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Evolution of the oceanic circulation on the Levant margin during the Late Cretaceous

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Within the Late Cretaceous, the Campanian-Maastrichtian interval is marked by the occurrence of large deposits of phosphorites and organic-rich carbonate sediments on the southern Tethyan margin, that have been attributed to the development of upwelling regimes possibly linked to an intensification of the Tethyan Circumglobal Current (TCC). Our study aims to track changes in water masses on an area of the southern Tethyan margin that recorded phosphorites, organic-rich carbonate, and high productivity microfossil assemblages, through the evolution of local seawater neodymium isotope composition (εNd).

In this work we analyzed for their εNd and rare earth element (REE) concentrations fish teeth from 25 different levels within the Turonian to Maastrichtian interval on the Levant Platform (Negev desert, Israel) along with carbonate leachates from marine sediments of a core drilled in southern Israel (Mishor Rotem, RE-6 core). Similar εNd values and trends of the carbonate leachates and fish teeth along with REE pattern with pronounced negative cerium anomaly and enrichment in heavy rare earth elements similar to modern seawater, point to a local seawater origin for both records. Our dataset highlights an increase of about 1.5 ε-units, from about -6.5 to about -4 ε-units of bottom waters on the Levant Platform during the Campanian, coeval to the initiation of extensive chert and phosphorite deposition, that could reflect enhanced inputs of radiogenic upper ocean Pacific waters in this region or the establishment of large-scale upwellings if Tethyan deep waters are sourced in the Pacific.

In order to explore the potential impact on local seawater εNd of Nd inputs from nearby eroded crustal material, the clay-size fraction of RE-6 core sediments was isolated by successive removal of carbonates, oxy-hydroxides and organic matter according to the leaching procedure derived from Bayon et al. (2002) and clay-size fraction isolated through decantation and centrifugation steps. According to XRD analyses, clay-size fraction, dominated by smectitic minerals, were then analyzed for their REE concentrations and εNd. The data display less radiogenic values than carbonate leachates and fish teeth except within the main phosphate member, but an evolution that resembles that of local seawater. REE patterns of these fractions present a slight enrichment in heavy REE and a negative cerium anomaly, hinting to the presence of a carrier of a seawater signal that has not been eliminated by the leaching procedure. In order to test this hypothesis, a more aggressive additional step was applied (1M HCl, 120°C, 15h) to remove this carrier and both the HCl leachate and the remaining fraction were analyzed. The HCl leachate display more radiogenic εNd values than the original clay-size fraction, and REE patterns showing more pronounced negative Ce anomalies and heavy REE enrichments, while the residues are defined by more unradiogenic εNd values and an absence of cerium anomalies. This confirming the existence of a refractory phase in the clay-size residues carrying a seawater signal, that may be composed of phosphate minerals and/or authigenic smectitic minerals.

Bayon, G. et al., 2002. Chemical Geology 187, 179-199.