Mediterranean seawater circulation reconstructed for Holocene sapropel S1 period using Nd isotopes in fish debris and foraminifera

JIAWANG WU [1,2*], KATHARINA PAHNKE [3], PHILIPP BÖNING [3], LI WU [1], ANNIE MICHARD [4], GERT J. DE LANGE [1,2]

[1] State Key Lab of Marine Geology, Tongji Univ., 200092 Shanghai, China (*: jwwu@tongji.edu.cn, j.w.wu@uu.nl)
[2] Dept. of Earth Sciences, Utrecht Univ., 3584 CC Utrecht, The Netherlands
[3] ICBM, Univ. of Oldenburg, 26129 Oldenburg, Germany
[4] CEREGE, Aix-Marseille Univ., 13545 Aix en Provence, France

Mediterranean sediments are renowned for the recurrent deposition of organic-rich sapropel units, reflecting global climate variability and basin dynamics. The most-recent S1 unit (~10.8–6.1 ka) formed during the African Humid Period in the eastern Mediterranean Sea (EMS). Its deposition has been attributed to deep-water stagnation and enhanced biological production. However, the underlying climatic interactions, paleoceanographic processes, and associated ventilation dynamics are still debated. Using the paleo-seawater Nd isotope composition (ε_{Nd}) as water-mass tracer, a basin-wide circulation systematics during S1 formation is reconstructed for the first time. Our ε_{Nd} data from fish debris, foraminifera, and bulk-sediment leachates are remarkably radiogenic compared to today, and spatially and temporally constant. These results predominantly reflect Nile versus Atlantic contributions, and indicate that EMS deep-water stagnation prevailed below ~800 m water-depth over the whole S1 course. The ε_{Nd} records show that such stagnation was preconditioned ~2,000 years prior to S1 initiation by intensified Nile flooding, and ended synchronously with S1 termination. Furthermore, deep EMS and western Mediterranean Sea (WMS) were decoupled during the S1-period. Using a box-model for Nd in the EMS, the observed ε_{Nd} distribution can be adequately explained by a 2-fold increase in Nile discharge, and a 50% decrease in the EMS–WMS exchange that was mostly limited to the surface waters alone. The corresponding circulation during S1 was more sluggish and shallow for the EMS, but largely unaffected for the WMS. This implies that deep-water stagnation is a prerequisite for sapropel formation.