WATER COLUMN REDOX CONDITIONS DURING SAPROPEL FORMATION; COMPARISON BETWEEN SEDIMENTARY RECORD RECENT ANALOGUES

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Abstract

Redox sensitive metals enrichment has been used for the reconstruction of deep water ventilation in the Eastern Mediterranean. We compare fixation of Mo and U on the Black Sea, the present day largest anoxic basin, and sapropels from different periods to elucidate formation conditions based on the recent analogues. Most sapropels present preferential Mo enrichment, attributed to different degrees of water column anoxia and primary productivity. Some layers present Mo:U ratio similar to present day seawater, suggesting anoxic bottom water and constant turnover. Basin stagnation comparable to the Black Sea is only punctually observed in the Mediterranean for the most intense sapropel events.

Keywords: Anoxia, Black Sea, Sapropel

Redox conditions of the water column and circulation in the Eastern Mediterranean during sapropel formation has been extensively discussed [e.g., 1, 2, 3], yet stagnation is still under debate [1, 2]. Using ICP-MS geochemical data, we compare the behaviour redox sensitive elements on Mediterrranean sapropels spanning from 2Ma to recent, from 4 ODP sites, and sediments from a cores in the Black Sea and data from [4]. The co-variation between Mo and U in the sediment depends on sea water chemistry, water column circulation, and shuttle transport adsorbed to organic matter, [4]. The rate of turnover and different fixation process for Mo and U must also have an effect.

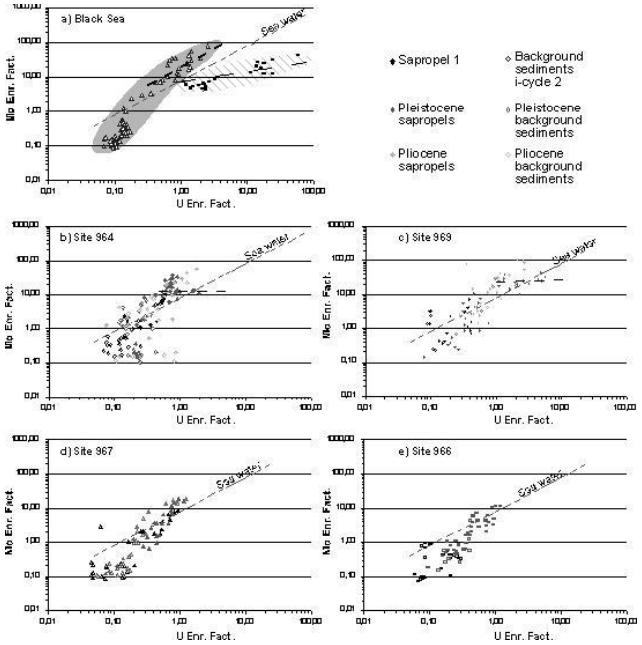

Fig. 1. Mo:U variations (in Enrichment Factors) for Black Sea (a) and Eastern Mediterranean (b-e) sediments. Sea water line marks average Mo:U ratio on sea water (7,8 aprox.). Shading on 1-a distinguish platform (solid grey) and basin (stripes) sediments. Data from the deep basin are from [4].

Black Sea sediments show two trends (Fig.1-a): Samples from the platform (grey shading) are either slightly enriched only in U or following the trend of sea water Mo:U. Fixation of U begins earlier than Mo, and occurs by diffusion into the sediment, whereas Mo can be scavenged from the water column. These evidences indicate a variable chemocline and a constant input of both elements so that none is depleted in the waters. Recent sediments from the deep basin (stripes) follow the same sea water trend, whereas the last sapropel shows relatively constant Mo concentration and progressive U enrichment. This was interpreted [4] as the result of stable stagnant condition that depleted Mo from the upper water layers. A similar representation on Mediterranean sapropels samples shows similar trends. A cloud of background sediments are slightly enriched in U under sub-oxic conditions. Only when the redoxcline shifts upwards into the water column Mo starts to be fixed. Where deepwater circulation allows U and Mo input, a steady state is reached and Mo:U runs parallel to the sea water line. This is the case for S1 at sites 964 and 967 (Fig.1-b and 1-d) and Pleistocene sapropels at 966 (Fig 1-e). Most Plio- Pleistocene levels are preferentially enriched in Mo on sites 964 and 969, which may imply restricted bottom water circulation and thus limited U fixation. However, intermediate water circulation and Atlantic input was not restricted so Mo was continuously scavenged from the anoxic water column, favoured by organic matter shuttle, [4]. A situation similar to the Black Sea sapropel, with a stable shallow chemocline and long term stagnation, is only inferred locally for S5 and S7 at sites 969 and 964 (Fig. 1-b and 1-c, discontinuous black line).

References

1 - Nijenhuis, I.A., Brumsack, H.J., De Lange, G.J., The trace element budget of the eastern Mediterranean during Pliocene sapropel formation, 1998. *Proce. ODP: Scien. Res.* 160: 199-206.

2 - Casford, J.S.L., Rohling, E.J., Abu-Zied, R.H., Fontanier, C., Jorissen, F.J., Leng, M.J., Schmiedl, G., Thomson, J., A dynamic concept for eastern Mediterranean circulation and oxygenation during sapropel formation, 2003. *Palaeog, Palaeoclim, Palaeoec.* 190: 103-119.

3 - De Lange G.J., Thomson J., Reitz A., Slomp C.P., Principato M.S., Erba E., and Corselli C. (2008) Synchronous basin-wide formation and redox-controlled preservation of a Mediterranean sapropel. Nature Geo 1, 606-610.

4 - Algeo, T.J., Tribovillard, N., Environmental analysis of paleoceanographic systems based on molybdenum-uranium covariation, 2009. *Chem.Geol.*