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MARINE TERRACES AND EXTENSIONAL FAULTING IN THE TARANTO GULF, BRADANIC TROUGH, SOUTHERN ITALY

CONTENTS

ABSTRACT

The front of the Southern Apennines in the Taranto Gulf is sealed by Pliocene-Pleistocene foredeep deposits, which represent the infill of the Bradanic Trough. The upper portion of the Middle Pleistocene succession consists of marine sands and conglomerates, that previous work considered arranged in several orders of terraces. The local drainage pattern appears controlled by prominent geomorphic lineaments. Some of these structures coincide with normal faults with vertical offsets of ca. 10 m each. Their trend defines an arcuate pattern that mimics the present coastline.

Fieldwork shows that all the terraced deposits belong to a single sedimentary body displaced by normal faults. The terraced deposits are related to an event of beach progradation, of Middle Pleistocene age, documented in other areas of the Italian peninsula. The recognition of normal faults offsetting a single terrace unit outline an intimate relationship between the arcuate trend of the mapped fault set and the present coastline pattern. Normal fault development can be related to large-scale gravitational processes developed after the general tilting towards the SE of the Bradanic Trough.

KEYWORDS: Marine terraces, normal faults, Taranto Gulf.

1. INTRODUCTION

The Southern Apennines of Italy are a Neogene fold-and-thrust belt whose outer zones mainly consist of a allochtonous Miocene flysch and a tectonic mélange, the so-called Varicoloured Clays (CASERO *et alii*, 1988; MONACO *et alii*, 1998). The present thrust front, now buried below the deposits of the Bradanic Trough, crosses the present coastline within the Taranto Gulf (Fig. 1a). The Bradanic Trough is filled with a sedimentary wedge of Pliocene-Pleistocene age that covers unconformably the Cretaceous limestones of the Apulian platform as well as the allochtonous Apennine units. The foredeep sediments include clays and marly clays, with intervening sandstone layers, of Middle Pliocene – Middle Pleistocene time (PATACCA & SCANDIONE, 2001). These deposits were deformed by thrusting and were covered by the allochtonous units up to Early-Middle Pleistocene time (BALDUZZI *et alii*, 1982).

The youngest rocks of the Bradanic Trough form marine terraces (Fig. 1b) whose moderate SE dip is not directely related to the northeastward migration of the Apennine front, but rather appears to reflect a prominent structural control by normal faults not hitherto recognised. In this short note we describe the main features of the terraces and their relationships to normal faults. Additional stratigraphic and geomorphological data, that go beyond the purpose of this contribution, have been described in a companion paper (BENTIVENGA *et alii*, in press).

2. MARINE TERRACES AND SIGNIFICANCE OF THEIR BOUNDING ESCARPMENTS

Low elevation scarps, generally interpreted as the geomorphic manifestation of several orders of marine terraces (AMATO, 2000, and references therein), dominate the landscape of the Bradanic through. The stratigraphic features of the marine terraces (AMATO, 2000; BENTIVENGA *et alii*, in press) suggest the lack of relevant tectonic movements during deposition of the terraced units. There are, however, several indications that some of the scarps are related to the activity of faults, as summarised in Figs. 1b, c. The occurrence of seaward dipping normal faults has been primarily established where these structures intersect competent lithologic units, such as marine sands and gravels. For instance, 8 km east of Pisticci, a normal fault offsets the deposits of the marine terrace, accommodating a vertical displacement of ca. 10 m (Fig. 2a). The fault is associated to an evident step in the topography, that is of the same order of magnitude of the fault displacement. The most spectacular fault is observed in the western side of the Taranto Gulf, along the Avena stream (Fig. 2b). This structure, first described by CUCCI & CINTI (1998), trends N 50° E, dips ca. 80° to the southeast, and accommodates a vertical displacement of at least 10 m.

Information on the morphological lineaments and on evidence of faulting has been summarised into a cross-section traced between Pisticci and the Ionian sea (Fig. 1c). Here, the difference in elevation between contiguous surfaces of the marine terrace is more pronounced towards the WNW. In particular, this is well illustrated between Pisticci and San Leonardo, where the two surfaces are displaced by about 50 m. Morphological features strongly suggest the presence of a fault plane in this area, because the two surfaces are separated by a deep gully oriented ca. N 40° E. In the south-eastern segment of the cross-section (Fig. 3b) steps separating different surfaces are less obvious, becau-

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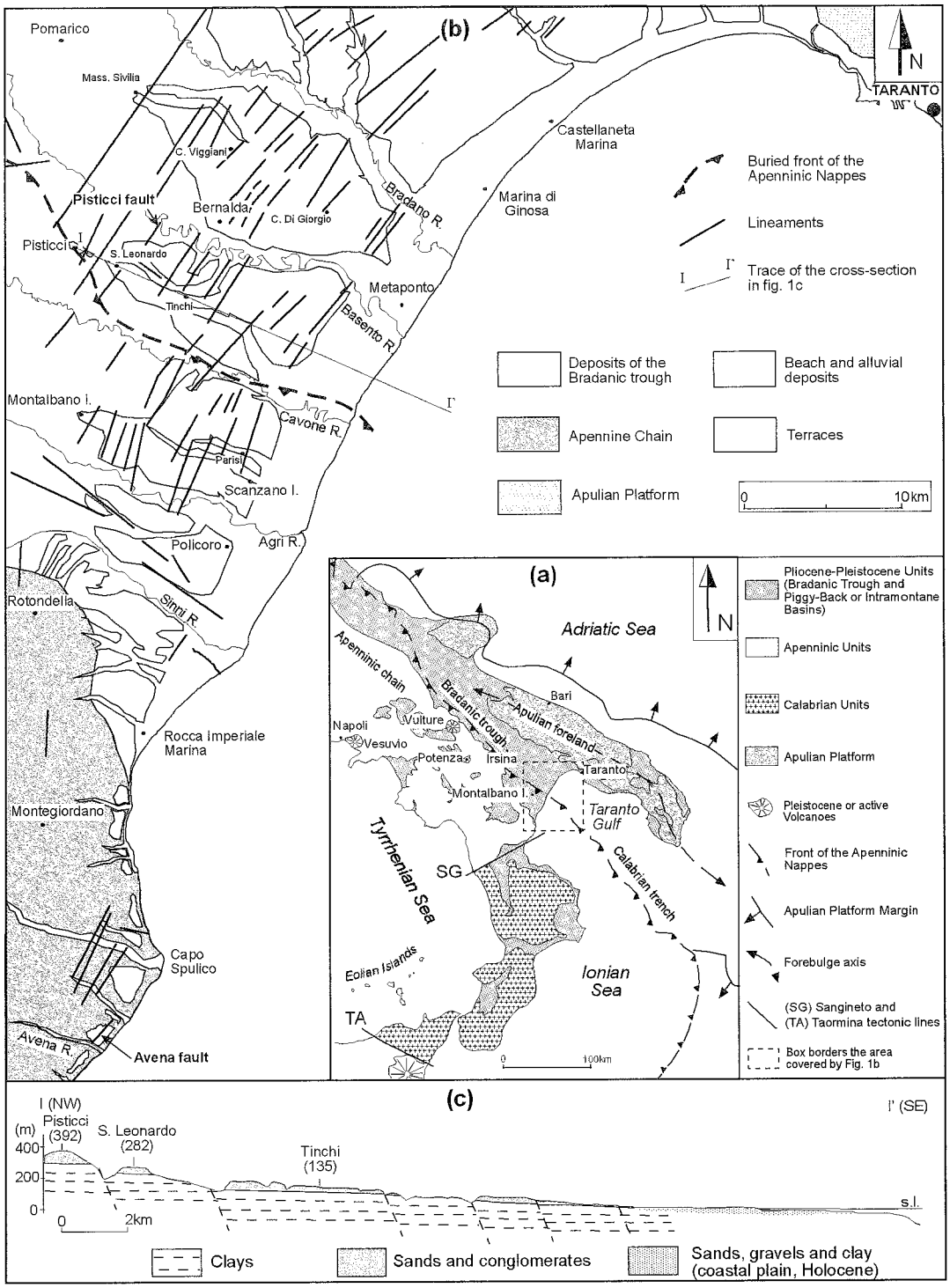
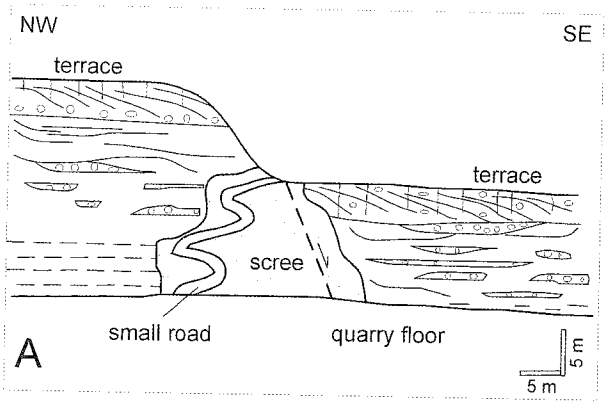


Fig. 1 - a) Sketch map of the Southern Apennines and the Calabrian Arc with location of Bradanic Trough. b) Scheme of lineaments observed by aerial photographs and satellite images. The location of the normal faults d observed in the Avena stream and near Pisticci village (Fig. 2) is indicated. c) Cross section of the marine terraces (for location see Fig. 1b).

se the difference in elevation between adjacent surfaces is small, possibly in the order of 10 m.

In summary, there is good evidence for faults offsetting the marine terraces in the Bradanic Trough and the adjoining Apennine chain. Orientation of fault planes varies gradually between N 10° E and N 45° E, with a concave pattern similar to the map trace of the present coastline of the Taranto Gulf (Figs. 1a, b). Fault traces run almost undisturbed across the buried front of the Apennine nappes. Field data reveal an extensional kinematics, with the hanging-wall displaced to words SE, i.e., towards the Taranto Gulf. The displacement of individual faults is comprised between about 50 and 10 m, and seems to vary along-strike. Normal faulting in the Bradanic Trough was associated to a general tilting towards the SE, with uplift of the land area located NW of the Taranto Gulf. Tilting is clearly shown by the regional attitude of the upper surfaces of the marine terraces, which dip slightly to the SE (Figs. 1b, c).



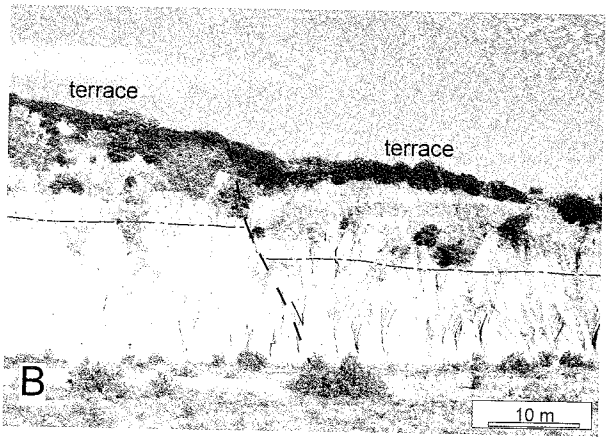


Fig. 2 - Evidence of faulting in the terraced deposits. a) Field sketch of a terrace offset by a normal fault observed in an abandoned quarry 8 km E of Pisticci; b) Normal fault exposed at the Avena stream. Locations are reported in Fig. 1b.

3. CONCLUSIONS: 3D-MODEL OF THE BRADANIC FOREDEEP

The recognition of a set of NE-SW trending fault traces in the Bradanic Trough strongly supports the hypothesis of a single marine terrace unit displaced by SE-dipping normal faults (Figs. 1b, c). Although this interpretation has been proposed for the first time in our companion paper (BENTIVENGA *et alii*, in press), and further outlined in this study at the front of the Southern Apennines, it is commonly accepted in other areas of the Periadriatic domain (NANNI *et alii*, 1986; BIGI *et alii*, 1996). Slip along the normal fault surfaces generated escarpments, that in the past have been interpreted as the geomorphological manifestation of different orders of marine terraces (e.g. see AMATO, 2000). Although individual faults accommodate a maximum displacement of some tens of metres, their cumulative displacement could be in the order of hundreds of metres. At the scale of the entire Bradanic Trough, these faults are arranged in an arcuate set and gradually change in orientation from SSW-NNE, in the south-west, to WSW-ENE in the north-east.

Evidence for faults offsetting the marine terraces in the Taranto Gulf has been incorporated into a schematic 3D model (Fig. 3). The model shows the uplifted portion of the Bradanic Trough, i.e. the foredeep basin of the Southern Apennines, that has its southeastward continuation in the morphological depression of the Taranto Gulf. Here the front of the Southern Apennines and the foredeep deposits are found at a depth exceeding 1500 m below the sea level (SILVESTRINI *et alii*, 1984). The occurrence of this deep basin can be related to the oblique incorporation of the thick Apulian platform into the southern Apennine chain

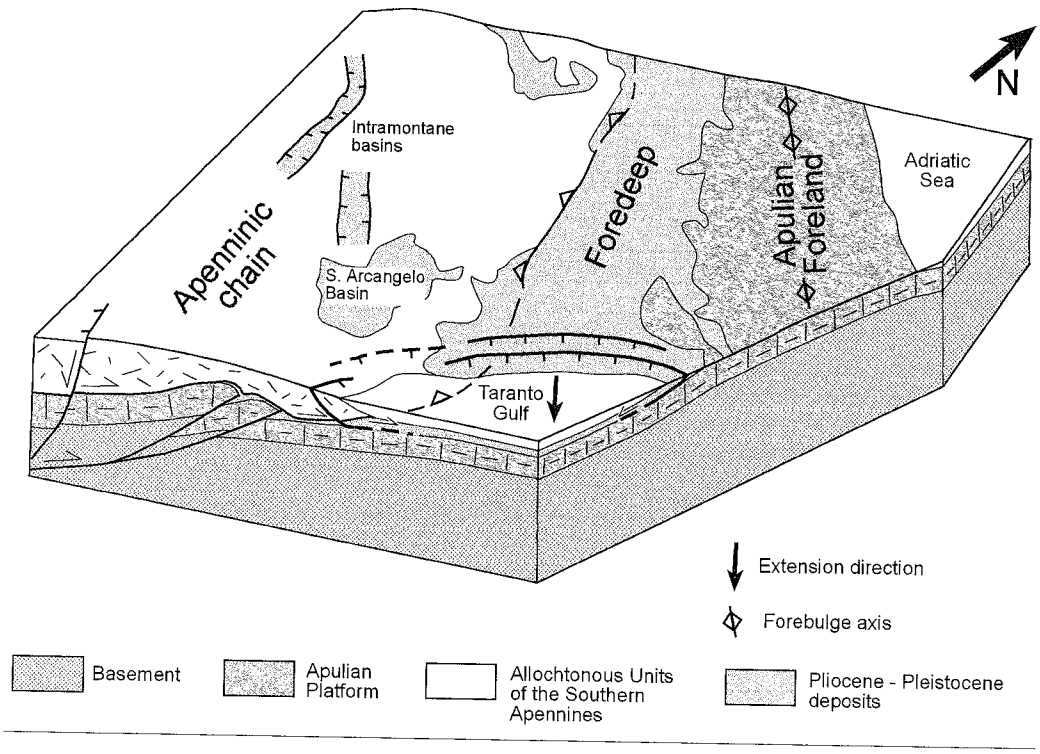


Fig. 3 - Tectonic 3-D model illustrating the formation of marine terraces by fault activity in the Taranto Gulf.

(I.E., GAMBINI & TOZZI, 1996). Deeper indentation of the Apulian platform in the northern segment of the Southern Apennines results into stronger uplift of the northern part of the Badanic Trough, because the forebulge axis is adjacent to the orogenic belt in this area (Fig. 3).

Normal faults perpendicular to the axis of the Bradanic Trough around the Taranto Gulf are interpreted as the ultimate result of this differential uplift process. This area corresponds to the transition between the uplifted and submerged parts of the Apenninic foredeep, where a relatively high topographic gradient is observed. In this framework, the faults described in this study could be related to along-strike gravitational collapse of the southern part of the Apenninic foredeep. The arcuate pattern of the normal faults is readily explained by the same process, i. e. by the presence of a gently SE-dipping detachment at the base of a giant landslide, that affects the entire Taranto Gulf and its hinterland domain (Fig. 3). In this gravitational framework, the fault escarpments could be regarded as "breakaway zones" of individual faults emanating from the common detachment or sliding surface. The detachment level of these faults is unknown, but it is probably deeper than the basal detachment of the buried Apenninic nappes, as indicated by the map pattern of the tectonic lineaments, that are smoothly curved around the Taranto Gulf and run straight across the buried front of the Southern Apennines. This observation would suggest that the detachment horizon is located at the base of the foredeep deposits, that locally are found below the buried Apennine nappes. This is coherent with the length of the fault escarpments, which can be traced for distances in the order of 10 km (Fig. 1b).

The recognition of gravity-induced sliding processes, connected to the sudden deepening of the basin at the transition to the Calabrian trench, could have more regional manifestations, and similar processes could also affect the eastern side of the Calabrian peninsula.

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