

Organomineral nanocomposite carbon burial during Oceanic Anoxic Event II

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The geological record is punctuated by intervals of widespread organic carbon (OC) enrichment known as Ocean Anoxic Events (OAEs). These are intensively studied because they source the majority of commercial hydrocarbons as well as recording carbon burial mechanisms and feedbacks not evident today but characteristic of greenhouse oceans. The origin of OC enrichment in OAE sediments is commonly attributed to increased primary production and/or enhanced preservation due to bottom-water anoxia. Here we show that high but variable OC concentration in the late Cenomanian aged OAE2 at Demerara Rise was controlled by co-occurrence of anoxic bottom-water, sufficient productivity to saturate available mineral surfaces and variable deposition of high surface area detrital smectite clay.

Redox indicators show consistently oxygen-depleted conditions, while a strong correlation between OC concentration and sediment mineral surface area ($R^2=0.92$) occurs across a range of TOC values from 9-33%. X-ray diffraction data indicates intercalation of OC in smectite interlayers while electron microscopy, synchrotron infrared and X-ray microscopy show an intimate association between clay minerals and nano-scale OC. This is consistent with preservation of OC as organomineral aggregates and nanocomposites rather than discrete, μm -scale pelagic detritus. The strong mineral surface area/TOC correlation indicates that excess OC relative to surface area is lost, so that we propose that it is the varying supply of smectite that best explains variable organic enrichment against a backdrop of continuous anoxia, which is conducive to generally high TOC during OAE 2 at Demerara Rise.

Smectitic clays are unique in their ability to form stable organomineral nanocomposites that preserve organic matter. They are common weathering products of continental volcanic deposits, and an increased flux of smectite coinciding with high carbon burial around OAE 2 is consistent with published evidence for widespread volcanism.