Hypotheses and facts on the when, why and how of sapropel formation in the Mediterranean Sea

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Sapropels in the Mediterranean Sea are sediment layers that were deposited during periods when the deep waters of the eastern Mediterranean Sea were anoxic for several thousands of years. Anoxia was caused by enhanced water column stratification. I review the state of knowledge on three aspects of sapropel formation: the timing of sapropels and implications for the underlying climatic mechanism, the causes for stratification and geographical patterns of run-off, and the coupled chemical and biological consequences that led to enhanced organic carbon accumulation.

Differing from previous hypotheses, recent investigations on speleothems suggest that enhanced rainfall and onset of anoxic conditions were synchronous with insolation maxima. Large negative excursions in $\delta^{18}O$ in sapropels are largely accounted for by increasing SST and pooling of isotopically depleted water in the surface layer. Spatial patterns in coeval sapropels are consistent with climate processes in the low latitude catchment and of regional surface water warming associated with insolation cycles. However, much of the excess moisture apparently originated from evaporation in the Mediterranean Sea.

Regional and global temperature evolution modulated the basic sapropel rhythm and raised the threshold for full stagnation of deep water during glacials, but each insolation-related swing from cold to warm and from dry to wet conditions is expressed as a “failed sapropel” in the isotopic, chemical, and faunal records.

Increased accumulation of organic matter was a consequence both of higher productivity and enhanced preservation of organic matter. Both were caused by anoxic conditions at the sea floor. Very low (-1 to 1‰) $\delta^{15}N$ ratios in sapropels require a very light source of nutrient-N assimilated at a minimum of ten times the modern export flux. Because isochronous records show no spatial gradient in the $\delta^{15}N$, we may exclude both Ekman-type upwelling and direct riverine discharge as likely sources of nutrients. Instead it appears that phosphorus release from sediments and denitrification at a relatively shallow redox boundary resulted in an imbalanced supply of nutrients (N:P< 16:1) to the photic zone. The result was a slow assimilation of carbon during summer stratification and extensive N_2-fixation providing the majority of the export flux from a N-limited system.

Sapropels thus result from a basic mechanism operating in all silled basins of the temperate climate zone at transitions from cool to warm climate. The robust relationship between climate, surface water properties and biological consequences seen in the Mediterranean Sea is an analog for many black shale events of the geological record.

Element contents in the ash of dropwort roots and in the soil around the roots

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Biogeochemical mapping for characterising the pollution of the environment with heavy metals and other hazardous elements has been carried out in Estonia using dropwort (Filipendula Ulmaria) roots as indicators. Dropwort was chosen out, because this plant met the requirements established for indicator plants. Compared with geochemical mapping of soil, biogeochemical investigations give an overview of elements which are collected from the soil that surrounds the growing plants.

The aim of this investigation was both identifying the possible pollution of soil with a biogeochemical method, and analysing soil from the same sampling points were dropwort roots were collected.

50 sample pairs collected from the same sampling points have been compared. Root samples were washed, dried and ashed at 450ºC. Analysed were Cd, Cu, Fe, Mg, Mn, Pb and Zn by AAS, P by colorimetric and Nb, Rb, Sr and U by XRF method. In soil samples the same elements were analysed with the same methods.

Results will show that the elements Cd, Cu, Mg, Mn, Nb, P, Rb, Sr, Zn and U concentrate better in dropwort roots than in soil. These results show how intensively plants collect nutrient elements from the soil.It became evident that the anomalies in the analysed results can be caused by pollution in the surrounding soil, higher concentrations in bedrock but also by anthropogenic pollution.

Plants are more sensitive for identifying pollution. Plants show pollution from a whole catchment area, but soil only pollution in a certain sampling point. The heterogeneity of the soil in both vertical and horizontal layers interferes with a good comparison of the results; in this case plants are better indicators for the environment.