Carbon burial potential and reduced rates of oxidation during deposition; mineral surfaces and anoxia in OAEs

MARTIN J. KENNEDY[1], THOMAS WAGNER[2] AND STEFAN CARLOS LOEHR[1]

[1]Sprigg Geobiology Centre, University of Adelaide, South Australia, martin.kennedy@adelaide.edu.au

[2]School of Civil Engineering and Geosciences, Newcastle University, New Castle on Tyne, UK

The stratigraphic record of continental margin sediments indicates intermittent deposition of organic carbon rich rocks (ORR). Their basin wide persistence under anoxic conditions has led to the concept of oceanic anoxic events (OAE). By contrast, studies of other sediments show a first order relationship between mineral surface area (MSA) and total organic carbon (TOC) implying a mineral surface preservative effect. To understand the interplay of these two potential influences, we studied three examples of OAEs in which TOC varied against degrees of anoxia. The strongest relationship between MSA and TOC (R^2 = 0.90) was recorded from Cretaceous OAE 2 sediments (Demerara Rise) that showed both the broadest range and highest value in TOC (7-20%) that varied through persistent anoxia. MSA:TOC was also positively related (R^2 > 0.80) in the Devonian Woodford Shale and OAE 3 from the Deep Ivorian Basin, however where animal burrows indicated oxic conditions, TOC was significantly lower.

These results indicate that mineral surfaces provide a short-lived preservative effect sufficient to increase TOC only where it occurs in combination with low oxygen conditions that exclude the irrigating effects of bioturbating organisms and thus reducing the duration of exposure to oxidants. TOC values > 5% are a function of clay minerals with high MSA in these examples, but when deposited in combination with anoxic conditions, TOC enrichment up to 20% occurred. Similar mineral compositions in adjacent laminated and bioturbated sediments show ~ 60% lower TOC while low MSA sediments show minimal TOC values in either laminated or bioturbated sediments. These results implicate sediment mineralogy as a defining characteristics of the organic enrichment in the OAE's studied. Because MSA in these OAEs is dominated by detrital clay minerals derived from soils, changes in continental climate or weathering provenance played an equally important role in the TOC enrichment defining these OAEs.