Crunching of the primordial interpretation of the Lago-Mare phase: new insights from integrated ostracod biostratigraphy and Sr isotope ratios

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The discovery in the 70’s of the km-thick Mediterranean salt giant alongside the seismic observance of Pliocene-filled engravings along its shelf-slope systems concurred together to postulate that the Mediterranean-Atlantic seaway terminated during the late Messinian. The resulting changes in paleogeographic, paleohydrological and biological conditions, acknowledged as Messinian Salinity Crisis (MSC, 5.97-5.33 Ma), find their expression in the marginal sedimentary record in fauna-depleted gypsum and halite-bearing successions (5.97-5.42 Ma). During the Lago-Mare phase (5.42-5.33) that terminates the MSC the evaporitic deposition endures in the intermediate basins (e.g. Caltanissetta Basin, Sicily), whilst all the marginal basins fill with fluvio-lacustrine terrigenous sediments. Up to five conglomerate to sandstone-laminated pelite alternations thought to be precession controlled are counted underneath the Zanclean marine deposits featuring the restoration of a marine environment. Finer hemicycles tuned to insolation maxima period stand out above all for the occurrence of faunal assemblages consisting of brackish water ostracods, mollusks and dinoflagellate cysts. The affinity of these faunal elements with the coeval inhabitants of the Eastern Paratethys region, fragmented in isolated, long-lived brackish lakes (i.e. Euxinic and Caspian Basin), led to the primordial hypothesis of a similar paleoenvironment in force during the Lago-Mare phase for the Mediterranean, coherent with the paleoenvironment subsisting immediately prior to it. However, the progress of scientific research provided additional evidence arguing against the desiccation theory and supporting a basin filled even during the Lago-Mare phase. Within the full Mediterranean model controversial views exist on the hydrochemistry of the water mass, disputed between marine, brackish and density-stratified. To elucidate Mediterranean base level and hydrology just preceding the restoration of open marine conditions we merge together new and published ostracod biostratigraphic data and radiogenic strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) from locations (SE Spain, Piedmont, Sicily and Cyprus) covering the whole extent of the Mediterranean Basin. Ostracod faunal assemblages share approximately the same species and the same distribution pattern. Within a single pelitic bed, richness varies from oligotypic assemblages dominated by *Cyprideis torosa* to heterotypic assemblages with up to 17 Black Sea-derived species. Consequently, we conclude that it is most
likely that the Mediterranean water level during the final phase of the MSC was high enough to let the Paratethyan fauna to reach and spread throughout the shallow Mediterranean depositional environments. \(^{87}\text{Sr}/^{86}\text{Sr}\) ratios measured on ostracod valves range between 0.709131-0.708715. The generally lower and higher Sr isotopic composition than contemporary seawater (∼0.709024) alongside the data spreading are considered as a further proof of the presence of multiple lakes acquiring their own isotopic composition. We demonstrate that, when taken individually, none of the marginal basins yields an isotopic signature that matches that of the local rivers. If anything, these \(^{87}\text{Sr}/^{86}\text{Sr}\) values arise from the mixing of local river water with Mediterranean water and we show that the discrepancies among each basin are consistent with variations in the lithologies of the contributing catchments. Lastly, we show that multiple, isotopically different water sources of both internal (major peri-Mediterranean rivers) and external (Atlantic and Eastern Paratethys) contributed to building up the Mediterranean water mass.