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CALABRIA-LUCANIA OPHIOLITES

Abstract. Available data indicate that the Calabria-Lucania ophiolites may be considered fragments of the oceanic lithosphere developed during the Jurassic opening of the Western Tethyan basin separating the European and Insubrian continental blocks. The primary rock assemblage includes: mantle ultramafics mostly of spinel-lherzolite character; cumulus gabbros derived from MORB-type tholeiitic magmas at various fractional crystallization stages; basaltic extrusives showing a mostly undepleted tholeiitic composition of transitional MORB type. The sedimentary cover includes radiolarian chert of late Jurassic age. In primary characteristics they are similar to the ophiolites from the Western Alps, Northern Apennines and Corsica, particularly to the External Liguride sequences of the Northern Apennines. An origin in a pericontinental position is supported by the primary stratigraphical relationships with continental rocks from the lower crust and terrigenous sequences. Their tectonic-metamorphic evolution included dismemberment, subduction-related high-pressure and low-temperature (HP/LT) metamorphism, and emplacement as distinct tectonic units. The distribution and inferred age of the HP/LT metamorphism indicate that the ophiolites from the Lucanian Apennines and the Calabrian Arc represent two distinct belts. One includes the blueschist facies ophiolites of the Calabrian Arc, which record an Eoalpine tectonic-metamorphic evolution assigned to the Cretaceous-Paleogene. A second belt includes the metaophiolites and associated metasedimentary rocks of the Lucanian Apennines which record a later tectonic event assigned to the late Oligocene-early Miocene. The high-pressure and very low-temperature conditions of the post-late Oligocene metamorphic event can be accounted for in a subduction environment. It is suggested that in the Calabria-Lucania sector, Western Tethys underwent fragmentation of the oceanic lithosphere (or crust) and subsequent diachronous closure, including a mid-Tertiary stage, at the time when continental collision is known to have occurred in other sectors of the Alpine-Apennine system. The hypothesis of a mid-Tertiary subduction has important implications for the geodynamic relationships of the Oligocene-Miocene calc-alkaline volcanism represented in the peri-Tyrrhenian area.

INTRODUCTION

The major questions regarding the origin of the Tethyan ophiolites in the Alpine-Apennine orogenic system involve their paleogeodynamic setting, their position with respect to the continental margins, and the extension and structure of the oceanic basin. Further questions related to their tectonic-metamorphic evolution involve the effects of subduction and continental collision, and the timing and duration of tensional and compressive processes.

Petrological and geochemical studies have provided useful criteria on the genesis and evolution of the ophiolites. For the ophiolites in the Western Alps, Corsica and the Northern Apennines in particular, there is petrological evidence of generation in ocean ridge and transform fault settings, and of involvement in subduction processes. In view of these characteristics they are all assigned to a Western Mediterranean belt of the Tethyan realm (Beccaluva et al., 1980; and references therein).

The ophiolites outcropping in the Calabrian-Lucanian area form the southernmost segment

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of the Western Mediterranean ophiolitic belt. Though highly dismembered and outcropping mostly in extremely small bodies, they show surprisingly well-preserved sections of the volcanics and capping sediments, still detectable primary magmatic features, as well as clear evidence of subduction-related metamorphism with some particular distinctive features compared with other Western Mediterranean ophiolites.

This paper presents a synthetic review of previous data and recent work, and discusses the implications from studies of the ophiolites with respect to the tectonic evolution of the Alpine-Apennine system.

GEOLOGICAL SETTING

The Calabrian-Lucanian ophiolites include mantle and crustal rocks associated with pelagic and flysch deposits of Jurassic to Oligocene age, outcropping in different tectonic units in the Lucanian Apennines and the Calabrian Arc orogenic belts. The ophiolitic units are geometrically superposed over a thrust nappe pile of Mesozoic sedimentary sequences derived from external Apenninic domains; in the Calabrian Arc they are overlain by thrust nappes of Paleozoic igneous and metamorphic continental rocks and their sedimentary cover (Fig. 1).

In terms of primary features and internal stratigraphy, there are many similarities among the ophiolites belonging to different tectonic units in the Lucanian Apennines and the Calabrian Arc (Beccaluva et al., 1983). In terms of metamorphic features, a group of weakly metamorphosed ophiolites, mostly affected by oceanic metamorphism (previously referred to as Apennine-type ophiolites, for their similarities with the ophiolites from the Ligurian Apennines: Dietrich and Scandone, 1972) and a group of metamorphosed ophiolites typically, but not evenly affected by high-pressure and low temperature (HP/LT) metamorphism (previously referred to as Alpine-type ophiolites for their similarities with the ophiolites from the Western Alps: Dietrich and Scandone, 1972, Haccard et al., 1972, Alvarez, 1976) are distinguished (Amodio Morelli et al., 1976; Lanzafame et al., 1979a).

Recent stratigraphical (Bonardi et al., 1988, 1992) and structural studies (Knott, 1987; Cello et al., 1991; Monaco, 1992; Monaco et al., 1992; Wallis et al., 1993) suggest that previous models assigning the ophiolitic terrains to a Liguride Complex (Ogniben, 1969, 1973), or those dividing them into an Eoalpine and an Apennine thrust belt (Amodio Morelli et al., 1976) fail to correlate the ophiolitic units in the Lucanian Apennines with those from the Calabrian Arc, or to explain some differences in their metamorphic evolution.

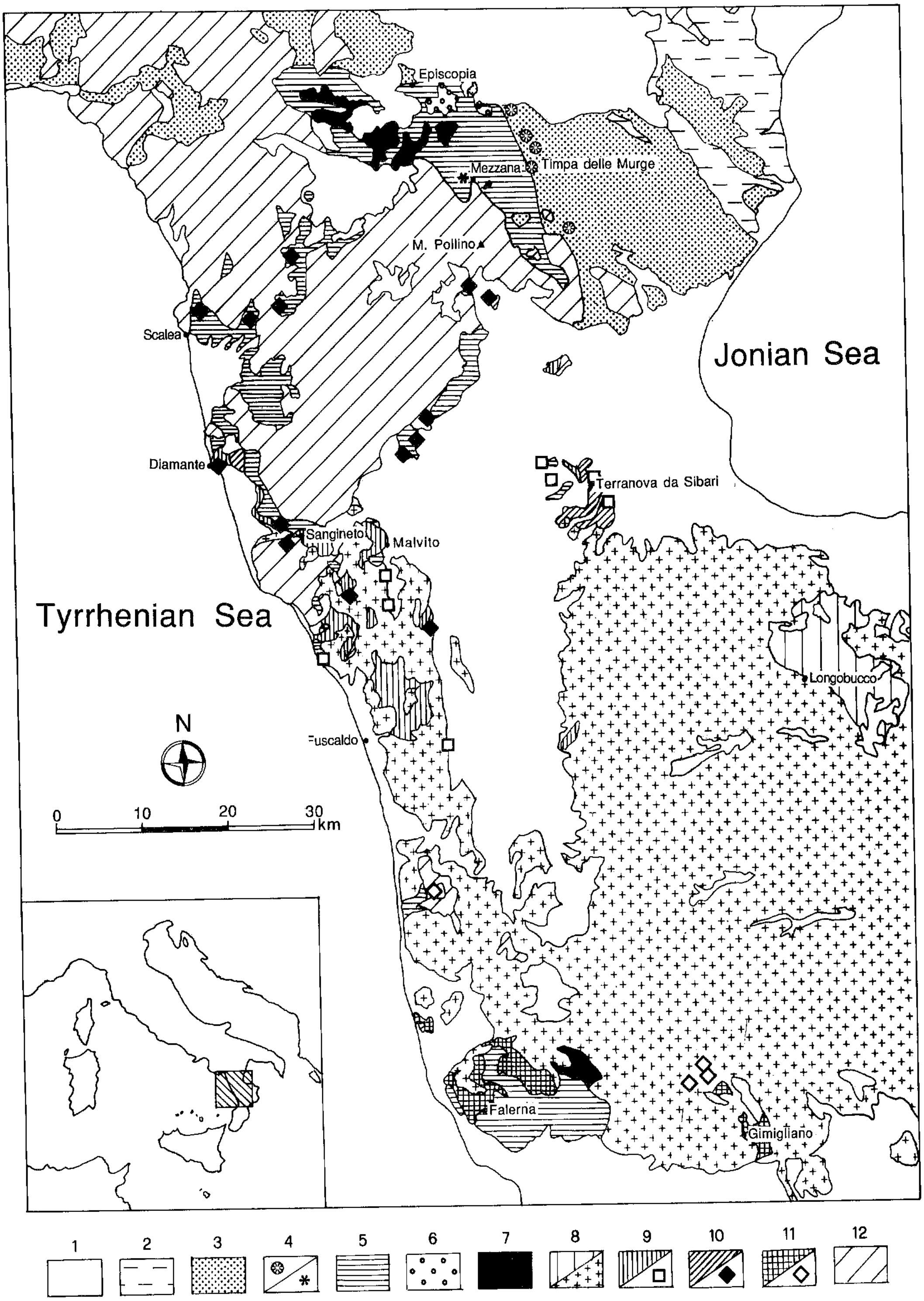
An outline of the prominent stratigraphical, petrological and metamorphic features is therefore reported separately for the two geographical areas and summarized in the Table.

LUCANIAN APENNINES

Structural relations

In the Lucanian Apennines, the ophiolitic terrains are exposed discontinuously in an area

Fig. 1 — Geological map of the Calabria-Lucania ophiolites (From Amodio Morelli et al., 1976 and Lanzafame et al., 1979a, simplified and modified). Legend: 1. Quaternary and Neogene sediments; 2. Varicoloured shale, flysch, tuffite (Sicilide units: Cretaceoous-Miocene); 3. Calabro-lucano Flysch Unit (Cretaceus-Eocene) and transgressively overlying flysch units (Eocene-Miocene); 4: ophiolitic slices (gabbro-basalt-chert: late Jurassic) at the base of unit 3 (wheel), Mezzana limestone (Jurassic) and overlying basalt (asterisk); 5. Phyllite, calcschist, quartzite (Frido Formation: ?Jurassic-late Oligocene), in the Lucanian Apennine associated with ophiolites and continental crust rocks as mélange (Frido Unit); 6. Polymetamorphosed continental rocks from the lower crust within the Frido Unit; 7. Serpentinized ophiolitic peridotites; 8. Metamorphic and igneous rock units of continental crust provenance (cross) and sedimentary cover (vertical line); 9. Upper ophiolite unit of the Calabrian Arc: sub-greenschist to lawsonite-albite facies metamorphosed basalt, chert, limestone, graywacke (?late Jurassic- early Cretaceous). Square for unmappable outcrop; 10. Gimigliano Unit: mostly greenschist facies metabasalt, metagabbro, phyllite, metaconglomerate. Open diamond for unmappable outcrop; 11. Lower ophiolite unit of the Calabrian Arc: mostly blueschist facies metabasalt and meta-ferrogabbro, calcschist, phyllite. Diamond for unmappable outcrop; 12. Carbonate rock units from external Apenninic domains.


Episcopia
Mezzana
Timpa delle Murge
M. Pollino
Scalea
Jonian Sea
Diamante
Terranova da Sibari
Sangineto
Malvito
Tyrrhenian Sea
Longobucco
N
Fuscaldo
0
10
20
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km
Falerna
Gimigliano
1
2
3
4
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6
7
8
9
10
11
12

Table — Ophiolitic units of Northern Apennines and the Calabrian Arc.

AREA	LUCANIAN APENNINE		CALABRIAN ARC		
Tectonic unit	FRIDO UNIT	CALABRO-LUCANO FLUSCH UNIT	UPPER OPHIOLITE UNIT	LOWER OPHIOLITE UNIT	GIMIGLIANO UNIT
Primary ophiolitic lithologies	basalt, dolerite, peridotite	basalt, dolerite, Fe-gabbro	basalt, dolerite, Fe-gabbro	basalt, dolerite, Fe-gabbro	basalt, dolerite, gabbro, peridotite
Mode of occurrence	tectonic mélange, slices	nappe, slice	nappe	nappe, slice	nappe, slice
Covering sediments (primary lithologies)	chert, calcarenite (? late Jurassic)	radiolarian chert (late (Jurassic), shale, qz-arenite, marl	radiolarian chert, (late Jurassic)	calcarenite, pelite	? pelite, arenite
Stratigraphically related rocks prior to HP/LT metamorphism and/or displacement	metamor. flysch sequence (early Cretaceous-late Oligocene); continental crust rocks	flysch sequence (early Cretaceous-late Oligocene)	metam. *Calpionella* limestone, graywacke, slate (early Cretaceous)	calcschist, phyllite	metarenite, phyllite, metaconglomerate
Type of metamorphism, facies	HP/LT, blueschist; greenschist facies retrogression	mostly oceanic, sub-greenschist to amphibolite	? oceanic (sub-greenschist), MP/LT, lawsonite-albite, greenschist facies retrogression	HP/LT, blueschist, greenschist facies retrogression	LP/LT, mostly greenschist, relict of previous HP/LT, blueschist

measuring about 40 km in an ESE-WNW direction (Fig. 1). The ophiolites include mostly serpentinized peridotites, lesser basaltic lavas and capping sediments, and rare gabbros, and occur in distinct units as:

a) blocks and fragments mostly affected by high-pressure and low-temperature (HP/LT) metamorphism included in the polylithic and polygenic mélange sub-unit (metamorphosed ophiolites, metamorphosed sedimentary rocks, continental crust rocks) included in the Frido Unit (Lanzafame et al., 1979a, 1979b; Spadea, 1982);

b) serpentinite lenses occurring within and at the base (Monaco et al., 1992) of the metasedimentary sequence (previously defined as the Frido Formation assigned to the Neocomian-Aptian by Vezzani, 1969, recently revised and assigned to the late Jurassic-late Oligocene by Bonardi et al., 1992) belonging to the Frido Unit;

c) fragments unaffected by HP/LT metamorphism, consisting mostly of basalts and minor gabbros intruded by basaltic dikes covered with radiolarian chert (Oxfordian: Marcucci et al., 1987), pelagic sediments and overlying flysch deposits (Lanzafame et al., 1978), assigned to the Calabro-lucano Flysch Unit (Monaco et al., 1992) of late Jurassic-late Oligocene age (Bonardi et al., 1988).

The metamorphosed flysch included in the Frido Unit, and the Calabro-lucano flysch are thought to derive from the same sequence (Lanzafame et al., 1979b; Knott, 1987).

Primary petrochemical features

The basic extrusives from the Calabro-lucano Flysch Unit are basaltic pillow lavas and breccias with aphyric and plagioclase and, rarely, olivine phyric textures. Chemically they are tholeiitic basalts similar to mid-ocean ridge basalts of transitional type (Fig. 2).

The gabbros consist of plagioclase, clinopyroxene with or without olivine, and represent cumulates related to primitive tholeiitic magma (Mg-gabbros: Beccaluva et al., 1983). The associated dikes are basaltic and doleritic rocks. It is worth mentioning that, as in the ophiolites from the Northern Apennines, a sheeted dike complex is missing. Other occurrences of dike rocks intruded at shallow depth are found within the serpentinized peridotites and in continental rocks associated with ophiolites in the Frido Unit mélange; they are thought to be related to the ophiolitic extrusives (Spadea, 1982).

The peridotites are mostly serpentinized tectonites and include derivatives from lherzolite, less frequently harzburgite, dunite and pyroxenite (Lanzafame et al., 1979a). Serpentinized ultramafics deriving from mela-troctolite of cumulus origin are also represented (Spadea, unpublished data).

Metamorphic features

In the Frido Unit, the regional metamorphism of the ophiolites and sedimentary rocks covering basalt (Lanzafame et al., 1979b), and from the blocks and fragments of lower continental crust included in the mélange (Spadea, 1982), shows comparable characteristics resulting from a similar evolution under HP/LT conditions (Spadea, 1976, 1982; Monaco et al., 1992). A fingerprinting of the metamorphic environment and history is given by the occurrence of widespread aragonite, which suggests that the low-grade metamorphism developed at unexpectedly high pressure. This is inferred mainly from a study of the meta-calcareous rocks of the Frido Formation (Spadea, 1976). The physical conditions and timing of the HP/LT metamorphism are still not well known, nor is metamorphic overprinting uniform in each lithology (Monaco et al., 1992), as is common in tectonic mélanges. However, the available data suggest that pressure was higher than 6 kb (up to 8-10 kb according to Monaco et al. 1992) at the climax of the metamorphism, and that shearing subsequently occurred still at high pressure (Spadea, 1976, 1982; Monaco et al., 1992). There are some indications about retrogression, suggesting low-grade greenschist conditions for the metabasics (Monaco et al., 1992). In metasedimentary rocks, aragonite is often largely preserved, indicating that the rocks did not completely re-equilibrate during retrogression. It is therefore argued that metamorphism occurred under very low temperature, possibly even less than the 400-450°C estimate by Monaco et al. (1992), and that exhumation was rapid (Spadea, 1976, 1982). These characteristics indi-

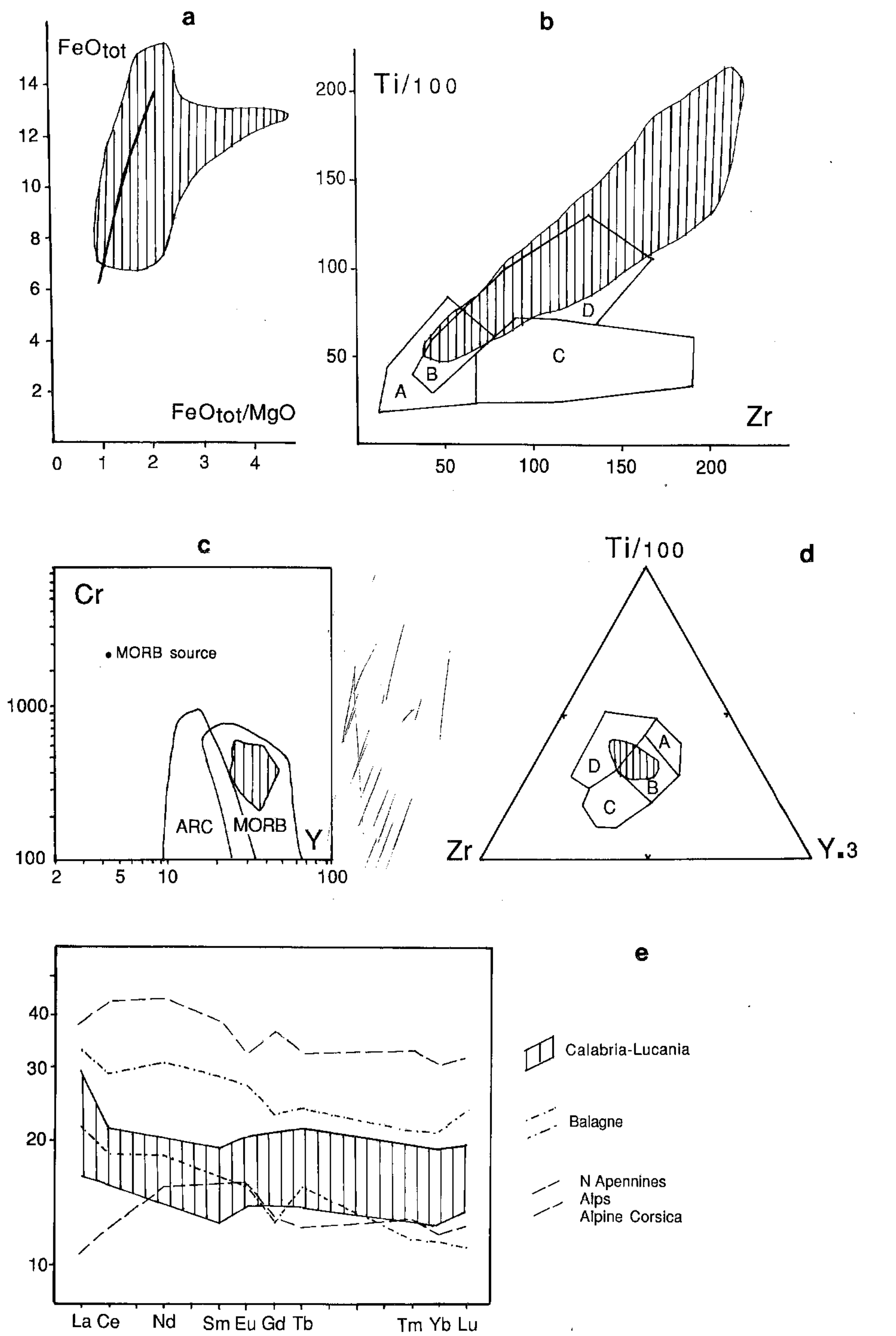

Fig. 2 — Field of basalts from the Calabria-Lucania ophiolites (vertical hatching) in variation and discriminant diagrams (from Spadea, 1979 and Beccaluva et al., 1983) showing: tholeiitic affinity (diagram a: solid line is the ocean floor tholeiite trend according to Miyashiro, 1975), MORB character (diagrams b, c, d. Fields in diagrams b and d, A: island-arc tholeiites, B: island-arc tholeiites, calc-alkaline basalts, ocean floor tholeiites, C: calc-alkaline basalts, D: intra-plate basalts from Pearce and Cann, 1973. Fields for MORB and arcs in diagram c from Pearce, 1982) and affinity with transitional MORB similar to the Balagne (Corsica) ophiolitic basalts (diagram e).

cate a subduction environment, which has important consequences for the reconstruction of the geodynamic evolution, as will be discussed below.

In the Calabro-Lucano Flysch Unit, the metamorphism of the basalts is of very low grade, indicating sub-greenschist facies, which could be related to either regional metamorphism or hydrothermal alteration in the oceanic environment. In gabbros and associated dikes, on the contrary, there are clear indications of a dominant oceanic metamorphism developed under amphibolite to greenschist facies conditions (Beccaluva et al., 1983).

CALABRIAN ARC

Structural relations

In northern Calabria, ophiolites occur in two superposed units (Dietrich and Scandone, 1972; Spadea, 1976), which probably represent highly eroded nappes emplaced during distinct tectonic events, resting above Apennine units and overlain by nappes of continental crust terrains (Amodio Morelli et al., 1976). These two units are as follows:

a) an upper ophiolite unit, composed mostly of basaltic pillow lavas covered with sediments which were originally radiolarian chert, detrital limestone and arenite of Tithonian-Neocomian age, showing variable metamorphic inprinting;

b) a lower ophiolite unit, consisting mostly of metabasalt and overlying meta-sediments derived from limestone and pelite; this unit includes also metamorphosed breccias of sedimentary origin with ferrogabbro clasts.

In central Calabria the southernmost ophiolite fragments of the Calabrian Arc crop out, and include:

c) lenses of metamorphic serpentinite occurring at the base of unit a;

d) a metamorphic ophiolite unit (Gimigliano Unit: Amodio Morelli et al., 1976), similar in primary lithologies to unit b.

Unit b has for a long time been interpreted as a relict fragment of an Eoalpine chain of Cretaceous age (Dal Piaz et al. 1989, and references therein) verging toward the European foreland (Amodio Morelli et al., 1976) recording early tectonism and subduction in the Alpine realm. The results of recent structural studies (Cello et al. 1991) are in agreement with this interpretation.

In the light of the new data coming from the study of the Frido Unit in the Lucanian Apennines (Bonardi et al., 1992), previous models interpreting the lower ophiolitic unit of the Calabrian Arc as a Frido Unit (Spadea et al., 1976; Lanzafame et al., 1979b) need to be revised.

Primary petrochemical features

The basaltic pillow lavas from the upper ophiolite unit include both aphyric types and plagioclase- (sometimes also olivine-) phyric rocks with sub-alkaline tholeiitic chemistry similar to that of normal to transitional MORB (Fig. 2). Highly plagioclase phyric basalts are common and characteristic lithologies of this ophiolite unit. The metabasalts (sometimes pillowed) from the lower ophiolite unit and the Gimigliano Unit include aphyric and plagioclase- with or without olivine phyric basalts with transitional MORB chemistry.

Gabbros in the metasedimentary breccia in the lower ophiolite unit were originally olivine, plagioclase and pyroxene cumulates with high contents of apatite and Fe-Ti oxides. They are similar to the Fe-gabbros in the Northern Apennines ophiolites which are interpreted as late cumulates generated from oceanic tholeiitic magmas (Beccaluva et al., 1983).

Metamorphic features

In the upper ophiolite unit, the basalts and associated sedimentary rocks are overprinted by a low-grade metamorphism under prehnite-pumpellyite to lawsonite-albite facies conditions (De Roever, 1972; Spadea et al., 1976). The lawsonite-albite facies assemblages are typical for this unit (De Roever, 1972) and ascribed to medium- pressure conditions (3-4.5 kb) of a low-gradient metamorphism. Retrograde metamorphism under greenschist facies conditions is also shown.

In metabasalts from the lower ophiolite unit, typical blueschist facies assemblages are developed and overprinted by retrogressive greenschist facies assemblages (Hoffmann, 1970; Spadea et al., 1976; Cello et al., 1991). Estimated conditions for the climax of the HP/LT metamorphism are in the range 6-8 kb and 350-400°C, and in the order of 3 kb and 300° C for the retrogressive greenschist event.

In the Gimigliano Unit previously mentioned, the metabasites display mostly greenschist facies assemblages, with relicts of older blueschist assemblages (Piccarreta and Zirpoli, 1975). A greenschist facies metamorphism is also recognized in the serpentinites at the base of the Gimigliano Unit by the presence of dominant antigorite among the serpentine minerals.

In spite of the high dismemberment, a zoneography of the metamorphism has been inferred by De Roever (1972). For the HP/LT event, pressure and temperature appear to increase from the east to west.

DISCUSSION

In the following discussion, the significance of the Calabria-Lucania ophiolites in the context of the geodynamic evolution of the Southern Apennines is considered, and some outstanding problems, which require further investigation, are outlined.

Primary tectonic setting

The available data indicate that the Calabria-Lucania ophiolites may be considered fragments of the oceanic lithosphere developed during the Jurassic opening of the Western Tethyan basin separating the European and Adria continental blocks. The primary rock assemblage includes mantle ultramafics mostly having spinel-lherzolite character, cumulus gabbros deriving from MORB-type tholeiitic magmas at various fractional crystallization stages, and basaltic extrusives showing mostly undepleted tholeiitic composition of transitional MORB type. Compared with an ideal oceanic lithosphere, the reconstructed sequence is notably less thick, particularly the intrusive section, with a significant absence of any sheeted dike complex. Similar characteristics are shown in the ophiolitic sequences in the Western Alps, in the Northern Apennines and Corsica, and have been interpreted as indicative of oceanic lithosphere generated during the early stages of oceanic basin formation in a rift zone and subsequently in a ridge-fracture zone setting (Beccaluva et al., 1980; Piccardo et al., 1990). For the External Liguride sequences of the Northern Apennines, which the Calabria-Lucania ophiolites most closely resemble, a development during pre-oceanic rifting has been inferred, mostly from the study of the peridotites (Piccardo et al., 1990).

Features pointing to a pericontinental generation

The first evidence indicating that the Calabria-Lucania ophiolites originated in a near-continental site is provided by the association of ophiolites and retrograde continental rocks from the lower crust in the Frido Unit mélange. This association has been shown to be both primary (i.e., due to the intrusion of basaltic dikes petrologically similar to the ophiolitic extrusives into the continental crust) and prior to the tectonic dismemberment and HP/LT metamorphism (Spadea, 1982). The continent involved is identified as the Adria plate.

Also, the abundance of terrigenous components early in the sedimentary sequence (i.e., since the Tithonian) deposited on top of the ophiolitic basalts is indicative of a nearby continental source (or sources).

A pericontinental position does not necessarily constrain the width of the pre-existent ocean, and the main, and as yet unsolved, problems are the site of inception of subduction and its timing and duration.

Evidence for subduction-related metamorphism

The HP/LT metamorphism affecting the Calabrian Arc ophiolites has been related to the subduction of the Tethyan oceanic crust because of its similarities with the HP/LT metamorphism of the Alpine ophiolites. The metamorphic history is however not known in detail, particularly as far as the prograde and retrograde path constraints and the relation to the Alpine metamorphism of the Calabrian Arc crystalline thrust sheets (Platt and Compagnoni, 1990) are concerned.

In the Lucanian Apennines, there is evidence of high-pressure metamorphism at very low-temperature, particularly in the Frido Unit metasedimentary rocks associated with the ophiolites. This metamorphism is related to subduction of oceanic crust together with overlying flysch and remnants of continental crust, as constrained by blueschist facies imprinting and the particularly widespread occurrence of aragonite and its persistence during shearing and exhumation. Metamorphic rocks with similar diagnostic mineral assemblages have recently been discovered by drilling in the Mariana forearc, so giving direct evidence that blueschist metamorphism takes place within a subduction zone (Maekawa et al., 1992). The generalized Cretaceous age of the HP/LT metamorphism which had previously been inferred must be revised on the basis of the Oligocene minumum age recorded in the Frido Unit of the Lucanian Apennines (Bonardi et al., 1992). A single interpretation relating the age of the metamorphism of both the Calabrian and Lucanian sectors seems unsatisfactory, as it does not agree with the structural relations of the ophiolitic units of the Calabrian Arc. With the available data it is therefore conceivable that the ophiolites from the Lucanian Apennines and the Calabrian Arc represent two distinct belts, as far as tectonic evolution is concerned.

Two ophiolitic belts in the Southern Apennines

In the Lucanian Apennines, the stratigraphical relations and the primary and metamorphic features of the ophiolites and associated flysch formations in the Frido Unit and the and Calabro-Lucano Flysch Unit suggest that a portion of the Tethyan ocean survived subduction until the late Oligocene. After this time (prior to early Miocene: Bonardi et al., 1988) a subduction occurred, which caused a decoupling of the crust and possibly the tectonic emplacement of metamorphic ophiolites and primarily associated rocks above unmetamorphosed ophiolites and flysch (Monaco, 1992).

In the Calabrian Arc, on the contrary, the blueschist facies ophiolites can be regarded as fragments of Tethyan crust recording deformation and subduction related to the Cretaceous-Paleogene tectogenesis (Eoalpine event). No age younger than early Cretaceous is recorded in the sedimentary sequences associated with the ophiolites, the flysch sequences possibly of younger age being included in the Frido Unit and probably unrelated to the cover of the outcropping ophiolites (Bonardi et al., 1988).

Recent models on the evolution of the Alpine-Apennine system (Treves, 1984; Abbate et al., 1988; Polino et al., 1990) suggest that the ophiolites originated in a single ocean basin and evolved in a long-lasting accretionary wedge which developed along the Adria margin during the Cretaceous, and later, during early Eocene, collided with the European foreland. The Calabria-Lucania ophiolites do not fit these models in terms of timing and duration of the accretionary wedge. A more complex model predicting segmentation of Tethys and accretion of oceanic materials until the late Oligocene would account for the characteristics of the Calabria-Lucania ophiolites. This model implies that the ophiolites from the Lucanian Apennines and the Calabria Arc mark two distinct suture zones in the development of the Alpine-Apennine system.

The hypothesis of a post-late Oligocene subduction event needs to be confirmed by further investigations, particularly the radiometric dating of the HP/LT metamorphism on which the preliminary data obtained with the K/Ar method (Delaloye, Fontignie and Spadea, unpublished data) are rather ambiguous.

It can finally be noted that the Frido Unit mélange from the Lucanian Apennines could represent an interesting case study on the still debated problem of evolution, uplift and exhumation of high-pressure metamorphics (as discussed and modelled by Ernst, 1975; England and Holland, 1979; Platt, 1986; Hsu, 1991; Wallis et al., 1993; and many other authors).

Implications of an Oligocene-Miocene subduction

The Cainozoic volcanism, which is well known in Sardinia and extensively recorded in the peri-Tyrrhenian area, is dominated by calcalkaline products with orogenic affinity (Beccaluva et al., 1989 and the quoted references). In the Lucanian Apennines in particular, volcanic rocks with a similar calcalkaline serial character and probably related to the same volcanic activity are recorded in turbiditic sequences lying on the Calabro-lucano Flysch Unit (Lanzafame et al., 1977; Critelli and Monaco, 1992).

The presence of a volcanic arc in the Oligocene-Aquitanian has been inferred, whose development is related to a prolonged subduction of oceanic lithosphere toward the north-west below the Sardinian block (Beccaluva et al., 1989). The mid-Tertiary subduction inferred for the Lucanian Apennines ophiolites should provide significant indications for locating the oceanic realm involved.

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