GRUPPO NAZIONALE DI GEOFISICA
DELLA TERRA SOLIDA

Atti del 32° Convegno Nazionale

Trieste, 19–21 novembre 2013
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Tema 3: Geofisica applicata

ISTITUTO NAZIONALE DI
OCEANOGRAFIA E DI
GEOFISICA SPERIMENTALE

EAGE
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SEISMIC SIGNATURE OF MESSINIAN EVENT IN THE MEDITERRANEAN BASINS

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Introduction. In this study we interpret deep penetration multichannel seismic profiles (Fig. 1) to analyze the Messinian Salinity Crisis (MSC) markers in the different domains of the Mediterranean basins.

The MSC represents a huge succession of events that modified the entire Mediterranean region in a relative short period of time (Hsü *et al.*, 1973); it produced a thick deposition of evaporate lithologies in the deep basins and an erosional unconformity on the marginal and onshore domains.

This study is based on the analysis of both old and new seismic profiles in order to correlate the different seismic evidences of the MSC markers across the several different basins of the Mediterranean Sea.

Seismic dataset. We used multichannel MS lines, sponsored by National Council of Research (CNR) and acquired and processed by OGS in 1972; deep crustal MCS profiles of the Italian Deep Crustal Exploration Project (CROP) (Scrocca *et al.*, 2003; Finetti, 2005),

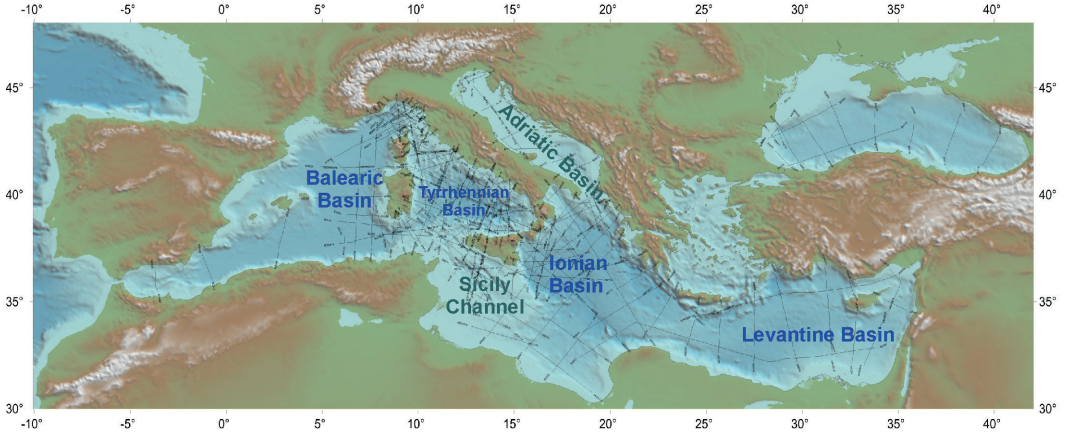

Fig. 1 - Map of the Mediterranean Sea with the position of the MS and CROP profiles. The deep basins are highlighted with blue color, the shallow basins with green color.

sponsored by CNR, Ente Nazionale Energia Elettrica (ENEL) and Ente Nazionale Idrocarburi (ENI); high resolution seismic profiles of the WS10 Project acquired and processed in 2010 by the R/V OGS Explora in the western Sardinian offshore.

Geological setting. Seismic profiles of the Mediterranean basins have been analysed by many Authors (CIESM, 2008; Lofi *et al.*, 2012 with cited references) to reconstruct the different seismic signature of the Messinian Units. The "Messinian trilogy" recognized in the Balearic abyssal plain (Rehault *et al.*, 1984), has been expanded on with the interpretation of the different seismic facies that form the Lower evaporite Unit (LU), the salt Mobile Unit (MU) and the Upper evaporite mainly gypsiferous Unit (UU). On the lower continental slope of the West Sardinia margin, which represents the eastern passive margin of the Balearic Basin, a thinning salt layer overlayed by the Upper Unit, turns into the Messinian Erosional Surface (MES): it is generally characterized by a strong reflector which truncates the top lapping pre-Messinian reflectors.

The Ionian oceanic crust underthrusts below the Calabrian and Hellenic Arcs forming active subducting slabs. In the deep basin the Messinian event is commonly evidenced by gypsum and salt layer that was piled up by compressive tectonics for a total thickness of some hundred meters (Finetti, 1982). The Ionian Basin represents, with the Levantine Basin in the Eastern Mediterranean Sea, the remnant of the Permo-Triassic Neo-Tethys (Finetti, 2005; Stampfli, 2005); the basin is characterized by a thick sedimentary package overlying the oceanic crust where the Messinian salt is often affected by plastic deformation. The Messinian trilogy seems to be absent and only MU, with some internal reflectors, has been recognized (Lofi *et al.*, 2012), bounded by two erosional surfaces on the top and on the bottom.

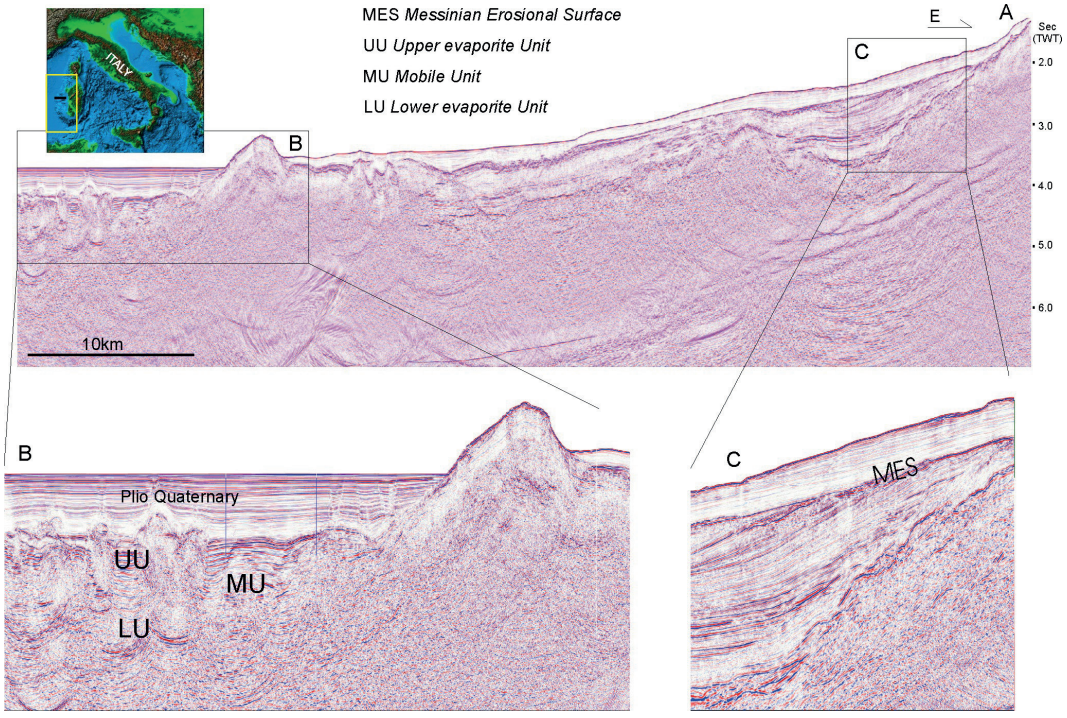

Fig. 2 - A:seismic profile WS 10-07 located in map where the continental slope and basin domains are respectively highlighted in frames B and C. In B the stratified Plio Quaternary sequence covers the Upper Units (UU) deformed by salt tectonics where the Mobile Unit (MU) is evidenced with transparent facies. The underlying Lower Unit (LU) is weakly reflecting, due to the high absorption by the diapir structures. In C the Messinian Erosional Surface (MES) on the slope clearly truncates the pre-Messinian horizons.

No seismic evidences of Messinian trilogy have been recorded in the present shallow basins. In the Adriatic Basin the Messinian sequence is absent or mainly represented by gypsum and anhydrite with marls intercalation, named Gessoso Solfifera formation. It is calibrated by a great number of boreholes and reaches a thickness of about 120m. Also in the Sicily Channel we can recognize hiatus related to the MES or, alternatively, the Gessoso Solfifera layer, calibrated by some boreholes.

The Tyrrhenian Basin opened, from west to east, since the Tortonian age. No relevant presence of Messinian evaporite units has been recorded, just some samples of gypsum lithologies are testified along the continental margins (Fabbri and Curzi, 1980).

Discussion. In Fig. 2 the WS10-07 seismic profile crosses with an east-west direction the Sardinian slope of the continental margin till the deep Balearic Basin. In the detail B we have highlighted the Messinian trilogy where the thick and high reflecting UU covers the MU which is deformed by halokinetics processes; the LU is partially masked by the signal absorption due to the diapir presence. In the frame C the typical seismic signature of the MES is evident along the upper continental slope by a prominent reflector that truncates the pre-Messinian horizons.

In Fig. 3 four seismic portions of a virtual profile starting from the Adriatic Basin, crossing the Ionian Basin and reaching the Levantine Basin are described.

A portion of seismic profile ADRIA-95 (Fig. 3A) shows the Messinian layer as a prominent reflector that encompasses the entire gypsum deposits of about 100 m, as calibrated by Eterno 1 borehole. It is covered by the thick low reflecting Pliocene sediments and by the Quaternary prograding sequences originated by the erosion of the Apennine Chain.

Moving to the deep Ionian Basin the Gessoso Solfifera formation turns on the thick salt layer of the abyssal plain, as shown along the seismic profile CROP-22 (Fig. 3B); the bottom of its characteristic transparent facies is well evidenced by a prominent reflector, west-tilted and giving a structural high. The pre-Messinian horizons show toplap terminations on the salt bottom that is probably associated to a sub-aerial exposure due to the joint effects of the Messinian sea level drop and of the tilting. Toward west the compressive tectonics originate more and more irregular reflectors on the top and inner the salt layer producing typical diffractions.

The thick layer of Messinian salt is proved to be present till the eastern sector of the Mediterranean Sea: the portion of the seismic profile MS-50 (Fig. 3C) shows an eastward increasing of salt deformation, where the deep Nile fan delta has been deposited after the Messinian crisis. The underlying salt layer is squeezed by the Plio-Quaternary sediment load and a single high amplitude reflector identifies the remaining discontinuity .

In the West Cilicia Basin, along the seismic profile MS-49 (Fig. 3D) the salt layer clearly pinches out toward the margin. A high reflecting upper sequence, interpreted by Bertoni and Cartwright (2006) as deep-water clastic sediments, are very similar to the seismic facies of the UU in the Balearic Basin, suggesting their possible ascription to gypsum layer.

Conclusions. The MSC, even if it is well documented in the whole Mediterranean Sea by several different seismic markers, is a still open question. The interpretation of the seismic signatures let to distinguish alternated phases of exposure and flooding of the different basins which often result to be hardly correlated to one another.

In the Adriatic basin and in the Sicily Channel the Messinian layer, where it is not replaced by an erosional surface, is present as a thin evaporate layer mainly constituted by Gessoso Solfifera formation. The Messinian trilogy has been observed only in the deep Balearic Basin, while in the Ionian and Levantine Basins it shows a mainly salt seismic facies.

The presented seismic data aim to contribute to the recognition of the different seismic facies which characterize the different units; their comparison could improve the comprehension of the processes that affected the Messinian events in the Mediterranean region, specially because of the critical lacking of boreholes.

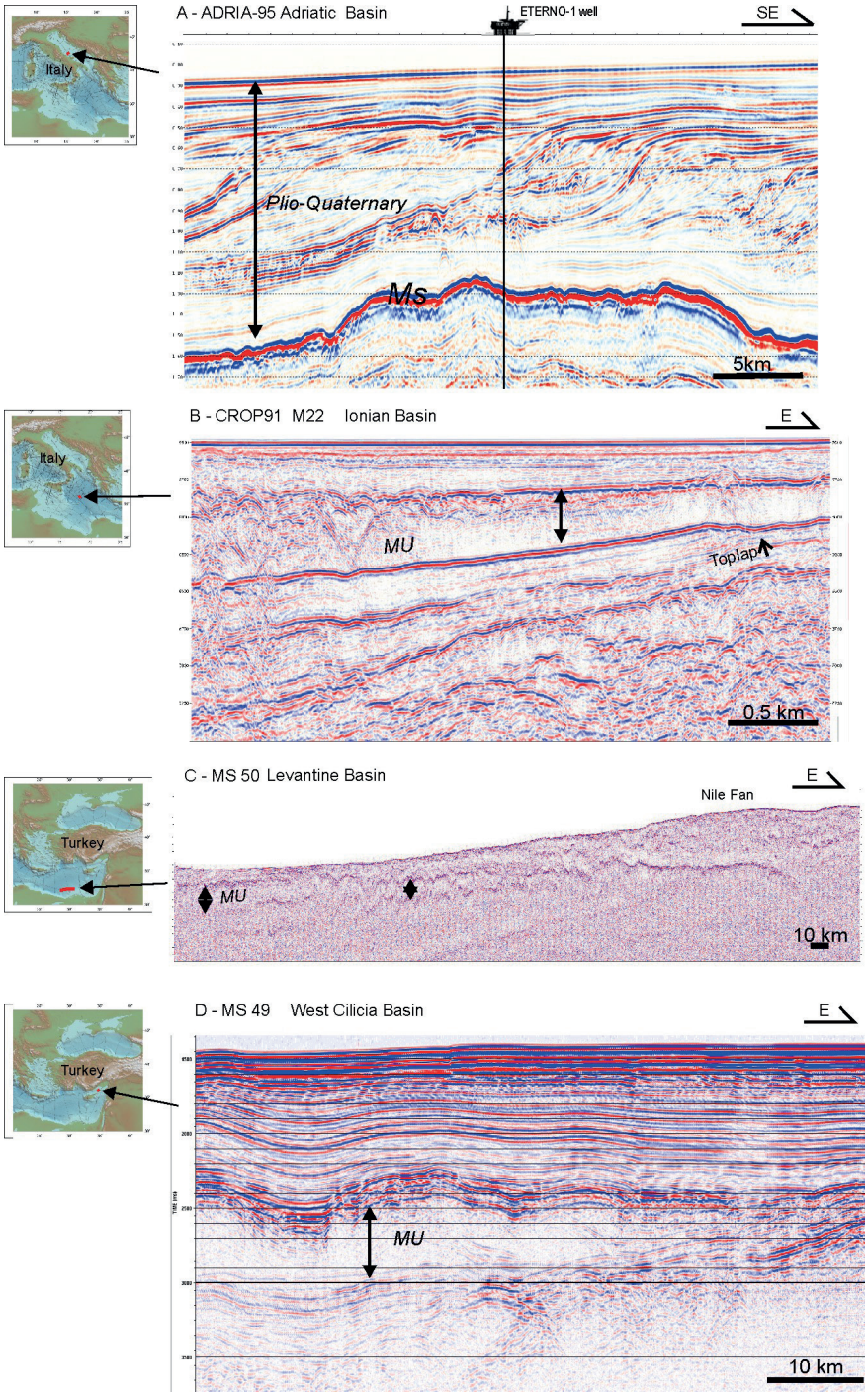

Fig. 3 - A:portion of seismic profile ADRIA-95 located in the Central Adriatic Basin where the Messinian layer is evidenced by reflector Ms; B: portion of CROP-22 seismic profile located in the Ionian Basin with a wes-tilted Mobile Unit (MU); C: portion of seismic profile MS-50 located in the Levantine Basin where the salt layer is deformed by the deep Nile fan deposits; D: portion of seismic profile MS-49 located in the West Cilicia Basin, where the transparent facies of the Messinian salt pinches out on the basin's margin.

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