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THE APENNINIC-MAGHREBIAN OROGEN IN THE CENTRAL MEDITERRANEAN REGION: A REVIEW

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The present-day physiographic-tectonic features of the Central Mediterranean region are the product of the geodynamic evolution in which a fundamental role is played by the distribution of crustal components (Finetti et al., 1996) (fig. 1). The orogenic belt is located between an old oceanic crust, the Ionian basin, which has been partially consumed, and a new oceanic crust, the abyssal plane of the Tyrrhenian basin. Moreover, the CROP-Mare project (Finetti Ed., 2005) recognized a continental crust in the circum-Tyrrhenian margins associated with migrated tectonic stacks that were colliding with the continental blocks of the Africa and Adria plates.

Structural domains in the central Mediterranean

In the Central Mediterranean region, the orogenic belt originated during the Tertiary through the convergence between the European margin and the Africa-Adria plates. The recognizable structural domains are the following: the Foreland Domain, the Orogenic Domain and the Hinterland Domain (Ben Avraham et al., 1990; Lentini et al., 1994, 2006, and references therein) (fig. 2).

The Foreland Domain includes the still undeformed continental areas of Africa, represented by the Pelagian Block, and that of the Adriatic microplate, consisting of the Apulian Block, which is separated since the Mesozoic from the main Africa Foreland by the oceanic crust of the Ionian Basin.

The Orogenic Domain is composed of three main tectonic belts, the External Thrust System (ETS), the Apenninic-Maghrebian Chain (AMC) and the Kabilo-Calabride Chain (KCC), generated by the detachment of the internal sedimentary cover of the flexured sector of the continental foreland, by the imbrication of the sedimentary sequences belonging both to the oceanic crust-type sectors (Tethys and Ionian basins) and to the continental crust-type ones (inner carbonatic platform), and by the delamination of the European margin, respectively.

The Hinterland Domain is represented by the Sardinia Block and the Tyrrhenian Basin. This latter is characterised by an oceanic crust, and its opening started in the Middle Miocene (Lentini et al., 1995, 2002).

In the south Tyrrhenian area, the features of the Apenninic-Maghrebian Orogen are controlled by the thickness of the crust of the Foreland Domain. The oceanic crust of the Ionian Basin is located between the continental crust of the Apulian Block to the north and the Pelagian Block to the south-west. This morpho-tectonic shape influences the evolution of the whole Calabrian Arc.

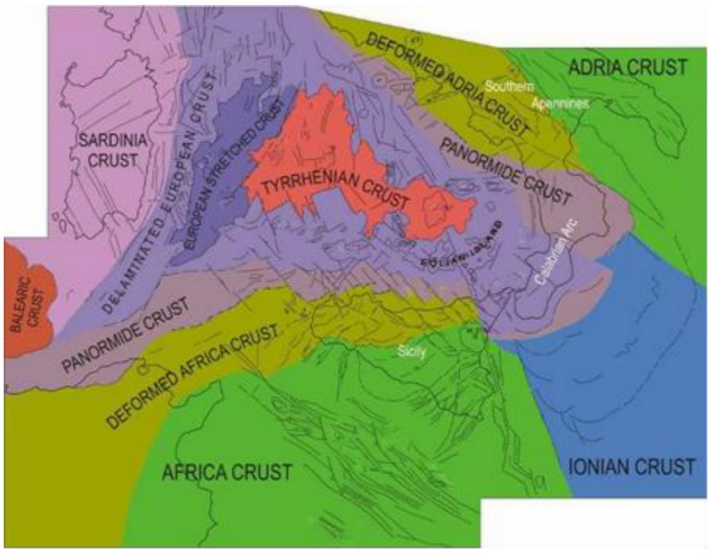


Fig. 1 Schematic representation of crustal domains in the central Mediterranean. The foreland domains are characterized by the Adria and the Africa continental crust separated by the old crust of the Ionian Sea. At the present time, the subduction of the Ionian crust is active only beneath the southern Calabrian Arc. Remains of parts of the Paleo-Ionian slab are seismically recognizable between the deformed margins of the continental blocks and a collisional crust (the Panormide crust). The Tyrrhenian Sea is constituted mostly of an oceanic crust placed on a delaminated European crust, and the Panormide crust before the forearc basin developed (after Lentini and Carbone, 2010)

The interpretation of regional profiles in Sicily and the Southern Apennines, based on the crustal sections of the CROP-Mare project (fig. 3), show that both foreland blocks are in collision with a continental crust, named the “Panormide crust”, recognised in the Tyrrhenian offshore of the northern coast of Sicily and of the Southern Apennines. This crust has been interpreted as the original basement of the carbonate platforms (Panormide and Apenninic Platform Units) (Lentini et al., 2006, 2009). The Meso-Cenozoic sedimentary covers originally located on the oceanic area have been interpreted as a

prosecution of the modern Ionian Basin involved in orogenesis. They are completely detached and tectonically rest on the ETS. These covers, named the Lagonegro and Imerese Units in the Southern Apennines and in Sicily, respectively, are grouped into the Ionide Units (Finetti et al., 2005a, 2005b).

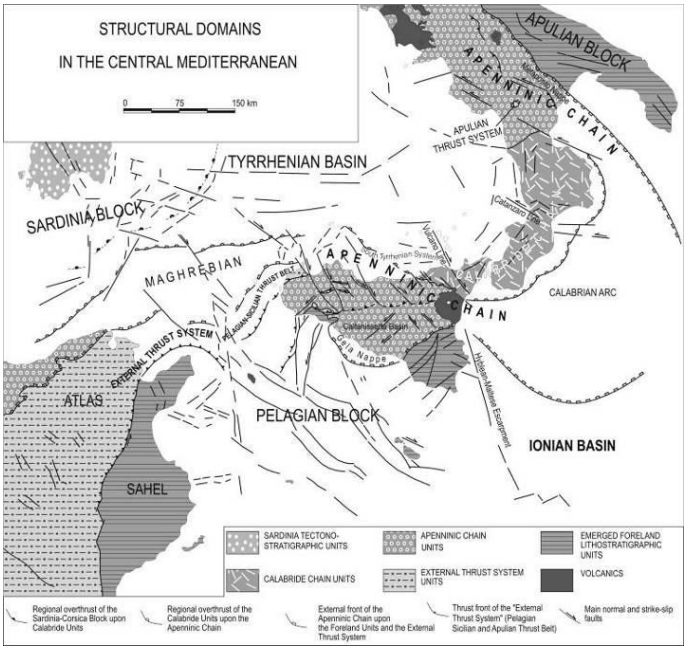
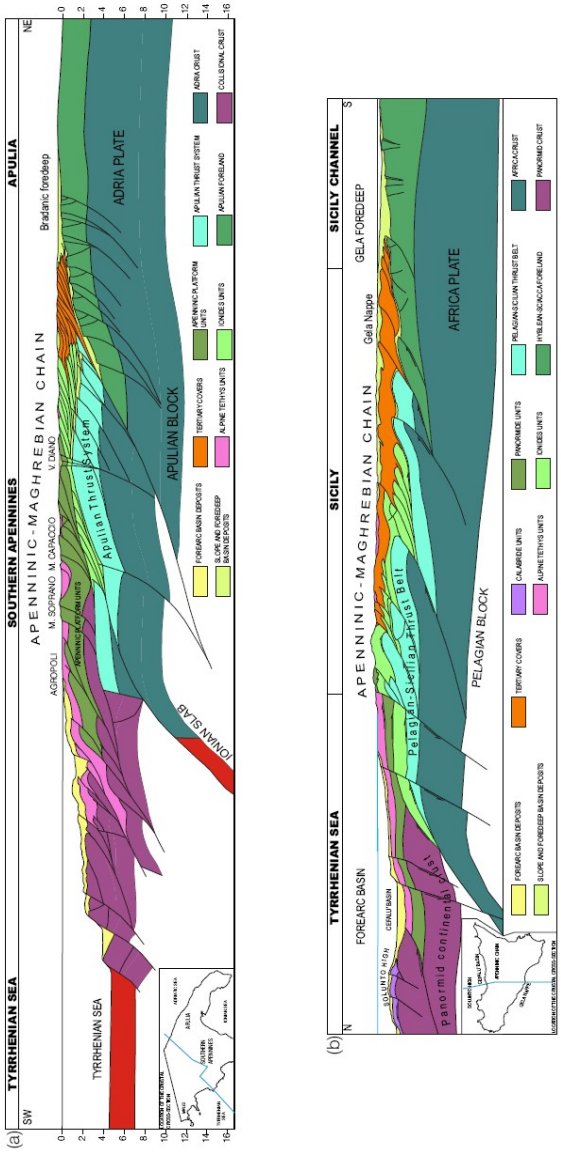


Fig. 2 Structural domains of the central Mediterranean. The Foreland domain consists of the Apulian Block (Adria crust) and the Pelagian Block (Africa crust), separated by the oceanic crust of the Ionian basin. The lowermost structural level of the orogen is an External Thrust System: Atlas in North Africa, the Pelagian-Sicilian Thrust Belt in Sicily and the Apulian Thrust System in the Southern Apennines. These are overlain by the Apenninic-Maghrebian Chain, a roof thrust system generated by post-Oligocene thin-skinned tectonics, underthrusted an edifice composed of basement nappes derived through the Eocene-Oligocene delamination of the margin of the Europe Plate, the Kabilo-Calabride Chain (after Lentini et al., 2006)

The peculiarity of the orogenic belt in the Southern Apennines, as well as in Sicily, mainly lies in a general duplex geometry (fig. 3). The roof thrust system, several thousand meters thick, is made up of the allochthonous units of the AMC, while the floor thrust is represented by the ETS. This latter corresponds to the Apulian Thrust System in the Southern Apennines, and to the Pelagian-Sicilian Thrust Belt in Sicily, and is composed of more or less rooted carbonate units derived from the internal edge of the Adria and of the Africa plates, respectively (Finetti et al., 2005a, 2005b).



(A) (B)

Fig. 3 Crustal profiles across (A) the southern Apennines and (B) central Sicily (after Finetti et al., 20005a, 2005b, modified)

In the crustal profiles of figure 3, the continental crust of the Adria and Africa plates extends beneath the orogenic belt, which characterizes the on-shore areas to the Tyrrhenian shoreline. The Afro-Adriatic crusts show a progressive thinning and laterally grade into an old Ionian slab, completely subducted. The Panormide crust is currently colliding with the Adria and Africa crusts, in the Southern Apennines and Sicily, respectively. The geological evidences of this collisional setting are the NW-SE oriented transcurrent faults, sinistral in the Southern Apennines and dextral in Sicily. This latter constitutes the South Tyrrhenian System (STS) (Finetti et al., 1996), which affects both off-shore and on-shore areas of Sicily. Of the South Tyrrhenian faults, the most relevant is the NNW-SSE oriented Vulcano Line (fig. 2), that represents a boundary between the collisional setting to the west and the still subducting Ionian slab.

Palaeogeographic and geodynamic evolution

The Ionian basin opened since the Permian-Triassic inside the Adria Plate, separating the Apulian Block from the "Apenninic" Block. Northward along the Apennines, the Ionides, represented by the Lagonegro basinal sequences, progressively disappear. That indicates that the Ionian crust was narrowing and both continental blocks, the Apulian Block and the "Apenninic" one, were joined in a unique continental plate: the Adria Plate. Similarly, there is no continuity of the Ionides toward western Sicily, and this may indicate the progressive closure of the oceanic crust and the direct connection of both Apenninic continental crusts: the Africa one and the Panormide one. An Alpine Tethys basin was located between the Europa Plate and the Adria-Africa Plates.

The geodynamic evolution of the convergent system can be summarized into three orogenic stages:

Eo-Alpine stage: this stage occurred during Late Cretaceous-Eocene times. Africa-Ionian-Adria, as unique block, and the Eurasian plate converged. Poor evidences of an eo-alpine stage can be observed in western Calabria, in the Tyrrhenian basin and in the Alpine Corsica. A tectonic wedge, made up mainly by Ligurides and by ophiolites-bearing sequences, is characterized by a Europa vergence. In the Calabria-Lucania boundary, Jurassic-Cretaceous ophiolites and low metamorphic rocks, belonging to the Ligurides, are sealed by the Oligo-Miocene foredeep deposit. At the present time, they are completely detached onto the Apenninic Platform or directly overlying the Ionides tectonically, and display an Apulian vergence originated during the following stages.

Balearic stage: This stage (Oligocene-Early Miocene) produced an orogenic belt with opposite vergence, toward the Adria-Africa Block. In NE Corsica, the W-verging thrust systems, which originated during the Eo-Alpine stage, have been successively affected by Adria-verging low-angle thrust faults of the Balearic stage. Pre-rift, syn-rift and post-rift sequences are seismically well defined. This stage allowed a further consumption of the remnant of the Alpine Tethys oceanic crust and to the collision of the European Plate with the Panormide crust. The consumption of the Tethys crust was contemporaneous with the emplacement of extensive frontal nappes, with the opening of the Balearic back-arc basin, and the counter-clockwise rotation of the Corsica-Sardinia Block, which ended at the Burdigalian-Langhian boundary. The flysch-type successions of Late Oligocene to Early Miocene age, characterized by tuffitic sandstones, indicate the presence of a volcanic arc,

which belongs to the Alpine Tethys subduction complex. Contemporaneously, in the areas of the Ionian Foreland and partly on the carbonate platform itself, a pelitic-quartzarenitic sequence of Numidian flysch and "epicontinental" glauconitic calcarenites and marls were deposited.

Tyrrhenian Stage: Since the Burdigalian-Langhian boundary, the Apenninic-Panormide Platforms were stripped off from their basement and were thrust over the Ionides. Later, the latter suffered a general décollement and overrode the External Thrust System, with the consumption of the Palaeo-Ionian crust originally interposed between the continental crusts. In the Calabrian Arc, where the foreland is represented by the Ionian oceanic crust, the Ionian pelagic sequence was stripped off from their subducting oceanic basement and was transported eastward, forming most of the external wedge of the Calabrian Arc. In the Southern Apennines, the Late Miocene external flysch deposited in a basinal area, the Irpinian Basin, inherited by the Ionides (Lagonegro sequence). At that time, this basin represented the Ionian foredeep, with an inner tectonic wedge in which the topmost Tortonian levels of flysch-type deposits are tectonically overlain by a further nappe of Tethydes that indicates the involvement of the foredeep successions in the Ionian subduction. This marked the consumption of the oceanic crust of a part of the Ionian Paleo-basin and, thus, the beginning of the phase that led to the opening of the Tyrrhenian backarc basin and the emplacement of the Aeolian volcanic island arc.

On the African foreland, the crustal lineaments inherited from the Mesozoic palaeogeography show an oblique direction with respect to that of the deformation front of the chain, conditioning its advance and causing a diachronous collision from west to east. This is expressed in the indentation of the continental margin and the formation of a transcurrent junction oriented about NW-SE, which has been active since Early Pleistocene times and indicates the cessation of the subduction process at this time in the Southern Apennines and in Central-Western Sicily.

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