

THE EASTERN MEDITERRANEAN RECORD OF THE MESSINIAN SALINITY CRISIS: NEW INSIGHTS FROM MARGINAL AND DEEP BASINS

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Abstract

Based on a revisit of the main outcropping Messinian successions on Cyprus, Zakynthos, Crete and of subsurface data from offshore areas, a preliminary stratigraphic model for the Eastern Mediterranean basin has been reconstructed and compared to the Western and Central Mediterranean basins.

Keywords: Messinian, Stratigraphy, Evaporites, Eastern Mediterranean

The Eastern Mediterranean record of Messinian events is mainly preserved in deep offshore basins. The limited and scattered Messinian outcrops of marginal basins offer a unique opportunity to find out a key for interpreting coeval offshore successions and thus reconstructing the development of the Messinian salinity crisis (MSC) of this area. This is a fundamental step for establishing the stratigraphic relationships between western and eastern Mediterranean Messinian units and testing the MSC two steps/three stages scenario recently put forward by CIESM [1], [2]. We focussed in particular on the Messinian successions of Cyprus and Zakynthos. A complete revisit of Southwestern Cyprus Messinian basins (Polemi, Pissouri and Maroni/Psematismenos) led to point out that the local Lower Gypsum unit actually consists of clastic evaporites associated with subordinate gypsum cumulates deposited in very shallow depocenters, thus suggesting that only the second MSC step is here recorded (stages 2 and 3). The basal part of the unit usually comprises clastic carbonates ("barre jaune") containing resedimented selenite fragments formed during the first MSC step (PLG-Primary Lower Gypsum). This unit passes upwards to both stratified and/or chaotic gypsum-bearing clastic deposits. Gypsum cumulates commonly occur in the intermediate part of the unit; at Maroni the latter deposits show evidence for precipitation in very shallow water (bird tracks), but no clear desiccation features have been observed throughout the succession. We interpret these deposits as a shallow-water equivalent of the RLG unit (Resedimented Lower Gypsum), defined in western and central Mediterranean [1], [2] and recording the very short second MSC stage during which large volumes of halite and K-salts precipitated in deeper basins. These deposits are conformably overlain by the Upper Gypsum and Lagomare units which are very similar to their Sicilian equivalents [2], [3]. According to this interpretation, the base of the local Lower Gypsum unit is actually a regional unconformity corresponding to the Messinian erosional surface (MES) which can be traced downbasin in the offshore domain at the base of the deep basin evaporitic unit (Mobile Unit in [4], [5]). Halite is not preserved in this basin, but according to the regional scale considerations [6] it is possible that small lenses can be found included within the RLG unit. The Zakynthos Messinian succession shows a complex evaporite distribution largely controlled by synsedimentary compressive tectonics, very similar to what we have observed in the Northern Apennines and Sicily [2], [7], [8]. Step 1 Primary Lower Gypsum cyclically stacked selenites (PLG), cut on top by the MES and unconformably capped by thin paleosol-bearing Lago Mare deposits, occur in shallow wedge-top basins (Kalamaki section); deeper depocenters formed in front of the main thrust fronts are characterized by the accumulation of thick clastic gypsum (RLG), also comprising displaced selenite blocks (Agios Sostis section). Subsurface data indicate that the RLG unit also contains thin lenses of halite developed in the more subsiding sectors of the basin(s) (K. Nikolaou, Hellenic Petroleum, 2009, pers. comm.). These results suggest that, like in the western and central Mediterranean areas, the eastern Mediterranean record of the 2nd MSC stage is characterized by the generalized dismantling of first step primary evaporites (PLG). This was probably triggered by tectonic activity coupled with sea-level falls during TG12-TG14 glacials which caused a concurrent short-lasting block of deep Mediterranean water outflow and the consequent widespread precipitation of halite in deeper basins and of gypsum cumulates in shallow marginal basins. However, the lack of evidence for desiccation in the latter settings suggests that the amplitude of the associated sea-level drop could have been considerably lower than the usually envisaged 1.5 km. A revisit of available cores suggests that the evaporites included in the Upper Evaporites seismic unit in both western and eastern deep Mediterranean basins have mainly a clastic and subaqueous nature. Moreover, the high ⁸⁷Sr/⁸⁶Sr values of halite and/or anhydrite recovered from DSDP sites

374 and 376 suggest that, similarly to what observed for the Lower Evaporites, the usually envisaged correspondence between the seismically defined and the outcropping Upper Evaporites units is highly questionable. These data and observations result in a comprehensive MSC evolutive scenario based on more reliable stratigraphic correlations between marginal and deep basins across the western and eastern Mediterranean basins.

References

- 1 - CIESM, 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. N° 33 in *CIESM Workshop Monographs* [F. Briand, Ed.], 168 pages, Monaco.
- 2 - Roveri M., Lugli S., Manzi V. and Schreiber B.C., 2008. The shallow- to deep-water record of the Messinian salinity crisis: new insights from Sicily, Calabria and Apennine basins. *In: Briand F. (ed.), CIESM, 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. CIESM Workshop Monographs*, 33: 73–82.
- 3 - Manzi V., Lugli S., Roveri M. and Schreiber B.C., 2009. A new facies model for the Upper Gypsum (Sicily, Italy): chronological and palaeoenvironmental constraints for the Messinian salinity crisis in the Mediterranean. *Sedimentology*, available online.
- 4 - Lofi J., Deverchère J., Gaullier V., Gillet H., Gorin C., Guennoc P., Loncke L., Maillard A., Sage F., Thion I., Capron A. and Obone Zue obame E., 2008. The Messinian Salinity Crisis in the offshore domain: an overview of our knowledge through seismic profile interpretation and multi-site approach. *In: Briand F. (ed.), CIESM 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. CIESM Workshop Monographs*, 33: 83–90. Monaco
- 5 - Hübscher C., Beitz M., Dümmong S., Gradman S., Meier K. and Netzeband G.L., 2008. Stratigraphy, fluid dynamics and structural evolution of the Messinian Evaporites in the Levantine Basin, Eastern Mediterranean Sea. *In: Briand F. (ed.), CIESM 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. CIESM Workshop Monographs*, 33: 97–105. Monaco
- 6 - Robertson A.H.F., Eaton S., Follows E.J. and Payne A.S., 1995. Depositional processes and basin analysis of Messinian evaporites in Cyprus. *Terra Nova*, 7: 233-253.
- 7 - Roveri M., Bassetti M.A. and Ricci Lucchi F., 2001. The Mediterranean Messinian salinity crisis: an Apennine foredeep perspective. *Sedimentary Geology*, 140: 201-214.
- 8 - Manzi V., Lugli S., Ricci Lucchi F. and Roveri M., 2005. Deep-water clastic evaporites deposition in the Messinian Adriatic foredeep (Northern Apennines, Italy): did the Mediterranean ever dry out? *Sedimentology*, 52: 875-902.