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Drilling through the Messinian evaporites: the beginning of a new adventure?

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The sensitivity of past environments tell us a lot about the nature of changes, either of climatic or geodynamic origin. In this respect, the Mediterranean basin represents the ideal natural laboratory for studying the interaction between deep processes, tectonics, sedimentary fluxes and sea-level oscillation that are at the origin of the sedimentary records.

A spectacular example of reactivity of this system have been experienced less than 6 Myrs ago, when the pan-Mediterranean realm underwent rapid and abrupt changes of paleo-environmental parameters that led to the well known Messinian Salinity Crisis (MSC, Hsü et al., 1973).

This short-term event at the geological scale (∼5.96-5.32 Ma) results from the progressive closure of the two-way connection between the Atlantic Ocean and the Mediterranean Sea. The most important characteristics of this event are: (1) a reduction of the Atlantic water supply having as a consequence, an increased salinity and in the precipitation of thick evaporites within shallow water marginal basins (presently disconnected from the deep basins); (2) a subsequent major sea-level fall exceeding 2000 m and resulting in the massive erosion of the margins and the development of deep subaerial canyons; (3) the accumulation of the product of the erosion in the downslope domain of the margins; (4) the deposition of thick evaporites (up to 3000 m thick) above the deep Mediterranean abyssal plains and (5) and a very rapid refilling of the Mediterranean basin during the Latest Miocene/Lower Pliocene, following the re-connection between Atlantic and Mediterranean through the Gibraltar straight.

Timing, causes and chronology of the MSC are not yet fully understood, but different scenarii have been proposed to explain in details the modalities of this catastrophic event.

Certainly, the ongoing discussion about not fully conclusive interpretations are mainly linked to the fact that so far, only the deepest and buried Mediterranean basins might offer the most complete sequence from the Messinian to the Quaternary. Anywhere else, the MSC mostly generated a sedimentary/time lag corresponding to a widespread erosion surface extending from onshore down to the lower slopes of the margins. Onland, Messinian outcrops (e.g. Morocco, Cyprus, Spain, Italy…) are all incomplete and pre-date the drawdown phase and/or are tectonically/geometrically disconnected from the deep basin sequence. Correlations with the offshore depositional units are thus complex, preventing the construction of a coherent scenario of the MSC linking the outcropping evaporites, the erosion of the margins, and the deposition of clastics and deep evaporites in the abyssal plains.

The discovery of the Messinian evaporites in the Mediterranenan is probably one of the major achievements of the DSDP program. Unfortunately, the Joides Resolution never drilled through evaporites because of technical impossibility (non-riser drilling vessel). Only the upper few meters of the pinch out of the deep basin sequence has been recovered. Thus, all hypothesis are based on onland outcropping evaporites and offshore seismic data interpretations. Improved quality of seismic data allowed some important advances in the recognition and understanding of Messinian markers (erosion surfaces, depositional units and bounding surfaces) but without the recovery of the full succession, all interpretations lack lithological and stratigraphical calibrations.

At present, several basic questions are still open:
- What are the true nature of the deep basin depositional units? What are their ages and chronologies?
- What was the water depth before, during and after halite deposition in the deep basin? Did the basin(s) completely dried out? What are the associated amplitude and dynamics of the base-level changes?
- Did the desiccation impact the regional climate and river run-off? What about climatic variability during the drawdown phase?
- What was the balance between erosion and sedimentation during the crisis? What are the vertical movements (tectonic/isostatic responses) associated to margin unloading and basin loading?
- What are the present-day fluid dynamics related to the salt layer? Their impact on the deep biosphere?

The response to all of these questions would only come from drilling through the complete Messinian succession. It would represent an outstanding opportunity to unravel the history of extreme environmental changes during the Messinian and a unique chance to constrain the age, nature and paleo-environment of deposition of the deep-basin Messinian sequence.

For that reason, in the framework of the IODP drilling program, we propose to sample and log two different sites in the western and eastern Mediterranean basins, with the new scientific riser drillship Chikyu perfectly adapted to overcome all safety problems.

In order to promote a continuous sedimentary record of the MSC since the pre-crisis paleo-environmental changes, the sites should be drilled in areas where the Messinian salt is tabular and exempted of significant tectonic influence. A complete set of integrated studies (sedimentology, geochemistry, micropaleontology, bio-and cyclostratigraphy) should be carried out.

This project opens the perspective of a new intellectual and scientific adventure that we expect to be as rich and exciting as the discovery of this unusual event was.