Coupled measurement of Ca and Sr isotopes in evaporites from the Sorbas basin, SE Spain

N.P. EVANS[1]*, J. MAILES[1], T.K. BAUSKA[1], F. GÁZQUEZ[2], H.J. CHAPMAN[1], H.J. BRADBURY[1], A.V. TURCHYN[1] AND D.A. HODELL[1]

[1] Dpt. Earth Sciences, University of Cambridge, Cambridge, CB2 3EQ, UK. (*correspondence: ne243@cam.ac.uk)
[2] School of Earth and Environmental Sciences, University of St. Andrews, KY16 9AL, Scotland, UK.

During the first stage of the Late Miocene Messinian Salinity Crisis (5.97–5.60 Ma), large volumes of sulfates and interbedded carbonate marls (the Primary Lower Gypsum) were deposited in silled subbasins of the Mediterranean. The Sorbas basin (SE Spain) has become a type-locality for this first stage of cyclic evaporite deposition, and is important in the study of the oceanographic evolution of the Miocene Mediterranean Sea due to its proximity to the Atlantic gateway. Questions remain, however, about the factors that mediated the precipitation of gypsum and carbonate during each of the 14 cycles, as well as the primary ion source during each depositional episode.

Here we utilize calcium isotopes ($\delta^{44/40}Ca$) to constrain the hydrological changes during the deposition of the massive gypsum beds and interbedded carbonate marls of the Yesares Member in the Sorbas basin. Individual gypsum cycles display differing degrees of $\delta^{44/40}Ca$ enrichment throughout the section; values increase from 0.41‰ (BSE) at the base of cycle 1 to a maximum of 1.23‰ in cycle 9, before subsequently decreasing toward the top of the section. Within individual gypsum cycles, the most isotopically depleted values occur at the base of each sampled interval.

The existence of enriched values, some above the $\delta^{44/40}Ca$ of modern seawater, cannot be achieved without significant Rayleigh fractionation of Ca isotopes. We deconvolved the Rayleigh fractionation displayed in the $\delta^{44/40}Ca$ by normalization to $^{87}Sr/^{86}Sr$ measured in the same samples. Using this method, we can differentiate the different amounts of enrichment caused by variations in the Ca replenishment rate, and the changes in the relative proportions of freshwater and seawater inputs. We conclude that the Sorbas basin experienced a gradual reduction in the volume of the marine endmember due to increased closure of the basin during the ~300ka of deposition, resulting in a qualitative increase in the freshwater fraction to the mother fluid of the deposits upsection.