DEEPWATER-/ REDOX-CONTROLED FORMATION, PRESERVATION, AND INTERRUPTION OF ORGANIC-RICH SAPROPEL S1

Gert J. de Lange [1]*, Amalia Filippidi [1] and Rick Hennekam [1]
[1] presently at:NIOZ-Texel - gdelange@geo.uu.nl

Abstract
The synchronous initial deposition and preservation at a basin-wide scale of the most recent sapropel S1 appears mainly controlled by redox-conditions. The latter are determined by a complex interplay between S-borderland-related precipitation and N-borderland-related cooling episodes. The continuing deep-water ventilation after its deposition & initial reventilation event resulted in a downward progressing oxidation front that degraded the upper part of S1. Pronounced double Manganese peaks in the sediment are clear markers for this reventilation and the subsequent downward oxidation. In addition, even during S1 deposition, initially thought to be continuously anoxic, distinct re-ventilation events appear to have taken place. The 8.2 ka event is the most noticeable of these, but others, probably of more reduced duration, also occurred.

Keywords: Sapropel, Mediterranean Sea, Anoxia, Sediments, Paleoceanography

In Mediterranean marine deposits, distinct organic-rich units (sapropels) occur in a repetitive, climate-controled way. Their deposition is precession-related and associated with humid climate conditions [1] The most recent sapropel S1 formed between 9.8 and 5.7 14C ky BP, thus simultaneously with a circum-Mediterranean humid period. (11 - 5 kyr 14C) [2]. S1 deposition occurred synchronously at all water depths greater than a few 100m. The effect of such increased precipitation over evaporation is water-column stratification, and the resulting restricted deep-water ventilation. This has caused predominantly anoxic water column conditions, and as a consequence preferential preservation of organic matter has occurred below 1.8 km during 4,000 years of S1 formation. This resulted in a differential basin-wide preservation of S1 determined by water depth, as a result of different ventilation/climate-related redox conditions above and below 1.8 km. A sedimentary,basin-wide, MnO2-peak marks the abrupt re-ventilation of deep-water at 5.7 kyr. The subsequent oxic conditions resulted in a downward progressing oxidation-front that is not only marked by degradation of organic matter over its active pathway, but also by the built-up of a secondary Mn-peak below the first, ventilation Mn-peak [3] (Fig.1).

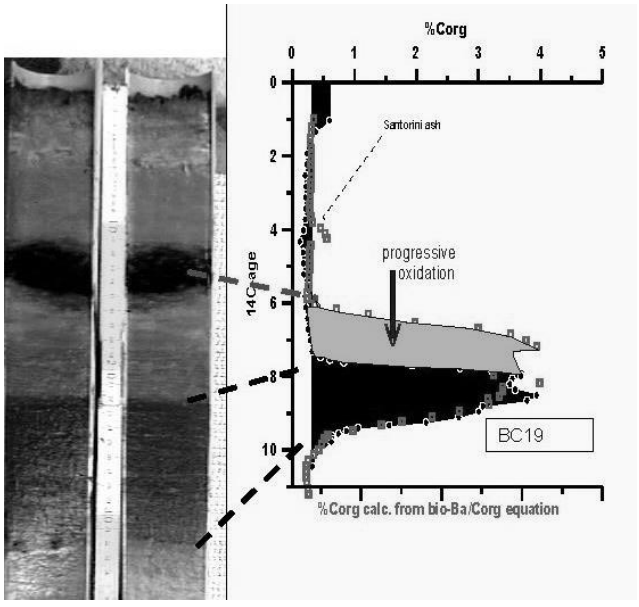

Fig. 1. Sapropel S1: Left: manganese-rich Marker-Bed (black-unit), remaining S1 (darkgreen); Right: initial %Corg (green), upper oxidized (blue), and lower un-oxidized, remaining S1 unit (black)

Apart from the major re-ventilation event at the end of sapropel S1 formation, also other, short-term ventilation events have occurred, notably the 8.2 ka event. [4] This basin-wide event is particularly noticeable at relatively shallow near-coastal sites of high sedimentation rates. It marks a brief episode of not only re-oxygenated deep water thus reduced preservation, but also decreased primary productivity thus nutrient supply. Similar but potentially shorter water-column ventilation events during S1 deposition have been demonstrated [5], thus pointing to a subtle hydrological balance governed by northern and southern borderland related climate variability. The 8.2 ka event is the most outspoken example for this. The 8.2 cal ka BP interruption event is related to enhanced deep-water formation in the Aegean or Adriatic due to a period of sustained cold air fluxes from Polar regions. The amount of precipitation thus stratified water-column conditions is associated with N.African monsoonal system, whereas deep-water formation, thus disrupture of a stratified water column is related to the N-borderland climate system. Sapropel formation mechanisms, therefore, are related to a sensitive interplay between S- and N- borderland climate systems. Assessing distinct, sub-Milankovitch climate variability is vital for understanding and forecasting future climate change.

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