The messinian event on the eastern sardinian margin (tyrrhenian sea) from seismic study: new insights from the “metyss” cruise (june 2009)


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Summary

Seismic reflexion profiles have been acquired during the “METYSS” cruise (2009) along the Eastern Sardinian and South-Eastern Corsican margins. These high-resolution seismic profiles penetrate up to 1 second TWT below the sea-floor, allowing to clearly image the Plio-Quaternary sequence, Messinian Salinity Crisis deposits (Upper Unit and salt) and erosion surfaces, and locally the basement. Interpretation of this set of data will allow to discuss the evolution of this area over the last 6 Ma from both Messinian and geodynamical perspectives.

Introduction

The “METYSS” project has been undertaken in the framework of an integrated study of the Messinian Salinity Crisis (MSC, HSU et al., 1973) seismic makers at the scale of the Mediterranean basin. This new approach is based on multi-site comparative studies (Figure 1) and on a new common nomenclature for Messinian
sedimentary units and surfaces (LOFI et al., 2008). The objective of this work is focused on the impact of the MSC event on margin segments and deep basins that are characterized by various geodynamical, structural and sedimentary settings. Moreover, we aim to document the way the MSC left its imprints in the offshore domain. In this scientific framework, the Tyrrhenian Sea and especially its western part, constitutes a major target first because of the sparsity of recent geophysical data adapted to the Messinian topics relative to other western Mediterranean domains. Geodynamically, the Tyrrhenian Sea is a Neogene back-arc basin opened by continental rifting and oceanic spreading related to the eastward migrating Apennine subduction system from Tortonian to Pliocene (JOLIVET et al., 2006). Rifting of the Tyrrhenian Sea started first on the Eastern Sardinian margin during the Tortonian-Messinian times and the series of that age have to be therefore considered as syn-rift sediments (SARTORI et al., 2004). For these reasons, the western part of the Tyrrhenian basin is a key-area to document relations between Messinian deposits and tectonic activity. The study domain presents a complex segmented morphology including: 1. The narrow Corsica and Sardinia margins; 2. Northward, the shallow-water Eastern-Corsican basin (or “intermediate-depth” basin), limited eastward by the still-active Pianosa Ridge; 3. Southward, the deep Eastern-Sardinian basin, corresponding to several mini-basins separated by N-S ridges such as the Baronies Ridge or the Cornaglia Terrace; and 4. The very deep oceanic Tyrrhenian basin s.s. (Figure 2). Specific objectives of the “METYSS” cruise are first to identify and to map the MSC surfaces and sedimentary units (seismic facies, geometry, distribution, volume; Figure 2). Indeed, seismic units similar to those observed in the deep Provençal basin of the Western Mediterranean basin (upper bedded unit; transparent mobile unit, chaotic unit, Figure 3) can be interpreted in respect to the new nomenclature from old seismic lines within this area (MOUSSAT, 1983; KASTENS et al., 1990). In addition, we plan to correlate the METYSS seismic profiles with existing data, especially the DSDP and ODP
results (sites 653 and 654) and older seismic profiles. Finally, this project will lead to a better understanding of the tectonic and sedimentary evolution of this particular area during the MSC.
Data Set

The "METYSS" cruise has been carried out from June 17th to June 30th 2009 along the Eastern Sardinian and Corsican margins on the R/V "Tethys II" (INSU-CNRS/CIRMED). 15 high-resolution seismic profiles (±1200 km, Figure 2) were acquired using a 25 m-long 12-channel streamer with a mini-GI air-gun shooting every 12.5 m, allowing to accurately image the MSC seismic markers, i.e. surfaces and depositional units using the new terminology and color codes as illustrated on Figure 3.

Preliminary Results

Preliminary METYSS processed seismic lines show that some Messinian markers are clearly imaged over the study area (Figure 4). These markers consist of several erosion surfaces (MES, TES, BES) and two depositional units (UU: Upper Unit; MU: Mobile Unit). These commonly form the two upper units of the Messinian trilogy observed in the deep Provençal basin. With caution, the third term of this trilogy (LU: Lower Unit) can be observed in some places, below the MU. Preliminary observations show that the spatial organization of the Messinian markers strongly varies according to their location on the different margin and basin segments. South-eastward, in the vicinity of the Cornaglia Seamount, salt tectonics appears surprisingly huge. Preliminary interpretation illustrates the syn-rift character of some of the Messinian deposits. In addition, some post-rift deformation can be evidenced within the Plio-Quaternary sequence (e.g. unconformity outlined by the blue dotted line on figure 4). Consequently, numerous mass-transport deposits and channel-levee systems observed in the Plio-Quaternary sedimentary cover can be partly controlled by tectonic activity. We expect that further interpretation will allow to better understand: 1. The paleogeography, paleo-depths, connections and evolution of the basin and sub-basins during the MSC; 2. The base-level dynamics in these basins and the modalities of salt precipitation during this event; 3. The interactions between crustal tectonics, salt tectonics and sedimentation in order to precise the relative vertical movements (tilting, subsidence, magmatism...) and geodynamical history of the different segments of the area since 6 Ma.
Conclusions

This new « METYSS » data set confirms the occurrence of MSC seismic markers as already evidenced in other Mediterranean areas. Future work will be dedicated to their detailed characterization and mapping in order to better constrain the chronostratigraphic and geographical evolution on that domain during the MSC. Furthermore, the MSC seismic units and surfaces will provide markers for the vertical movements due to thick-skinned tectonics. The study of the salt-related structures will constitute a very efficient tool to discriminate the respective contribution of gravity-driven, salt tectonics and deep-seated, crustal tectonics (GAULLIER et al., 2006). The “METYSS” cruise will be followed by field work in the Gulf of Orosei area, and by shallow-water high-resolution seismic acquisition on the continental shelf, in order to ensure an integrated land-sea study of the MSC markers and Pliocene deposits.

References


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