Low-salinity Mediterranean gypsum deposits: chemical vs biological products

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Large deposits of gypsum accumulated in the marginal basins of the Mediterranean Sea during the Messinian Salinity Crisis. These form the marginal portions of the Mediterranean Salt Giant (MSG) that also occupies the deep, central Mediterranean basins. Although the marine, evaporitic origin of the MSG is undisputed, the analysis of gypsum fluid inclusions and of gypsum-bound water ($\delta^{18}$O$_{H_2O}$ and $\deltaD_{H_2O}$) suggest that marginal basin gypsum formed from low- to moderate-salinity water masses (5 - 60 ‰), rather than from high-salinity brines (130 - 320 ‰), as expected during the evaporation of seawater. We present a new set of water isotope and fluid inclusion salinity data that extends the low salinity signature of gypsum to include five Mediterranean Sea marginal basins: Caltanissetta Basin (Sicily), Sorbas Basin (Spain), Piedmont Basin and Vena del Gesso Basin (northern Italy) and Catanzaro Trough (Southern Italy). With a simple geochemical model we explore the salinity-$\delta^{18}$O$_{H_2O}$-$\deltaD_{H_2O}$ evaporation path and the $^{87/86}$Sr and $\delta^{34}$S$_{SO_4}$ composition of the Mediterranean Sea subject to a variety of evaporation conditions and mixing ratios with continental runoff. This approach suggests that evaporation and mixing with continental runoff - including freshwater transiting via the Paratethys - cannot lead to the observed geochemical signature of MSC gypsum deposits. An alternative process that decouples the saturation state with respect to gypsum from salinity must have been active. We are exploring the possibility that the biogeochemical sulfur cycle leads to spatially and temporally localized gypsum supersaturation conditions via the production of SO$_4^{2-}$ by the oxidation and disproportionation of reduced sulfur compounds.