Relation between recent tectonics and inherited Mesozoic structures of the central-southern Adria plate

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ABSTRACT The analysis of several seismic reflection profiles offshore the Adria plate reveals a complex spatial-temporal distribution of the carbonate platforms, often linked to different conditions of the crustal thicknesses. The "platform sequence", the "platform-to-basin sequence" and the "oceanic sequence" seem to represent the principal paleogeographic domains and are associated with different crustal types which, during the Tertiary age, became the foreland of the southern Apennine/Calabrian Arc and the Dinaric/Hellenic Chain. In this work, we have tried to highlight how these main crustal domains affect recent tectonics in a remarkable way. The migration of the Calabrian Arc and the Hellenic Chain brought about a regional compressive regime, which currently affects the whole crustal thickness of the Adria plate, causing transpression along the main strike-slip systems of the plate, inversion tectonics in the Salento offshore, and underthrusting below the Dinaric front, whereas the external front of the central-southern Apennines does not seem to be active any more.

1. Introduction

The analyzed area represents part of the Adria plate which, accordingly to many authors, was an independent block that detatched itself from Africa via the Ionian oceanic crust from Mesozoic (Finetti, 1982; Dercourt *et al*., 1986) or Permian times (Finetti, 2005b; Stampfli, 2005). Presently, GPS measurements from D'Agostino and Selvaggi (2004) do not seem to exclude an independent movement of Adria, and D'Agostino *et al*. (2008) suggest that the southern Adriatic, the Ionian Sea and, possibly, the Hyblean region, form a single microplate rotating relative to Nubia.

The sedimentary domains of the Adria plate, already described by Zappaterra (1990), can be schematically classified into three main paleogeographic units, produced during the main extensional phase of the Tethyan opening, as follows: "platform sequence" (Middle Triassic-Tertiary platforms, like Apulian, Gavrovo and Dinaric); "platform-to-basin sequence" (Medium Triassic-Liassic platform drowned during the Liassic and covered by pelagic sedimentary sequences: Belluno, Umbria-Marche, Ionian/South Adriatic basins); "basinal sequence" (a continuous Triassic- to- Cenozoic pelagic sequence such as the one present in the Lagonegro basin), hereafter renamed "oceanic sequence" in accordance with the oceanic attribution of the Ionian-Lagonegro basin (Finetti, 1982; Finetti, 2005a).

The contour map of the Moho reconstructed by Finetti (2005a) shows a regional crustal thickening of the Apulia platform with respect to the basin domains. The different thicknesses of the continental crust and lithosphere control the rollback rate of the Adria foreland (Doglioni *et* *al*., 1994; Argnani *et al*., 1996); the lateral heterogeneity of the foreland between the Adria-continental and Ionian-oceanic crust also determined a different rollback, slab tearing and detachment. Some authors argue that the slab broke off from NW to SE, along the Apulia platform margin (Argnani, 2000; Lucente *et al*., 2006), below the central-southern Apennine axis (Wortel and Spakman, 2000); Govers and Wortel (2005) hypothesized a Subduction Transform Edge Propagator (STEP), through the Lucanian Apennine, even if the authors consider it poorly constrained. Rosenbaum *et al*. (2008) describe some lithospheric tear faults that cross the foreland, by integrating seismic tomography and magmatic data. Del Ben *et al*. (2008) suggest that, along this lateral heterogeneity, the WNW-ESE-oriented Apulian-Ionian Tear Fault underlies and controls the overlain Sibari Transcurrent Fault System, cutting the chain.

The southern Adria plate represents the common foreland of both the Appennine and Dinaric Chains, and has been considered mainly a solid and aseismic block, except for the case of the Tremiti Islands and the Mattinata-Gondola Fault System; the seismicity (Castello *et al*., 2006; INGV, 2006) proves that an active area is located also in the southern offshore of the Salento Peninsula. This area was in fact affected by a strong earthquake which struck the Salento area (M=6.9) in 1743 and, more recently, in 1974, by a seismic sequence with main shock M=4.9, bringing about a strike-slip focal mechanism and a compression axis NE-SW-oriented and slip plane NW-SE-oriented (Favali *et al*., 1990); D'Ingeo *et al*. (1980) found the hypocenter at a depth of 33 km and justify this seismicity as the consequence of the presence of the boundary between the Adria and Ionian crust across the Otranto Channel. Argnani *et al*. (2001) support the idea that the seismicity of this area is caused by the strong bending of the Adria continental lithosphere under the Calabrian Arc and the Hellenic Chain, respectively westwards and eastward, which produced a compressive regime in the inner arc and an extension in the shallow outer arc. Recently, Del Ben (2010) has identified features of inversion tectonics, reactivating previous normal faults, and suggests that they are caused by the transpressive regime involving the Adria plate, which is a common foreland of the SSE-verging Calabrian Arc and of the WSW-verging Hellenic Chain.

Furthermore, the seismicity of the central Adriatic Sea indicates the presence of faults caused by a S-N directed tectonic pressure (Herak *et al*., 2005) along the active Jabuka Fault System; recent events, recorded in March 2003, should be referred to a regional compressive regime generated by a NW-SE Dinaric thrust. In the central Adriatic Sea, an alignment of structural highs [Mid-Adriatic Ridge, Finetti *et al*. (1987)], extending south-eastwards to Palagruza, has been interpreted as a forebulge by de Alteriis (1995) or as the result of a foreland deformation linked to the Apennine belt by Argnani and Frugoni (1997). The ridge is depicted as the eastern effect of the regional detachment of the Apennine accretionary wedge by Scrocca (2006) and Scrocca *et al*. (2007) or, of the external Dinaric Chain by Finetti and Del Ben (2005). Bertotti *et al*. (2001) recognized a Pliocene uplift, associated with reverse faulting and folding in the Pelagruza High, separating the central and south Adriatic basins. Geletti *et al*. (2008) attributed the Mid-Adriatic Ridge to a halokinetic deformation of the Burano sequence, connected to a regional compressive regime, which began in the pre-Pliocene. Scisciani and Calamita (2009) suggest contractional reactivating of pre-existing Mesozoic normal faults from the Paleogene along the Mid-Adriatic Ridge, as already supposed by Gambini *et al*. (1997).

2. Geological setting

The Adria plate drifted from Africa in the initial rifting phase that led to the creation of the Ionian lithosphere during the Late Permian-early Triassic ages (Vai, 1994; Finetti, 2005b; Stampfli, 2005). In the Adria plate, the extensional phase produced a very thick Paleozoic-Triassic sedimentary cover of the crystalline basement, as also defined by Patacca *et al*. (2008). The Upper Triassic sequence is represented by a thick carbonate platform composed of dolomite (Dolomia Principale formation) and evaporites and dolomites (Burano formation). From the Late Liassic to the Early Cretaceous, the Adria plate was affected by tensional tectonics that caused the break-up of the Triassic carbonate platform; this event gave birth to horsts and grabens superimposed respectively by carbonate sequences and by pelagic basin sedimentation (Mattavelli *et al*., 1991).

Currently, the Apulia carbonate platform is cropping out in the Puglia region (Gargano, Murge, Salento), in the Maiella Mountain and in the Monte Alpi structure. This sedimentary sequence consists of Jurassic-Upper Cretaceous shallow-water carbonates disconformably covered by Miocene, open-ramp carbonate deposits (Bolognano Formation), that never exceeds a few hundred meters in thickness, followed by Messinian evaporites (Gessoso Solfifera Formation).

The pelagic carbonate sedimentary succession of the Ionian/south Adriatic basin is characterized by basal, shallow water sequences of Burano Formation/Dolomia Principale dating back to the Upper Triassic/Lower Liassic age. The following basinal sequence from the Liassic to the Paleocene is made up of pelagic limestones and marls; the Paleocene-Early Oligocene boundary is represented by a non-depositional and, locally, erosional hiatus correlated to a seismic reflector that coincides with the top of the Scaglia Formation (de Alteriis and Aiello, 1993).

Since the Oligocene, clastics, shed by growing orogens processes, produced a sedimentary cover both on the Cretacic carbonate platform and on the carbonate basinal sequence. The Lower Miocene is characterized by the Bisciaro formation, that is a regular alternation of sands and shales with a cyclic, fining upward arrangement, revealing a general deepening of the basin, by the late Early Miocene (de Alteriis and Aiello, 1993); then Serravallian-Tortonian marly silty and clay turbidites of Schlier Formation follow, overlined by the Upper Messinian evaporites (Gessoso Solfifera formation). This evaporite deposit is seismically characterized by a strong reflector and is usually considered as a guide horizon. Finally, the Plio-Quaternary deposits are characterized by marl and clay sediments.

The geometry of the Apulia platform margin is still a matter of debate: it crops out in the Gargano promontory (Bosellini *et al*., 1993) and along the eastern Salento coast (Bosellini *et al*., 2001). Evidence of a platform margin has been also recognized along the Salento Adriatic coast, near Ostuni (Borgomano and Philip, 1987). It continues southeastwards into Albania, as confirmed by Argnani *et al*. (1996), Ballauri *et al*. (2002) and Nicolai and Gambini (2007). These last authors also identify, in the Apulia platform, some intraplatform basins, mainly developed during the Late Cretaceous and in some cases up to the Eocene, such as the Rosaria Mare basin located in the Brindisi offshore, between the coast line and the platform margin to the east.

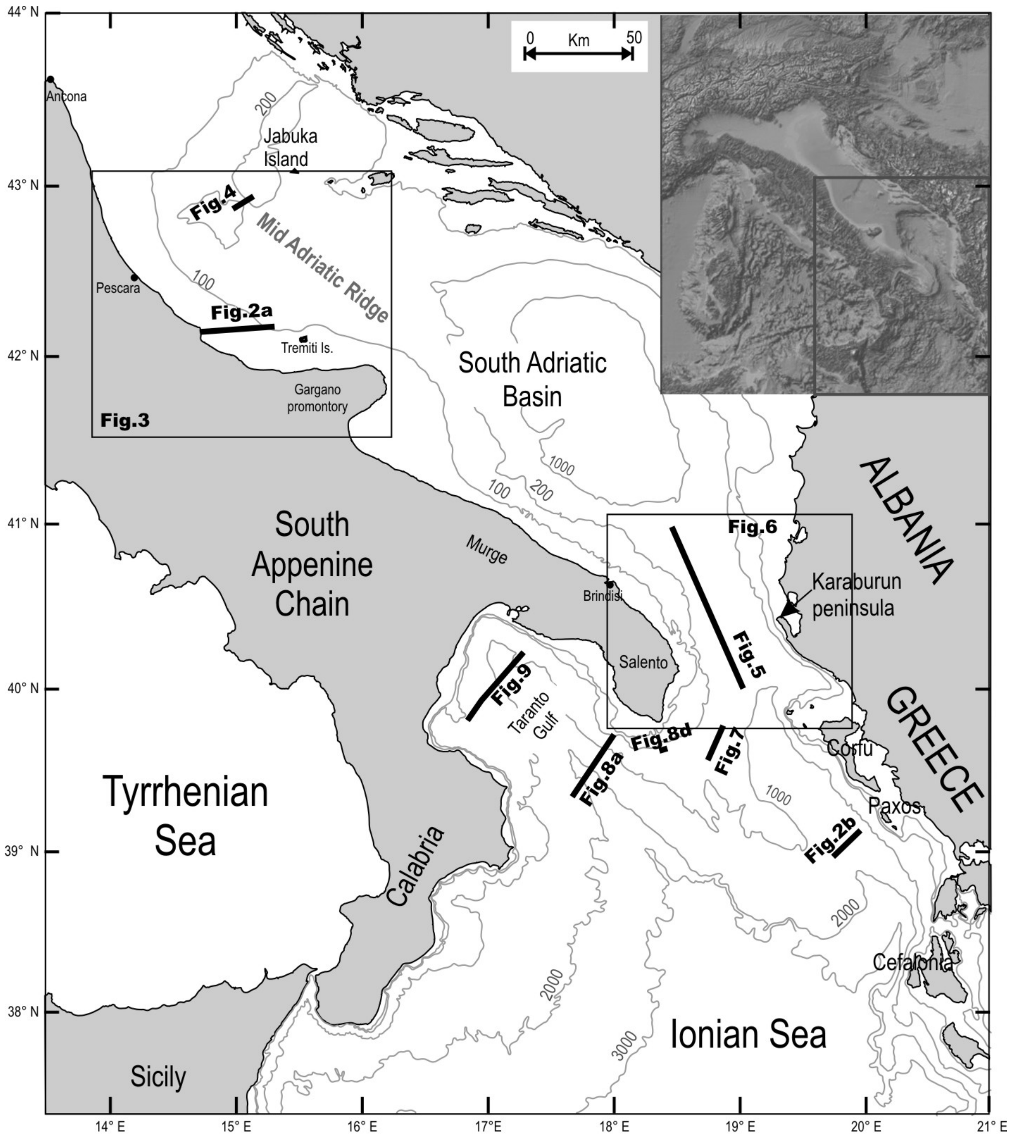

Fig. 1 - Map of the investigated area. Seismic profiles present in the relevant figures are indicated.

3. Seismic data

Hydrocarbon exploration of the peri-Italian seas has been carried out since the 1960s through seismic surveys and drillings (Mattavelli and Novelli, 1990). The first seismic data-set (medium resolution – petroleum target) was acquired offshore the Italian coast (public data-set from the Italian Ministry of Industry), and many boreholes have been drilled in different settings (Cati *et al*., 1987; Mattavelli and Novelli, 1990). In 1971, crustal MCS profiles were acquired for the Italian National Council of Research (CNR) by the Osservatorio Geofisico Sperimentale (OGS) of Trieste and processed in 1972. More precisely, we re-processed several parts of lines MS20Ext, MS26, MS28 and MS29 (position on map in Fig. 1), in particular, on the shallow part. In 1991, the R/V OGS Explora, within the framework of the Italian Deep Crustal Exploration Project (CROP) (Scrocca *et al*., 2003; Finetti, 2005a), collected over 200 km of deep crustal MCS profiles (CROP-M5) in the Calabrian Arc - Salento offshore (Fig. 1). In 1995, the R/V OGS Explora collected 100 km of the ADRIA95 profile, in the central Adriatic Sea, processed by Geletti *et al*. (2008). The CROP profiles in the Ionian Sea were designed for deep crustal exploration (frequency from 15 to 40 Hz), and some parts were reprocessed in this study due to the shallow, post-Messinian target.

Compared to the first processing of, the MS lines in the early 1970s, an updated package software (Focus™ by Paradigm™) and the availability of a powerful work-station, now allow us to test an interactive velocity analysis with a more effective picking of semblance velocity spectra. The results obtained have clearly improved the signal quality of the reflectors in the Plio-Quaternary sequence.

4. Seismic interpretation and discussion

With regard to the central Adriatic, the Apulia carbonate platform is easily identifiable in some seismic profiles near the Vasto/Gargano shore for its characteristic semi-transparent seismic facies. Particularly evident is the transition from the platform to the pelagic domain; the latter, developing from the Liassic age, is predominant in the Italian Adriatic offshore. Fig. 2 shows the position of the Apulia platform margin relative to some Permo-Triassic features. In Fig. 2a the margin between the platform and the Ionian/south Adriatic basin in the north Gargano offshore overlies the Permo-Triassic layered unit which seems to be highly fractured by a normal fault system that involves also the top of the lower crust and defines a tilted hanging-wall. The fractured, well-reflecting top of the Permo-Triassic sequence suggests a partial re-activation of the fault system during the platform deposition. In Fig. 2b the margin between the platform and a basinal domain, extending between the Apulia and the Pre-Apulia platforms in the south Salento offshore [south Apulia basin by Del Ben *et al.* (2010)] is highlighted. The clearly layered Permo-Triassic unit, although it disappears below the Apulia carbonate platform, due to seismic attenuation, is well illustrated below the Liassic-Tertiary basin and slope. A normal fault system has been interpreted below the platform-to-basin transition, joined to a conspicuous growth wedge. Not many seismic profiles allow one to reconstruct the pre-platform structures, anyway, we can generally recognize tectonic structures coeval to the Permo-Triassic deposition re-activated by later extensional phases. Grandic *et al*. (2001) also interpreted the reactivation of Ladinian-Carnian normal faults along the Dinaric platform margin, separating shallow water and pelagic domains during the post-Liassic. These extensive tectonics probably involved the whole crustal thickness, as also suggested by the structural high of the Moho between the Dinaric and Apulia platforms to the north of the Gargano promontory (Finetti, 2005a).

Fig. 3 highlights the relationship of the northern edge of the Apulia carbonate platform to the external front of the Apennine Chain. In the north, seismic profiles clearly highlight an Adriatic foreland (Umbria-Marche basin) bending below the Apennine front during the Lower Pliocene. To the south, the foreland, represented by the thicker continental crust of the Apulia carbonate

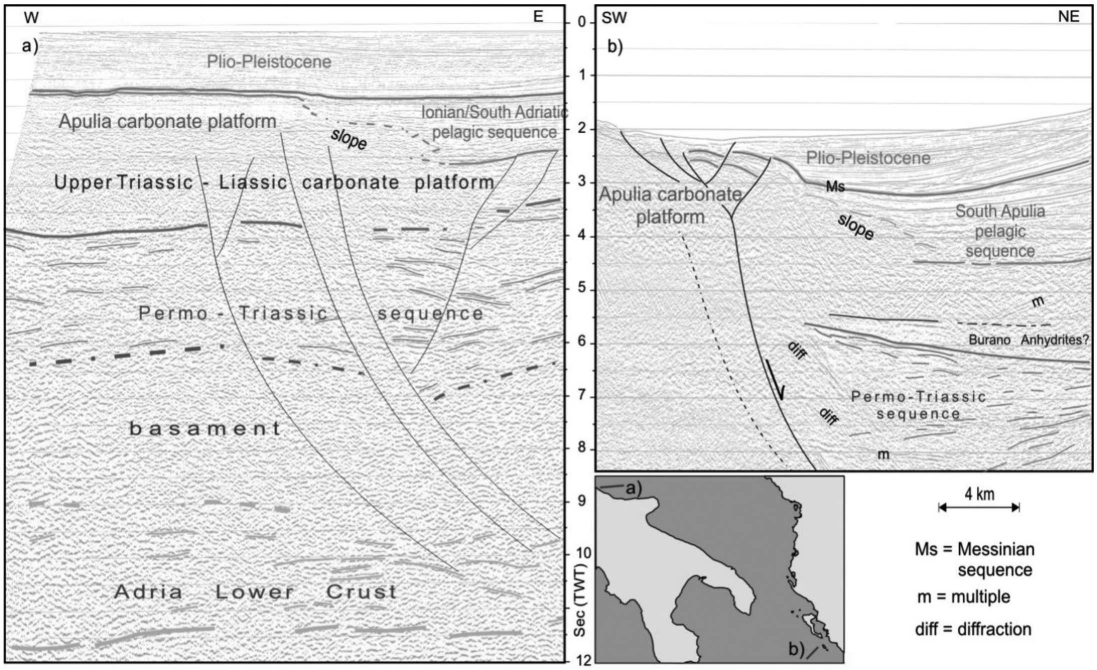

Fig. 2 – Deep-reflection profiles across the Apulia platform margin. a) western part of the CROP-M13 profile, on the northern offshore of the Gargano promontory. The carbonate platform lies above the well-reflecting Permo-Triassic sequence. The Liassic-Tertiary platform/basin transition seems controlled by a reactivation of the Permo-Triassic normal fault system. This last terminates on the top of the deformed and thinned lower crust, fracturing, thinning and tilting the basement. b) ENE part of the CROP-M34 profile, in the offshore of the Ionian Island. The Permo-Triassic sedimentary wedge suggests a coeval tectonic activity of normal faults, successively reactivated, to separate the carbonate and the pelagic domains.

platform, prevented the thrust front migration, which has not been allowed to reach the offshore; rather, the same thick foreland was heavily involved by the compressive regime during the Pliocene/Early Pleistocene age [Maiella and Casoli Bomba structures; Patacca and Scandone (2007)]. In the offshore, the Upper Pliocene/Pleistocene sediments are unfolded and unthrusted, and the sub-horizontal reflectors are covered by the progradational sequence fed from chain erosion. In Fig. 4, a weak deformation affects the sea-floor along the Mid-Adriatic Ridge: as analyzed by Geletti *et al*. (2008) this deformation is due to a halokinetic process, already active in the pre-Pliocene, which causes instability within the depositional sequence. As a matter of fact, the whole ridge, spreading longitudinally onto the axis of the central Adriatic basin, seems to be connected to an alignment of halocinetic structures. The seismicity in the Croatian offshore near Jabuka Isle [compressive focal mechanisms by Herak *et al*. (2005) and Pondrelli *et al*. (2006)] should be linked to a NW-SE external thrust of the Dinaric Chain (Herak *et al*., 2005); on the basis of seismic data interpretation, the compressive events of the central Adriatic basin should be ascribed to a regional compressive regime, without any current compressive stress by the Apennine thrust front.

The central Adriatic basin is bordered southward by the Tremiti and Mattinata-Gondola strike-

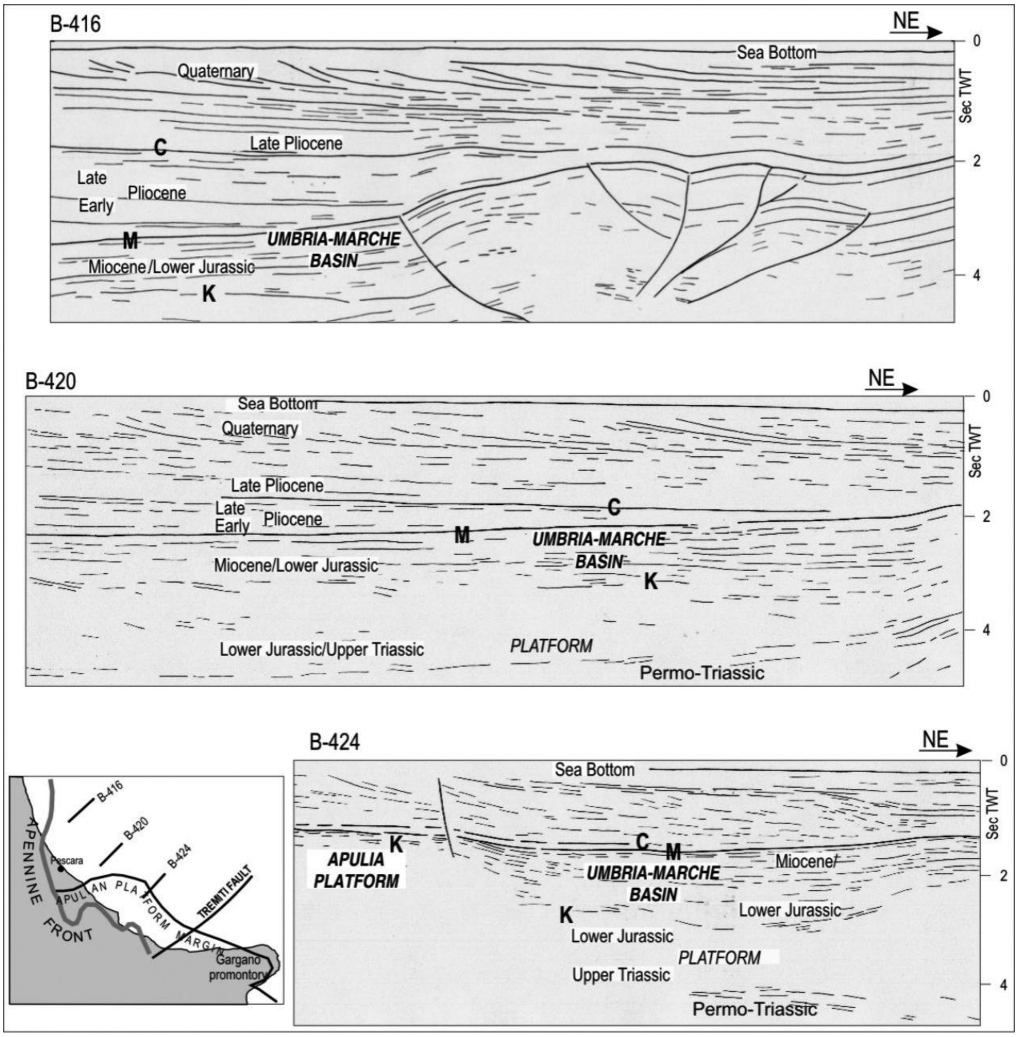

Fig. 3 - Line-drawing of three seismic profiles, normal to the Italian shore, in the central Adriatic Sea. Progradational sequence is highlighted by oblique shallow reflectors in the Quaternary sequence. C is a reflector in the Late Pliocene, M is the base of the Plio-Quaternary sequence, K is the top of the carbonate platform. Profiles, positioned in the map, depict different foreland behaviors in front of the Apennine Chain: profile B-416 shows a foreland, mainly covered by the pelagic sequence of the Umbria-Marche basin, westward tilted during the Lower Pliocene, folded and thrusted by compression during the Late Pliocene. Profile B-420, near the northern margin of the Apulia carbonate platform, shows a minor tilting without folding. Profile B-424 shows the Apulia platform with its margin and the pelagic basin, without evidence of tilting: during the Upper Pliocene/Lower Pleistocene, the Apennine compressional structures are confined to in the inner onshore sector of the platform.

slip systems, respectively with WSW-ENE and W-E directions, both of them characterized by an important compressive component, as proved by the seismic profiles (Finetti and Del Ben, 2005) and by focal mechanisms (Pondrelli *et al*., 2006). The platform margin, defined by Bosellini *et al*. (1993) in the Gargano promontory, is well recognizable along the seismic profiles (Fig. 5, left part) in the south Adriatic basin: Ballauri *et al*. (2002) and Nicolai and Gambini (2007) analyzed

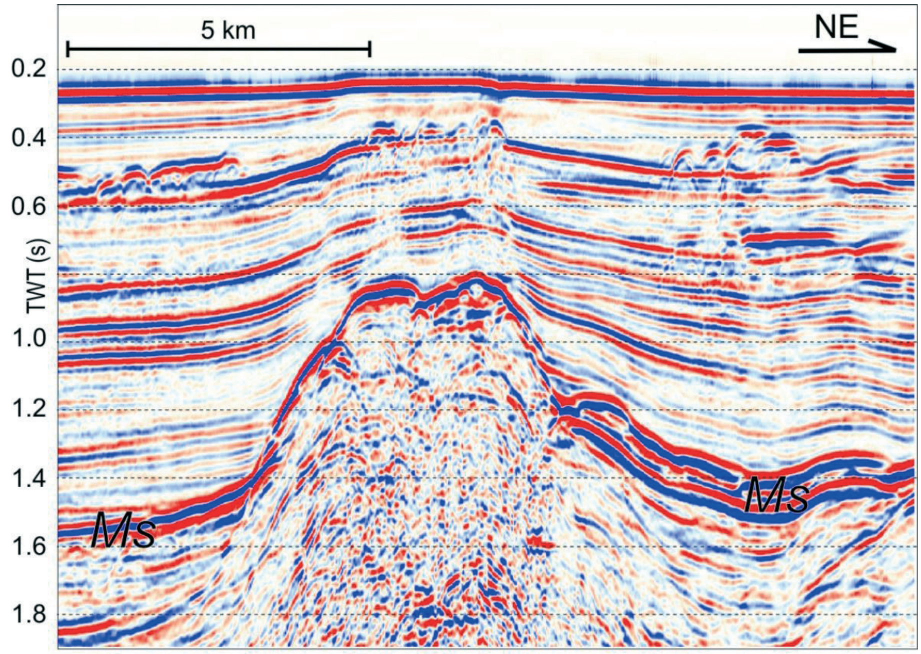

Fig. 4 – Detail of the seismic profile CROP-M15 crossing the Mid-Adriatic Ridge (position in Fig. 1): the gentle bathymetric high of the ridge is connected to a deep structure, due to a halokinetic feature.

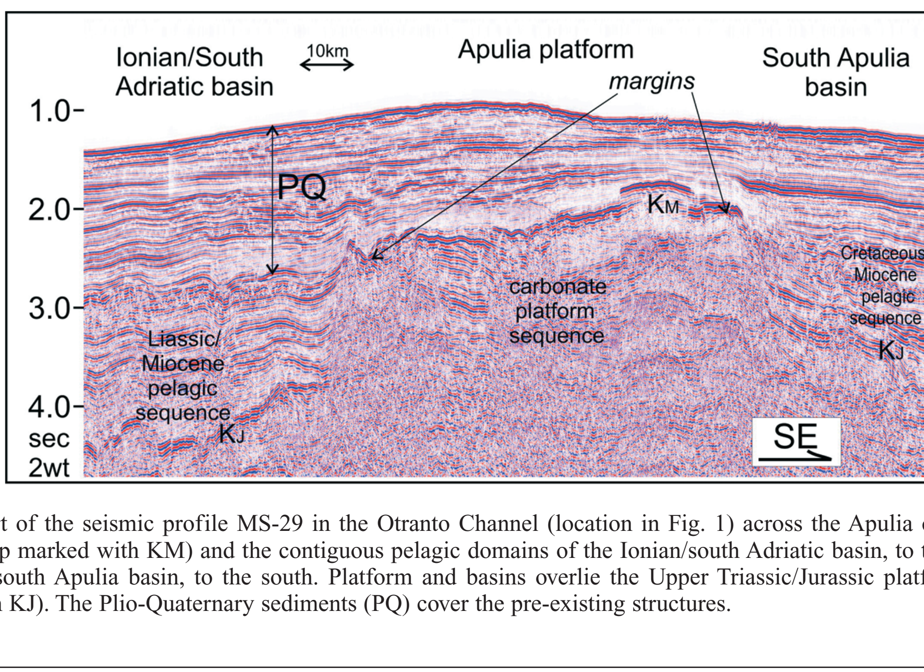

Fig. 5 – Part of the seismic profile MS-29 in the Otranto Channel (location in Fig. 1) across the Apulia carbonate platform (top marked with KM) and the contiguous pelagic domains of the Ionian/south Adriatic basin, to the north, and of the south Apulia basin, to the south. Platform and basins overlie the Upper Triassic/Jurassic platform (top marked with KJ). The Plio-Quaternary sediments (PQ) cover the pre-existing structures.

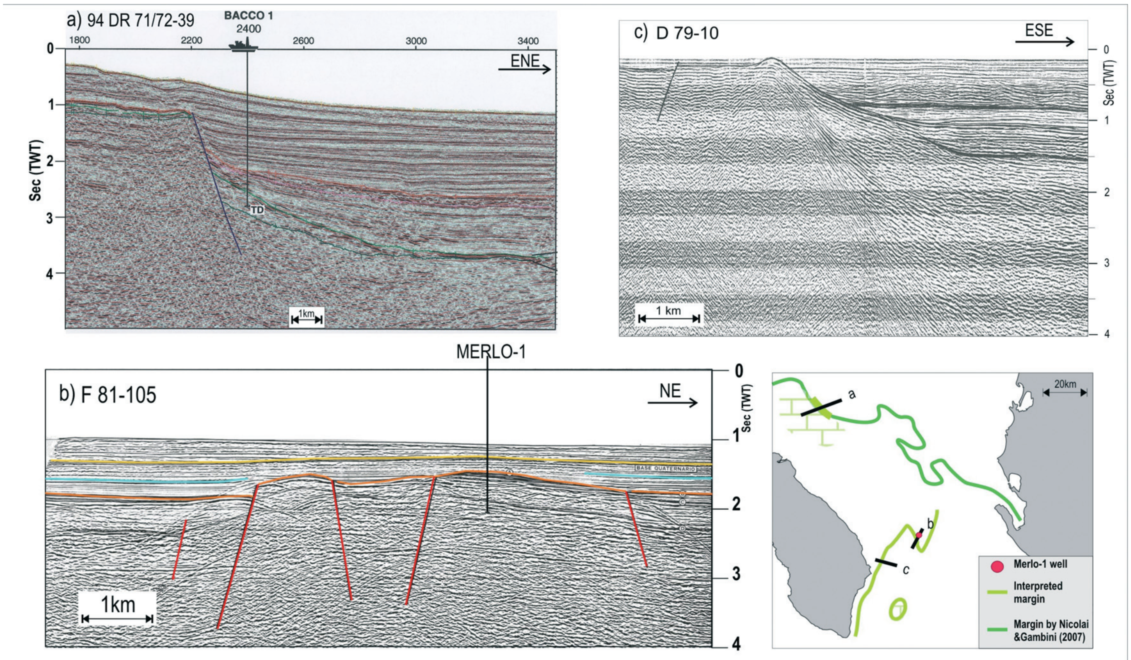

Fig. 6 – Seismic profiles crossing the Apulia platform margin in the east Salento offshore (location in Fig. 1 and in the inset). In a) the margin between the platform and the Ionian/south Adriatic basin is evident. In b) the platform is calibrated by the Merlo-1 borehole. In c) the margin between the platform and the south Apulia basin is also clearly depicted by reef and slope features.

the carbonate platform extension, which includes also the Karaburun Peninsula in Albania and is NE-ward separated from the Ionian/south Adriatic basin through a complex margin. More southward, we recognized a complex reef structure, SE-ward bordering the Apulia platform, clearly defined along the MS-29 (Fig. 5, right part) and other seismic profiles (examples in Fig. 6); this structure can to be linked to the Messinian reef identified by Bosellini *et al*. (2001) along the SE-Salento shore. We have no calibration on the age of the contiguous deep basin in the southern Otranto Channel. On the basis of seismic facies and thickness considerations Del Ben *et al.* (2010), suppose an Early Cretaceous origin for this south Apulia basin. In the eastern Puglia offshore, Nicolai and Gambini (2007) outlined the Rosaria Mare intra-platform basin, which developed no later than in the Upper Cretaceous and could be the northern, perhaps late, extension of the south Apulia basin.

In this pelagic basin, that extends toward the Ionian Islands, an area of relatively high seismic hazard was identified (INGV, 2006) on the base of some important earthquakes, generally characterized either by compressive or transpressive focal mechanisms. The seismic profiles highlight a widespread morphology made of uplifted and folded shallow sediments covering and filling graben or structural minima of post-Miocene age (Fig. 7). These typical geometries has been recently interpreted by Del Ben *et al.* (2010) as structures originated by inversion tectonics due to a recent (Middle/Upper Pleistocene) compressive/transpressive regime. The latter would

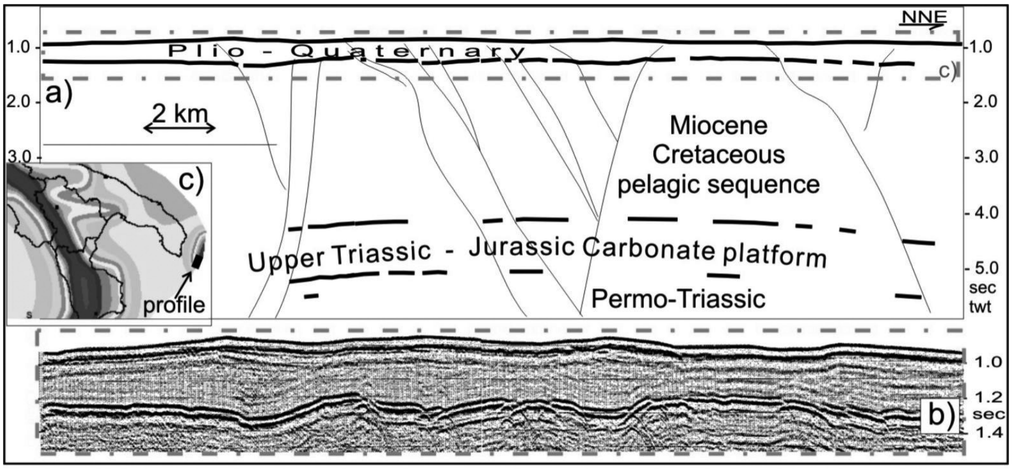

Fig. 7 – Part of the seismic profile F-55 (position in Fig. 1): inversion tectonics in the south Salento offshore [modified by Del Ben (2010)]. a) schematic line-drawing of the profile: here the interpretation shows a system of normal faults cutting the base of the Plio-Quaternary sequence. b) the upper part of the profile, with a vertical exaggeration x6, highlights typical morphologies of the area with gentle swells of shallow sediments and of the sea-floor: they are focused on the graben or structural minima defined by the normal faults. This morphology was interpreted as a consequence of inversion tectonics that rotate previous normal faults, uplift rigid blocks and fold and uplift shallow sediments. c) a relatively high seismic risk area [maximum value of acceleration at bedrock by INGV (2006)] was recognized in the area involved in this deformational style.

be due to the Calabrian and Hellenic Chains, pushing the common Adria foreland in an almost opposite direction. The compressive stress produced a rotation of the normal oblique faults, therefore reactivating them: the fault blocks made a back-rotation, which provoked the uplift of the rigid blocks and a gentle deformation and uplift of recent soft sediments. It is not easy to recognize the strike-slip component highlighted by the earthquakes, but it is likely that it contributed to the deformation of the sedimentary sequence.

Inversion tectonics seem to be a common deformational style also along the western margin of the Adria foreland, where further reactivation seems to be more likely and more pronounced in the case of oblique displacements (Wang *et al.*, 1995). In the Adria margin, low-angle faults are linked to back-rotated fault blocks, E-dipping, originated by the tilting of the continental foreland below the Calabrian Chain (Fig. 8): in these conditions, inversion tectonics generally produce very low angle back-thrusts, preferably inside post-extensional sediments or at the base of soft sediments.

In the editing process of this paper, Butler (2009) published his interpretation of two regional seismic profiles acquired by Fugro, that cross the northern Ionian Sea in a SW-NE direction. He has interpreted an array of generally low-displacement faults with normal throws cutting the intra-Messinian unconformity and sealed by the youngest Plio-Quaternary sediments. He also recognized some plausible reverse offsets relative to some faults. In our opinion these inversion tectonics could have been under-estimated because of their very young age and consequent small deformations, only evident in detailed analysis of recent unconsolidated sediments.

The margin between the Adria continental plate (platform and platform-to-basin sequences)

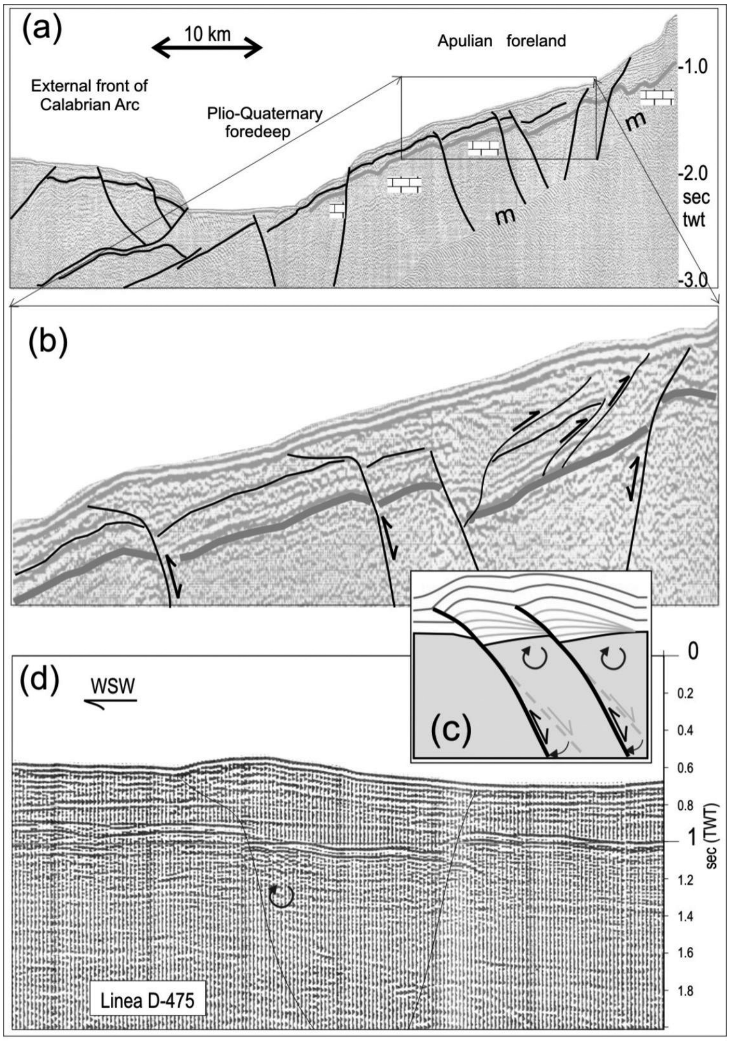

Fig. 8 – a) part of the seismic profile MS-26: a normal fault system related to the Pliocene-Lower Pleistocene bending phase. b) the detail shows how recent, normal faults have been inverted, producing the gentle swelling of shallow soft sediments; c) outline of the effects of inversion tectonics in the area: the new compressive regime produces the rotation of previous normal faults, back-rotation and uplift of rigid fault blocks, uplift, folding and thrusting of shallow soft sediments (after Wang *et al*., 1995); d) detail of seismic profile D-475: inversion tectonics generally seem to involve particularly E-dipping normal faults, which are more oblique, producing a back-thrust (NW-vergence), with respect to the direction of migration of the Calabrian Arc. Location of sections in Fig. 1.

and the Ionian oceanic sequence is generally involved and masked by the Calabrian and Hellenic Arcs and is only preserved along an intermediate region between Calabria and the Ionian Isles. Along the NW-prosecution of this margin Del Ben *et al*. (2008) interpreted a NW-SE-trending tear [or STEP, according to the definition of Govers and Wortel (2005)], decoupling the continental from the oceanic foreland, below the Sibari left-lateral strike-slip fault (Fig. 9). During the Upper Pliocene/Lower Pleistocene, the Sibari fault produced a large transtensive flower structure and drove the ESE-ward migration of the North Calabrian Arc, detached from the outer sectors of the southern Apennines. Since the Middle Pleistocene, age the collision with the complex Adria continental margin triggered the inversion of the strike-slip in a transpressive mechanism, that involved the Calabria Arc in a clock-wise rotation (Scheepers *et al*., 1994).

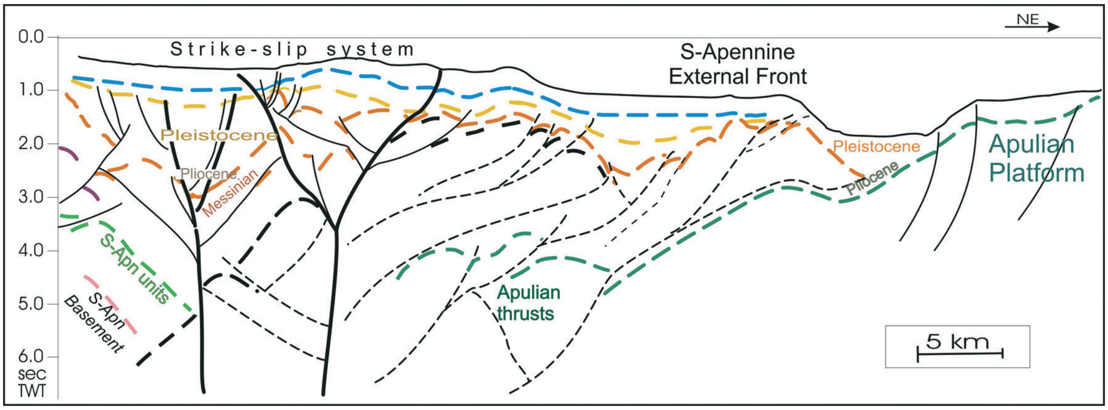

Fig. 9 - Line-drawing of a NE-SW profile in the Taranto Gulf [modified after Del Ben *et al.* (2008)]. The deep Plio-Pleistocene basin on the left was originated by transtensional tectonics of the Sibari strike-slip fault, the Apulian/Ionian tear fault, that separated the buoyant continental crust from the oceanic crust subsiding below the Calabrian Arc is supposed to be located below it. The crust underneath the Apulia platform, detached from the Ionian crust, thrusted below the South Apennine units.

5. Conclusion

The paleogeographic pattern and the main tectonic features of the southern Adria plate analyzed in this study are summarized in Fig. 10. Three main paleogeographic domains have been schematically recognized, in order to investigate their different behaviour relative to the front migration of the Calabrian and Hellenic Arcs.

The different domains of carbonate platform, continental pelagic basin and oceanic basin, separated during the Mesozoic through normal fault systems, are differently resistant to subduction below the chains. The different crustal domains do not bring about an independent subduction in a slab-pull mode, but the thicker and more buoyant the crust, the higher the resistance to the migration of chains.

The Apulia platform margin seems developed by the reactivation of Permo-Triassic normal fault systems, that generally terminate in the upper part of the deformed and thinned lower crust; this fact contributes to defining important crustal heterogeneities, at least partially coincident with the platform margin.

In the central Adriatic basin, during the Lower Pliocene, the northern edge of the Apulia carbonate platform seems to affect the behaviour of the Adria foreland and the forward movement of the chain. Seismic profiles highlight both the Adriatic pelagic foreland, bending below the Apennine front, and the thicker Apulia platform preventing the front migration. There is no evidence of active compressive structures related to the Apennine Chain in the central Adriatic basin: present weak deformations along the Mid-Adriatic Ridge depend on a halokinetic process which is likely to be active since the pre-Pliocene age. The seismicity of the Croatian offshore should be ascribed to the regional compressive regime mainly involving the inherited discontinuities of the Adria crust, which deforms the sedimentary sequence (Herak *et al*., 2005)

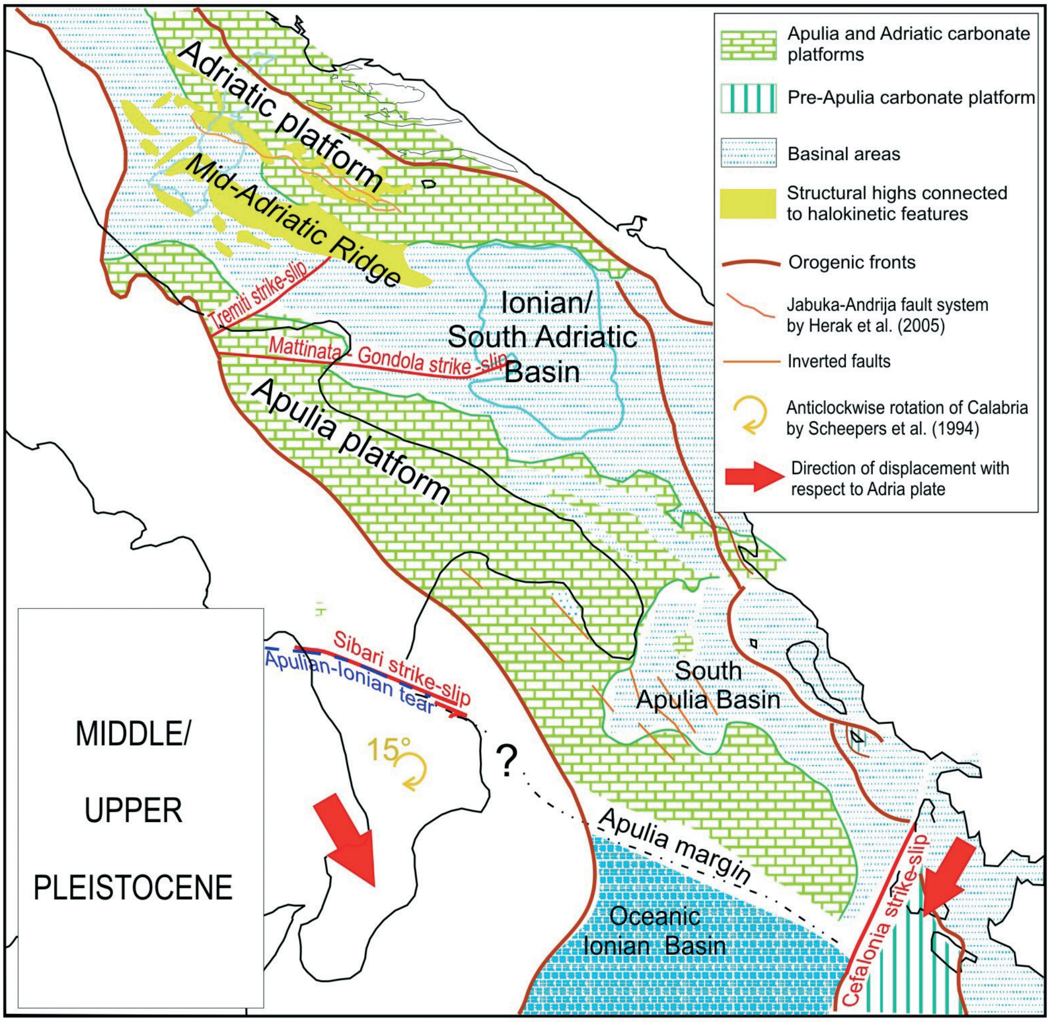

Fig. 10 - Map of the tectonic features active during the Middle/Upper Pleistocene in the study area: the margins of Dinaric (from Grandic *et al*., 2001), NE-Apulia (from Argnani *et al*., 1996; Nicolai and Gambini, 2007) and SE-Apulia (from Del Ben *et al.*, 2010) shallow platforms are outlined. Main halokinetic structures in the central Adriatic basin (from Geletti *et al*., 2008) depict the Mid-Adriatic Ridge. The orogenic fronts of Dinarides (from Grandic *et al*., 2001), Albanides (from Del Ben *et al*., 1994; Argnani *et al*., 1996), Hellenides (from Kokinou *et al*., 2005) and southern Apennines (CNR-Progetto Finalizzato Geodinamica, 1991) are indicated. The two arrows highlight the direction of migration of the Calabrian Arc (from Del Ben *et al*., 2008) and of the SW-Hellenic Arc (from Khale *et al*., 1995).

along the external Dinaric Chain.

In the southern Apennines, during the Upper Pliocene/Lower Pleistocene, the thicker foreland was affected by the compressive regime, giving origin to the External Chain. The North Calabrian Arc, separated by the South Apennine Chain through the left-lateral Sibari transtensive system, could easily migrate on to the oceanic Ionian foreland, which itself became separated by the Adria continental foreland through the Apulian-Ionian tear fault. During the Pliocene, when the tear had not yet separated the two forelands, the Ionian slab pulled the western Adria plate down, fractured by several normal faults.

During the Middle Pleistocene, the Calabrian Arc continued its migration onto and along the old passive margin of the Apulia carbonate platform, presently buried in the Taranto Gulf: this foreland, which is resistant to subduction, forced the chain to decelerate and change direction, from ESE-ward to SSE-ward. We suggest that also the rearward Tyrrhenian asthenospheric flow decelerated and changed direction, thus exhausting the compressive deformation of the southern Apennines as supported by the cessation of a flexural subsidence, around 0.65 Ma (Patacca and Scandone, 2007).

A main left-lateral transpressive system was active between the Calabrian Arc (which decelerated and rotated clock-wise) and the South Apennines. The compressive component on the Adria plate was added to the one produced by the Hellenic Chain, involving the eastern margin of the same continental foreland in an approximate opposite direction: both these chains contributed to the regional northward compressive regime of the Adria deep crust. Inversion tectonics affected the southern Salento offshore through back-rotation of fault blocks, causing the compressive/transpressive earthquakes that occurred in the region, as well as producing the uplift of thick rigid blocks and folding recent soft sediments. These deformed sediments generated the typical gentle positive structures at the sea floor, spotted right above the hanging wall of the Pliocene-Early Pleistocene normal faults. The seismic area of the SE-Salento offshore is positioned in correspondence to a weaker crustal sector with complex margins, separating the carbonate platform by the pelagic domain of the South Apulia basin.

According to our observation, the compressive tectonics, which are currently involving the main part of the Adria plate, seem to be correlated to the stress domains stemming from the South Apennine/Calabrian Arc and the Dinaric/Hellenic Chain, and originated in the context of the Africa/Europe collision.

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