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LITHOSTRUCTURAL CHARACTERS OF THE ACOUSTIC BASEMENT OF THE SARDINIA CHANNEL (SOUTHWESTERN TYRRHENIAN SEA)

by

R. COMPAGNONI, E. MORLOTTI and L. TORELLI

The sea-floor of the Sardinia Channel (Fig. 1), located between the stable Sardinia block and the deformed belts of Sicily and Tunisia, is composed of several structural elements only partly affected by Neogene extensional tectonics (BATICCI et al., 1983; TORELLI et al., 1985). Therefore it can be considered an outstanding natural laboratory where to study and clarify the Tertiary Europe—Africa collisional history and the evolutionary stages of the adjacent Tyrrhenian basin.

The interaction of these geodynamic events is widely reflected by the depositional style of the sedimentary cover and by the complex lithostructural characters of the underlying acoustic basement considered here as a surface of maximum interpretable acoustic penetration. Both units have been extensively investigated since 1982 through the analysis of all the available seismic reflection profiles and interpretation of aeromagnetic data accompanied by a detailed sampling programme (Fig. 1) (BARBIERI et al., 1984; CATALANO et al., 1985).

We wish only to outline here the nature and characters of the sedimentary cover well described and contoured in a previous paper (BARBIERI et al., 1984). It generally unconformably overlies the acoustic basement and reaches a maximum thickness of about 2500—3500 m in the Upper Miocene subsiding basins of the Sicily continental slope as well as in the Cornaglia Terrace where a Middle Miocene rift axis was detected. When complete, the sedimentary cover includes a Plio—Quaternary unit, Messinian salts and evaporites and a pre-Messinian unit certainly not older than Early Miocene. Seismic reflection profiles across the Sardinia Channel (Fig. 1) show great variability in depth and characters of the acoustic basement, the features of which strictly depend on the Tertiary geodynamic evolution of the area. The seismic grid is not very dense and homogeneous and most information concerning the basement structures is provided by magnetic and sampling data which are used to interpolate between seismic lines and to produce a structural contour map (Fig. 2).

The seismic penetration is variable in many sectors depending on the quality of the processing as well as on the strong deformation of the subsurface. The acoustic and crystalline basement rarely coincide except in the southern margin of the Sardinia block where the acoustic basement surface reflects Palaeozoic metamorphic and igneous rocks (asterisks in Fig. 1). Furthermore along the axis of the Cornaglia Terrace, across a strongly block-faulted zone, a very thick Messinian basinal facies seems to overlie an acoustic basement characterized by a very high interval velocity and topped by a prominent reflector which may indicate an oceanic nature of the crust.

The acoustic basement between the Drepano—Aceste alignment and the Sicily—Sardinia Trough shows a diffraction pattern and a rugged topography typical of erosional processes in a subaerial environment. Sometimes it displays discontinuous, parallel and variable-amplitude reflectors which can be referable in the upper part to

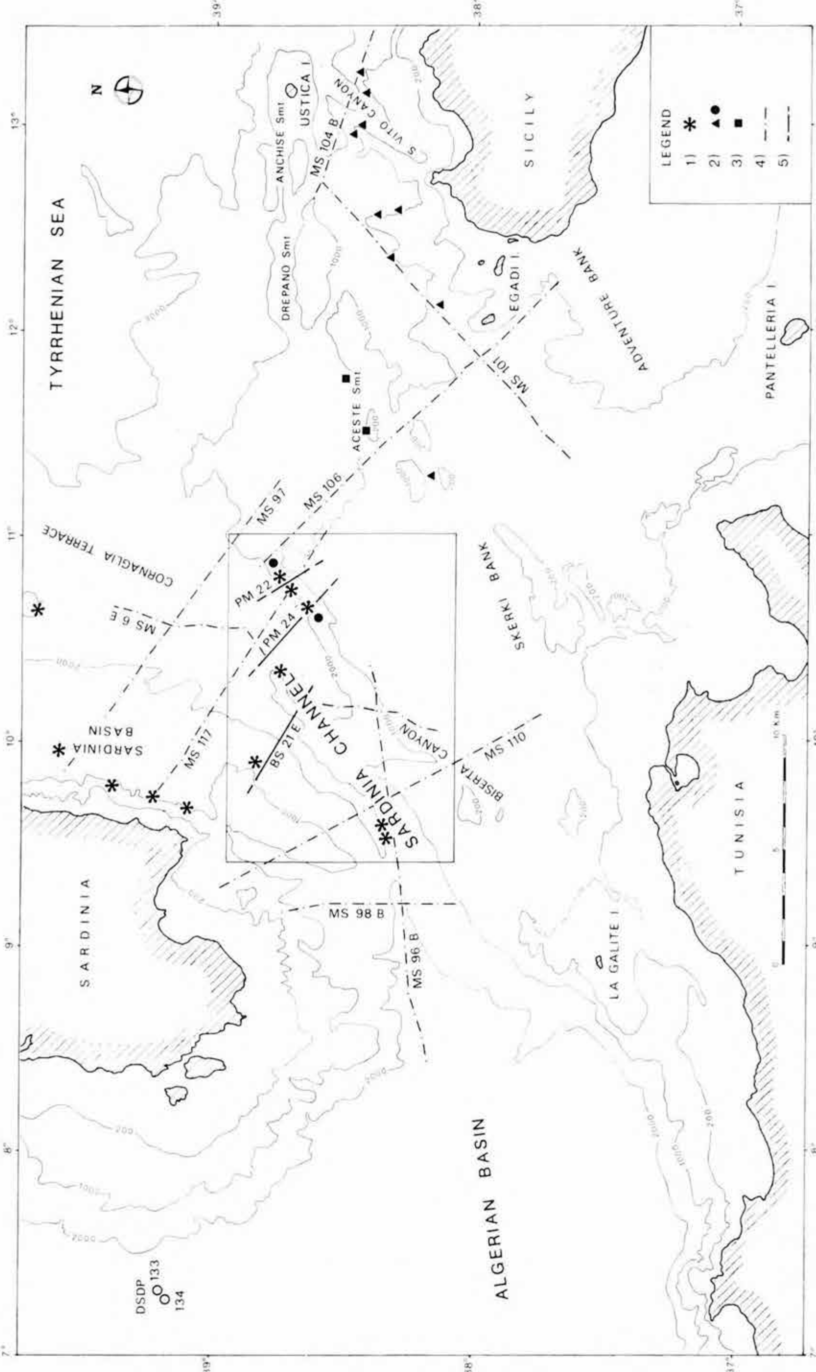

Fig. 1. Map of the investigated area with traces of main seismic profiles and location of dredging hauls
1 Crystalline rocks, *2* carbonate rocks, *3* igneous rocks, *4* multichannel lines, *5* single-channel lines

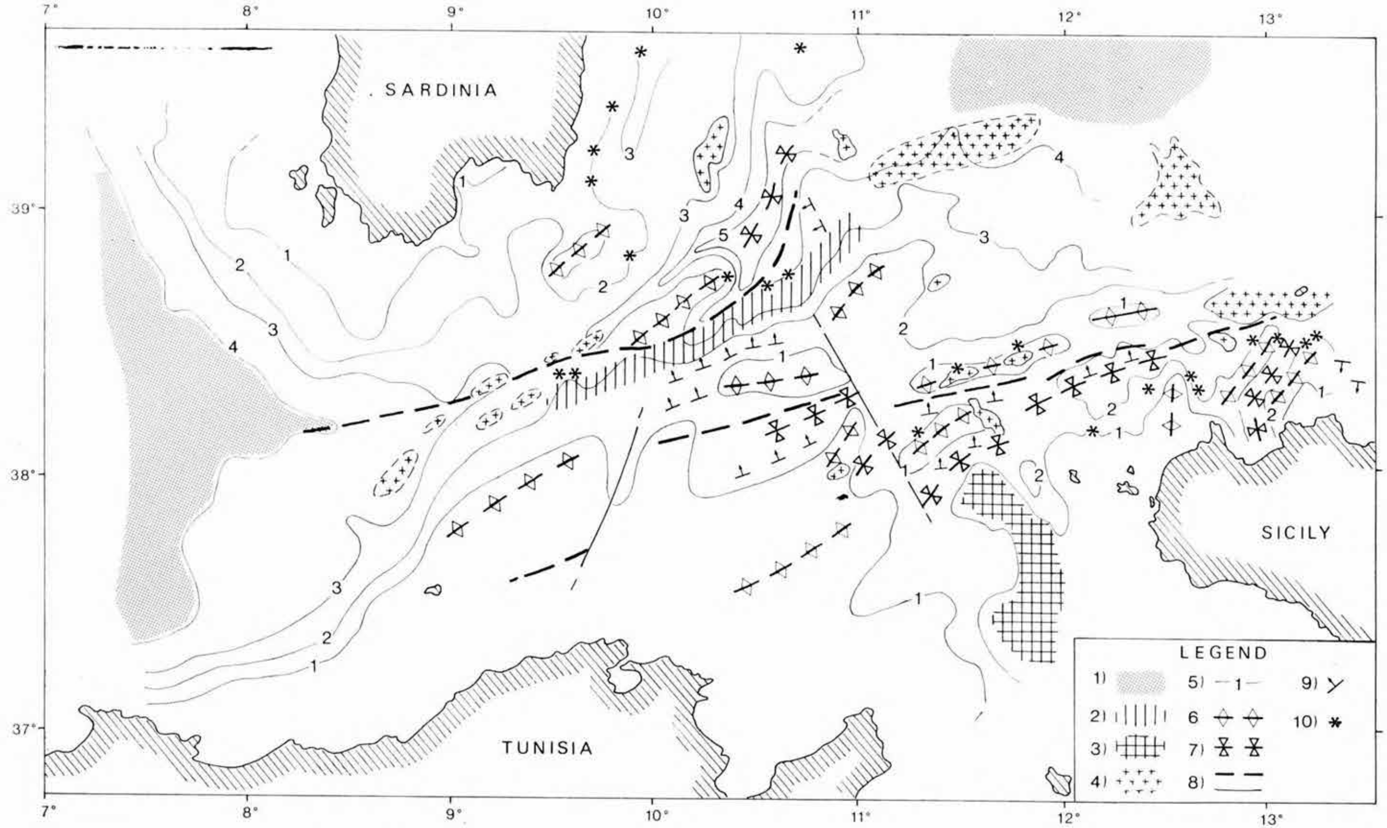

Fig. 2. Tectonic structural map of the acoustic basement of the Sardinia Channel

1 Oceanic stretching zone, *2* low-grade Alpine metamorphic belt, *3* outcropping of the basement, *4* igneous rocks, *5* isobath of the acoustic basement in seconds, *6* axes of structural highs, *7* axes of structural lows, *8* major tectonic boundaries, *9* deepening of the basement inferred from magnetics, *10* dredging hauls a silicoclastic sedimentation. In fact dredge samplings of the basement in the western sectors of the central plateau led us to identify a contact between an Oligo–Miocene deep-sea clastic unit and crystalline–metamorphic rocks (Fig. 3) to form a stratigraphic superposition which can be traced to the Sardo–Tunisia district (Auzende et al., 1974).

Diffuse diffraction hyperbolas coupled with more continuous high-amplitude reflections characterize the seismic grain of the acoustic basement in the southern and southeastern sectors of the Sardinia Channel. Its direct sampling (Fig. 1) recovered also blackish shales and brown fine sandstones of the Numidian Flysch but mainly carbonate basinal lithologies, ranging in age from the Jurassic to the Palaeocene, well correlatable with the Panormide unit (part of the Maghrebian Africa-verging chain) widely outcropping on the mainland Sicily (Catalano et al., 1985).

The interpretations of the magnetic anomalies (Agip, 1981, 1982; Boccaletti et al., 1984) allow to provide depth estimates for the crystalline basement and to distinguish between its regional features and local shallow magmatic intrasedimentary bodies. Intense high-frequency anomaly patterns are localized along the Elimi Chain and are related to volcanic apparatus of the Ustica–Anchise complex and Aceste Seamount (Fig. 2). In this latter area the volcanic rocks are referable to the hawaiite-mugearite-trachyte transitional suite and are of Late Miocene–Early Pliocene age

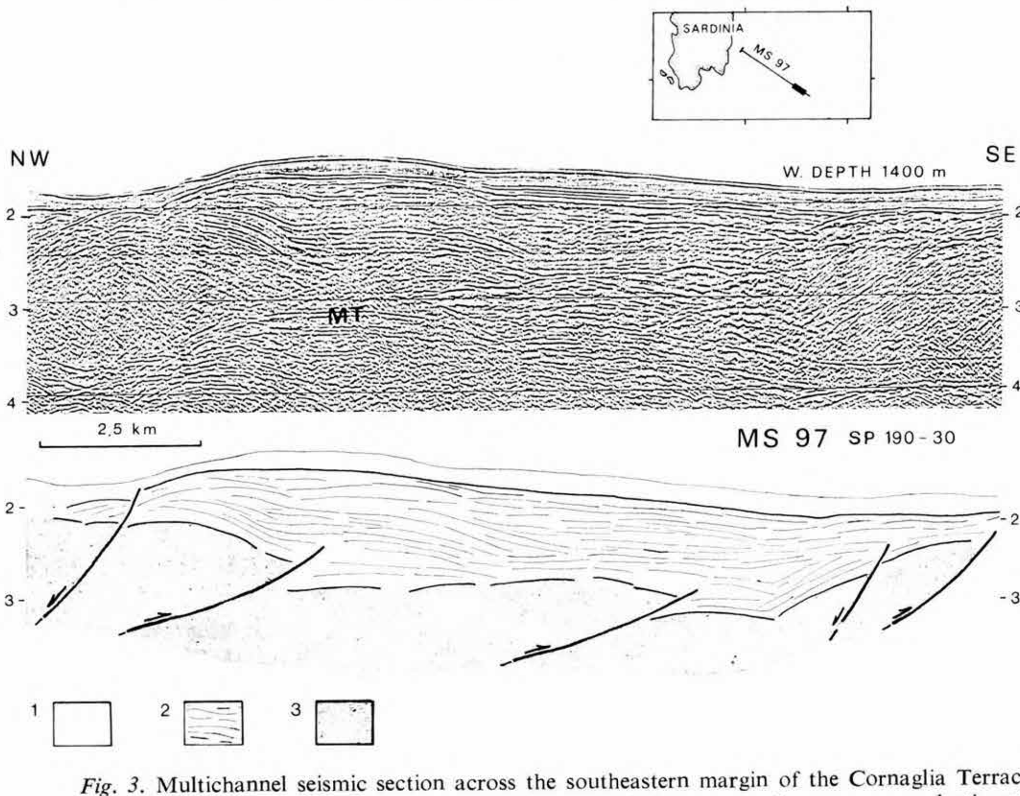

Fig. 3. Multichannel seismic section across the southeastern margin of the Cornaglia Terrace, showing the lithostratigraphic characters of the acoustic basement, where an upper clastic unit overlies a lower crystalline unit

1 Plio—Quaternary, *2* Oligo—Miocene deep-sea clastic unit, *3* crystalline basement

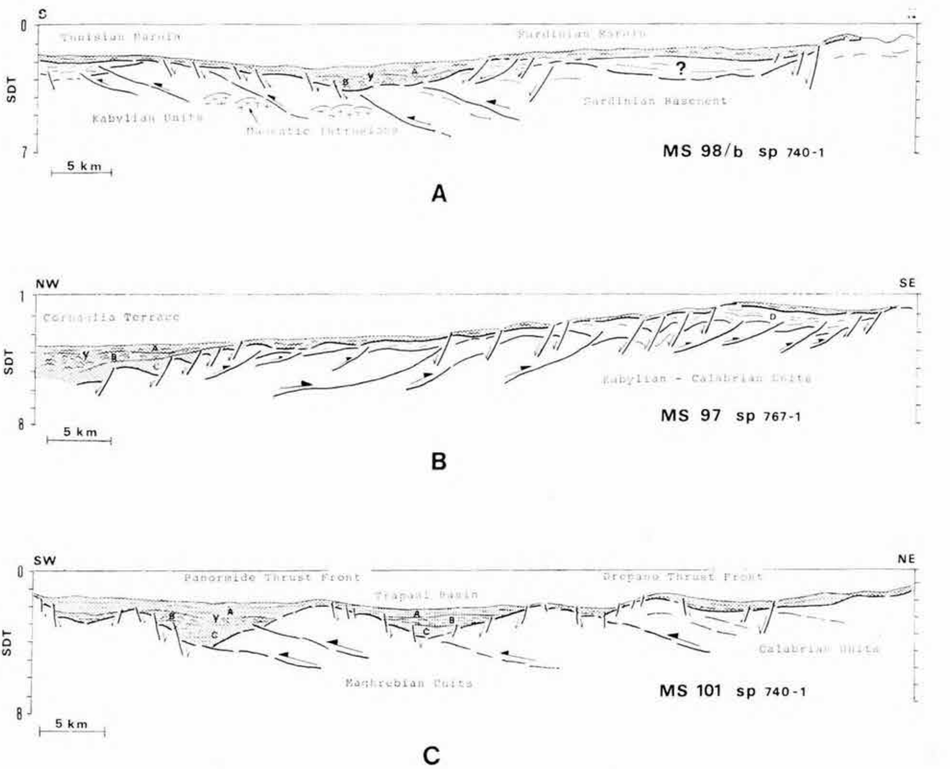

Fig. 4. Interpreted time-sections across the main thrust units of the Sardinia Channel. The stippled area represents post-orogenic cover

A Plio—Quaternary unit, B Messinian unit, C pre-Messinian unit. SDT: second double time. For location see Fig 1

(BECCALUVA et al., in press). Other local high-frequency anomalies are distributed to the south of the Sardinia block and may be caused by mafic intrusions along the trough connecting the oceanic sectors of the North Algerian basin and the Tyrrhenian bathyal plain. Nevertheless some igenous features of the Sardo—Tunisia district, which are interpreted on seismic reflection lines (Fig. 4), can be probably referred to Middle—Upper Miocene anatectic bodies, well-known and dated in La Galite Island (BELLON, 1981).

A medium deep basement (3—6 km), which becomes shallower in the Drepano Seamount and shows an acid—schistose crystalline character, appears to be responsible for the low-frequency anomalies recorded in the area. This magnetic pattern is well distinctive in the central sectors and the quantitative interpretations generally suggest a strong deepening of the basement towards the Sicily—Sardinia Trough (Fig. 2). It appears to be characterized by several block uplifts with ENE—WSW trending alignments to define tectonic slices of a complex thrust system mainly interpreted on the multichannel seismic sections.

As regards the composition the petrographic study of the crystalline basement revealed that a strong difference exists between the rocks coming from southern and northern scarps of the Sicily—Sardinia Trough (COMPAGNONI et al., in progress). The former ones mainly consist of medium-grade metamorphic and minor plutonic rocks with a peralouminous affinity, exhibiting a significant cataclastic to mylonitic deformation accompanied in most cases by the development of a rough foliation marked by low-grade metamorphic minerals. On the other hand, the Sardinia margin lithotypes are mainly granitoids and minor amphibolite-facies metamorphic rocks without any evidence of low-grade metamorphic overprinting (Carta Litologica e stratigrafica dei Mari Italiani, 1981; BORSETTI et al., 1979). Consequently a sharp difference may be detected between the Sardinia margin lithologies and the southeasternmost rocks here referred as belonging to the Kabilian—Calabrian palaeogeographic realm deformed in high-strain environment during the Upper Oligocene—Burdigalian eastward migration of the Corsica—Sardinia block (CHERCHI and MONTADERT, 1982). It is to point out that a similar low-grade metamorphic overprinting (Fig. 2) of probable Alpine age (younger than 30 m.y. ?) has been recently described in the Southern Calabria (Aspromonte units; BONARDI et al., 1984) and in Eastern Algeria (Little Kabilíe; BOUILLIN, 1982).

In summary the acoustic basement of the Sardinia Channel can be divided in three lithostructural domains (Fig. 2) on the basis of seismic grain, magnetic patterns and lithostratigraphic data. The boundaries between the above mentioned domains are interpreted on seismic profiles as low-angle major overthrusts, one of which is probably related to a Tertiary subduction zone (TORELLI et al., 1985). The southern margin of the Sardinia block superimposes on the intermediate Kabilian—Calabrian fold/thrust belt, which in turn overlies the Maghrebian units. The two thrust fronts are dissected by a set of strike-slip dextral faults which acted in connection with the development of the Upper Miocene—Lower Pliocene oceanic spreading of the Tyrrhenian Sea and appear to be responsible for the formation of the eastern pull apart basins and for the intense break up of the acoustic basement in the central sector. The tectonic framework so far defined can be clearly seen in the interpreted time sections of Fig. 4, where the SE-verging Kabilian—Calabrian and Maghrebian units are sandwiched between the Sardinia block and the Sicilian foreland as a result of crustal shortening phases which took place in Late Oligocene—Pliocene times.

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R. COMPAGNONI
Dipartimento di Scienze della Terra
TORINO, Italy

E. MORLOTTI and **L. TORELLI**
Istituto di Geologia
4 via Kennedy
PARMA, Italy