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The northern fault of the onshore-offshore Monte Giove relief in the southern Adriatic Sea, Italy: implications for tectonic reactivation in the Apulian Foreland

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We provide improved constraints on the timing, geometry and kinematics of the fault that may control the northern submerged morpho-structural relief termed Monte Giove, offshore from the town of Polignano a Mare. We have integrated onshore and offshore data, and interpreted seismic profiles from the ViDEPI project pertaining to the offshore Adriatic Sea of the Murge area, and made field observations north of Polignano a Mare. The fault has been surveyed onshore and mainly offshore along a distance of ~25 km. Generally striking E–W, it dips at high angle to the NNE in the west and to the N in the east. Active since at least the Cretaceous, this was reactivated after the Early Pleistocene with dextral oblique-slip kinematics. It borders the Monte Giove submerged relief/structural high, and continues eastwards in the Adriatic Sea into the Northern Deformation Zone/"Murge basse" graben, that in turn affected the onshore Murge area. Fault reactivation may have been related to a strain field in the outer part of the gentle buckle fold that involved the continental lithosphere of the Apulian Foreland (i.e., the areas of the Murge onshore and the Adriatic Sea offshore) since the Middle Pleistocene, as roll-back of the subducting lithosphere halted. Besides its tectonic reactivation, this fault has important implications as regards local seismic hazard, as well as the morphology influencing the present-day bioherm.

Key words: Apulian Foreland, Monte Giove, Murge, fault reactivation.

INTRODUCTION

In the southern Adriatic Sea, offshore from the Murge plateau of southern Italy (Fig. 1), Corriero et al. (2019) documented the presence of recent bioherms on submerged morphological relief ~10 m deep, bordered, to the NNE by a ~30 m slope. This slope, roughly WNW–ESE-striking and surveyed for ~3 km in length (using CHIRP pulse side-scan sonar and a sub-bottom profiler), was hypothesized as due to the recent activity of a sub-vertical fault (Corriero et al., 2019; Fig. 2), though with no documented constraints. This interpretation may be corroborated by the presence of similar morpho-structures, both onshore and offshore the Murge area, related to sub-vertical faults active at least during Quaternary (Iannone and Pieri, 1982; Tropeano et al., 1997; di Bucci et al., 2009, 2011; Festa et al., 2019a), and, moreover, responsible for frequent low-energy seismicity (Tropeano et al., 1997; Del Gaudio et al., 2001, 2005; Festa et al., 2019a).

The possible lateral continuation of these faults in the Adriatic Sea area, from the adjacent Murge area onshore, was discussed by Morelli (2002), where the so-called Monte Giove submarine relief (de' Dominicis and Mazzoldi, 1987), including the slope on which bioherms presently grow (Fig. 2) (i.e., Corriero et al., 2019), was related to the Monopoli fault system (Fig. 1A).

The fault controlling the southern margin of the Monte Giove submarine relief (Figs. 1B and 2), which is seismically active, has recently been geometrically constrained (Festa et al., 2019a). On the regional structural sketch by Morelli (2002), the northern margin seems controlled by faults belonging to the Monopoli system (Fig. 1A), albeit poorly constrained in terms of kinematics and geometry at a more detailed scale, and considered active up to the Pliocene.

Therefore, the main objective of the present research paper is to better constrain the timing, geometry and kinematics of the fault possibly controlling the slope bordering the northern margin of the Monte Giove submerged relief. The results may have implications for the tectonic reactivation within the Apulian Fore-

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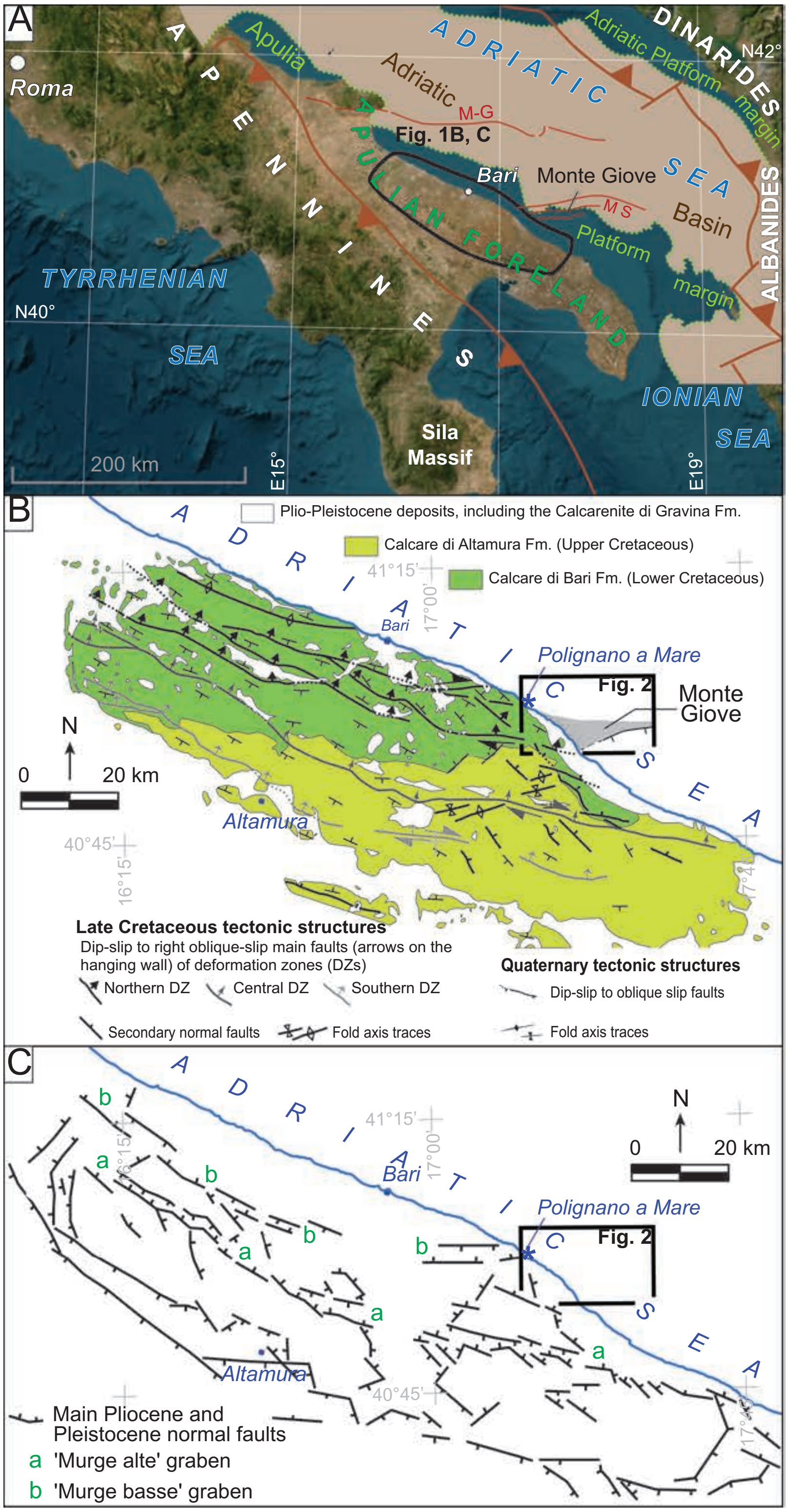

Fig. 1A – schematic structural map of the region around the southern Adriatic Sea (modified after Festa et al., 2014); M-G – Mattinata-Gondola Fault, MS – Monopoli system of faults (modified after Morelli, 2002); the solid black line encloses the Murge area (i.e., Fig. 1B, C); B – structural sketch map of the Murge area (modified after Festa, 2003); the Monte Giove submarine relief and the southern fault bordering it (modified after Festa et al., 2019a) are also indicated; C – neotectonic structural sketch map of the Murge area (modified after Iannone and Pieri, 1982)

land, for seismic hazards in the area (Festa et al., 2019a and references therein), and as regards forming the submarine topography on which the present-day bioherm grows (Corriero et al., 2019).

GEOLOGICAL SETTING

The southern Adriatic Sea region corresponds roughly to both the southern Adriatic Basin, i.e., the Mesozoic-Eocene basin domain lying adjacent to the Apulia Platform realm (Zappaterra, 1994), and the present-day Dinarides-Albanides-Hellenides foreland basin (de Alteriis and Aiello, 1993; Bertotti et al., 2001; Fantoni and Franciosi, 2010; Cicala et al., 2021; Fig. 1A). In the Oligocene – Quaternary evolution of the Dinarides-Albanides-Hellenides orogen, the Adriatic Basin and a part of the Apulia Platform were progressively involved to the west in the foreland basin; moreover, in the framework of the southern Apennines (farther west), the Apulia Platform was progressively involved to the east in the related Neogene-Quaternary foredeep domain (Ricchetti et al., 1988; Doglioni et al., 1994; Onofrio et al., 2009). Therefore, a remnant of the Apulia Platform largely characterizes the Plio-Pleistocene foreland of both the Dinarides-Albanides-Hellenides and the Apennines, i.e., the Apulian Foreland (Selli, 1962; Ricchetti et al., 1988; Fig. 1A, B). According to Doglioni et al. (1994), the uplift since the Middle Pleistocene of the Apulian Foreland occurred in relation to a NW–SE striking regional, continental lithospheric gentle buckle fold, that in turn resulted from the inhibited eastwards roll-back of the continental lithosphere during Apennines subduction.

The Apulian Foreland basically consists, in its upper part, of a sedimentary cover resting on a Variscan basement (Ricchetti et al., 1988), whose nearest coeval and similar rock-types crop out in the Sila Massif (Festa et al., 2006) (Fig. 1A). The sedimentary cover is represented, from the bottom to the top, by Permo-Triassic continental deposits of the Verrucano Fm. (up to ~1000 m thick), Upper Triassic limestones/dolostones and anhydrites of the Burano Fm. (up to ~2500 m thick), and Lower Jurassic limestones of the Calcare Massiccio Fm. (up to ~1000 m thick); the Middle Jurassic-Upper Cretaceous inner platform carbonates of the Apulia Platform extensively crop out in the Apulian Foreland, where they show a thickness of ~4 km (Ciaranfi et al., 1988; Ricchetti et al., 1988; Spalluto et al., 2005).

Marginal and pelagic carbonates (both at outcrop and drilled) testify to the occurrence of the platform-basin transition and the Adriatic Basin (Fig. 1A), respectively (Borgomano, 2000; Nicolai and Gambini, 2007). Similar deposits, however, filled some narrow extensional

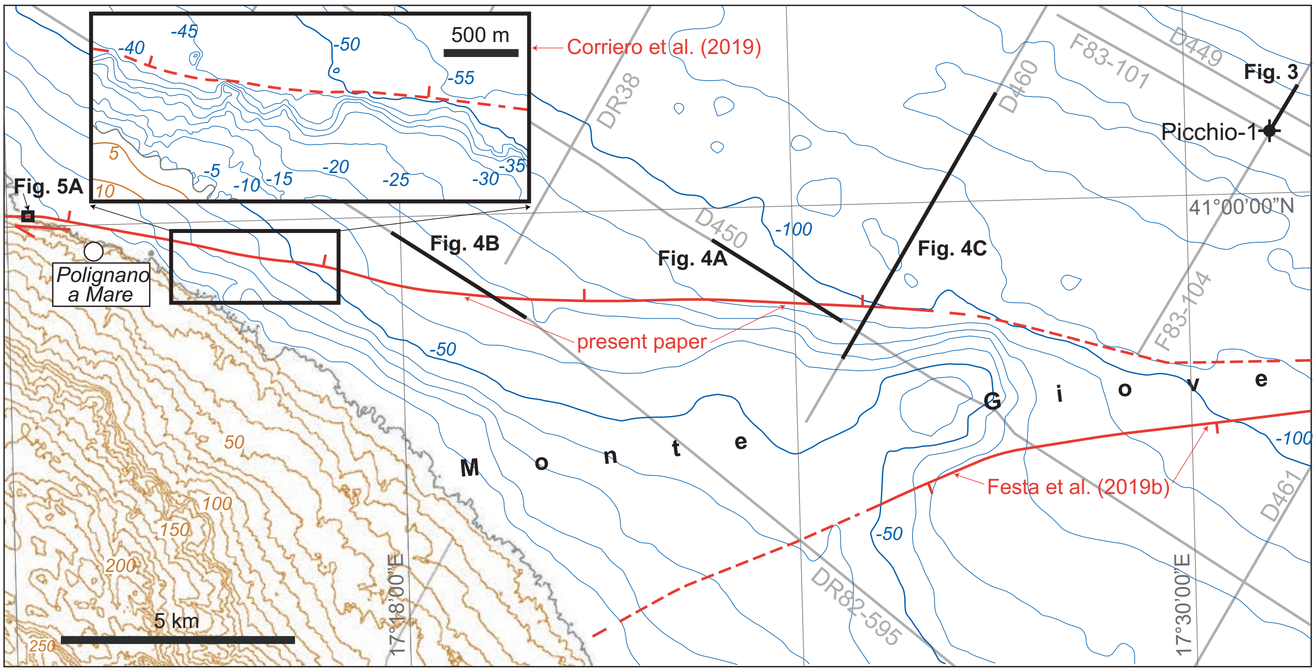

Fig. 2. Structural sketch map of the Adriatic Sea offshore from Polignano a Mare (for location see Fig. 1B)

Blue contour lines of the marine area, after EMODnet (2022), and brown contour ones of the onland zone, after puglia.con (2020); the inset magnified area is modified after Corriero et al. (2019); the position of Picchio-1 exploration borehole (Fig. 3), the traces of the seismic profiles (Fig. 4), and the coastal onland study area (Fig. 5A) are shown; the southern fault of the Monte Giove structural high is after Festa et al. (2019a)

fault-controlled Upper Cretaceous intra-platform basins (de' Dominicis and Mazzoldi, 1987; Nicolai and Gambini, 2007; Mastrogiacomo et al., 2012; Festa et al., 2018).

The Murge area, i.e., the central portion of the emerged Apulian Foreland (Fig. 1A), is characterized by an extensive outcrop of the Apulia Platform carbonates, here represented by the "Calcare di Bari" Fm. (Lower Cretaceous), below, and "Calcare di Altamura" Fm. (Upper Cretaceous), above. According to Festa (2003), the deposition of the limestones of the "Calcare di Altamura" Fm. was controlled by a system of faults with normal and dextral transtensional kinematics (Fig. 1B). Thin Plio-Pleistocene calcarenites belonging to the "Calcarenite di Gravina" Fm. unconformably overlie the Cretaceous carbonates, and crop out along the flanks and, locally, in the inner of the Murge high (Ciaranfi et al., 1988; Fig. 1B). The Quaternary tectonics of the Murge area is mainly characterized by extensional faults striking in the range NW–SE and W–E, towards the Adriatic Sea coastline, and dipping in the range NE and N, respectively (Iannone and Pieri, 1982; Tropeano et al., 1997); some of these faults, and others dipping in the opposite direction, gave rise to the "Murge alte" and "Murge basse" grabens (Fig. 1C; Iannone and Pieri, 1982).

In the Adriatic Sea offshore from Murge, Oligocene to Quaternary deposits unconformably overlie bedrock made of Mesozoic-Eocene Apulia carbonates, i.e., the platform and basin carbonates (Nicolai and Gambini, 2007), and increase in thickness towards the inner Albanides foreland basin (de' Dominicis and Mazzoldi, 1987; de Alteriis and Aiello, 1993; de Alteriis, 1995; Bertotti et al., 2001; Nicolai and Gambini, 2007; Fantoni and Franciosi, 2010). Here, the platform-basin transition was controlled by dominant extensional faults that, moreover, were active also during the Neogene (de' Dominicis and Mazzoldi, 1987). In this respect, the Monte Giove (Fig. 1A), i.e., a narrow E–W-submarine ridge dominated by Apulia Platform carbonates, was present along the platform-basin transition (de' Dominicis and Mazzoldi, 1987; Nicolai and Gambini, 2007), possibly controlled by faults belonging to the Monopoli system, active up to the Pliocene (Morelli, 2002; Fig. 1A). Furthermore, the southern fault bordering Monte Giove shows evidence of Quaternary and present-day activity (Festa et al., 2019a).

MATERIAL AND METHODS

To detect the fault that may control the northern slope of the Monte Giove submerged relief, the Adriatic Sea offshore from Polignano a Mare was examined up to ~30 km from the coastal line (Fig. 2).

First, the offshore bathymetry, as well as the onshore topography of the adjacent emergent area, were reconstructed in GIS by the processing of a public dataset from The European Marine Observation and Data Network (EMODnet, 2022) and a DTM of the Puglia region (puglia.con, 2022), respectively (Fig. 2).

The Visibility of Petroleum Exploration Data in Italy, ViDEPI, project (ViDEPI Project, 2015), contributed greatly to the geological interpretation. Although dealing with vintage reflection seismic profiles and exploration well logs, the related dataset has been widely used in case studies from the southern Adriatic Sea since its online publication in 2007 (see ViDEPI Project, 2015). It provided remarkable input into the study of the relationships between tectonics and sedimentation within the Mesozoic Apulia Platform-Adriatic Basin system and the Paleogene-Quaternary foreland basins of both the Apennines to the west, and the Dinarides-Albanides-Hellenides to the east (Fig. 1A; Nicolai and Gambini, 2007; Scisciani and Calamita, 2009; Del Ben et al., 2010, 2015; Fantoni and Franciosi, 2010; Santantonio et al., 2013; Festa et al., 2014, 2019a, b; Volpi et al., 2016, 2018; Milia et al., 2017a, b; Cicala et al., 2021, 2023a, b; Chizzini et al., 2022; Pellen et al., 2022).

The following seismic profiles were downloaded as .pdf documents from the ViDEPI Project (ViDEPI Project, 2015), georeferenced in GIS (QGIS, 2020) and interpreted:

– the Picchio-1 exploration well;
– unmigrated seismic profiles DR82-595, D450, F83-101, D449, DR38, D460, and F83-104 (located on Fig. 2).

These seismic profiles have several limitations (e.g., the basic shape of the seismic wavelets and the seismic polarity are missing on the related document headers), so for optimal interpretation of the seismic profiles the analysis of the shape and polarity of the principal reflectors was made according to Cicala et al. (2023a). In the absence of the sonic log for the Picchio-1 exploration well, average velocities were calculated by considering both the thickness of the lithostratigraphic units drilled and the related two-way-times (TWT) values on the seismic profile F83-104 (Fig. 3). The average velocities obtained for each seismostratigraphic unit recognized fit within the range of the reference values given by Morelli (2002) and Cicala et al. (2023a).

Finally, the cliff at Polignano a Mare was surveyed geologically in detail, to seek morpho-structural evidence for a possible onshore continuation of the submarine slope identified by Corriero et al. (2019) (Fig. 2).

NORTHERN FAULT OF THE MONTE GIOVE SUBMARINE RELIEF

INTERPRETATION OF OFFSHORE SEISMIC PROFILES

The reference stratigraphy for the Adriatic Sea offshore from of Polignano a Mare is summarized in Figure 3, showing the correlation between the 1780 m thick lithostratigraphic log of the Picchio-1 exploration well and the related seismic reflection features of the seismic profile F83-104, the latter showing a zero-phase normal polarity; the seismic profile DR82-595 (Fig. 4A) displays a minimum phase reverse polarity, whereas the seismic profiles D450 (Fig. 4B) and D460 (Fig. 4C) exhibit a zero-phase reverse polarity. As shown in Figure 3, the top of the Mesozoic-Eocene Apulia carbonates is generally well-defined and characterized by a high amplitude, strong reflector; for these carbonates, encountered in the exploration well for a thickness of 280 m, and represented by Eocene limestones and Upper Cretaceous dolostones, an average velocity of 4500 ms^{-1} has been assigned. Above this reflector, Oligo-Miocene, Pliocene and Quaternary seismostratigraphic units have been identified based on particular seismostratigraphic features.

The Oligo-Miocene seismostratigraphic unit is dominated by 630 m of marls, calcareous marls and sandstones giving moderate to high amplitude reflections, and generally showing subparallel continuous to discontinuous reflectors (Fig. 3). This unit, that is characterized by an average velocity of 3400 ms^{-1}, is topped by a strong reflection due to the sharp transition to the 870 m thick clays and sandstones that dominate both the Pliocene and the Quaternary seismostratigraphic units, for which an interval average velocity of 1950 ms^{-1} was obtained (Fig. 3). Low- to medium-amplitude subparallel discontinuous and continuous reflections are exhibited by these two units, although separated from each other by a strong continuous reflector (Fig. 3).

The Oligo-Miocene, Pliocene and Quaternary seismostratigraphic units thin towards both the west and the south, where they are deformed by a major high-angle fault (dip of ~70°), dipping to the north, and having a dip-slip component of movement (Fig. 4). In plan view, this fault, surveyed for a length of ~25 km, strikes E–W in the Adriatic Sea offshore from Polignano a Mare, and it bounds the Monte Giove structural high to the north (Figs. 2 and 4).

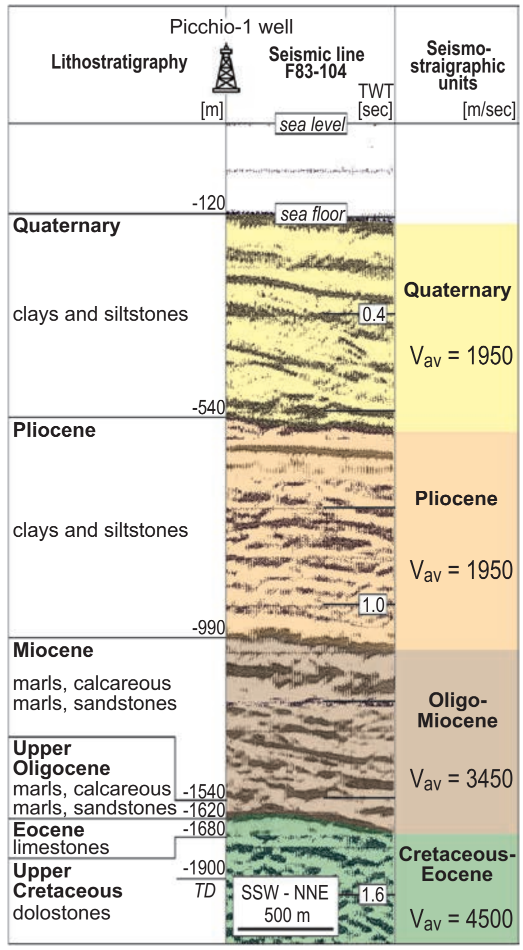

Fig. 3. Correlation between the lithostratigraphy of the Picchio-1 exploration borehole (TD – total depth), seismic facies recorded by the seismic profile F83-104 (for location see Fig. 2), and the seismostratigraphic units recognized; V_{av} (P-waves average velocity) is indicated for each seismostratigraphic unit

Gentle folding, observed in the reflectors around the fault, indicates both fault propagation and dragging of the strata, during movement between the hanging wall and the footwall (Fig. 4). Evidence of Cenozoic synsedimentary activity of the fault is represented by the increasing thickness of the Oligo-Miocene, Pliocene and Quaternary seismostratigraphic units on the hanging wall, and, hence, by a downwards increase of the throw, up to ~400 m (e.g., Fig. 4A). Moreover, along the fault a minor throw can be observed towards the west (e.g., Fig. 4B). The tip of the fault is generally located within the Quaternary seismostratigraphic unit (Fig. 4A, C). Unfortunately, due to the low resolution of the unmigrated seismic profiles available, it was not always possible to establish whether the Quaternary stratigraphic succession is deformed by faulting also in its uppermost part, though, locally, the fault seems crosscut the whole Quaternary seismostratigraphic unit (Fig. 4B).

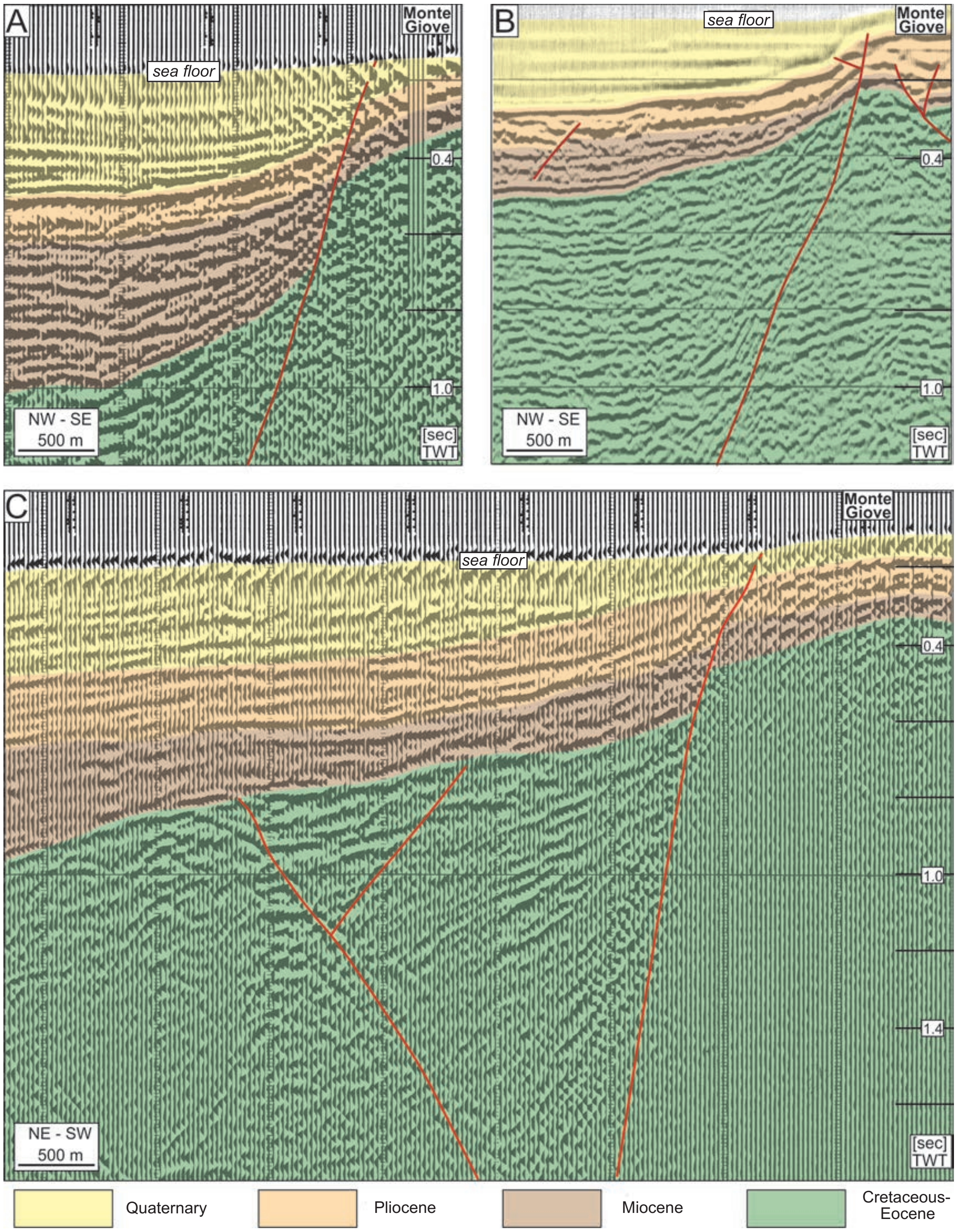

Fig. 4A – interpretation of a portion of the seismic profile D450 (for location see Fig. 2); B – interpretation of a sector of the seismic profile DR82-595 (for location see Fig. 2); C – interpretation of a part of the seismic profile D460 (for location see Fig. 2). The three portions of the seismic reflection profiles cross the Monte Giove submerged relief northern fault

ONSHORE FIELD OBSERVATIONS

The possible lateral continuation, even farther west, of the fault that borders the Monte Giove structural high to the north has been searched also on the cliff at Polignano a Mare. Evidence of this fault has been found along the Adriatic coast north of the town (Fig. 2), where Lower Cretaceous limestones of the "Calcare di Bari" Fm. and Lower Pleistocene calcarenites of the "Calcarenite di Gravina" Fm are juxtaposed along an E–W striking, sub-vertical tectonic contact (Fig. 5A). The calcarenites to the north are downthrown (Fig. 5A) by not <6 m, and are characterized, along the tectonic contact, by centimetre- to decimetre-thick well-cemented sub-vertical bands, which result in straight to curvilinear ridges detectable, in plan-view, for several metres (Fig. 5B, C). Among these well-cemented bands, that are structurally and genetically related to the major fault determining the tectonic contact, the main one is sub-vertical and strikes E–W (parallel to the tectonic contact) (Fig. 5B, C); its

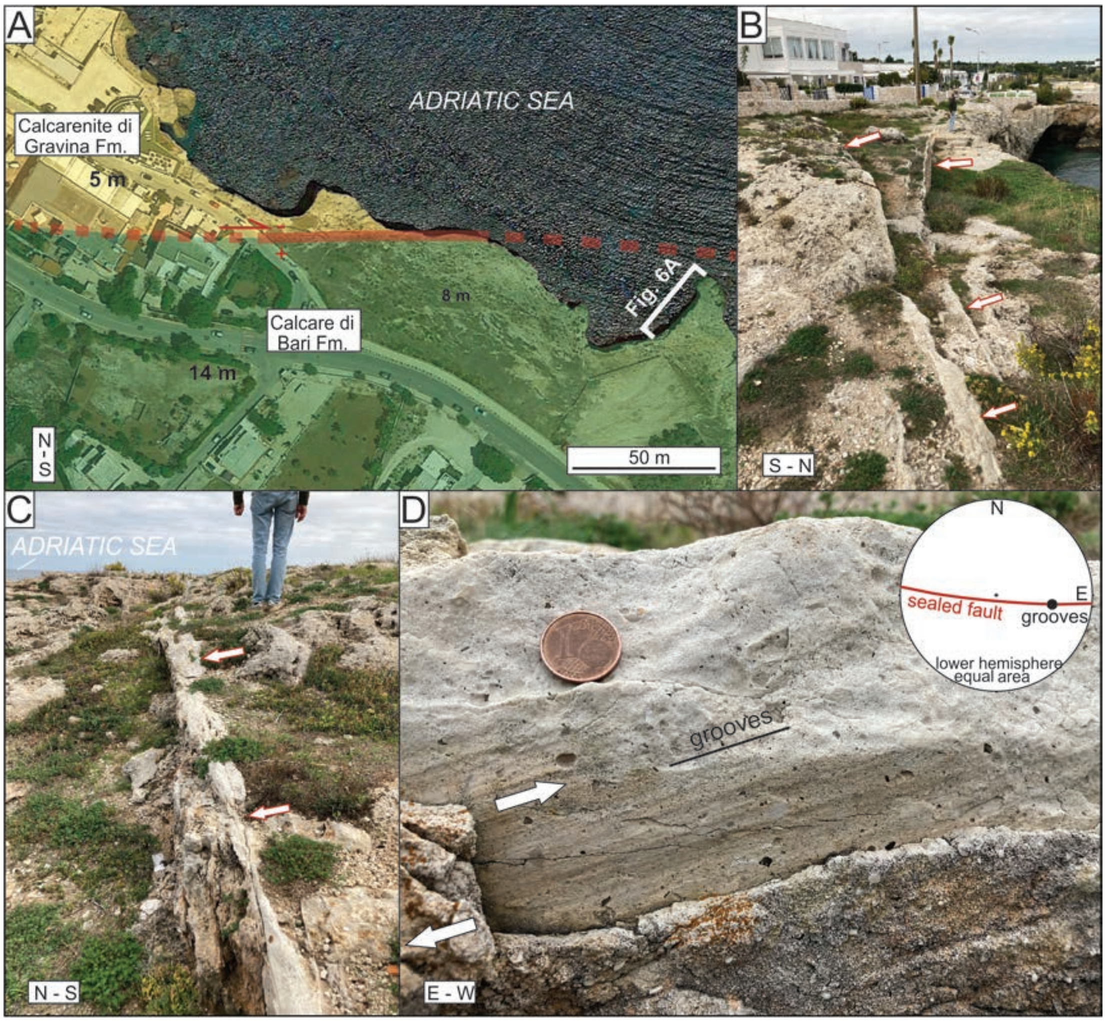

Fig. 5A – geological sketch map of the area north of Polignano a Mare (for location see Fig. 2); note the tectonic contact, i.e., the dextral oblique-slip sub-vertical fault between the "Calcarenite di Gravina" and the "Calcare di Bari" fms.; B – decimetre thick well-cemented sub-vertical sealed faults in the "Calcarenite di Gravina" Fm., occurring, in plan-view, as straight to curvilinear ridges (arrowed); the main sealed fault is located to the south (photograph taken from the east); C – detail of the main sealed fault in the "Calcarenite di Gravina" Fm., arrowed (photograph taken from the west); D – grooved margin of the main sealed fault in the "Calcarenite di Gravina" Fm.; the stereographic projection of the groove lineations is shown; the arrows indicate the sense of movement along the sealed fault

margins, locally exposed, show frictional wear striation as grooves with a pitch of 35° (Fig. 5D), indicating that this main well-cemented band developed by sealing an oblique-slip sub-vertical fault. Therefore, these well-cemented bands are represented by sealed faults (Fig. 5B–D).

As regards the "Calcare di Bari" Fm. adjacent to the tectonic contact with the "Calcarenite di Gravina" Fm. (Fig. 5A), planar anisotropies, roughly NNW-dipping, show an abrupt variation of the dip, of ~45° near to the tectonic contact, and from weakly-dipping to sub-horizontal, moving away from the contact (Fig. 6A). Moreover, the spacing of the planar anisotropies decreases towards the tectonic contact, so that where a higher dip occurs a strong increase of the planar anisotropies can be observed (Fig. 6B). These latter are here characterized by alternating very fine-grained brighter and darker carbonate bands millimetres to centimetres thick (Fig. 6C, D). These bands locally wrap brighter centimetre-scale sigmoid-type objects and hinge zones of asymmetrical unrooted folds (Fig. 6C); up to centimetre-thick brighter lenses can be found stretched sub-parallel to the main banding (Fig. 6D). However, a ductile shearing, geometrically coherent with primary laminae, cannot be excluded. Finally, later fracturing is superimposed on the ductile shearing (Fig. 6D). Summing up, a ductile deformation involved the "Calcare di Bari" Fm. adjacent to the tectonic contact with the "Calcarenite di Gravina" Fm. the weakly dipping to sub-horizontal planar anisotropies of the "Calcare di Bari" Fm. that extend from the tectonic contact (Fig. 5A), are clearly represented only by stratal surfaces. Therefore, it can be inferred that the "Calcarenite di Gravina" and the "Calcare di Bari" fms. north of Polignano a Mare, were juxtaposed after the Lower Pleistocene by a dextral oblique-slip sub-vertical fault (Fig. 5A) which represents the lateral continuation, to the west, of the fault that forms the northern border of the Monte Giove structural high (Fig. 2). However, the ductile behaviour of the "Calcare di Bari" Fm. (e.g., Fig. 6C, D) indicates that fault activity likely occurred well before the brittle deformation recorded in the "Calcarenite di Gravina" Fm. (Fig. 5B–D).

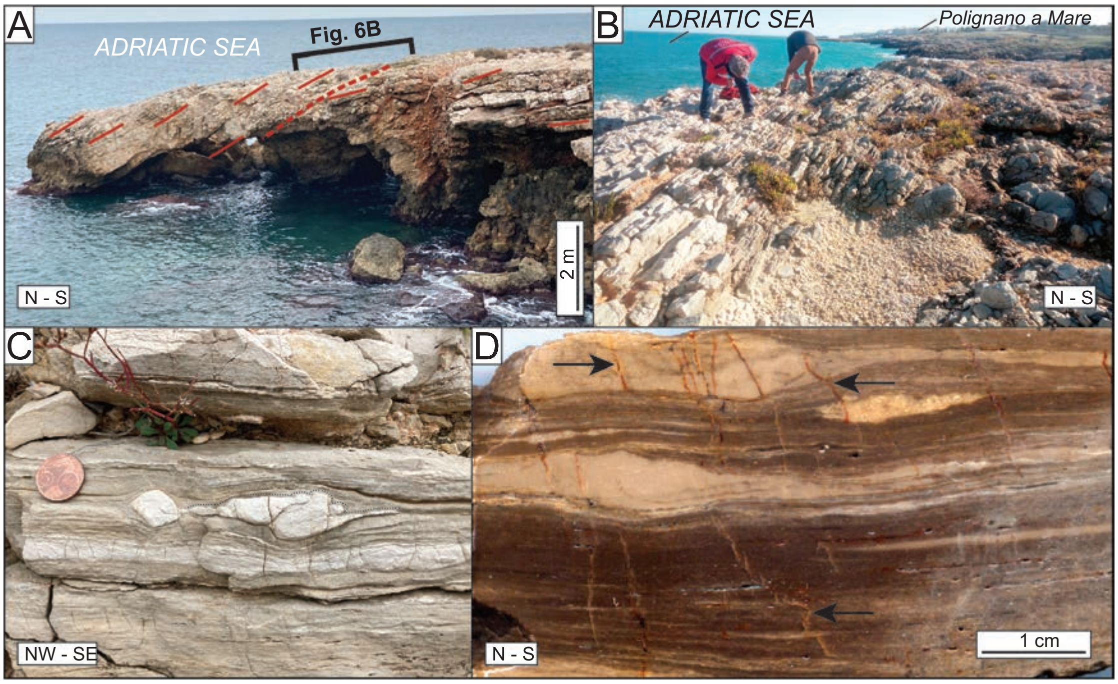

Fig. 6A – panoramic view of the "Calcare di Bari" Fm. characterized by a succession of fine-grained recrystallized carbonates (for location see Fig. 5A) involved, in the northern part of the cliff, in ductile behaviour; red segments indicate the dip of the planar anisotropies and stratal surfaces; dashed red line shows the limit between high-angle-dipping planar anisotropies (to the north) and low-angle-dipping to sub-horizontal stratal surfaces (to the south); B – low spacing of planar anisotropies within the "Calcare di Bari" Fm. affected by ductile deformation (for location see Fig. 6A); C – brighter centimetre-scale sigmoid-type lens (to the left) and hinge zone of asymmetrical unrooted fold (to the right) wrapped by millimetre- to centimetre-thick bands ("Calcare di Bari" Fm. affected by ductile shearing); D – brighter stretched lenses parallel to the main banding on a polished cut of a sample recording ductile shearing ("Calcare di Bari" Fm. affected by ductile shearing); later fractures sealed by red cement are arrowed

DISCUSSION

Fault reactivation is a common feature in the tectonic evolution of orogenic systems (e.g., Holdsworth et al., 1997; Tavarnelli et al., 2001; Lacombe and Mouthereau, 2002; Butler et al., 2006; Festa et al., 2020), including in foreland basins (Krzywiec, 2001; Krzywiec et al., 2005; Oszczypko et al., 2006; Pace et al., 2015). It is not generally acknowledged that tectonic inheritance may affect areas devoid of orogenic deformation (e.g., outer foreland areas). However, in the structural context of the Apulian Foreland the reactivation of Cretaceous faults has been hypothesized by Tropeano et al. (1997), di Bucci et al. (2009, 2011) and Festa et al. (2019a), but documented only by Chilovi et al. (2000) for the Mattinata-Gondola Fault (Fig. 1A), and by Festa (2003) for the Murge area. As shown by the comparison of the two structural maps in Figure 1B, C, the reactivation of faults is indicated regionally by the near correspondence of the Plio-Quaternary "Murge alte" and "Murge basse" grabens (Fig. 1C) (Iannone and Pieri, 1982) with the late Cretaceous faults related to the Central and Northern Deformation zones (Fig. 1B; Festa, 2003), respectively.

Our results show that the NNE- to N-dipping fault, striking from north of Polignano a Mare to the east in the Adriatic offshore Murge area, controls the geometry of the northern margin of the Monte Giove structural high/submerged relief (Fig. 2); this fault includes the sub-vertical segment, recording recent activity and governing the morphology of the slope, surveyed by Corriero et al. (2019) (Fig. 2). Therefore, this slope may represent an important witness to the recent activity of the fault, well after the timing of faulting (up to the Pliocene) suggested by Morelli (2002) for the Monopoli fault system (Fig. 1A). According to onshore field data (Figs. 5 and 6) and from the interpretation of the offshore reflection seismic profiles (Fig. 4), the northern fault of the Monte Giove structural high is sub-vertical and characterized by post-Lower Pleistocene dextral oblique-slip kinematics (Fig. 2). However, the seismic profiles suggest syn-sedimentary tectonics generally during Quaternary, as well as during the Pliocene and Oligo-Miocene, as revealed by the thickness increases of the related seismostratigraphic units in the hanging wall of the northern fault of the Monte Giove structural high (Fig. 4A, B).

The fault bordering the Monte Giove structural high to the north is in lateral continuity with the Northern Deformation Zone to the west, which was activated at least since the late Cretaceous within the Murge area (Fig. 7A; Festa, 2003). According to stratigraphic data interpretation by de' Dominicis and Mazzoldi (1987) and Nicolai and Gambini (2007), activity of the northern fault of the Monte Giove structural high can be traced back to the Cretaceous. In this respect, the ductile behaviour of the "Calcare di Bari" Fm. carbonates, observed in the field along the fault zone (Fig. 6), is in line with the Cretaceous tectonics within the Northern Deformation Zone. Moreover, the post-Lower Pleistocene activity in this deformation zone would also have occurred through the reactivation of the related faults (i.e., Fig. 5), and the formation of the "Murge basse" graben identified by Iannone and Pieri (1982) (Fig. 1C).

The reactivation of the faults within the Northern Deformation Zone may be related to the continental lithospheric gentle buckling invoked by Doglioni et al. (1994) for the Apulian Fore-

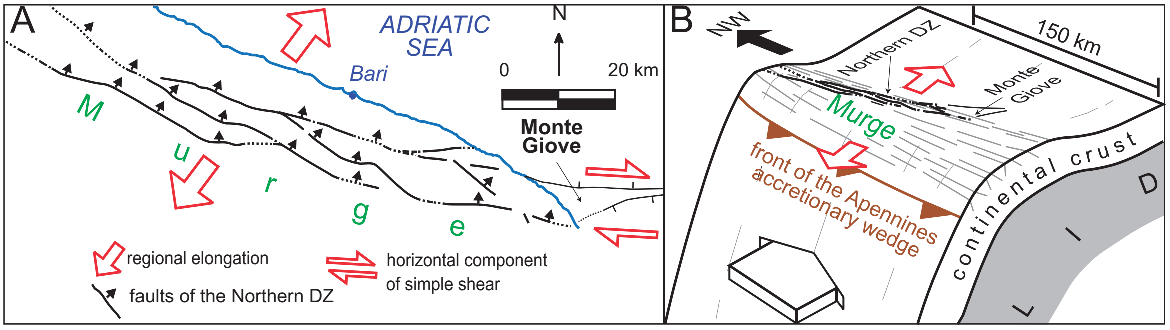

Fig. 7A – structural sketch map correlating the faults of the Northern Deformation Zone (DZ) (from Fig. 1B) with the faults bordering the Monte Giove structural high (from Fig. 2); B – schematic block diagram showing the Apennines subduction corresponding with the Apulian Foreland, adjusted for the Murge area (modified after Doglioni et al., 1994); the red arrows indicate the regional elongation (as in Fig. 7A) on the outer lithosphere buckle fold; the Northern DZ and the faults bordering the Monte Giove relief are also indicated

land during the Apennines subduction (Fig. 1A), which was accompanied by arching/uplift of the Murge area since Middle Pleistocene (Fig. 7B). Accordingly, a roughly NE–SW regional elongation of the outer part of the gentle buckle fold, NW–SE-striking and affecting the continental lithosphere (Fig. 7B), may have determined the reactivation of both late Cretaceous faults identified by Festa (2003), as well as the flexural extensional faults activated during the Plio-Pleistocene eastwards roll-back of the subducting lithosphere (Cicala et al., 2021). According to this interpretation, the reactivation of the NW–SE striking faults in the Murge area occurred with dip-slip kinematics (Fig. 7A), as suggested by focal mechanisms calculated by Del Gaudio et al. (2005) for recent earthquakes in the Murge area. Furthermore, in the southeastern Murge area, the NE–SW regional elongation occurred since the Middle Pleistocene (di Bucci et al., 2011). Accordingly, such a feature of the regional strain field would have determined the reactivation of E–W striking faults, within the Northern Deformation Zone and bordering the Monte Giove submerged relief, with a dextral horizontal component of simple shear (Fig. 7A). In this respect, Chilovi et al. (2000), di Bucci et al. (2009, 2011) and Festa et al. (2019a) interpreted the E–W striking right-lateral seismogenic faults in the Apulian Foreland as inherited and reactivated structures.

CONCLUDING REMARKS

Our main results, aimed at constraining the fault controlling the geometry of the northern margin of the Monte Giove submerged relief, support the following conclusions:

– onshore field data and seismic profile interpretations indicate that the geometry of the northern margin of the Monte Giove submerged relief/structural high is controlled by a NNE- to N-dipping fault, striking from north of Polignano a Mare to the east, in the Adriatic Sea;
– this fault is sub-vertical and characterized by post-Early Pleistocene dextral oblique-slip kinematics;
– syn-sedimentary tectonics during the Oligo-Miocene, Pliocene and Quaternary are shown by the increase in thickness of the related seismostratigraphic units in the hanging wall of the fault;
– the northern fault of the Monte Giove submerged structural high shows clues to Cretaceous activity, represented by ductile deformation structures under diagenetic conditions within the outcropping limestones of the “Calcare di Bari” Fm. involved in faulting;
– the faults bordering the Monte Giove structural high represent the offshore lateral continuation to the east, in the Adriatic Sea, of the Northern Deformation Zone within the Murge area, active since the late Cretaceous;
– the faults of the Northern Deformation Zone and those bordering the Monte Giove structural high may have been reactivated during post-Early Pleistocene time with normal dip-slip and dextral oblique-slip kinematics along NE-dipping and N-dipping/E–W striking sub-vertical planes, respectively;
– the reactivation of these faults may be related to the continental lithospheric gentle buckling of the Apulian Foreland occuring due to halting of the roll-back of the subducting lithosphere, which was accompanied by arching/uplift of the Murge area since the Middle Pleistocene.

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