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A dynamic concept for the formation of Black Shales and Marine Sapropels

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Abstract

We propose that the recently reported sapropel 'interruptions' represent centennial-scale episodes of enhanced frequency/ intensity of intermittent bottom-water ventilation and that this ventilation process continued to occur throughout periods of sapropel deposition. In essence, the modern high-frequency variability in deep-water formation (annual to decadal in frequency), affected by climatic variability over the northern basins on seasonal to longer time scales, prevailed also at times of sapropel deposition, although the overall ventilation state was much reduced.

In the Aegean, concomitant abundance of low-oxygen tolerant benthic foraminifera and presence of the more oxyphilic benthic foraminifer *Uvigerina mediterranea*, with surface-similar δ^{13}C values in the Aegean, indicate repeated bottom water re-oxygenation events throughout the deposition of organic rich sediments. In addition, the observations of benthic continuation through S1 Holocene sapropel (offshore from Israel) imply that no persistent anoxia developed at mid-depth levels in that region, which is far removed from direct deep-ventilation influences.

We believe this mechanism also provides insight into the differences in timing and depositional mechanisms in Black Shales. We present data from the Kimmeridge Clay and propose that bottom water anoxia may have been spatially restricted and/or of an intermittent nature and that even where anoxic/azoic conditions were present, they may be restricted to a veneer at the sediment/water interface. The extent of such an anoxic 'blanket' depends on the balance between advective oxygen supply into the deep ocean, and biological and chemical oxygen demand. The demand functions imply a decoupling of oxygenation from water-mass advection, allowing export produc-

tion and Corg posting rates to the sea floor to delimit the extent of the anoxic blanket in both space and time. Low-productivity regions would develop no anoxic blanket, allowing for the observed persistence of deep dwelling planktonic (in sapropels) and bottom dwelling benthic faunas.