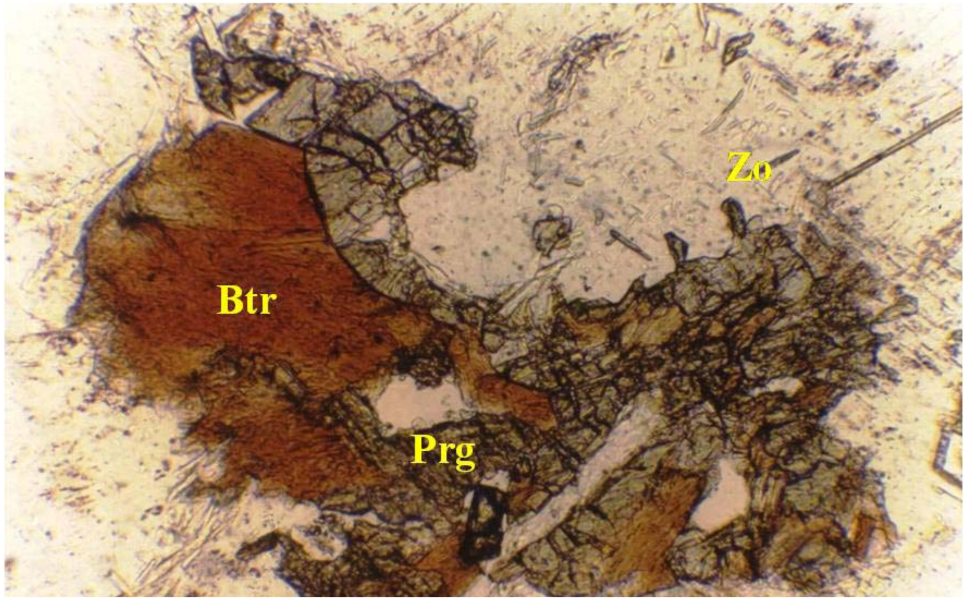
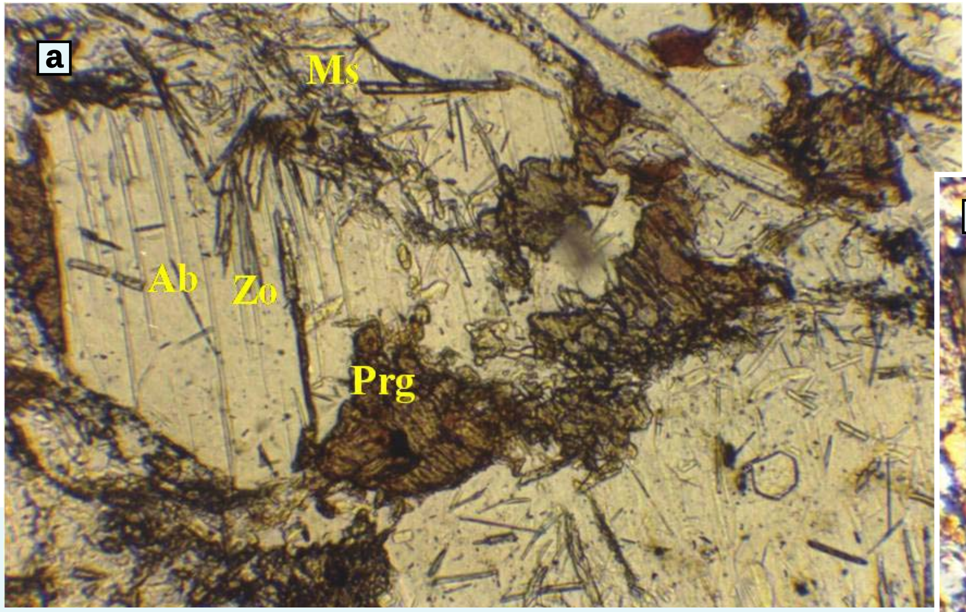


Fig. 55 - Variscan sillimanite+garnet+biotite Kinzigitic gneiss partly re-equilibrated into Alpine kyanite+Ca-almandine+pargasite+ phengite+albite+biotite Gneissic micaschist.
Microscopic structure: Alpine syn-Da_1 to post-Da_2 small Ca-almandine (Grt) developing, with coronitic structure, around the Variscan porphyroclastic garnet (Grtr), at the expense of both relict garnet and plagioclase (Pl). (Sample Map 39b. PPL, 45x).
Loc.: low Badiazza Valley, 4 km from Stop 3. North-Eastern Peloritani Mts.

Fig. 56 - Variscan sillimanite+garnet+biotite Kinzigitic gneiss partly re-equilibrated into Alpine kyanite+Ca-almandine+pargasite+phengite+albite+biotite Gneissic micaschist.
Microscopic structure: Alpine pargasite amphibole (Prg) develops at the expense of relict biotite (Btr) and plagioclase. This last mineral is replaced by albite, needle-like zoisite (Zo) and muscovite. (Sample Map 39b. PPL, 180x).
Loc.: low Badiazza Valley, 4 km from Stop 3. North-Eastern Peloritani Mts.





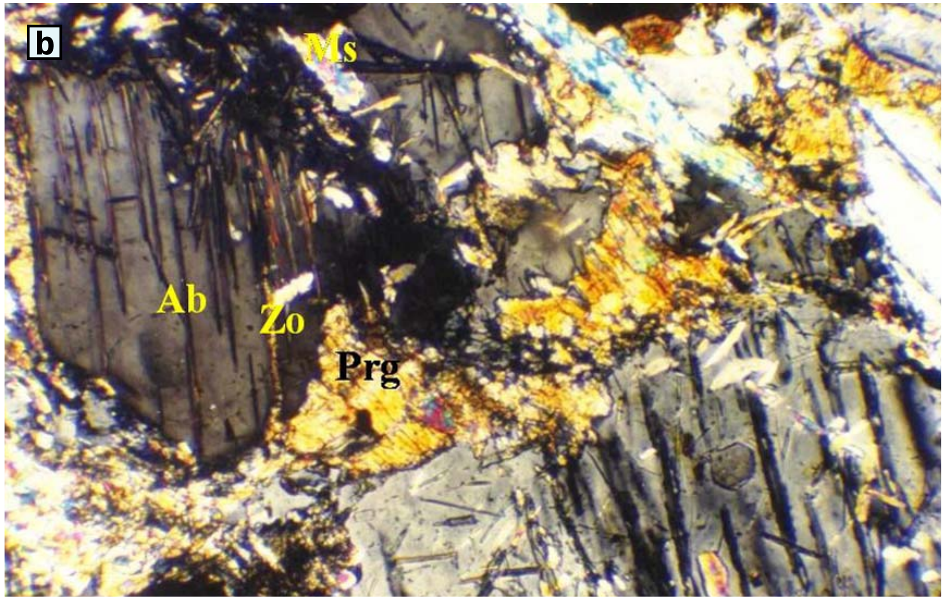


Fig. 57 - Variscan sillimanite+garnet+biotite Kinzigitic gneiss partly re-equilibrated into Alpine kyanite+Ca-almandine+pargasite+phengite+albite+biotite Gneissic micaschist.
Microscopic structure: Alpine pargasite amphibole (Prg) develops at the expense of Variscan biotite and plagioclase. Plagioclase is replaced by albite (Ab), needle-like zoisite (Zo) and muscovite (Ms). (Sample Map 39b. a. PPL, b. XPL, 180x).
Loc.: low Badiazza Valley, 4 km from Stop 3. North-Eastern Peloritani Mts.

Fig. 58 - Variscan sillimanite+garnet+biotite Kinzigitic gneiss weakly re-equilibrated into Alpine kyanite+almandine+pargasite+phengite+albite+biotite Gneissic micaschist.
Microscopic structure: detail of Alpine pargasite amphibole (Prg) and almandine (Grt), both grown at the expense of Variscan biotite (Btr). (Sample Map 167. PPL, 180x; after Messina & Macaione, 2010).
Loc.: S of Badiazza Valley. 6 km from Stop 3. North-Eastern Peloritani Mts.

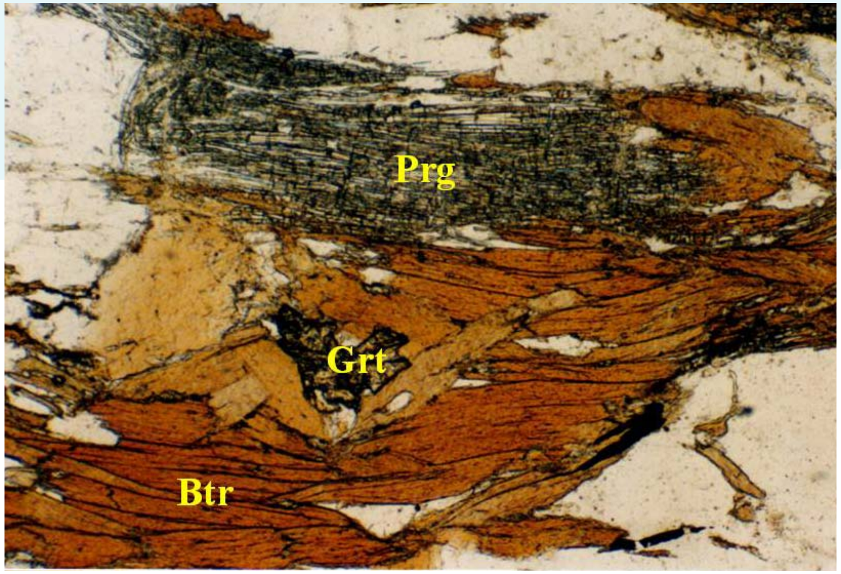
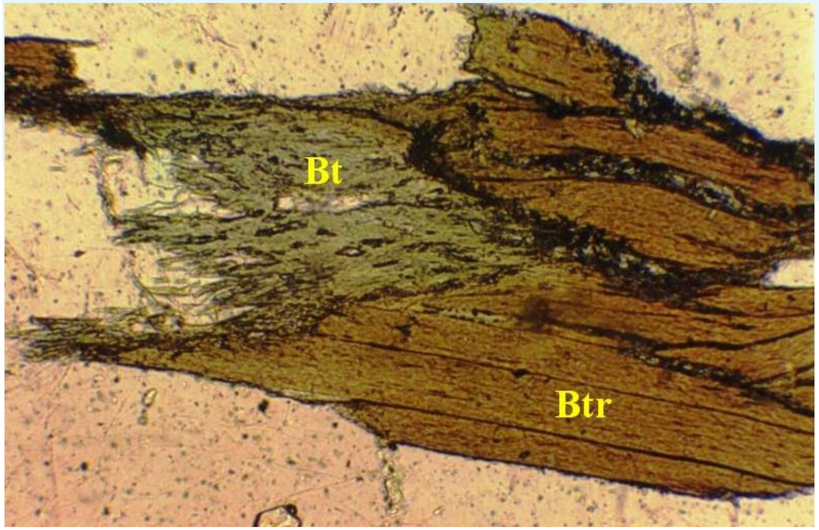


Fig. 59 - Variscan sillimanite+garnet+biotite Kinzigitic gneiss weakly re-equilibrated into Alpine kyanite+almandine+pargasite+phengite+albite+biotite Gneissic micaschist.
Microscopic structure: Alpine green-brown biotite (Bt) grows at the expense of relict kinked biotite (Btr). (Sample Map 167. PPL, 180x).
Loc.: S of Badiazza Valley, 6 km from Stop 3. North-Eastern Peloritani Mts.



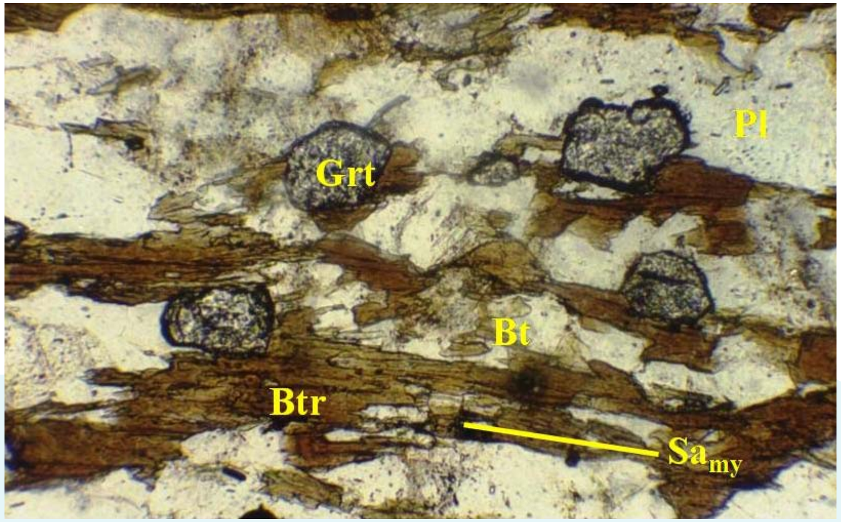


Fig. 60 - Variscan biotite Paragneiss weakly re-equilibrated into Alpine Fe-Ca-almandine+pargasite+low celadonitic white mica+albite+biotite Mylonitic gneiss.
Microscopic structure: syn-Da_1 to post-Da_2 Fe-Ca-almandine (Grt) after Variscan biotite (Btr) and plagioclase (Pl), cutting the Sa_{my} mylonitic foliation, along which Variscan relict quartz, plagioclase and biotite are transposed. Biotite is kinked and re-crystallized at rim in small green-brown laminae (Bt). (Sample Map 4. PPL, 45x).
Loc.: SS. Annunziata Valley, 7 km from Stop 3. North-Eastern Peloritani Mts.

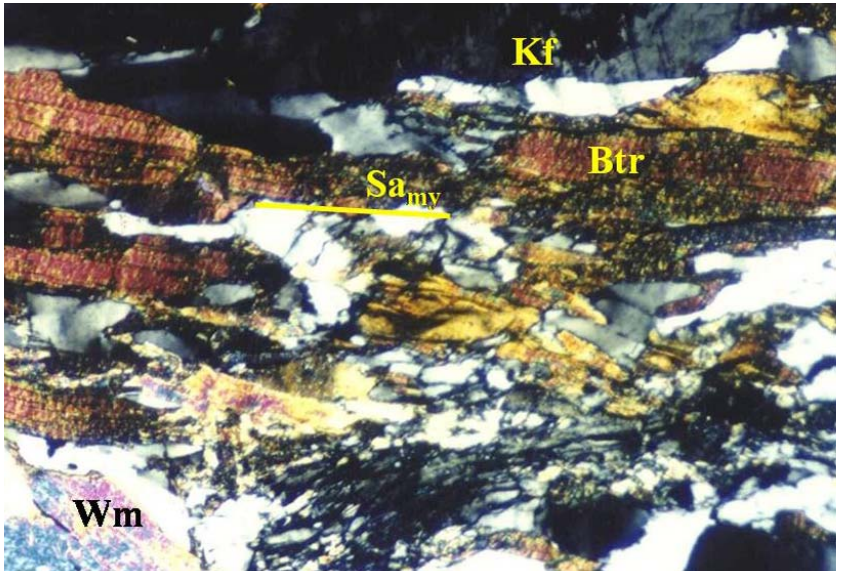


Fig. 61 - Variscan biotite+K-feldspar Gneiss softly re-equilibrated into Alpine low celadonitic white mica+albite+K-feldspar+epidote Mylonitic gneiss.
Microscopic structure: Variscan relics of quartz, oligoclase and K-feldspar (Kf) softly re-crystallized along the Alpine Sa_{my} mylonitic foliation, where Variscan relict biotite (Btr) is trasposed. This last mineral is strongly kinked and partly converted into Alpine white mica (Wm). (Sample Map 101. XPL, 45x).
Loc.: Mili St. Marco, 14 km from Stop 3. North-Eastern Peloritani Mts.

GEOSITE Marmora Torrent - SS 113 dir

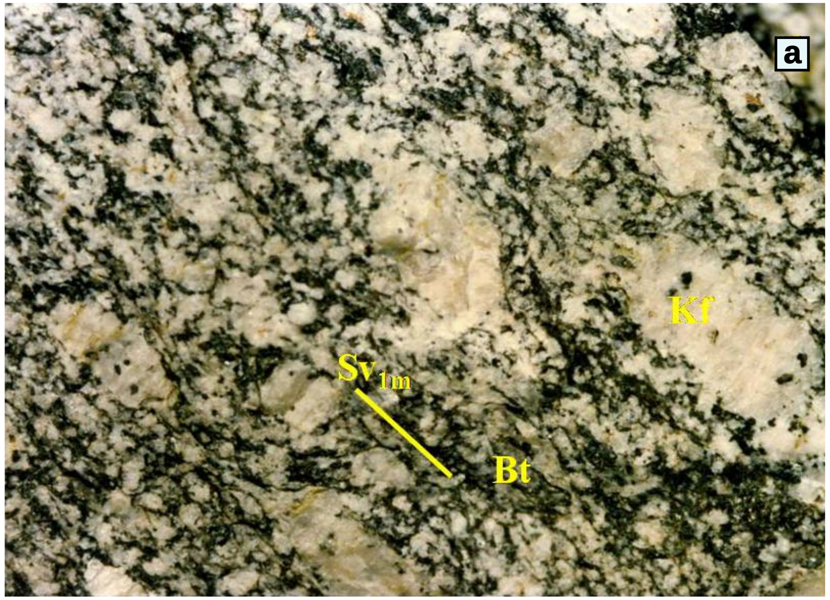
Geological features: Pre-Palaeozoic and Palaeozoic evolution in the Aspromonte Unit basement.

The Neo-Proterozoic-Cambrian plutonic event, dated 500-622 Ma (Table 1), is testified by the presence of the Variscan metaplutonics (Late-Pan-African plutonic series). They involve kilometer in extension bodies of metatonalites to metamonzogranites, where augengneisses prevail, and contain metagabbro to metadiorite microgranular inclusions, concordant centimeter to meter-thick leuco-orthogneisses (Late-Pan-African felsic dykes) in addition to polymetamorphic schlieren (Pan-African metaultramafics re-equilibrated in Variscan time; Messina et al., 1996a, 2004a, b). The magmatism is orogenic with calc-alkaline affinity (Ferla & Rotolo, 1992; Ferla, 1994).
The augengneisses, cropping out in plurikilometer bodies, constitute about 40% of the whole AsU basement (Bagnara-Scilla-Gambarie and Bova Marina-Bova Superiore, in Calabria; Ciccia Mt.-Salice, Tindari, Patrì-Fantina-Fondachelli Torrent, Gliaca di Piraino, in Sicily). The apparent thicknesses range from some hundred meters to about 800 m (Mazzarrà-Novara-Paratore Torrent, in Sicily).
In the northernmost area of the Aspromonte Unit (Bagnara in Calabria and Rasocolmo Cape in Sicily) the augegneisses also show anatectic mobilizations with the formation of leucosomes and melanosomes.

Stop 4. GEOTOPE: Variscan Augengneisses with Leuco-orthogneissic levels and polymetamorphic Schlieren.

The plurikilometer monzogranitic augengneissic body (Late-Pan-African plutonite), cropping out at the corner of SS 113 dir and SP 51, is characterized by grey colour, inequigranular coarse-grained and oriented texture (fig. 62) delineating the Variscan Sv_{1m} foliation. At the meso- (fig. 63a) and microscale (fig. 63b) the metaplutonite exhibits porphyroclastic structure, characterized by magmatic K-feldspar relics (max 6 cm) including zoned plagioclases and reabsorbed biotite, wrapped up in a fine matrix. This last one is oriented along the Variscan Sv_{1m} foliation and is made up of biotite, quartz, oligoclase and new K-feldspar.
The augengneiss contains concordant leuco-orthogneisses (Late-Pan-African aplitic and pegmatitic dykes) and polymetamorphic schlieren (Pan-Afican metaultramafics re-equilibrated in Variscan time; fig. 62). The Alpine cataclasis is widespread.

Fig. 62 - Variscan monzogranitic Augengneiss with Leuco-orthogneissic layers and polymetamorphic Schlieren. Macroscopic structure: whitish kilometer in extension augengneissic bodies, with concordant fine-grained leuco-orthogneiss (Lg) and oriented polymetamorphic schlieren (Sc). Loc.: Marmora Torrent, at the corner of SS 113 dir and SP 51. North-Eastern Peloritani Mts.



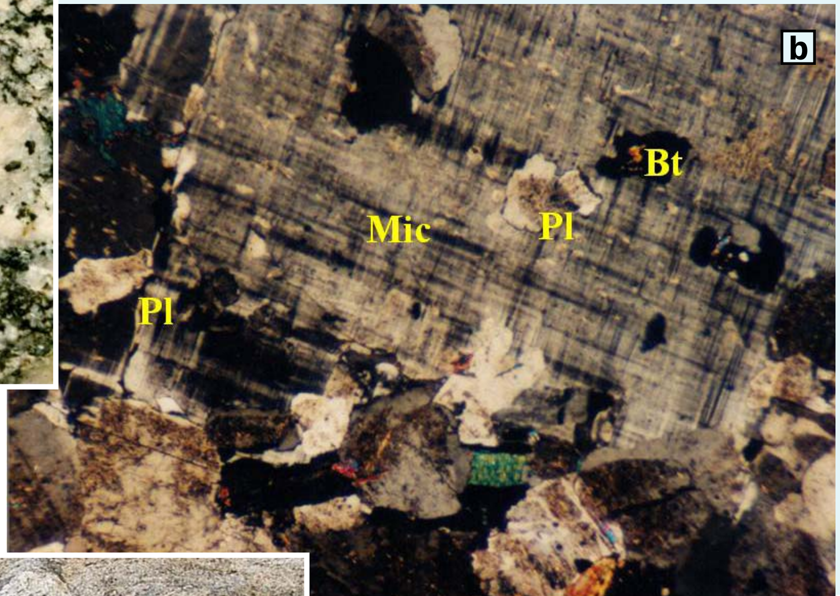


Fig. 63 - Variscan biotite monzogranitic Augengneiss with Leucogneissic layers and polymetamorphic Schlieren.
a) Mesoscopic structure: detail of fig. 62 with magmatic peciloclastic K-feldspars (Kf) wrapped up by the Variscan Sv_{1m} main foliation, defined by biotite (Bt), quartz, plagioclase and new K-feldspar.
b) Microscopic structure: detail of the large peciloclastic microcline (Mic), including plutonic zoned and altered plagioclase (Pl) and biotite (Bt). (Sample Tm 34, XPL, 60x).
Loc.: Marmora Torrent, at the corner of SS 113 dir and SP 51. North-Eastern Peloritani Mts.

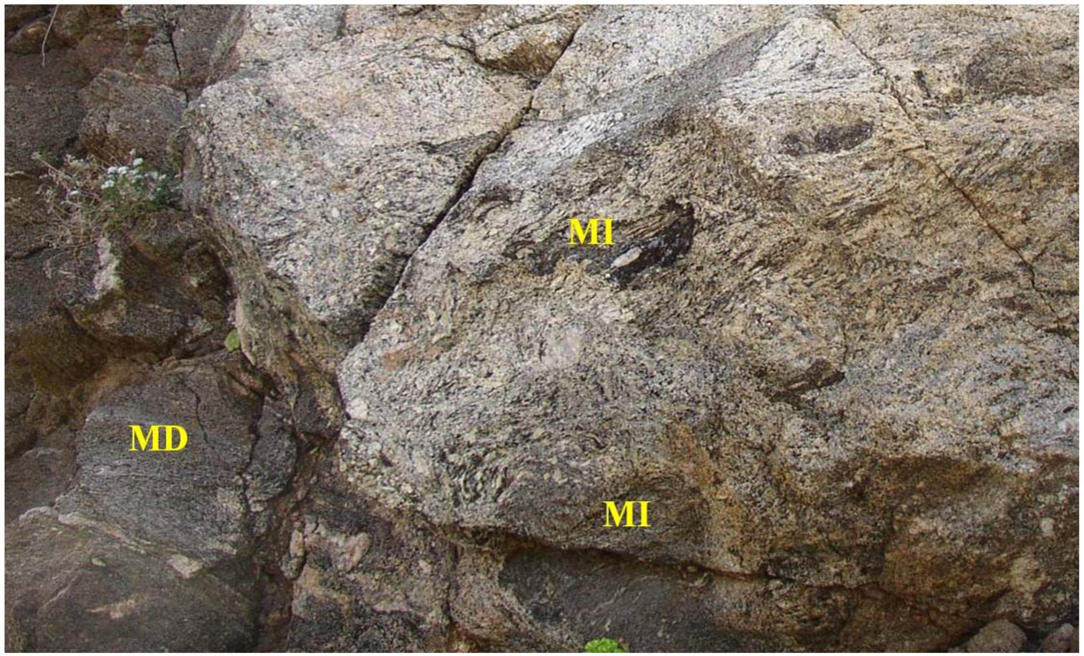


Fig. 64 - Variscan monzogranitic Augengneiss, with oriented Variscan Metagabbros as microgranular inclusions and dykes, all affected by a weak Alpine overprint.
Mesoscopic structure: Late-Pan-African mafic microgranular inclusions (MI) and dykes (MD) inside a Late-Pan-African monzogranite, the first two converted into Variscan metagabbros and the last one into Variscan monzogranitic augengneiss. At the mesoscale, the weak Alpine overprint is documented by the grain-size reduction and the abundant newly formed muscovite in the augengneiss.
Loc.: high SS. Annunziata Valley. North-Eastern Peloritani Mts.

Rb/Sr radiometric data in Calabria (Bonardi et al., 2008) and in Sicily (Atzori et al., 1990) have supplied "age" of Variscan metamorphism corresponding to 236-273 and 262-292 Ma, respectively. We interprete these data as mixed age, related to the widespread Alpine mylonitic shear zones.

Other records of plutonic magmatism characterizing the augengneisses, such as Late-Pan-African mafic microgranular inclusions and dykes, are illustrated in fig. 64. Along the SP 51, going to Ferraro Fort-Badiazza Valley pervasively re-equilibrated zone, augengneisses show different stages of Alpine re-equilibration, as indicated in fig. 65.

Representative geochemical features from North-Eastern (Atzori et al., 2004) and North-Western (Ferla & Meli, 2004) Peloritani augengneissic bodies have been here reported (Tables 10 and 11; figs. 66 and 67). Data of both Authors plot in the boundary of the Volcanic Arc and Syn-Collision Granite fields.

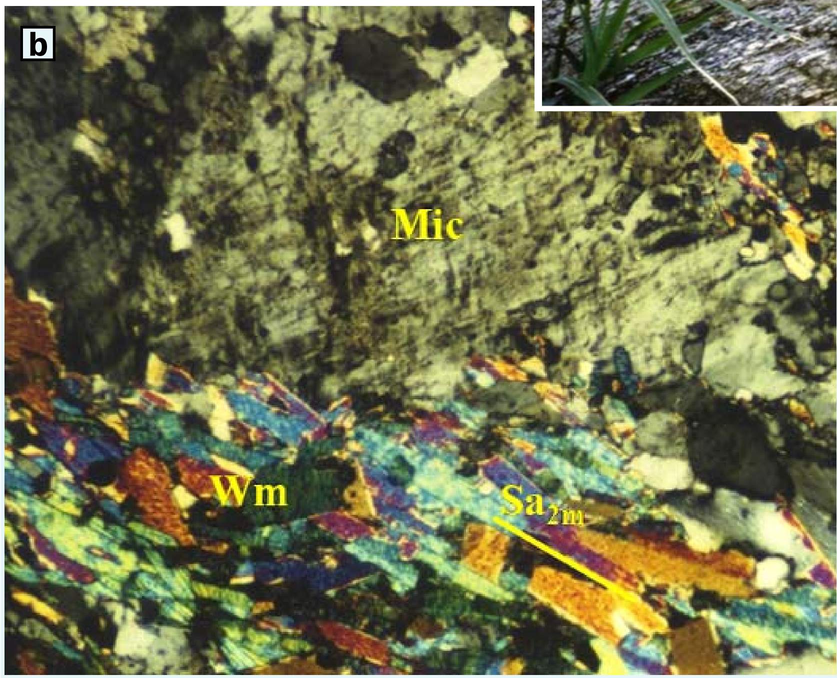


Fig. 65. Variscan Augengneiss partly re-equilibrated into Alpine K-feldspar relic+low celadonitic white mica+albite+K-feldspar Leuco-orthogneiss.
a) Mesoscopic structure: Alpine Sa_{2m} main foliation, defined by prevalent white mica and minor biotite, wrapping up Late-Pan-African porphyroclastic K-feldspar, already cut by the Sa_1.
b) Microscopic structure: detail of Variscan peciloclastic microcline (Mic), broken and rotated by the Alpine Sa_{2m} main foliation, defined by abundant low celadonitic white mica (Wm) after Variscan biotite. (Sample Map 205; XPL, 45x).
Loc.: Ciccia Mt., along SP 51 linking Stop 3 and Stop 4, about 3 km from Stop 4. North-Eastern Peloritani Mts.

Table 10 - Representative analyses of Major Elements from Aspromonte Unit augengneisses.

Sample	52	53	PO9	PO49
Element wt %	◊	◊	◆	◆
SiO_2	70.01	67.59	71.16	70.24
TiO_2	0.53	0.37	0.51	0.55
Al_2O_3	14.47	15.59	13.59	14.49
Fe_2O_3	4.00	3.60	3.49	3.42
MnO	0.06	0.08	0.02	0.06
MgO	1.18	1.39	0.98	1.35
CaO	1.73	1.73	1.03	1.56
Na_2O	2.93	3.00	5.06	4.33
K_2O	4.19	4.22	2.98	3.33
P_2O_5	0.15	0.10	0.14	0.13
LOI	0.79	1.14	1.03	0.54
Total	100.03	98.81	99.99	100.00

◊ = after Atzori et al. (2004);
◆ = after Ferla & Meli (2004)

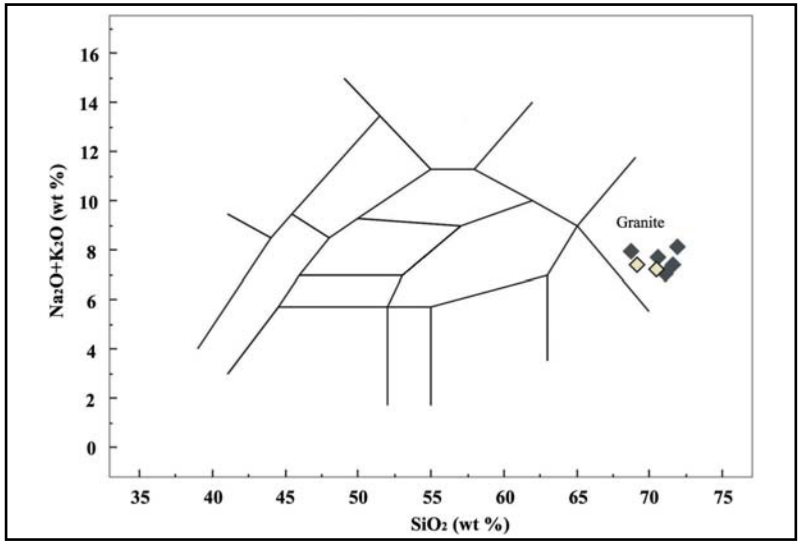


Fig. 66 - SiO_2 vs Alk diagram (Cox et al., 1979) for the Aspromonte Unit augengneisses (◊ = 52 and 53 samples, after Atzori et al., 2004; ♦ = PO8, PO9, PO44, PO48 and PO49 samples, after Ferla & Meli, 2004).

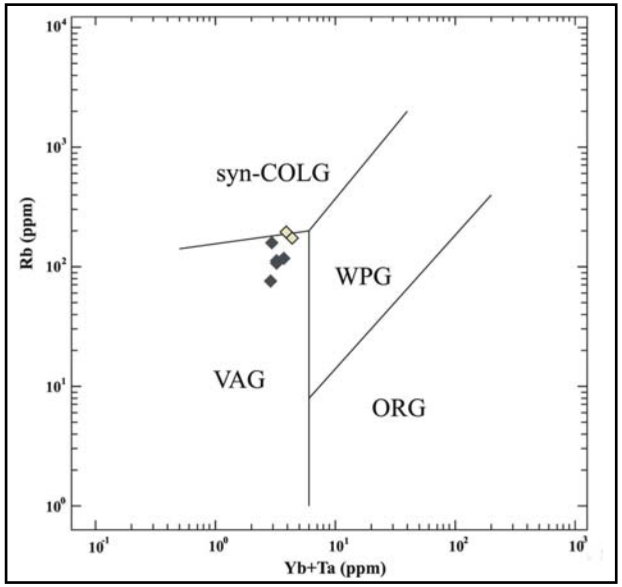


Fig. 67 - Yb+Ta vs Rb diagram (Pearce et al., 1984) for the Aspromonte Unit augengneisses (symbols as in fig. 66). Legend: Syn-COLG = Syn-collision Granites; WPG = Within-Plate Granites; VAG = Volcanic Arc Granites; ORG = Oceanic Ridge Granites.

Table 11 - Representative analyses of Trace and Rare Earth Elements from Aspromonte Unit augengneisses.

Sample	52	53	PO9	PO49
Element ppm	◊	◊	◆	◆
Ag	<0.50	<0.50	<0.50	<0.50
As	<5.00	<5.00	<5.00	<5.00
Ba	758.00	568.00	829.00	815.00
Bi	<0.06	<0.06	<0.06	<0.06
Ce	104.00	70.30	73.50	73.10
Co	9.00	5.00	5.00	6.00
Cr	31.00	<20.00	<20.00	28.00
Cs	4.70	7.20	4.30	2.80
Cu	<10.00	<10.00	<10.00	<10.00
Dy	6.71	3.86	4.45	5.03
Er	3.69	2.12	2.46	2.87
Eu	1.22	1.20	1.43	1.14
Ga	21.00	24.00	16.00	17.00
Ge	1.30	1.20	0.90	1.70
Gd	7.02	4.87	7.37	5.92
Hf	6.60	5.00	6.30	6.60
Ho	1.26	0.71	0.86	1.01
In	<0.10	<0.10	<0.10	<0.10
La	51.70	35.10	68.30	37.30
Lu	0.46	0.35	0.27	0.36
Mo	<2.00	<2.00	<2.00	<2.00
Nb	14.40	11.30	12.40	8.00
Nd	39.70	26.40	48.50	30.00
Ni	20.00	<15.00	18.00	<15.00
Pb	11.00	10.00	15.00	22.00
Pr	10.60	7.16	13.2	7.49
Rb	175.00	196.00	157	113
Sb	<0.20	<0.20	<0.20	<0.20
Sm	7.81	5.01	8.13	6.06
Sn	4.00	4.00	3.00	3.00
Sr	120.00	70.00	111.00	155.00
Ta	1.10	1.60	1.00	0.80
Tb	1.18	0.74	0.88	0.86
Th	22.50	18.40	13.20	18.70
Tl	0.44	0.86	0.72	0.63
Tm	0.53	0.32	0.33	0.42
U	3.53	4.82	3.15	2.12
V	55.00	43.00	32.00	42.00
W	5.60	3.10	0.70	-0.20
Y	40.00	23.20	25.10	30.30
Yb	3.30	2.26	1.96	2.45
Zn	<30.00	<30.00	36.00	44.00
Zr	243.00	181.00	237.00	252.00

◊ = after Atzori et al. (2004);
◆ = after Ferla & Meli (2004)

GEOSITE Tono - SS 113 dir

A - Geological features: Palaeozoic evolution in the Aspromonte Unit basement.

The Late Carboniferous-Permian plutonic event, dated 290 Ma (Table 1), is testified by several Late-Variscan plutonic bodies (Messina et al., 1996a). They show calc-alkaline affinity and consist of syn- to post-tectonic, meta- (subordinate) and mesoaluminous, and post-tectonic peraluminous intrusions. They form 30% of the AsU basement and crop out in many, spatially separated, stocks. In extension each body ranges from several kilometers (*Main Intrusions* - Palmi-Bagnara Stock - in the Aspromonte Massif), to few kilometers (*Minor Intrusions* - Villa San Giovanni Stock, in the Aspromonte Massif) up to max one kilometer (*Small Intrusions* - Punta D'Atò or Delianova, Stocks, in the Aspromonte Massif; Rasocolmo Cape Stock - in the Peloritani Mts., etc.). This orogenic magmatism exhibits a compositional interval from syn-tectonic amphibole diorites (Calabria) to post-tectonic two mica+cordierite+Al-silicate leucomonzogranites. In Sicily the intrusions are only post-tectonic and peraluminous, ranging from leucotonalites to leucomonzogranites.
The plutons contain gabbro-diorite to melatonalitite microgranular inclusions and medium-high grade metamorphic xenoliths similar to the country rocks. An intersected network of felsic dykes, with prevailing aplites and pegmatites, followed by rare mafic dykes, constitutes the latest intrusions.
The intrusive contact between plutonics and metamorphics produces retrograde phenomena, up to complete pseudomorphosis of Variscan metamorphic minerals.

The Aspromonte Unit plutonics are related to the Calabria-Peloritani Arc Late-Variscan orogenic magmatism, responsible for several plutonic complexes intruding both Pre-Palaeozoic and Palaeozoic CPA basements. Many studies have been devoted to these intrusives and heterogeneous contrasting genetic interpretations have been carried out in 1970-1990's (the first data on Rasocolmo Cape Stock have been defined by Puglisi & Rottura, 1973). Authors agree with the most important hypothesis reconstructed, on the basis of detailed geological, petrological and radiometric data, on heterogeneous in composition CPA plutonic complexes, as Sila Batholith (Northern Sector) and Serre Batholith (Southern Sector), that the Late-Variscan orogenic metaluminous to peraluminous magmatic series originated by mixing of mantle and crustal magmas, evolved by assimilation-fractional crystallization processes. So, the biotite+sillimanite+andalusite+cordierite+muscovite leucotonalites to leucomonzogranites constitute the most evolved terms of series. They are also characterized by a significative assimilation of Al-rich crust, responsible for the presence of the above defined Al-rich mineral phases, both as magmatic and xenolithic crystals (De Vivo et al., 1991, 1992; Messina et al, 1991a, b, 1993, 1996a; Rottura et al., 1993; Ayuso et al., 1994; Messina & Russo, 1994).

Stop 5. GEOTOPE: Late-Variscan Tono two mica+sillimanite+cordierite+andalusite Monzogranite cut by felsic dykes (Rasocolmo Cape Stock).

The Tono monzogranite belongs to the Rasocolmo Cape Stock, which involves many and different in grain-size, texture and composition, peraluminous plutonic bodies and dykes (figs. 68 and 71).
The monzogranite extends for about one kilometer (*Small Intrusions*). It is grey, massive and shows an equigranular medium-fine grained (fig. 68). The intrusion is characterized by the presence of biotite and muscovite, observable at the mesoscale; sillimanite, andalusite and cordierite, only at the microscale. These minerals exhibit both magmatic and xenolitic structures (figs. 69 and 70). The plutonic rock encloses small rounded centimeter-thick microgranular biotite-melatonalite inclusions and lengthened two mica+sillimanite+cordierite+andalusite metamorphic xenoliths.

Fig. 68 - Late-Variscan two mica+sillimanite+andalusite+cordierite Monzogranite of Tono (Rasocolmo Cape Stock).
Macroscopic structure: Late-Variscan grey monzogranite with massive texture and medium-fine grained, crossed by pegmatitic and aplitic dykes. The intrusions show an Alpine cataclasis.
Loc.: Tono. North-Eastern Peloritani Mts.

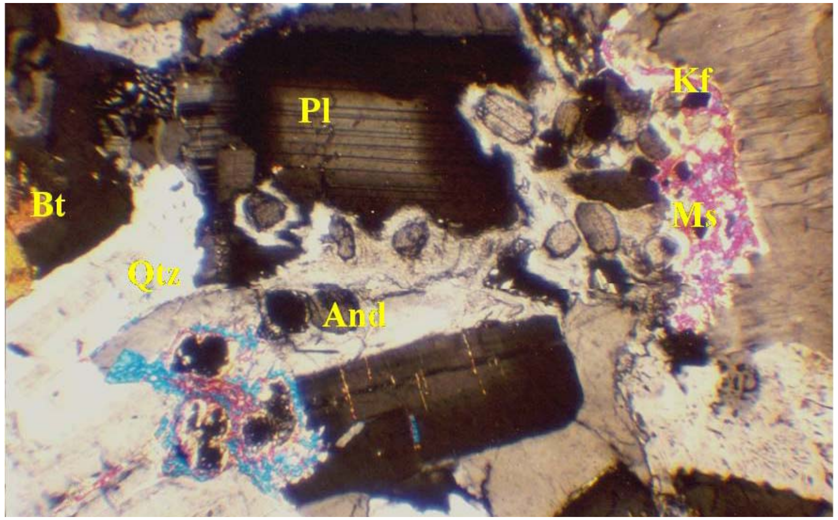


Fig. 69 - Late-Variscan two mica+sillimanite+andalusite+cordierite Monzogranite of Tono (Rasocolmo Cape Stock).
Microscopic structure: sub-ipidiomorphic structure characterized by subidiomorphic, zoned and twinned plagioclase (Pl), including magmatic pink andalusite (And) replaced by late magmatic muscovite (Ms) at the rim. Subidiomorphic biotite (Bt), granular quartz (Qtz) and late K-feldspar (Kf) plagues are also present. (Sample To 6, XPL, 60x; after Messina & Macaione, 2010).
Loc.: Tono. North-Eastern Peloritani Mts.

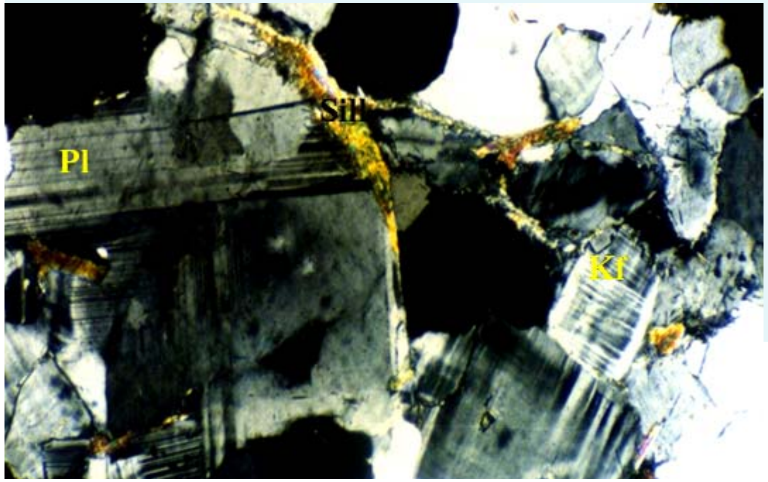
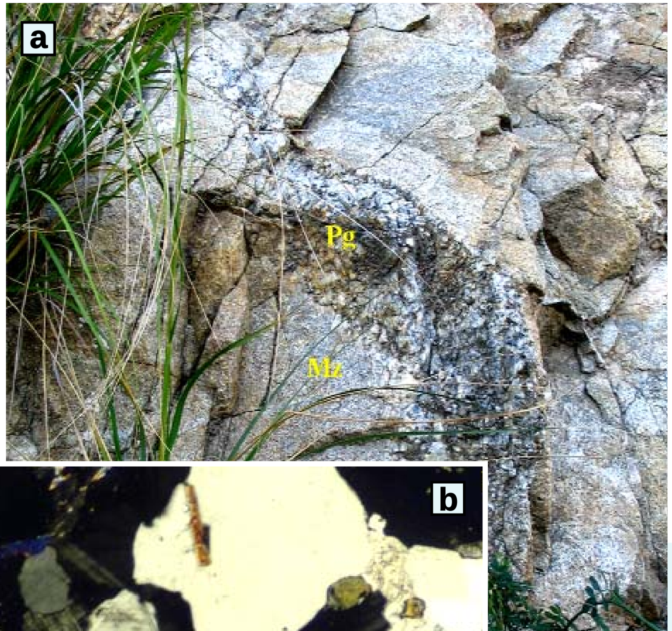


Fig. 70 - Late-Variscan two mica+sillimanite+andalusite+cordierite Monzogranite of Tono (Rasocolmo Cape Stock).
Microscopic structure: detail of xenolitic fibrolite (Sill) film, replaced by a late magmatic muscovite, among subidiomorphic little zoned and twinned plagioclase (Pl), granular quartz and K-feldspar (Kf) plagues. (Sample To 7, XPL, 60x).
Loc.: Tono. North-Eastern Peloritani Mts.



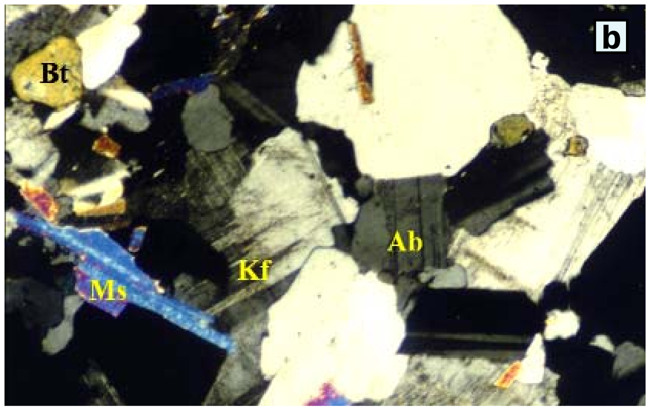


Fig. 71 - Late-Variscan two mica+sillimanite+andalusite+cordierite Monzogranite of Tono (Rasocolmo Cape Stock).
a) Mesoscopic structure: muscovite+garnet pegmatite (Pg) crosscutting the monzogranite (Mz), both affected by an Alpine cataclasis.
b) Microscopic structure: allotriomorphic, inequigranular fine-grained aplite defined by chloritized biotite (Bt), twinned albite (Ab), K-feldspar (Kf), muscovite (Ms) and quartz. (Sample MAPT 12, XPL, 180x).
Loc.: Tono. North-Eastern Peloritani Mts.

PART TWO
Stops 6-8: Pliocene-Quaternary deposits

GENERAL OUTLINES

The prevailing terrigenous formations, deposited later to the setting of the CPA Southern Sector, unconformably cover the tectono-stratigraphic units. They are involved by further both extensional and compressive structures, such as post-Burdigalian folds and thrusts and different Pliocene to Quaternary fault systems.
From base to top, they are: Capo d'Orlando Flysch (Upper Oligocene-Lower Burdigalian), Variegated Shales of the Antisicilide Complex (Upper Cretaceous), Floresta Calcarenites (Upper Burdigalian-Langhian), Middle Miocene-Pleistocene deposits and alluvial and beach deposits (Holocene).
The *Capo d'Orlando Flysch* (Ogniben, 1960; Lentini et al., 2000b) represents the first deposit after the emplacement of the CPASS tectonic units, involved in further tectonic phases. It crops out from Stilo in the Serre Massif (Calabria), to Capo d'Orlando in the North-Western Peloritani Mts., and consists of molasse-type sediments, evolving into flysch-type deposits. It unconformably rests on the units, characterized by variability in thickness and in facies distribution. Furthermore deformed by ramps which breach the whole Alpine Peloritani edifice, it progressively involves younger flysch horizons, from South to North. Flysch locally underthrusts the Variegated Shales (Carbone et al., 2008; Carbone et al., *in press*; Servizio Geologico d'Italia - F° 601 Messina Reggio di Calabria, 2008; F° 587 Milazzo - F° 600 Barcellona Pozzo di Gotto, *in press*). This deposit corresponds to the Lower-Middle Burdigalian-Langhian Stilo-Capo d'Orlando Formation of Bonardi et al. (1980a, 2002, 2003).

The *Variegated Shales* of the Antisicilide Complex (Ogniben, 1960), interpreted as allochthonous deposits (Lentini et al., 1987), are widely distributed in Southern and Eastern Aspromonte Massif and in Central and Northern Peloritani Mts.. The formation overlies the Capo d'Orlando Flysch and units, reaching a thickness up to 100 m (apparent thickness of 250 m). It is composed of polychrome clays with intercalations of radiolarites, cherty limestones and thin polychrome marly levels ascribed to Cretaceous (Carbone et al., 2008 and references therein). It locally includes quartz-sandstone megablocks of the Numidian Flysch, Lower Miocene in age.

The *Floresta Calcarenites* (Ogniben, 1960; Lentini et al., 2000a, b) deposited during the last overthrusting of the CPA onto the Apenninic-Maghrebian Chain, preceeding the initial opening of the Tyrrhenian Sea (Carbone et al., 1993, 2008). They are discontinuously scattered over Southern and Eastern areas of the Aspromonte Massif and Central and Northern Peloritani Mts., with a thickness from few meters to 100 m (apparent thickness of 250 m), unconformably covering the Variegated Shales and sometimes the Capo d'Orlando Flysch. They consist of prevailing shallow-water coralgal biostromes, bioclastic calcarenites and arkose glauconitic sandstones with calcareous cement (Carmisciano et al., 1981). Bonardi et al. (1980a), Carmisciano et al. (1981), Barrier et al. (1987), Guerrera et al. (1993) attribute these deposits to Langhian, while Carbone et al. (1993) ascribe them to a Late Burdigalian-Early Langhian interval.

The continental and marine *Middle Miocene-Pleistocene deposits*, prevalently cropping out, along the Tyrrhenian and Ionian foothills, on other sedimentary deposits or directly on crystalline units, are distinguished in chronological order in: sandstones, siltstones, marly and sandy-clayey alternations, marls, clayey marls and conglomerates (Middle Serravallian-Early Messinian); coralgal limestones and calcareous breccias (Upper Tortonian-Lower Messinian), evaporites (Gessoso-Solfifera Fm. - Upper Messinian); marls and marly limestones (Trubi - Lower Pliocene); sandy marls, sands and calcarenites (Middle Pliocene); calcarenites, bioclastic sands, clays and sandy clays (Upper Pliocene-Middle Pleistocene); sands, gravels, conglomerates (Messina Gravels and Sands Formation; Middle Pleistocene) (Lentini et al., 2000a, b; Carbone et al., 2008; Carbone et al., *in press*; Servizio Geologico d'Italia - F° 601 Messina-Reggio di Calabria, 2008; F° 587 Milazzo - F° 600 Barcellona Pozzo di Gotto, *in press*).

Finally, the Holocene *alluvial and beach deposits* are composed by clays, sands and polygenic, mainly crystalline, heterometric and rounded gravels.

GEOSITE Tono - SS 113 dir

B - Geological features: unconformable Pliocene deposits on the Aspromonte Unit.

Stop 6. GEOTOPE: Trubi (Lower Pliocene).

The meter-thick outcrop (fig. 72), that unconformably covers the peraluminous Monzogranite of Tono, represents a small example of Lower Pliocene Trubi deposit. These sediments, which consist of whitish marls and marly limestones, with intercalations of sandy levels, deposited during rising sea-level, following the Messinian salinity crisis (Gessoso-Solfifera Formation - Upper Messinian).

In the formation nannofossil associations referred to *Amaurolithus tricorniculatus* and *Ceratholithus rugosus* biozonas and to *Reticulofenestra pseudoumbilicus* biozona (upper levels) are signaled. A microfauna to *Sphaeroidinellopsis* sp. and *Globorotalia margaritae*, in the basal horizons, and to *Globorotalia puncticulata*, in the upper horizons, is indicated (Lentini et al., 2000a, b; Carbone at al., 2008 and references therein; Servizio Geologico d'Italia – F° 601 Messina-Reggio di Calabria, 2008).
This deposit is unconformably overlaid by the Messina Gravels and Sands Fm. (Middle Pleistocene).

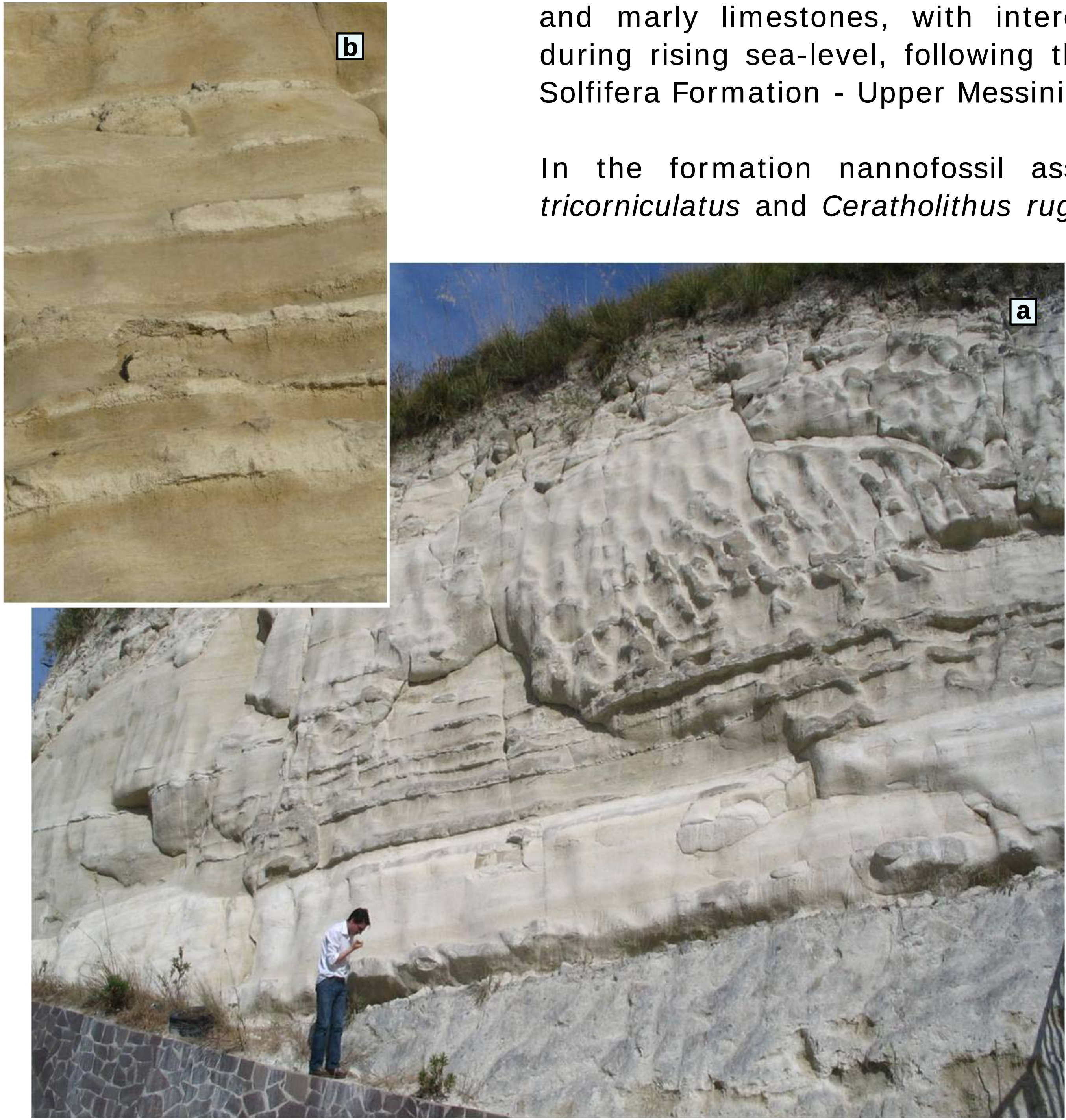


Fig. 72 - Trubi marls (Lower Pliocene).
Macroscopic (a) and mesoscopic (b) structures: meter-thick outcrop of whitish marls and marly limestones. Loc.: Tono. North-Eastern Peloritani Mts.

GEOSITE Strada Panoramica dello Stretto

Geological features: Pleistocene Deposits.

Stop 7. GEOTOPE: Messina Gravels and Sands Formation (Middle Pleistocene).

This deposit widely crops out in both sides of the Messina Straits. In Sicily it extends from Gravitelli (S of Messina), in the North-Eastern extreme of the Ionian coast up to Taormina to the S. The Formation reaches the real thickness of 250 m (apparent thickness of 600 m). It consists of greyish fluvial-deltaic sands, gravels conglomerates, with centimeter-decimeter thick clasts (fig. 73). The Formation is not very diagenitic and shows a high angle clynostratification. The pinkish or ochre clasts are, prevalently, altered plutonites and gneisses. The limestones are subordinate in amount and porphyroids are rare (Lentini et al., 2000a, b; Carbone at al., 2008 and references therein; Servizio Geologico d'Italia – F° 601 Messina-Reggio di Calabria, 2008).
In this geotope, the Formation unconformably rests on the Aspromonte Unit basement and on Trubi deposits (Lower Pliocene).

Fig. 73 - Messina Gravels and Sands Formation (Middle Pleistocene).
Macroscopic structure: plurimeter-thick levels of little diagenetic ochre sands and gravels.
Loc.: Strada Panoramica dello Stretto. North-Eastern Peloritani Mts.

GEOSITE Peloro Cape

Geological features: Holocene Deposits.

Stop 8. Geosite Peloro Cape: Beach Deposits (Holocene).

Peloro Cape (figs. 74 to 76) exhibits morphological onenesses correlated to its landscapes. It is located in the Northern entrance of the Messina Straits, with the Tyrrhenian Sea, to the N, and the Ionian Sea canalized in the Straits, to the E and SE. The most facing tract of the Cape, distant only 3.250 m from the magnificent Calabrian coast, is dominated by the high spurs of the Aspromonte Massif (figs. 74 and 76). Edge between East and West, the Peloro Cape represents a Mediterranean transit place, full of unknowns for the sailor: *place of seduction and death, according to Omero; site of meeting-fight between Etruria and Ionian Sea, according to Ovidio.*

Because of its peculiar position, the Peloro Cape consists of the final point of the of Tyrrhenian and Ionian transport processes and potentially place of continue sedimentation. The different morphology of its two coasts is linked both to the meteorological-climatic (winds and connected wave motion), and to hydrodynamic (tidal currents) conditions.

The whitish beaches are constituted by Modern littoral deposits, made up of sands and gravels with polygenic medium to fine grained clasts, mostly of gneissic and plutonic quartz-feldspar rocks (fig. 75). These deposits derive from the alluvial transport of torrents, fed by the Aspromonte Unit crystalline basement and by sedimentary formations of the area, above all by the Messina Gravels and Sands Fm..

Fig. 74 - Beach Deposits (Holocene).
Macroscopic structure: Northern entrance of the Messina Straits, with the Ionian Sea canalized in the Straits. The nearby Calabrian coast overlooks it with the high spurs of the Aspromonte Massif. In the Sicilian side, the Ganzirri Lake is also evident. It is one of the two coastal lakes characterizing the Peloro Cape Lagoon System (Oriented Natural Reserve).
Loc.: Strada Panoramica dello Stretto. North-Eastern Peloritani Mts.

Fig. 75 - Beach Deposits (Holocene).
Macroscopic structure: whitish sediments of sands, gravels with polygenic medium-fine grained clasts of prevailing gneissic to plutonic quartz-feldspar rocks. The picture focuses the minimum length of 3.250 m between the Sicilian and Calabrian coasts, in addition to the encounter of the Ionian (pale blue) and Tyrrhenian (blue) Seas.
Loc.: Peloro Cape (NE of Messina).

Fig. 76 - Historical Map "*Prospetto della città di Messina capitale della Sicilia veduta dal canale*" (after Sicuro F., 1769). Property: Regional University Library of Messina.

Comparison and final remarks

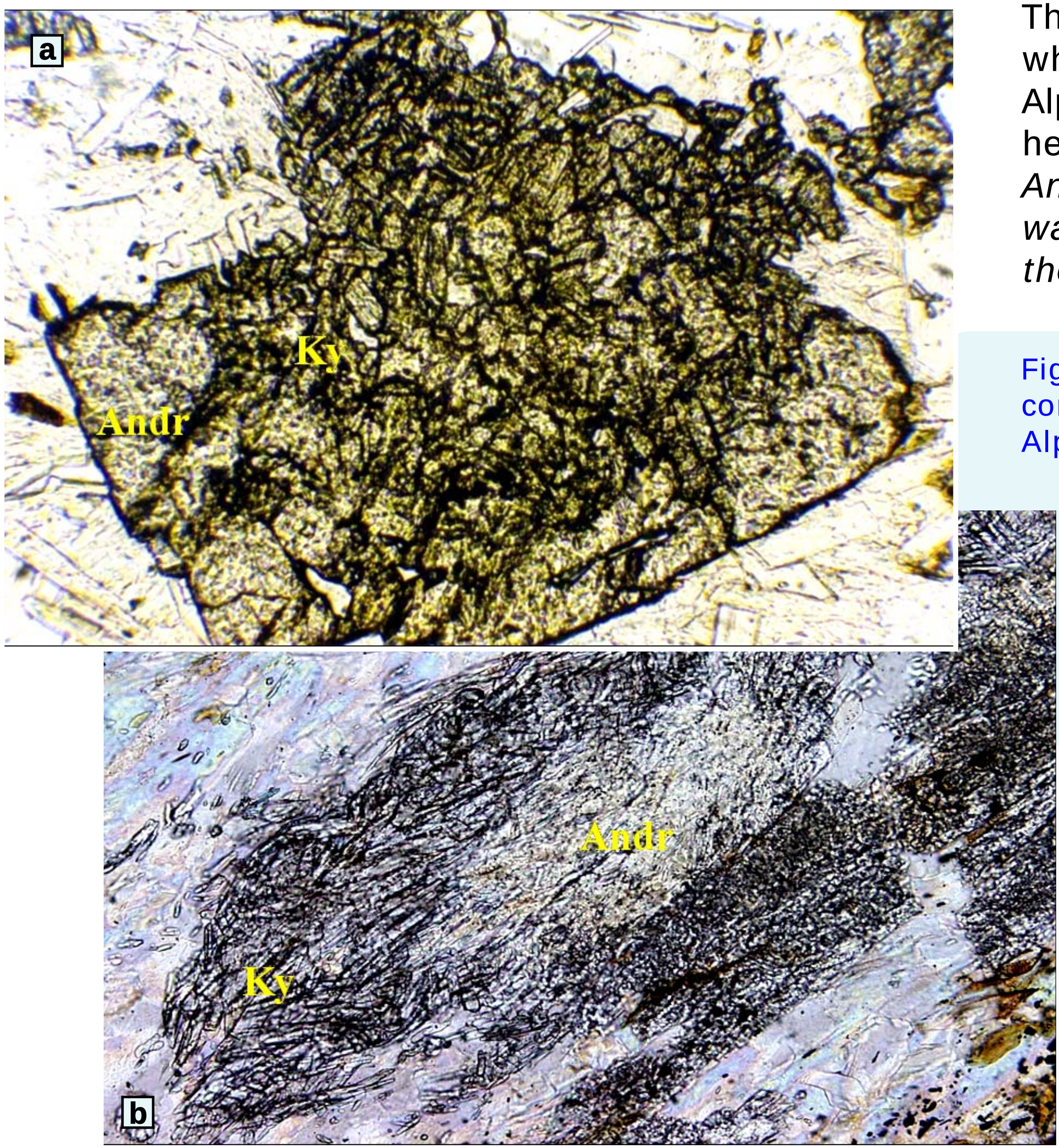
A detailed geological and petrological revision of the Alpujarride Torrox-Sayalonga Pre-Mesozoic metamorphic succession (Central-Western Betic Cordillera, Spain), carried out by the Authors in collaboration with A. Sanchez-Navas and A. Martin-Algarra, researchers of the University of Granada (Spain), provides new data on its Pre-Alpine and Alpine tectono-metamorphic evolution, which appears similar to that of the CPASS Aspromonte Unit basement.
In this guidebook we synthesize the most important results of this recent study, part of which has been discussed in the *84th Congress of the Italian Geological Society* (Macaione et al., 2008).
The Torrox-Sayalonga Unit (TSU), cropping out in the Velez Malaga-Sierra Tejeda Massif (Upper Alpujarride), consists of a Pre-Variscan crystalline basement affected by an important Alpine overprint. The literature supplies contrasting geo-petrological reconstructions on this Unit (Boulin, 1970; Garcia-Casco et al., 1993; Garcia-Casco & Torres-Roldan, 1999; Sanchez-Navas, 1999; Zeck et al., 1989; Zeck & Whitehouse, 1999, 2002; Zeck & Williams, 2001).
In the Torrox-Sayalonga basement our revision has allowed to delineate both Pre-Alpine and Alpine histories.

The Pre-Alpine evolution indicates the presence of:
- Pre-Alpine micaschists and gneissic micaschists preserving M-T and ML- to L-P Hercyno-type relict minerals, such as oligoclase, garnet, staurolite, sillimanite, cordierite and andalusite (fig. 77). This mineral association suggests a retrograde Pre-Alpine metamorphism;
- Pre-Alpine Torrox peraluminous K-feldspar rich orthogneisses, affected by a Hercyno-type process realized under oligoclase-garnet-sillimanite-andalusite-cordierite amphibolite facies (Sanchez-Navas, 1999);
- Pre-Alpine peraluminous aplitic and pegmatitic plutonic dykes.

The Alpine event produced five deformative phases. The first three (Da_1-Da_3) were accompanied by syn- to post-kinematic metamorphism, and the Da_3 phase was syn-metamorphic only in the most foliate rocks. Three different re-equilibrated areas (*partial, weak* and *soft*) have been recognized.

In the TSU, the Pre-Alpine history is considered Variscan in age, according to the Hercyno-type relict association and related tectono-metamorphic evolution. Geo-chronological data provide support for this interpretation (Zeck & Whitehouse, 1999, 2002; Zeck & Williams, 2001).

The compared geological and petrological features of the TSU and AsU partly Alpine overprinted rocks indicate analogous structures (figs. 77 and 78), compositions, and a similar tectono-metamorphic evolution. Among the newly formed Alpine minerals, in the TSU the sillimanite is present whereas the pargasitic amphibole and chloritoid observed in the AsU lack.



The first representative mineral chemistry data of white mica, biotite and garnet from AsU and TSU Alpine partly re-equilibrated gneissic micaschists are here reported (Tables 12 to 14; figs. 79 to 81). *Analyses were performed using a Cameca SX-50 by wavelength dispersive -WDS- electron microprobe, at the University of Granada, Spain.*

Fig. 77 - Variscan sillimanite+andalusite+staurolite+cordierite Gneissic micaschist partly re-equilibrated into Alpine kyanite+almandine+phengite+albite/oligoclase+biotite Gneissic micaschist.
Microscopic structure: Alpine kyanite (Ky) pseudomorphically grown on Variscan andalusite (Andr). a) Sample Map 39. PPL, 180x. Loc.: Middle tract of Badiazza Valley. North-Eastern Peloritani Mts. b) Sample Tr 28A. PPL, 45x. Loc.: SE of the Torrox metaplutonic Complex.

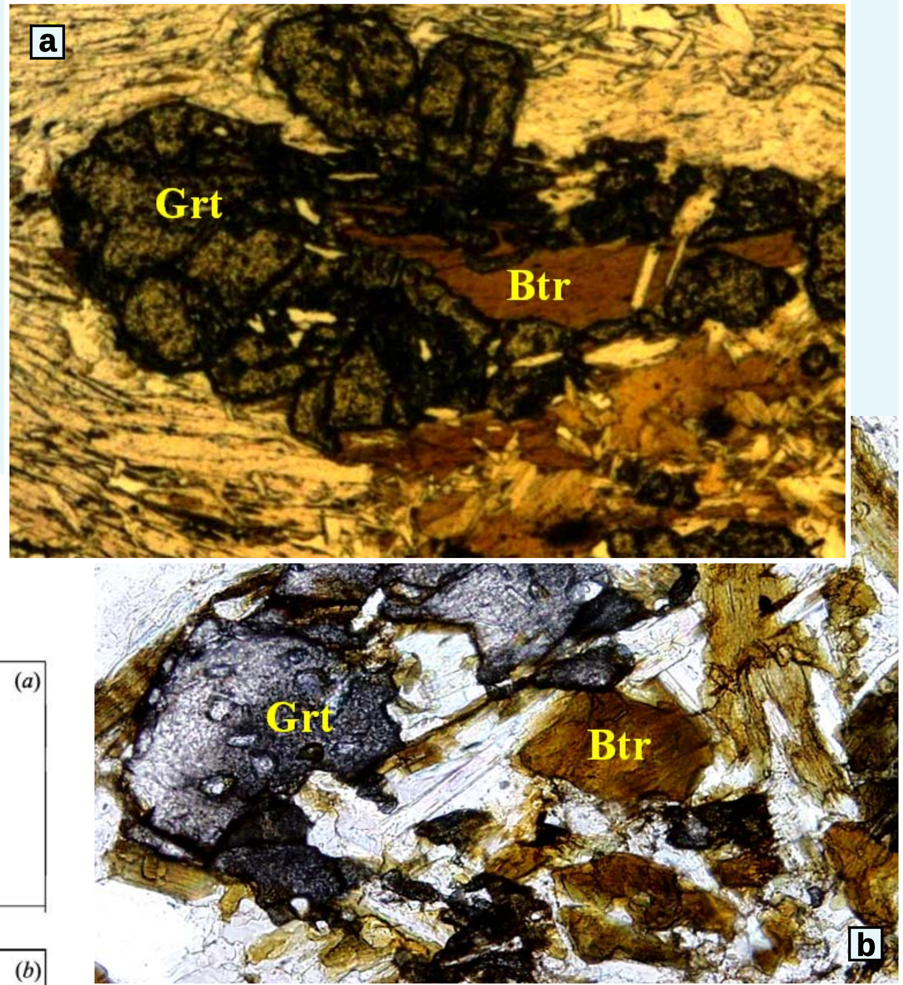
White mica (Table 12; fig. 79) was completely re-equilibrated in Alpine age in both units. The relatively high celadonitic content white micas (Si = 3.14-3.19 a.p.f.u., in the AsU; Si = 3.19-3.22, in the TSU) developed during the Da_1 phase. Low celadonitic content white micas (Si = 3.02-3.12 a.p.f.u., in the AsU; Si = 3.01-3.13 a.p.f.u., in the TSU) form Da_2-Da_3 crystals.

Table 12 - Representative mineral data and structural formulae of white mica from Aspromonte and Torrox-Sayalonga Units Alpine partly re-equilibrated gneissic micaschists.

Mineral	WHITE MICA			
Sample	Map 39	Map 42	Tr 7	Say 1
Site	△	▲	△	▲
SiO_2	47.81	44.94	48.02	45.52
TiO_2	0.35	0.58	0.45	0.66
Cr_2O_3	0.04	0.02	0.00	0.00
Al_2O_3	32.23	35.22	31.20	35.98
Fe_2O_3	1.03	1.57	2.36	1.09
FeO	0.46	0.00	0.00	0.00
MnO	0.03	0.03	0.03	0.01
MgO	1.84	0.80	1.94	0.58
CaO	0.13	0.01	0.01	0.00
Na_2O	0.63	0.65	0.52	0.52
K_2O	10.65	10.98	9.44	9.75
H_2O	4.50	4.46	4.49	4.50
Total	99.69	99.26	98.45	98.61
Cations calculated on the basis of 11 oxygens and 6 cations +Na+K+Ca				
Si	3.187	3.020	3.208	3.031
Ti	0.018	0.029	0.023	0.033
Cr	0.002	0.001	0.000	0.000
Al	2.532	2.789	2.456	2.823
Fe^{3+}	0.051	0.079	0.118	0.055
Fe^{2+}	0.026	0.000	0.000	0.000
Mn	0.002	0.002	0.002	0.001
Mg	0.183	0.080	0.193	0.058
Ca	0.009	0.001	0.001	0.000
Na	0.081	0.085	0.067	0.067
K	0.906	0.941	0.804	0.828
OH	2.000	2.000	2.000	2.000
X_{Mg}	0.878	1.000	1.000	1.000
$Al^{(IV)}$	0.813	0.980	0.792	0.969
$Al^{(VI)}$	1.719	1.809	1.664	1.854

△ = Da_1 crystal; ▲ = Da_2 and Da_3 crystal

Fig. 78 - Late-Variscan peraluminous Plutonite partly re-equilibrated into Alpine almandine+kyanite+phengite+albite/oligoclase+biotite Orthogneiss. Microscopic structure: detail of Alpine almandine (Grt) grown at the expense of Late-Variscan biotite (Btr).
a) Sample Map 39. PPL, 180x. Loc.: middle tract of the Badiazza Valley. North-Eastern Peloritani Mts.
b) Sample Tr 17c. PPL, 45x. Loc.: N of the Torrox metaplutonic Complex.



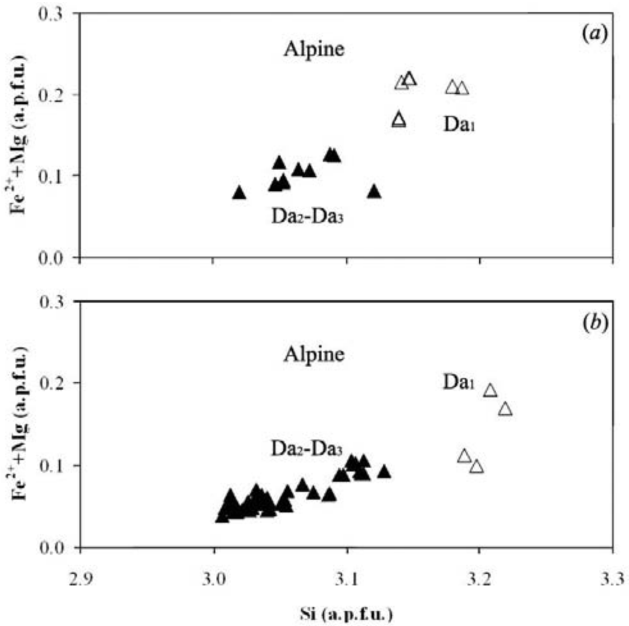


Fig. 79 - Fe^{2+}+Mg vs Si diagram of white micas from Alpine partly re-equilibrated Aspromonte (a) and Torrox-Sayalonga (b) Units gneissic micaschists. Legend as in Table 12.

Table 13 - Representative mineral data and structural formulae of biotite from Aspromonte and Torrox-Sayalonga Units Alpine partly re-equilibrated gneissic micaschists.

Mineral	BIOTITE					
Ample	Map 39	Map 39	Map 42	Tr 5	Say 2	Tr 7
Site	□	◊	◆	□	◊	◆
SiO_2	36.89	36.83	34.77	36.72	35.70	34.55
TiO_2	3.64	4.37	2.44	1.86	2.78	2.97
Cr_2O_3	0.03	0.06	0.06	0.02	0.04	0.04
Al_2O_3	18.67	17.90	18.94	21.42	20.53	21.60
Fe_2O_3	0.62	0.70	0.91	4.47	4.66	2.14
FeO	13.33	16.18	21.41	14.96	16.06	19.75
MnO	0.04	0.09	0.04	0.21	0.10	0.23
MgO	11.83	9.36	7.32	8.21	7.73	6.18
CaO	0.03	0.00	0.03	0.27	0.02	0.01
Na_2O	0.06	0.03	0.03	0.20	0.41	0.14
K_2O	10.04	9.95	9.51	7.22	7.05	8.88
H_2O	4.04	4.00	3.89	4.07	4.01	3.98
Total	99.21	99.47	99.35	99.62	99.09	100.46
Cations calculated on the basis of 11oxygens and cations-Na-K=7-Ti-Al(dioct)/2						
Si	2.736	2.762	2.679	2.708	2.669	2.604
Ti	0.203	0.247	0.141	0.103	0.156	0.168
Cr	0.002	0.004	0.004	0.001	0.002	0.002
Al	1.632	1.582	1.720	1.861	1.809	1.919
Fe^{3+}	0.034	0.040	0.053	0.248	0.262	0.121
Fe^{2+}	0.827	1.015	1.380	0.923	1.004	1.245
Mn	0.003	0.006	0.003	0.013	0.006	0.015
Mg	1.308	1.046	0.841	0.902	0.861	0.694
Ca	0.002	0.000	0.003	0.021	0.002	0.001
Na	0.009	0.004	0.005	0.029	0.059	0.021
K	0.950	0.952	0.935	0.679	0.672	0.854
OH	2.000	2.000	2.000	2.000	2.000	2.000
X_{Mg}	0.613	0.508	0.379	0.494	0.462	0.358
$Al^{(IV)}$	1.264	1.238	1.321	1.292	1.331	1.396
$Al^{(VI)}$	0.369	0.344	0.399	0.569	0.478	0.523

□ = Variscan relict core; ◊ = Variscan relict crystal; ◆ = Alpine crystal

Biotite (Table 13; fig. 80) shows an annite-rich composition with different Fe/Fe+Mg ratio in the Variscan relics and in the Alpine neoblastic crystals of both units. In the AsU only Da_2 and Da_3 neoblastic biotite is present, because of Fe-garnet and pargasitic amphibole developed after Variscan biotite during the Da_1 phase.
In the AsU, Variscan relict cores (Fe/Fe+Mg ratio = 0.40-0.42), Variscan laminae (Fe/Fe+Mg ratio = 0.47-0.58) and Alpine newly formed crystals (Fe/Fe+Mg ratio = 0.63-0.71) are present. In the TSU, relict cores (Fe/Fe+Mg ratio = 0.56) are very rare, whereas Alpine Da_1 (Fe/Fe+Mg ratio = 0.57-0.68) and Da_2-Da_3 (Fe/Fe+Mg ratio = 0.62-0.70) laminae are abundant.

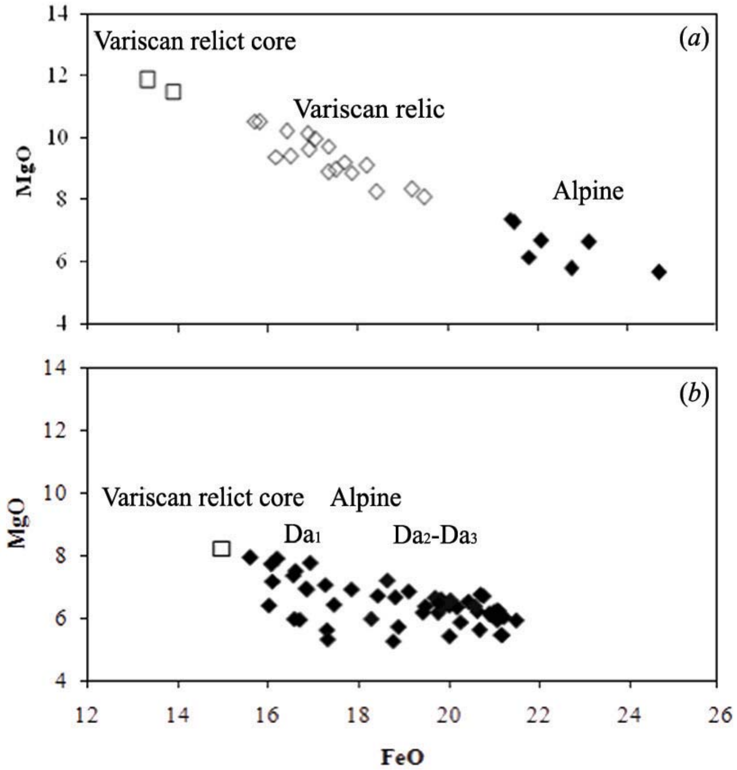


Fig. 80 - MgO vs FeO diagram of Variscan relict and Alpine neoblastic biotites from partly re-equilibrated Aspromonte (a) and Torrox-Sayalonga (b) Units gneissic micaschists. Legend as in Table 13.

Table 14 - Representative mineral data and structural formulae of garnet from Aspromonte and Torrox-Sayalonga Units Alpine partly re-equilibrated gneissic micaschists.

Mineral	GARNET				
Sample	Map 39	Map 42	Map 39	Tr 7	Say 2
Site	□	●	○	□	●
SiO_2	37.42	34.37	38.54	36.69	36.60
TiO_2	0.01	0.46	0.18	0.04	0.07
Cr_2O_3	0.00	0.04	0.00	0.00	0.01
Al_2O_3	21.49	22.03	21.82	21.78	20.67
Fe_2O_3	0.12	4.86	0.00	1.51	1.83
FeO	32.45	29.87	28.89	32.17	33.51
MnO	6.11	1.04	0.19	4.84	0.95
MgO	2.11	3.60	4.09	1.91	3.04
CaO	1.84	3.26	7.22	2.68	3.07
Na_2O	0.00	0.00	0.00	0.00	0.00
K_2O	0.00	0.00	0.01	0.00	0.00
Total	101.55	99.53	100.94	101.62	99.75
Cations calculated on the basis of 12 oxygens					
Si	2.985	2.775	3.006	2.928	2.956
Ti	0.001	0.028	0.011	0.002	0.004
Cr	0.000	0.003	0.000	0.000	0.001
Al	2.021	2.096	2.006	2.049	1.968
Fe^{3+}	0.007	0.296	0.000	0.091	0.111
Fe^{2+}	2.165	2.017	1.885	2.147	2.264
Mn	0.413	0.071	0.013	0.327	0.065
Mg	0.251	0.433	0.476	0.227	0.366
Ca	0.157	0.000	0.603	0.229	0.266
Na	0.000	0.282	0.000	0.000	0.000
K	0.000	0.000	0.001	0.000	0.000
X_{Mg}	0.104	0.177	0.201	0.096	0.139
$Al^{(IV)}$	0.015	0.225	0.000	0.072	0.044
$Al^{(VI)}$	2.006	1.871	2.006	1.976	1.924

□ = Variscan relict core; ● = Alpine crystal after Variscan biotite; ○ = Alpine crystal after both Variscan biotite and plagioclase

Garnet (Table 14; fig. 81) is present both as Variscan relict cores and Alpine newly formed crystals in the two compared units. Variscan and Alpine garnets show almandine composition with similar Mg-contents, whereas Mn abundance decreases from Variscan (X_{Mg} = 0.09-0.15 and Grs = 4-6 in the AsU; X_{Mg} = 0.10-0.12 and Grs = 3 in the TSU) to Alpine crystals. These last ones show heterogeneous Fe-values in both units and high Ca-values only in the AsU. The Fe-rich garnet, growing after Variscan biotite, is common in both compared units (X_{Mg} = 0.15-0.20 and Grs = 0-19 in the AsU; X_{Mg} = 0.10-0.14 and Grs = 0-11 in the TSU), whereas the Ca-rich garnet, developing after both Variscan biotite and plagioclase, is typical of the AsU (X_{Mg} = 0.08-0.21 and Grs = 19-29 in the AsU).

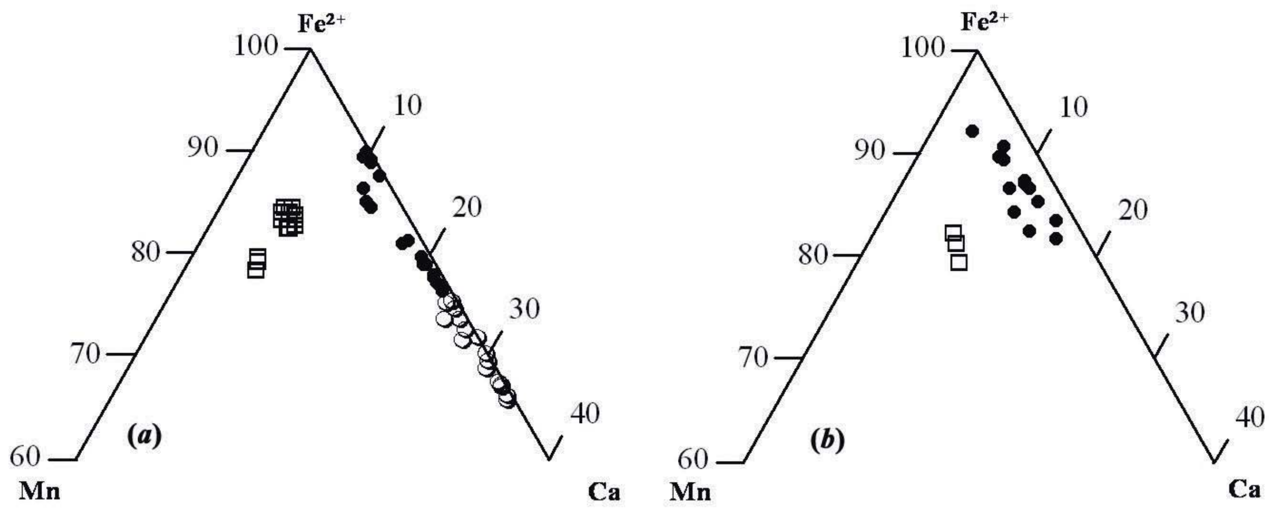


Fig. 81 - Fe^{2+}-Mn-Ca diagram of Variscan relict and Alpine neoblastic garnets from partly re-equilibrated Aspromonte (a) and Torrox-Sayalonga (b) Units gneissic micaschists. Legend as in Table 14.

The estimated Alpine P-T conditions for the Aspromonte and Torrox-Sayalonga Units partly overprinted rocks indicate a Barrovian-type polystage metamorphism. In the AsU, the Da_1 first stage realized under P=0.7–0.6 GPa and T=500±20°C (phengite+kyanite+almandine+pargasite+albite+ ripidolite assemblage), distinctive of greenschist facies garnet zone conditions; in the TSU it developed under the same pressure and at T>550°C (phengite+kyanite+almandine+oligoclase+biotite assemblage), typical of the beginning of amphibolite facies conditions. In both units metamorphism went on with a slight decrease of P and increase of T, recorded by the Da_2 + Da_3 second stage, occurred in the AsU at P=0.4-0.5 GPa and T>550°C (continue growth of kyanite and almandine, in addition to low celadonitic content white mica+oligoclase+biotite), corresponding to the beginning of amphibolite facies; and in the TSU at similar P and at T>620°C (continue growth of almandine, in addition to low celadonitic content white mica+oligoclase+sillimanite+biotite), corresponding to the M-T amphibolite facies conditions.
All reconstructed geological and petrological data indicate that both the Aspromonte and Torrox-Sayalonga Units represent parts of a continental metamorphic and plutonic Variscan crustal segment (low-intermediate the AsU and intermediate the TSU which is lacking of granulite rocks), characterized by both similar Pre-Variscan records (low crust metaultramafic relics absent in the TSU) and Alpine polystage overprint. The recognized analogies provide new support to the hypothesis of the provenance of the Calabria-Peloritani Arc and Betic Cordillera (internal units) continental crust units from a single palaeogeographic domain, the Mesomediterranean Microplate, deformed since Oligocene-Miocene.

The above traced, discussed and illustrated, Palaeo-Proterozoic to Modern field trip allows to know the characters of the oldest and the more recent history of the CPASS, according to macro-, meso- and microstructures, in addition to representative petrological features of the observed rocks. This tour develops in a spectacular and scenic zone, centre and crossroads of ancient Mediterranean civilizations.
This very important *Geomorphological and Geological Heritage,* characterizing the itinerary and the surrounded area, focused in Geosites and Geotopes, is peculiar of both sides of the Messina Straits Territory and, consequently, not present in other part of the Southern Sector.
In fact, markers of the Aspromonte Unit low-intermediate continental crust, such as Pre-Variscan metaplutonic ultramafics, Variscan augengneisses, granulite and migmatite facies rocks, as well as Late-Variscan calc-alkaline syntectonic meta- and mesaluminous plutonics, are only known in the Sila (Catena Costiera and Gariglione-Polia Copanello areas) and Castagna Units, in the CPA Northern Sector.

The strict analogies between the composition and Proterozoic to Oligocene evolution of the Aspromonte Unit continental crust with the Torrox-Sayalonga Unit crystalline rocks (Betic Cordillera, Alpujarride Complex) suggest the very significant role of this Territory in the Geodynamics of the Central-Western Mediterranean Alpine Chains.

The defined Geo-Heritage, in addition to the biotic and historical characteristics, constitutes a considerable cultural system promoter of innovative conservation and management models.

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