Consider Whether Your Evidence for Oceanic Anoxia Has Been Reworked

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In the first half of the 20th century, students of black shales were convinced that the preservation of organic matter in marine sediments always required an anoxic water column. But they weren't sure, and indeed debated vigorously, about the thickness of that water column [1]. One of the most significant contributions of the Deep Sea Drilling Project was to show that black mud can be deposited in both shallow- and deepwater environments. But now students of black shales weren't so sure anymore whether those environments were always anoxic.

In 1976, Schlanger and Jenkyns proposed the concept of an Oceanic Anoxic Event to explain the persistence of black shales in the middle Cretaceous [2]. In their model, black mud arrived at the deep seafloor with turbidity currents.

The idea that deepwater black shales are turbidites prevailed throughout the 1980s. But from the late 1990s onward, organic geochemists started finding biomarkers in deepwater black shales that seemed to indicate that the entire water column above had been anoxic [3]. Others have pointed out, however, that biomarkers are also sediment particles and, thus, susceptible of being transported [4].

Black shales are often used as sedimentary evidence for oceanic anoxia, but it is seldom considered whether the evidence is in situ. Organic matter and proxies for anoxia in deepwater mud may represent materials that were reworked from shallower water. For this reason, in geochemical studies of deepwater mud, it is important to distinguish turbidites from hemipelagites. This distinction is not always obvious to the naked eye, especially in black shales.

I will discuss examples of middle Cretaceous deepwater black shale successions that represent materials reworked from the shallower seafloor within the oxygen minimum layer. These materials should not be interpreted as evidence for deepwater oceanic anoxia. Detailed facies analyses of other Cretaceous deepwater black shales may reveal that more units are of turbiditic origin than currently presumed.

[1] Pettijohn (1949) *Sedimentary rocks*. New York: Harper and Row. [2] Schlanger & Jenkyns (1976) *Geol. Mijnbouw* **55**, 179-184. [3] Sinninghe Damsté & Köster (1998) *Earth Planet. Sci. Lett.* **158**, 165-173. [4] Meyer & Kump (2008) *Annu. Rev. Earth Planet. Sci.* **36**, 251-288.