



A multidisciplinary approach to the reconstruction of the Quaternary evolution of the Messina Strait area

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ABSTRACT

The reconstruction of the geological evolution in such a complicated sector as the Messina Strait must imply a multidisciplinary approach, involving structural geology, stratigraphy, sedimentology, geomorphology and geophysics.

Through the structural analysis the most recent fault system responsible for the present deformation of the area has been detected; the stratigraphic analysis allowed us to correlate the marine successions outcropping on both sides of the Strait; the sedimentological features of the Ghaie e Sabbie di Messina Fm. indicate that a Gilbert-type fan delta developed on the whole area, probably within the Riss glacial stage; the geomorphological elements are strictly linked to the tectonic features of the area; the historical seismicity shows a good agreement with the recognised recent faults; the interpretation of off-shore seismic lines gave the opportunity to follow the trend of important stratigraphic horizons and in particular the unconformity at the base of the Ghaie e Sabbie di Messina Fm., very well evident onshore.

In conclusion, the Geological Map of the Messina Strait, integrated by multidisciplinary analysis, represents an example of thematic cartography. It allows us to evaluate the geodynamics of the Messina Strait area, and that of the whole Calabrian Arc. The Quaternary evolution infact may be correlated to the deep involvement of the Ionian slab hinge, which undergoes a first SE-ward flexural retreat, during Late Pliocene-Early Pleistocene, and a second one SSE-ward, probably still active, since the late Middle Pleistocene; this latter originated the active Ganzirri-Scilla Fault System.

AIMS

The Recent geodynamics in the area of the Messina Strait can be correlated with the progressive retreat of the subduction hinge of the Ionian oceanic lithosphere. Retreat of the slab hinge is laterally bordered by tear faults, whose surface expression are the transcurrent faults of the South Tyrrhenian System, to which the collapse faults of the Calabrian-Peloritani System are related. The seismicogenic structures of this sector are mainly characterised by superficial extensional and transcurrent mechanisms in relation with a compressive tectonics at depth. A detailed geological map, based on both field evidences and geophysical data, has been carried out with the aim of pointing out the geological and morpho-structural features of the Strait of Messina area and outlighting the relationship between the sicilian and the calabrian side. A particular attention has been paid to the Plio-Pleistocene marine successions which have been sampled and studied, on the basis of the calcareous nanofossil content, on both sides of the Strait. The aim of this study is to highlight the presence of ENE-WSW and NNW-SSE oriented structures that control the Late Pleistocene and Recent evolution of the Messina Strait.

This work emphasized the relationship between the recent lineaments and the NE-SW oriented faults, which have controlled the setting of this sector of the Calabrian Arc during the Late Pliocene to Early Pleistocene. The Ghaie e Sabbie di Messina Fm represents the latest sedimentary event preceding the setting of the ENE-WSW and NNW-SSE trending fault systems, which are the structures responsible for the uplift observed in the Messina Strait, and constitute potentially seismicogenic faults.

KEYWORDS

Structural geology, biostratigraphy, applied geophysics, recent tectonics, Quaternary, Calabrian Arc, Messina Strait

RIASSUNTO

La comprensione dell'evoluzione geologica di un settore complesso come quello rappresentato dallo Stretto di Messina deve necessariamente passare attraverso l'analisi di dati derivanti da discipline diverse come: geologia strutturale, stratigrafia, sedimentologia, geomorfologia, sismologia, geofisica. Attraverso l'analisi strutturale è stato possibile individuare quali sono i sistemi di faglie più recenti e responsabili della deformazione attuale dell'area; la caratterizzazione stratigrafica, anche attraverso nuove datazioni derivanti dallo studio dei Nanofossili calcarei, ha permesso di correlare le sequenze sedimentarie tra le due sponde dello stretto; i caratteri sedimentologici della Fne delle Ghaie e Sabbie di Messina indicano un ambiente di sedimentazione di tipo Gilbert-fan delta che si sviluppava su entrambe le sponde, probabilmente durante uno stadio glaciale (Riss); gli elementi geomorfologici analizzati sono il riflesso dell'evoluzione recente, in connessione con le direttrici tettoniche individuate; la sismicità storica e strumentale mostra in generale un buon allineamento con i trend strutturali più recenti, infine, l'interpretazione delle linee sismiche presenti nell'off-shore ha permesso di ricostruire su tutta l'area dello stretto l'andamento di importanti orizzonti stratigrafici e in particolare la discordanza presente alla base della Fne delle Ghaie e Sabbie di Messina, ben correlabile con la discordanza riconosciuta a terra. In conclusione, l'integrazione dei dati cartografici con quelli analitici costituisce un esempio di cartografia tematica con approccio multidisciplinare. Esso permette di ricostruire l'evoluzione dell'area dello Stretto e in generale di tutto l'Arco Calabro, connessa alla strutturazione profonda della cerniera di subduzione dello slab ionico: questo infatti subisce una prima fase di arretramento flessurale verso SE durante il Pliocene Superiore-Pleistocene Inferiore, e una seconda verso SSE, molto probabilmente ancora attiva, a partire dalla fine del Pleistocene Medio, e ciò ha comportato l'attivazione del sistema di faglie Ganzirri-Scilla ad orientazione ENE-WSW.

GEOLOGICAL MAP OF THE MESSINA STRAIT AREA

SICILY

a

c

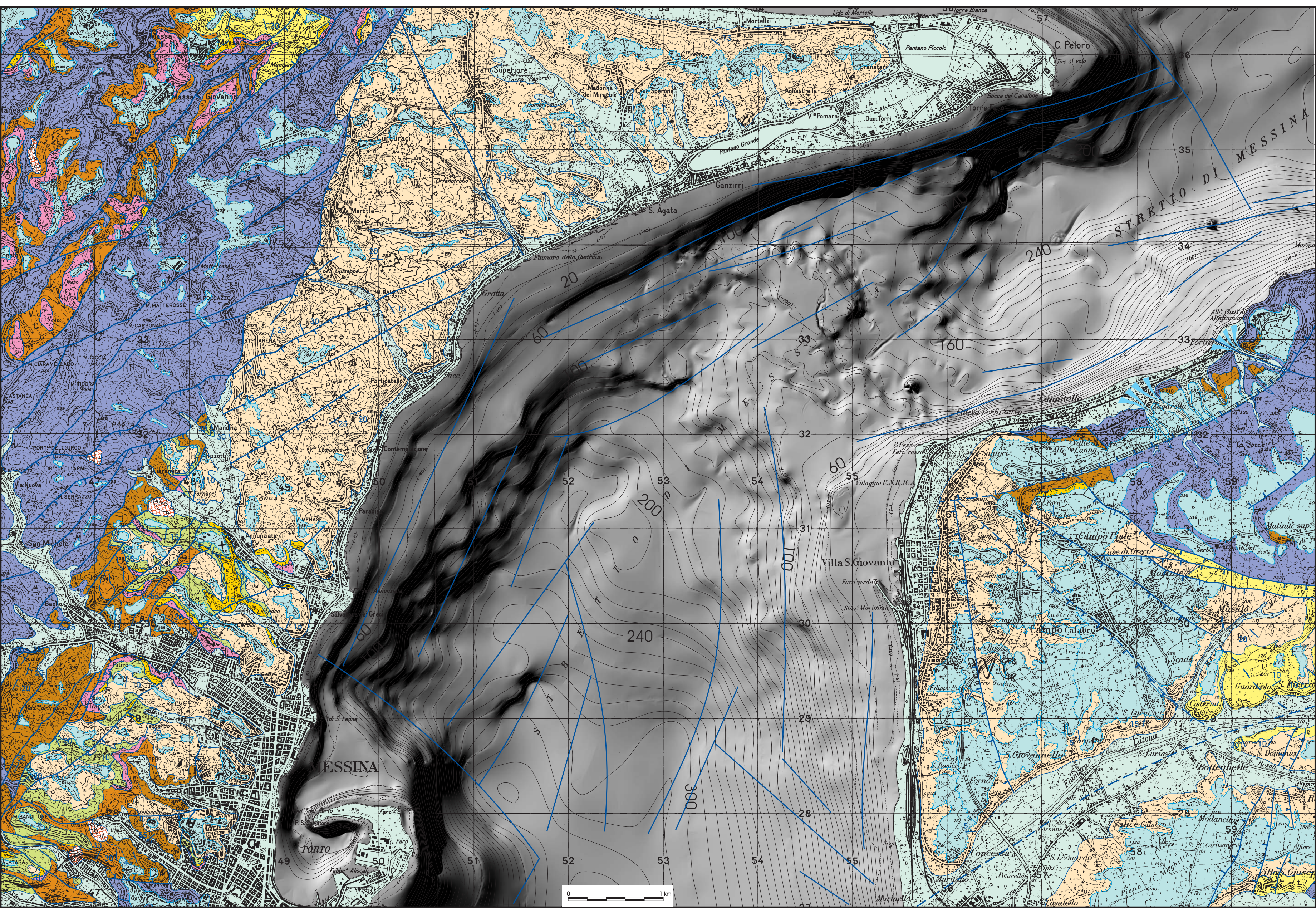
b

CALABRIA

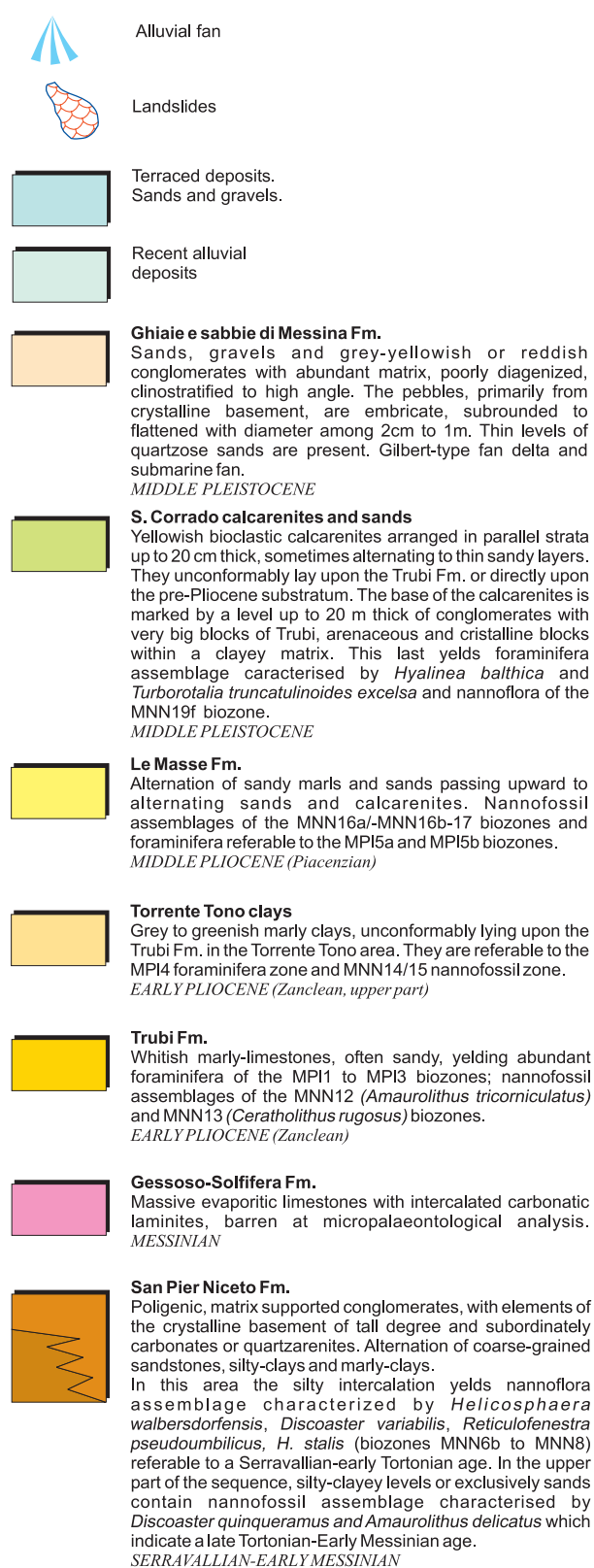
Messina

Field map survey after:
a) C. Gorgano 1994
b) P. Atzori et al., 1983; R. Lentini 1997;
Field map survey revised by:
A. Coliti, S. Corbone, P. Guarnieri, F. Lentini;
Field map survey Director:
F. Lentini
Stratigraphy and Biostratigraphy:
A. Di Stefano
Offshore data (c): A. Del Ben

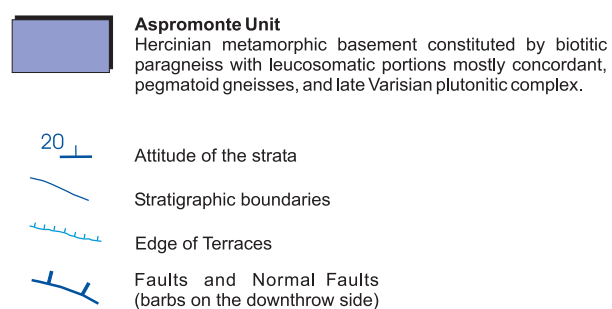
Fig. 1 - Geological Map of the Messina Strait area (Sicily and Calabria)



Messina Strait Quaternary evolution



KABILO-CALABRIDE CHAIN UNITS



INTRODUCTION

The geological context of the Messina Strait is an extremely complex one. The very high degree of seismicity and variability of geomorphological features of the area clashes with dense urbanization and the need for infrastructures for the development and growth of social and productive activities, and for transportation between the two shores of the Strait.

For this reason, our intent is to provide a geological map of this area containing basic geological elements but also useful tools for future territorial development.

Our purpose is to provide a prototype of a map drawn up using a multidisciplinary approach which takes in account not just hypothesis and interpretations, but mainly data and constraints. For this reason a new geological survey was carried out with the aim of refining the stratigraphic and structural data derived from the literature. This led to recognition of the fault systems, giving them a temporal sequence by dating the Plio-Pleistocene deposits on the basis of their nannofossil content, which provides an

optimal biostratigraphic and chronostratigraphic resolution, especially in the Quaternary. Stratigraphic and structural data have been integrated with geomorphological elements; furthermore, geophysical off-shore data have allowed the extension of field evidences to submarine areas, thus connecting the two shores of the Strait (Fig. 1).

GEOLOGICAL SETTING

The Messina Strait area is located upon the Kabilo-Calabride Units, which form the carapax of the Calabrian Arc, an arc-shaped segment of the Apenninic-Maghrebian orogen (Fig. 2). The orogenic belt extends from northern Africa across Sicily and the Calabrian Arc to the southern Apennines, and originated from several deformational steps: a first step, from the Oligocene up to the early Miocene, led to the complete closure of the Tethys; a second phase saw the consumption of a part of the Ionian oceanic lithosphere, which starting from the Middle Miocene began to be subducted beneath the Calabrian Arc. The active NW-oriented

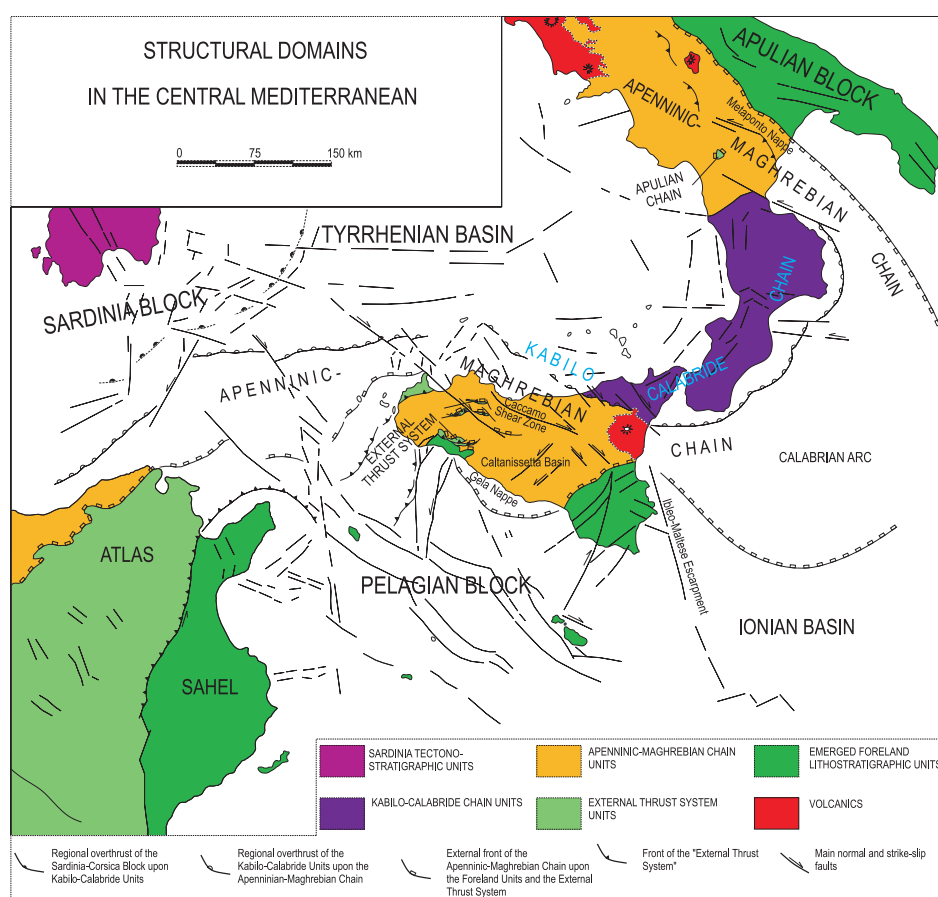


Fig. 2 - Main structural domains of the central Mediterranean (modified after LENTINI et alii, 1994).

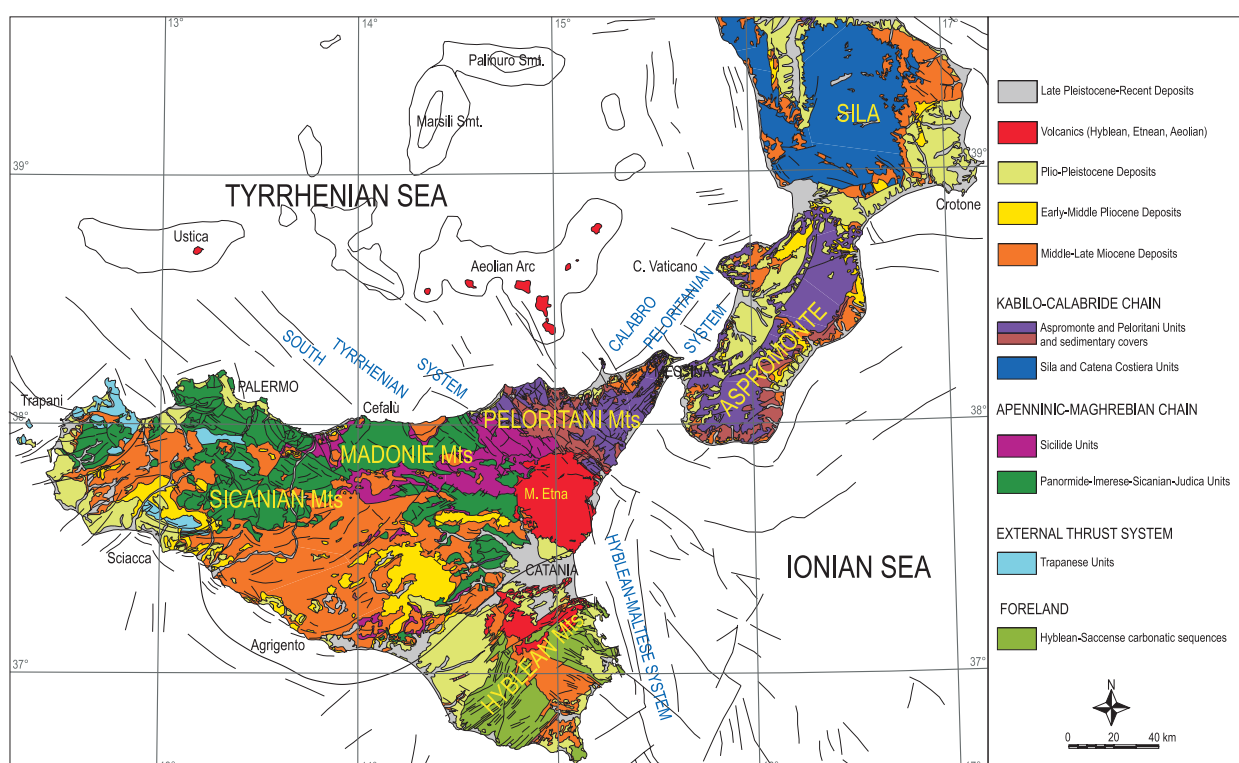


Fig. 3 - Structural scheme of the central Mediterranean. The main neotectonic elements characterising the Calabrian Arc/Ionian Basin/Sicily system are the Southern Tyrrhenian System, the Hyblean-Maltese System and the Calabro-Peloritanian System. These three fault systems, which are connected with deep structures, are associated with intense seismicity (modified after CNR, 1981).

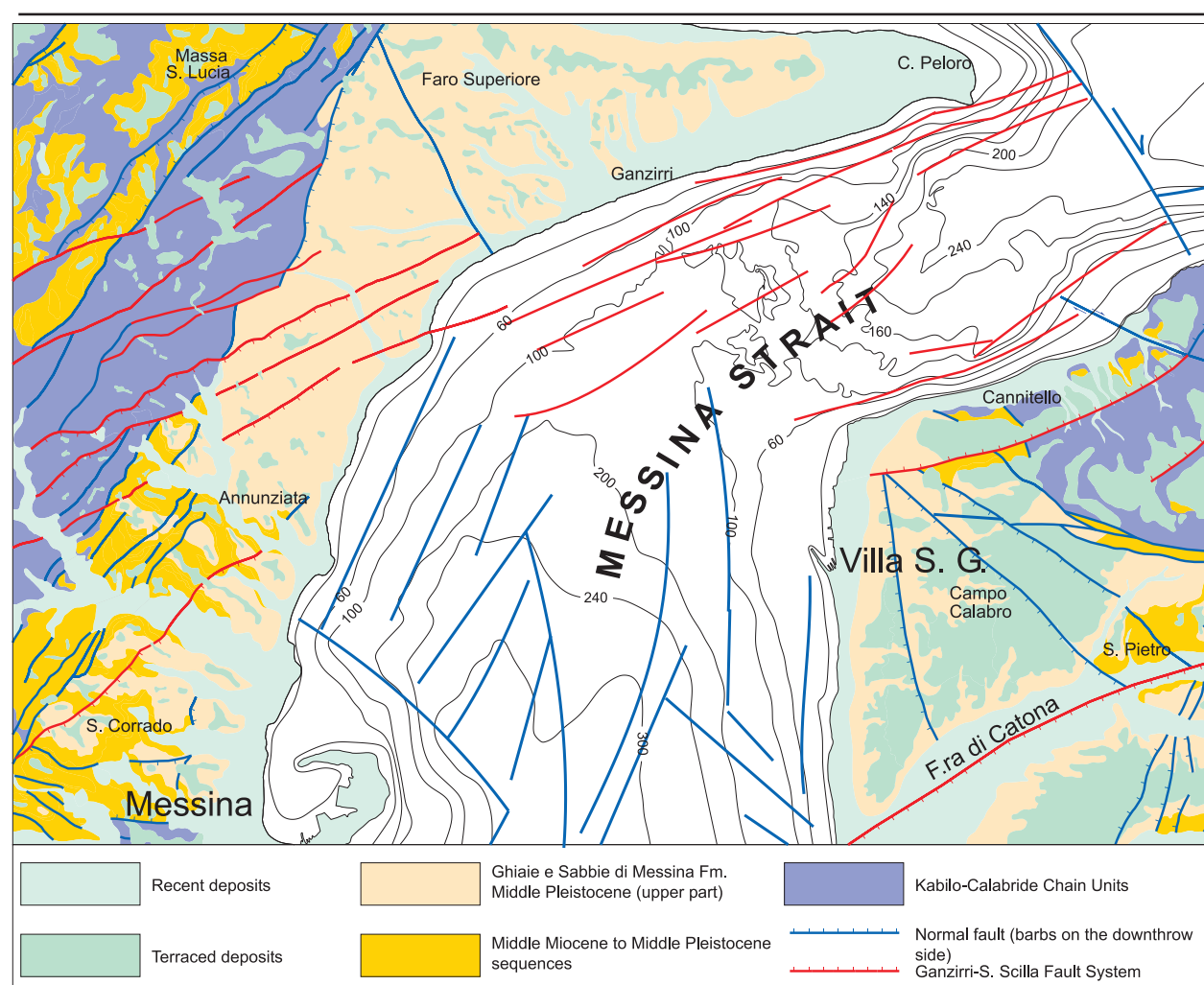


Fig. 4 - Tectonic Scheme of the Messina Strait area. This scheme shows the distribution of the Ghiaie e Sabbie di Messina Fm. and the recent fault systems that affected the whole area.

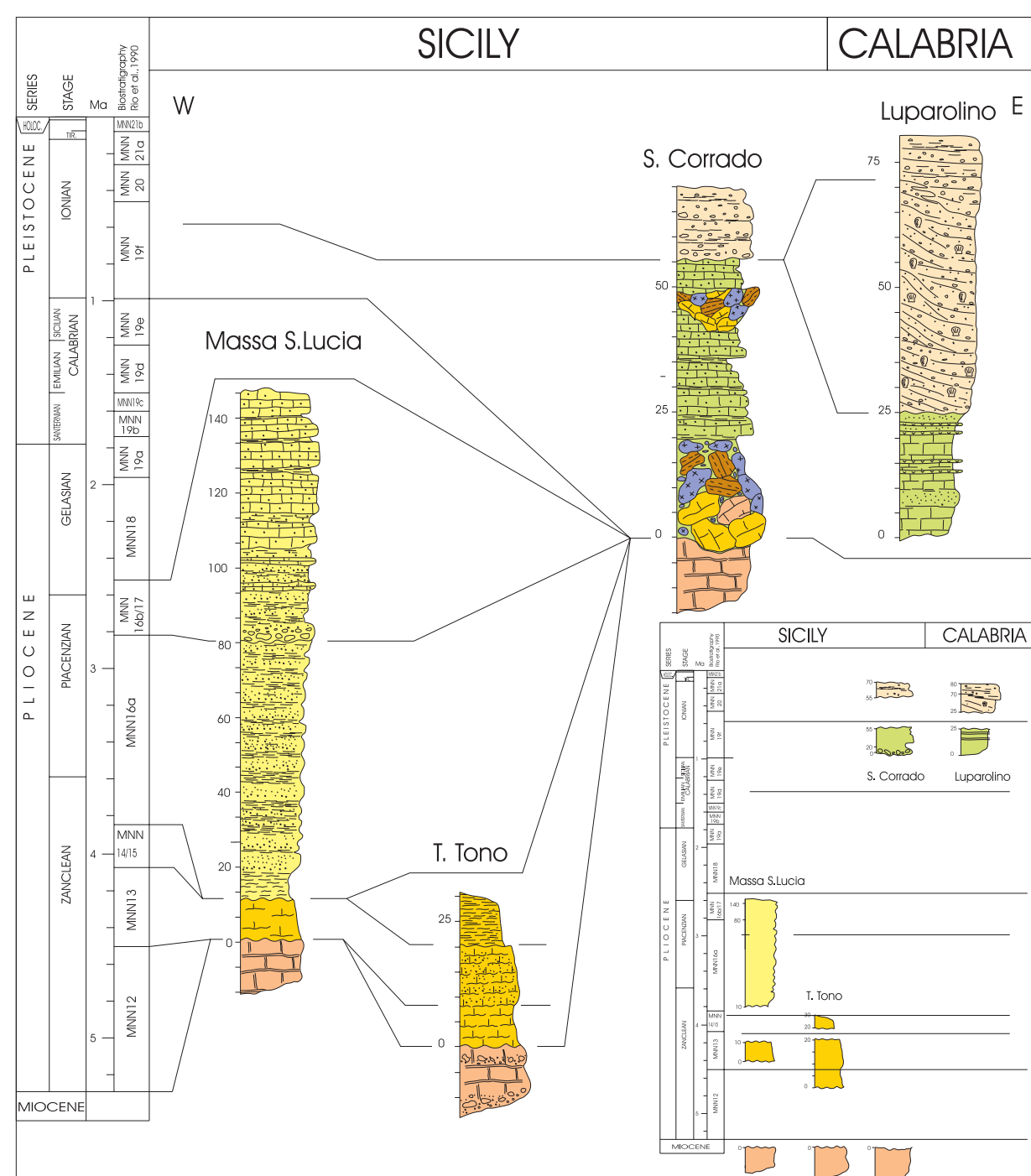


Fig. 5 - Stratigraphic scheme of the Plio-Pleistocene deposits of the Messina and Villa San Giovanni areas.

subduction of the Ionian lithosphere is now confined to the Calabrian sector of the chain.

In Sicily and the southern Apennines, the Foreland Domains (Hyblean and Apulian) are involved within the orogenic front; the collisional stage of these two sectors is marked by the presence of transcurrent fault systems.

New data deriving from the interpretation of seismic lines (CROP-Mare Project), led to the detection of the "back-stop" of the Chain, which lies along the Tyrrhenian margin and is composed of a continental crust sector actually colliding northward with the Apulia and southward with the African continental crusts respectively (Fig. 2).

The Plio-Quaternary evolution of the southern Tyrrhenian margin is thought to be related to the retreat of the Ionian subduction hinge (SCANDONE, 1979; MALIVERNI & RYAN, 1986; KASTENS *et alii*, 1988; MASCLE *et alii*, 1988; PATACCA & SCANDONE, 1989), which led to the development of a remnant back-arc basin (Vavilov Basin), a new back-arc basin with tholeiitic crust (Marsili Basin) and a new calc-alkaline volcanic arc forming the Aeolian Islands. At the same time, a complex system of transtensive structures became active in Sicily, and led to the collapse of the Sicilian margin towards the Tyrrhenian Sea (Fig. 3).

The high seismicity of this sector of the orogen is strongly connected to its Quaternary evolution, which is characterised by strong vertical uplift affecting both north-eastern Sicily and southern Calabria, in turn related to the activity of normal faults controlling the sedimentary basins.

STRATIGRAPHY

In the last decades, several multidisciplinary studies have been carried out with the aim of reconstructing the complex evolution which characterises the setting of the Calabrian Arc. The southernmost part of the Calabrian Arc ("Peloritani Mountains" in Sicily) is formed of a pile of basement nappes, with remnants of the original Meso-Cenozoic covers that were deformed during the Oligocene-early Miocene (OGNIBEN, 1973; AMODIO-MORELLI *et alii*, 1976; LENTINI & VEZZANI, 1978; LENTINI *et alii*, 1994). The ridge of the Peloritani Mountains consists of several tectonic basement slices of the Kabilo-Calabride Chain, overthrusting the units of the Apenninic-Maghrebian Chain (LENTINI *et alii*, 1996), forming a NE-SW-elongated Horst. On the Sicilian side, the Plio-Pleistocene sedimentation areas appear to generally extend parallel to the ridge of the Peloritani Mountains, and are dissected by the NW/SE-trending faults belonging to the South Tyrrhenian System (FINETTI *et alii*, 1996; LENTINI, 2000), which controlled its evolution locally (DI STEFANO & LENTINI, 1995; DEL BEN *et alii*, 1996) (Figs. 3 and 4). The Calabrian sector of the Messina Strait can be included in the Reggio Calabria Basin (GHISSETTI, 1981a,b), which is characterised by a thick sedimentary succession of Middle Miocene up to Pleistocene age (LENTINI, 2000) (Fig. 5). The sedimentary basins are characterised by a high vertical mobility controlled by normal fault systems, related to the Mésima-Reggio Calabria Basin to the east (Fig. 6).

A comparison of the stratigraphic and structural features of the sedimentation areas reveals the existence of a single forearc-type sedimentation

Messina Strait Quaternary evolution

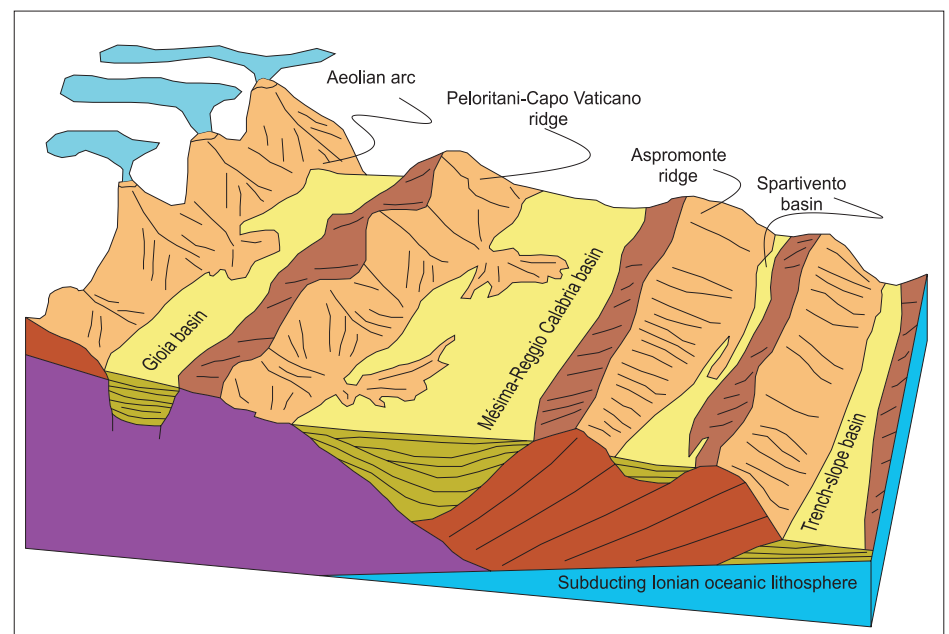
basin, which developed since the Middle-Late Miocene onward in an intermediate position between the accretionary wedge and the backstop of the Apenninic-Maghrebien Chain (GUARNIERI *et alii*, 2002; GUARNIERI & CARBONE, 2002; GUARNIERI, 2004) (Fig. 6).

Both sides of the Messina Strait are characterised by the presence of a crystalline basement consisting of medium to high-grade metamorphic rocks belonging to the Aspromonte Unit (OGNIBEN, 1960; LENTINI & VEZZANI, 1978), which forms the innermost nappe of the Kabylo-Calabride Chain. A thick terrigenous sequence of Middle-Late Miocene age rests unconformably upon the basement (LENTINI *et alii*, 1996; LENTINI, 2000). During the Late Messinian, sedimentation was characterised by deposits related to the evaporitic phase, consisting prevalently of evaporitic limestones.

The deposition of Lower Pliocene chalk (Trubi Fm.), showing a more terrigenous feature locally (T.te Tono Clays), and of Middle Pliocene sandy marls (Le Masse Fm.) was followed by a compressive tectonic event which led to the formation of an unconformity and a major uplift along the Peloritani-Capo Vaticano ridge with respect to the Mésima-Reggio Calabria Basin (GHISSETTI, 1981a, b) (Fig. 5).

The Middle Pliocene deposits are confined to the Tyrrhenian sector of the Peloritani Mountains and to the northern part of the

Fig. 6 - Geological model representing the evolution of the Calabrian Arc during the Late Pliocene - Early Pleistocene. The Messina Strait area is located within the Mésima-Reggio Calabria Basin, which is a part of the Tyrrhenian forearc basin. Its development is connected to the subduction of the Ionian oceanic crust beneath the Calabrian Arc.



Calabrian side of the Strait. The area is characterised by the absence of Upper Pliocene-Lower Pleistocene sediments, probably owing to a general uplift of the whole region during that period. During the Middle Pleistocene, a deepening of some sectors of the investigated area is testified by the presence of sandy calcarenites on the Sicilian side (S. Corrado calcarenites) and of marly sediments on the Calabrian side, both unconformably covering the substratum. The base of the calcarenites, on the Sicilian side, is marked by a ca 20-30 m-thick horizon of conglomerates, comprising very large

blocks of sedimentary and crystalline rocks from the substratum with a Middle Pleistocene silty matrix (nannofossil of the MNN19f biozone in the distribution range of *Gephyrocapsa* sp. 3, 0.98-0.58 Ma, RIO *et alii*, 1990; CASTRADORI, 1993), thus indicating a syndimentary tectonic activity. On the Calabrian side outcrops a coeval sequence consisting of marly limestones and marls upgrading to silty clays, showing a regressive feature (Fig. 5). This follows the deposition of a large amount of delta-type sediments, the Ghiaie e Sabbie di Messina Fm., consisting of

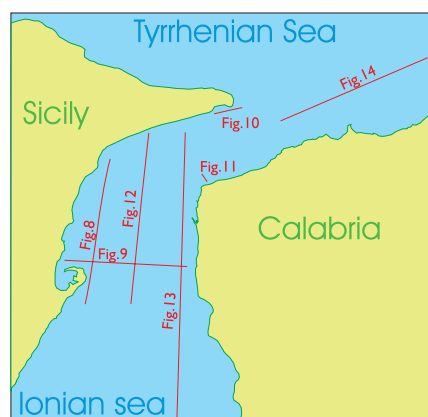


Fig. 7 - Position map of seismic sections.

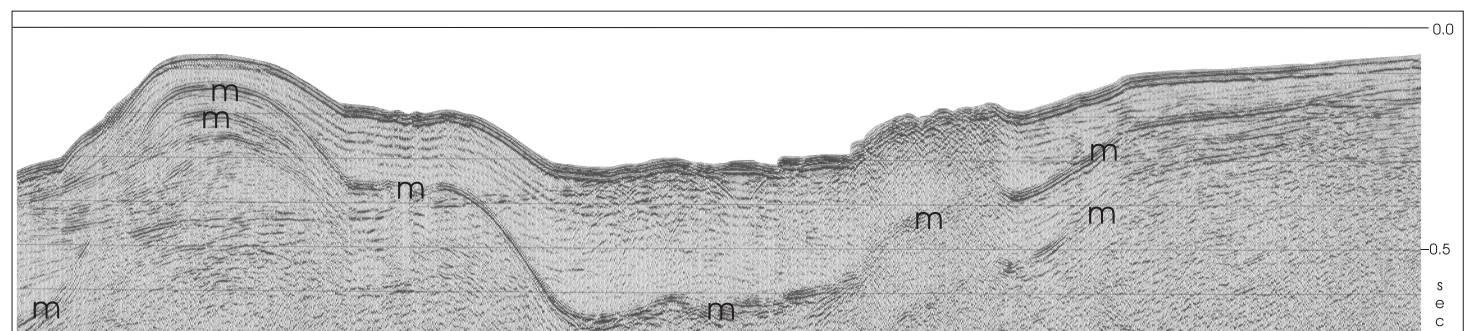


Fig. 8 - Seismic section parallel to the Sicilian coast on the Messina Strait (see Fig. 7 for position). Notwithstanding the strong multiple noise (indicated with "m"), some clear reflectors can be recognized: particularly evident are the deposition geometry of the Ghiaie e Sabbie di Messina Fm. (on the left) with down-lap configuration, and the nearly horizontal unconformity at the base. In the centre-right sector of the figure, an irregular sea bottom shows the effect of erosion of the sea current along a ENE-WSW strip of the northern sector of the strait.

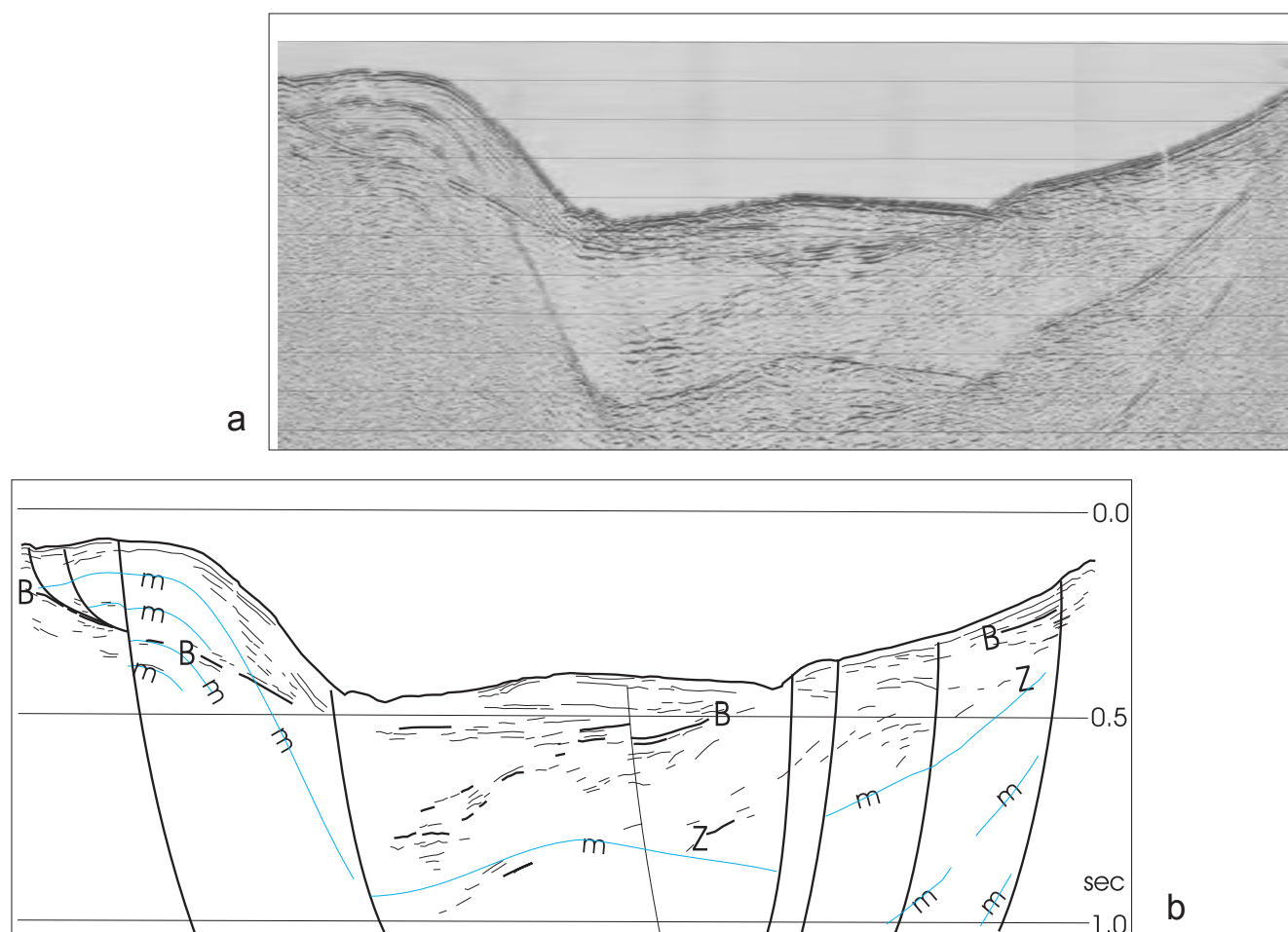


Fig. 9 - Seismic section across the southern sector of the Messina Strait (see Fig. 7 for position): 9a seismic section; 9b line-drawing. In same way as in Fig. 8, the build-up of the Ghiaie e Sabbie di Messina Fm. in the offshore of the Messina town is highlighted, with a perpendicular direction. Their down-lap deposition is still evident, with an E-sloping unconformity "B" on the base. In the deeper part of the section the W-sloping reflectors from the Calabrian margin (on the right) suggest a normal fault system (one normal fault in Fig. 9b) on the Sicily shore that originated the extensive tectonics in this region in Pliocene time. The following deposition of the Ghiaie e Sabbie di Messina Fm. seems to be particularly concentrated on the foot-wall of the fault system, whereas in the deep sector and on the Calabria margin it becomes much thinner. The deepest reflector "Z" is probably the top of the Aspromonte unit.

submarine fan deposits controlled by the activity of the NE-SW-trending normal faults along the margins of the whole basin. These clastic deposits were interpreted as the product of ancient fluvial-deltaic systems, fed from both clastic deposits were interpreted as the product of the Peloritani and the Aspromonte ridges. BONFIGLIO & VIOLANTI (1983) distinguish a

lower, marine, greyish facies from an upper, continental, reddish facies. BARRIER (1984) describes the geometries of the deltaic system, which has been deposited on both sides of the Strait since the Early Pleistocene, and recognises a bottomset (epibathyal clays and sands containing *Chlamys septemradiata*), a foreset (cross-bedded gravels), and a topset (Eu-

Tyrrhenian terraced deposits).

This formation lies upon a neat unconformity, clearly visible both on land and in the seismic lines across the Strait (Fig. 8; see also borehole AASS Ganzirri 2 in SELLI, 1978; COLANTONI, 1987).

North of the cities of Messina and Reggio Calabria, the Ghiaie e Sabbie di Messina Fm. have been dislocated by an ENE-WSW oriented normal fault system (GARGANO, 1994; LENTINI, 2000). The latter, named "Ganzirri-Scilla System", is oriented obliquely with respect to the preceding NE-SW-trending system, which controlled the evolution of the basin and led to the uplift of the Sinopoli-Delianuova Horst that divides the Reggio Calabria Basin into two sectors (GHISSETTI, 1981a, b).

This fault system very likely controls the Tyrrhenian coastline of Sicily in its northeastern portion, and furthermore represents one of the main structures responsible for the recent deformation in the area of the Messina Strait (BARBANO *et alii*, 1979; DEL BEN *et alii*, 1996), which make this area one of the most seismically active in the Mediterranean (VALENSISE & PANTOSTI, 2001), (Fig. 4).

The Ghiaie e Sabbie di Messina Fm. is overlain by several more recent formations consisting of gravelly levels passing into sands, which in a few cases contain *Strombus bubonius*, indicating a Tyrrhenian age (BONFIGLIO, 1974; LOMBARDO, 1980).

Traces of a shoreline, possibly of Tyrrhenian age, with cemented gravel deposits, occur at Pezzo, north of Villa S. Giovanni. A series of sandy-gravelly continental terraces has developed on top of the marine formations, its topmost levels being red soils that form wide platforms of different orders and dislocated by the fault systems cutting across the area.

On the basis of detailed studies carried out in southern Calabria and of the correlation between marine episodes and phases of continental erosion and sedimentation (GHISSETTI, 1981a, b; RICCHETTI & RICCHETTI, 1991), the following succession has been established: 1st order abrasion surfaces on crystalline units of uncertain age; 2nd order terraces emplaced on crystalline units (e.g., Piani di Aspromonte), probably of Early Pleistocene age; 3rd order terraces coeval with the Ghiaie e Sabbie di Messina Fm. (Middle Pleistocene); 4th order terraces superimposed upon the Ghiaie e Sabbie di Messina Fm., coeval with the Tyrrhenian deposits; and 5th order deposits superimposed upon the Tyrrhenian sediments (80 ka).

One of the aims of this study was also to correlate the terraces of the Calabrian and Sicilian sectors, and thus only the terraces occurring in the map sectors have been defined with regard to their order:

1st order terraces, which have developed as abrasion platforms on the metamorphic substratum, occur between elevations of 380 and 450 m; 2nd order terraces, which occur on both the metamorphic basement and the sedimentary covers, lie between 290 and 340 m; 3rd and 4th order terraces have prevalently developed on the Ghiaie e Sabbie di Messina Fm., the former lying between 125 and 285 m and the latter between 40 and 130 m.

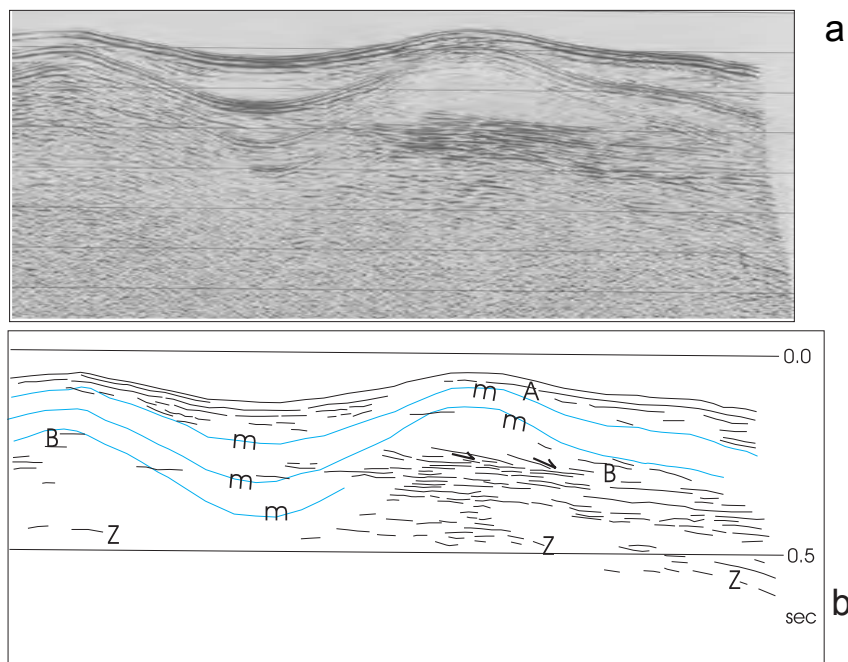


Fig. 10 - Seismic section in the northern sector of the Messina Strait, parallel to the Sicilian shore (see Fig. 7 for position): 10a seismic section; 10b line-drawing. The Capo Peloro promontory is characterised here by a build-up of Ghiaie e Sabbie di Messina Fm. between reflectors "A" and "B". The sequence laps down (arrows on the line-drawing) a flat, well-reflecting, sedimentary cover.

Fig. 11 - Seismic section along the central part of the southern sector of the Messina Strait (see Fig. 7 for position). From the Sicilian slope on the right, the section crosses the irregular bottom profile of the sea currents and the gradual deepening joined to some normal faults cutting the Pleistocene sediments.

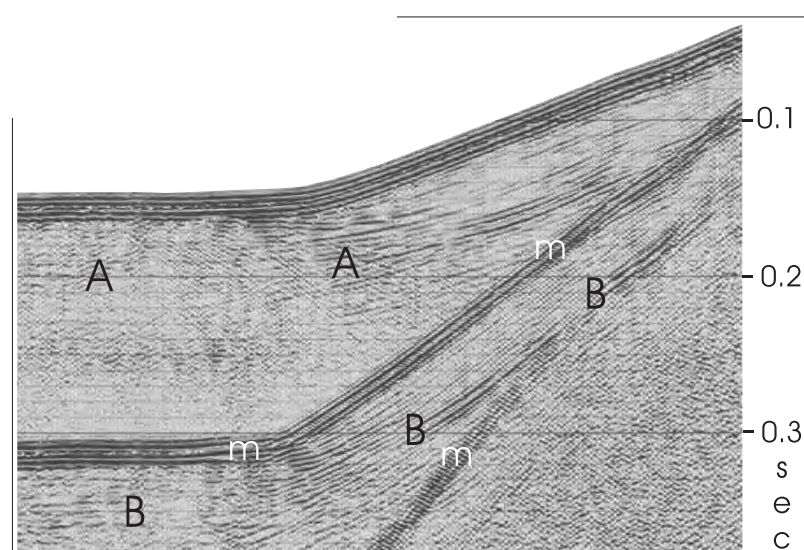
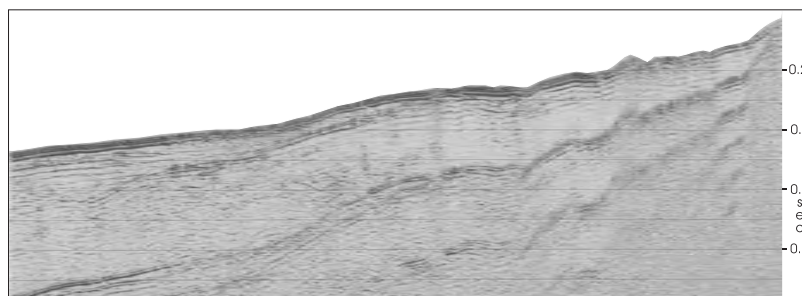
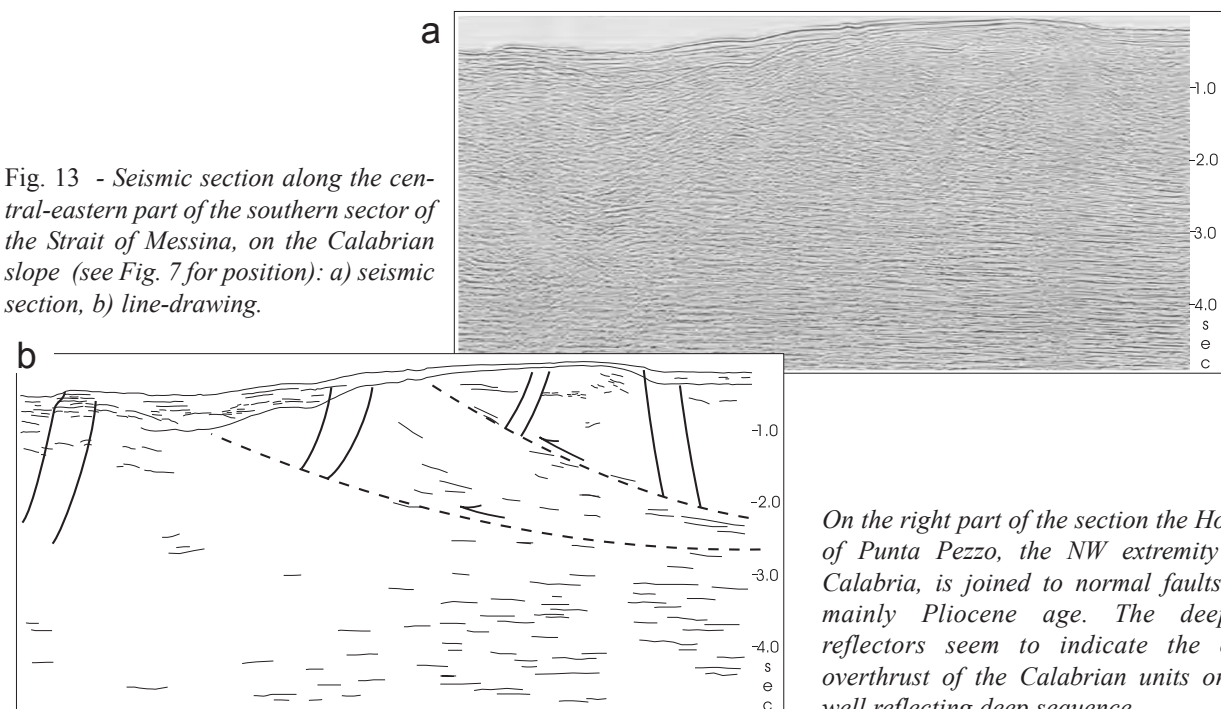


Fig. 12 - Analogical seismic section in the northern sector of the Messina Strait, on the Calabrian slope and perpendicular to the shore (see Fig. 7 for position). Multiple noise is indicated by "m", but, notwithstanding, primary reflectors are still evident. The presence of a number of borehole calibrations offshore close to the coast, allows the attribution of the sedimentary wedge between reflectors "A" and "B" to the Ghiaie e Sabbie di Messina Fm.

Fig. 13 - Seismic section along the central-eastern part of the southern sector of the Strait of Messina, on the Calabrian slope (see Fig. 7 for position): a) seismic section, b) line-drawing.



On the right part of the section the Horst of Punta Pezzo, the NW extremity of Calabria, is joined to normal faults of mainly Pliocene age. The deeper reflectors seem to indicate the old overthrust of the Calabrian units on a well reflecting deep sequence.

GEOPHYSICAL DATA

The project of a permanent railway and highway connection between Sicily and the mainland has induced the Company STRETTO DI MESSINA S.p.A., which is responsible for the project, to acquire a number of seismic reflection digital and analogical datasets in order to analyse the geological and tectonic picture of the area. These sets provide fundamental data for the study of the distribution of the stratigraphic sequences detected onshore in Calabria and Sicily and continuing offshore in the Strait (Fig. 7). Very important information has been produced, notwithstanding the difficulties in acquisition posed by the hard streams between the Tyrrhenian and the Ionian Seas, and the typical multiple noise present in the shallow sea of the shores (see Figs. 8 to 12).

Some interesting data concern the Ghiaie e Sabbie di Messina Fm., of Middle Pleistocene age, particularly on the Sicilian shore; near the city of Messina, under a thin layer of recent littoral sediments, as clearly shown in Figs. 8 and 9, the down-lap configuration of these sediments upon the underlying unconformity "B", and their conspicuous deposition emerges on the hook-shaped Messina port. Also, in the eastern sector of Sicily (Capo Peloro, Figs. 10 and 15), the Ghiaie e Sabbie di Messina Fm. outcrop is clearly related to the same depositional style. Conversely, on the Calabrian shore (Fig. 11), certain analogical sections indicate a land-ward gradual thinning of the sequences on the basal conglomerates of Upper Miocene age, outcropping onshore. This basal sequence marks the beginning of an extensional tectonic phase and is associated with normal fault systems, and sometimes with seismic evidences of a strike-slip component. The southern sector of the Messina Strait is clearly illustrated in Fig. 9, where some normal NNE-SSW faults on the Sicilian shore have produced a tilting of the lower sediments (of Late Miocene - Early Pliocene age, below the unconformity "B") and the on-lapping deposition of the upper sediments.

The northern sector of the Messina Strait shows an ENE-WSW main tectonic direction that drives the strong sea currents; the latter give rise to erosion and a more irregular sea bottom in the central part of the Strait (Figs. 9, 12 and 13, northern parts), bounded southward by the Punta Pezzo structure on the NW extremity of the Calabrian margin.

The northern sector of the Messina Strait is connected NE-ward to the margin of the Gioia Basin (Fig. 14) of the Tyrrhenian Sea, on the hinterland of the Southern Calabrian Arc.

TECTONIC FEATURES

The Calabrian-Peloritani sector corresponds to an area affected by repeated deformational events, which thus recorded, from a stratigraphic as well as a structural point of view, the superposition of the stress fields which have accompanied the emplacement and establishment of the Apenninic-Maghrebian Orogen since the Oligocene. The current setting is thus partially influenced by the presence of inherited structural lineaments, which in a few cases may have been reactivated.

In a preliminary morphostructural analysis, conducted also with the help of a DEM of the seafloor (Fig. 1), ENE-WSW - trending

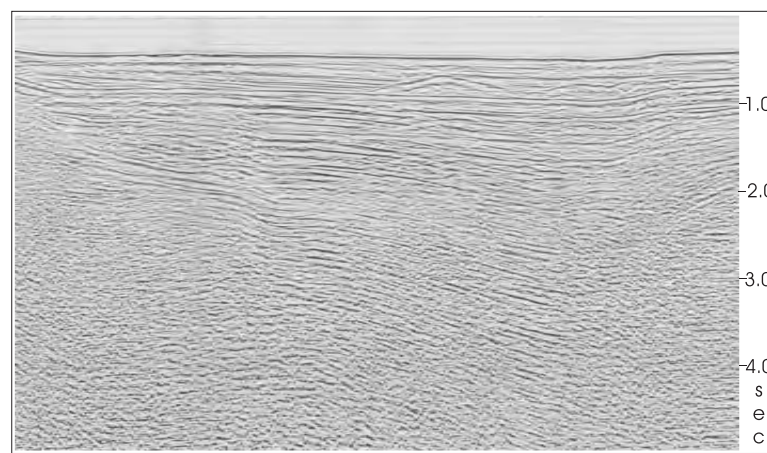


Fig. 14 - Seismic section on the Calabrian margin (see Fig. 7 for position); outside the Messina Strait the sedimentary sequence reaches a greater thickness, while in its shallow part two structures show a probable organogenic feature.

lineaments are observed (Ganzirri-Scilla System) corresponding to the main morphological escarpments characterising the setting of the Messina Strait. The ENE-WSW-trending morphological escarpment bordering the coast to the north of Villa S. Giovanni (Cannitello) appears to be particularly important. Single-channel seismic lines along the coastline between Pezzo and Scilla do in fact clearly show the truncation of the seafloor by these lineaments (DEL BEN *et alii*, 1996; LENTINI, 1996); furthermore, a little south of Cannitello, an ENE-WSW - trending normal fault with a north-dipping plane had already been mapped by GHISSETTI (1981a, b). The activity of these structures has been remarked by defining the relationship between the clastic deposits of the Ghiaie e Sabbie di Messina Fm. and their substratum. These deposits in fact represent the latest sedimentary event preceding the setting of the ENE-WSW and NNW-SSE - trending fault systems "Ganzirri-Scilla System", potentially seismogenic faults which are responsible for the remarkable uplift rate affecting the Messina Strait area.

The same tectonic lines, which control the Messina Strait and dislocate the Ghiaie e Sabbie di Messina Fm., also seem to have played an important role in modifying fluvial drainage orientation; indeed the direction of streams on the Calabrian side seems to run parallel to this fault system (Fig. 4).

CONCLUSIONS

The geological map produced shows the Plio-Quaternary evolution of the Messina Strait area, and the stratigraphic study carried out on the deposits outcropping on both shores leads to the conclusion that the palaeogeography of the Strait began to be outlined starting from the

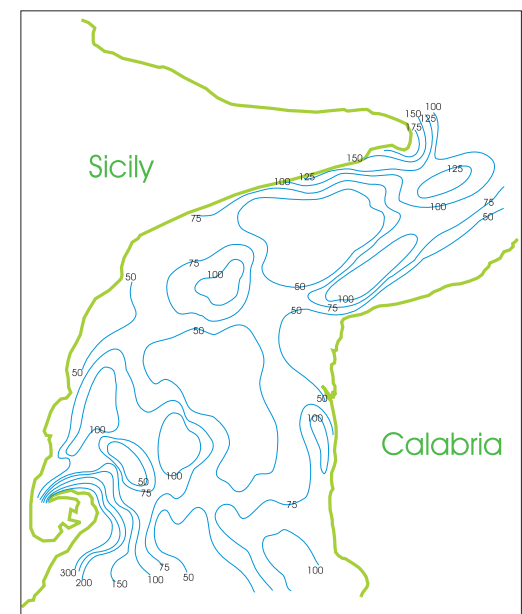


Fig. 15 - Isopach map (msec TWT) of the Ghiaie e Sabbie di Messina Fm.

middle Pleistocene, after the deposition of the S. Corrado calcarenites (0,98-0,58 ka).

The analysis of the main tectonic lines shows that these controlled the areal distribution of the Ghiaie e Sabbie di Messina Fm., mainly along a NE-SW direction. Subsequently, the "Ganzirri-Scilla System" became active; this actually controls the portion of the Strait falling between Ganzirri and Scilla. Off-shore geophysical data confirm those collected on land and clearly show the presence of active fault systems.

The outlined structures correspond to some of the main lineaments connected with a deep structural setting related to a re-orientation of the direction of retreat of the subduction hinge from SE to SSE (GUARNIERI & CARBONE, 2002; GUARNIERI, 2004). This new geodynamic setting seems to be responsible for the formation of the ENE-WSW-extensional faults connected with compressional mechanisms in depth (Fig. 16).

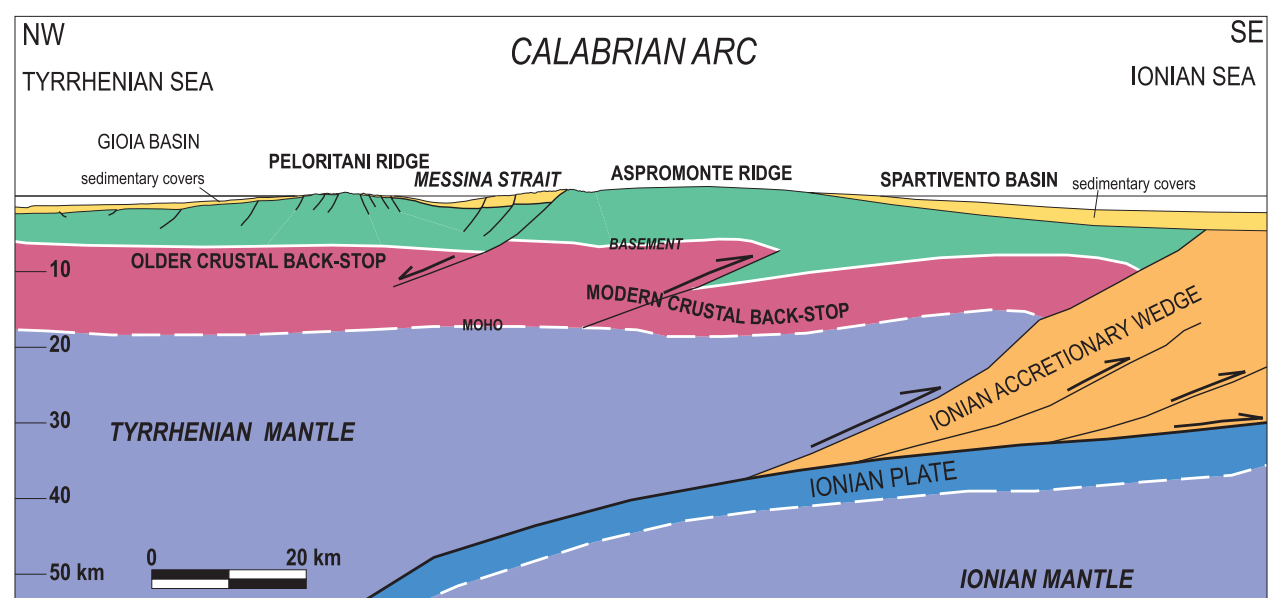


Fig. 16 - Crustal cross-section through the Calabrian Arc, illustrating the deep structure and the location of the Strait area within a surficial extensional zone due to a deep compressive deformation.

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