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A Zn isotope perspective on the basin-wide primary productivity and redox changes during the Mediterranean sapropel S1 formation

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The cyclic deposition of sapropels in the Mediterranean Sea basin represents a unique record of severe bottom-water deoxygenation events over the recent geological past [1,2]. Such episodes of deoxygenation are also associated to sluggish water circulation that involved an enhanced production and preservation of organic matter in these shale beds. However, the relative importance of surface-ocean productivity versus deep-water redox control on the sapropel formation has long been a debate [1,2].

Zinc is an essential micronutrient whose stable isotope systematics represent a promising tracer to provide constraints on the evolution of biological productivity and the redox history of the oceans [3,4]. Here we report the first Zn isotope data, together with an array of geochemical proxies for the most recent sapropel S1, in a suite of sediment cores covering the entire eastern Mediterranean basin. The sapropel S1 formed synchronously at all water depths greater than a few hundred meters between 9.8 and 5.7 ^{14}C kyr BP during the most recent African Humid Period. The end of this period is marked by an abrupt deep-water re-ventilation that has resulted in the built-up of a sedimentary manganese-oxide peak. These episodes with different hydroclimate backgrounds thus provide an exceptional archive for studying Zn isotope response to basin-wide event with dramatic change in ventilation/climate-related productivity and redox conditions. Our preliminary results show that authigenic enrichments of the investigated trace metals (i.e. EFs of Cu, Zn, Ni, Ba, Mo, and U) exhibit similar patterns across the S1 period, where peak enrichments occur in its early stage (S1a) while minimum enrichments occur in pre- and post-S1 time slices. We further demonstrate that the basin-wide sapropel intervals of diverse depths and oceanographic regimes have captured different characteristics in Zn isotopes and trace metal proxies. Altogether, these proxies provide detailed information on the interplay between productivity and oxygen conditions in the water column during sapropel deposition.

[1] De Lange et al. (2008) *Nat. Geosci.* **1**, 606–610; [2] Wu et al. (2019) *Earth Planet. Sci. Lett.* **511**, 141–153; [3] Vance et al. (2017) *Nat. Geosci.* **10**, 202–206; [4] He et al. (2023) *Geochim. Cosmochim. Acta* **343**, 84–97.