Organic carbon-sulphur coupling in the eagle ford formation

ORGANIC CARBON – SULPHUR COUPLING IN THE EAGLE FORD FORMATION

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The formation of organic matter (OM) rich rocks by the production, preservation, and burial of organic carbon is governed by a complex combination of paleo-environmental and climatic factors. Unravelling these is still an active area of research. One aspect that must be examined in further detail is the coupling between organic carbon, sulphur, and iron. Though pyrite (iron sulphide) is the largest sedimentary sulphur pool (Amrani, 2014), the dynamics between carbon and sulphur are equally important to understanding the fate of carbon and sulphur during deposition and diagenesis. The partitioning of sulphur into organic and inorganic phases, and its link with climatic and paleo-environmental factors including organic matter source and preservation, is examined in this study.

The Eagle Ford Formation, deposited in a dynamic and morphologically varied shelf environment (Harbor, 2011) during the global 'greenhouse' conditions of the Cretaceous, allows the influences of climate, oceanographic conditions, and paleo-environment on carbon-sulphur deposition and dynamics to be examined.

We here report new geochemical results from two cores of this formation, having sampled core sections from before, within, and following the major global carbon perturbation of oceanic anoxic event 2 (OAE2). One core was deposited in the Maverick Basin area, a distal part of the shelf with increased accommodation space and possibly restricted circulation. This was sampled at a sliding resolution (1 to 30 cm) to study variations in organic matter source and preservation, redox conditions, and degree of sulphurisation, in high resolution. The second core from the San Marcos Arch, a more open and shallow setting with influence of terrigenous export through deltas in the north-east, provides a contrast between distal and proximal paleo-environments.

In agreement with literature on other cores from the Eagle Ford Formation (e.g. Sun et al., 2016), our initial results concur that while the formation consists of dominantly marine-sourced organic matter and carbonate, it was deposited during highly dynamic paleo-redox and oceanographic conditions with corresponding variable effects on organic matter and sulphur preservation. Building on previous work on this formation, our study adds biomarker data on orbital timescales, integrated with other geochemical proxies to unravel the dynamics of, and controls on, carbon preservation.

The Lower Eagle Ford displays pronounced cyclic variations in TOC with values ranging from <0.1 to 9.9 wt% (Figure 1) and total sulphur contents between 0.3 and 4 wt%. These strong dynamic variations are also observed in both redox proxies and lithology. Different to most other settings in the global ocean, the onset of OAE2 is marked by a change from reducing to more oxic conditions, reflected by decreasing organic contents at the Lower-Upper Eagle Ford transition. Following OAE 2, the Upper Eagle Ford represents a return to less oxic conditions, but not as persistently reducing as observed before. Notably, variability and range of TOC does

not show a clear relationship to these redox fluctuations, suggesting that other controls have been active in the study region. The effect of strong diagenetic redox variations (principally of OM sulphurisation) is observed in samples from the San Marcos Arch, having resulted in pronounced diagenetic pyrite layers.

Despite their contrasting depositional environments, both cores show similar peak OM contents and variability. As indicated by previous geochemical studies (biomarkers, Rock Eval, microscopy, etc.; e.g. Sun et al., 2016), the OM is dominantly marine in origin with clear indicators of enhanced productivity and/or preservation environments, and at times elevated degrees of sulphurisation. Our new multi-proxy, orbitally resolved records provide further insights to unravel the influence of fluctuations in climate, redox conditions, and sulphurisation on the preservation of OM.

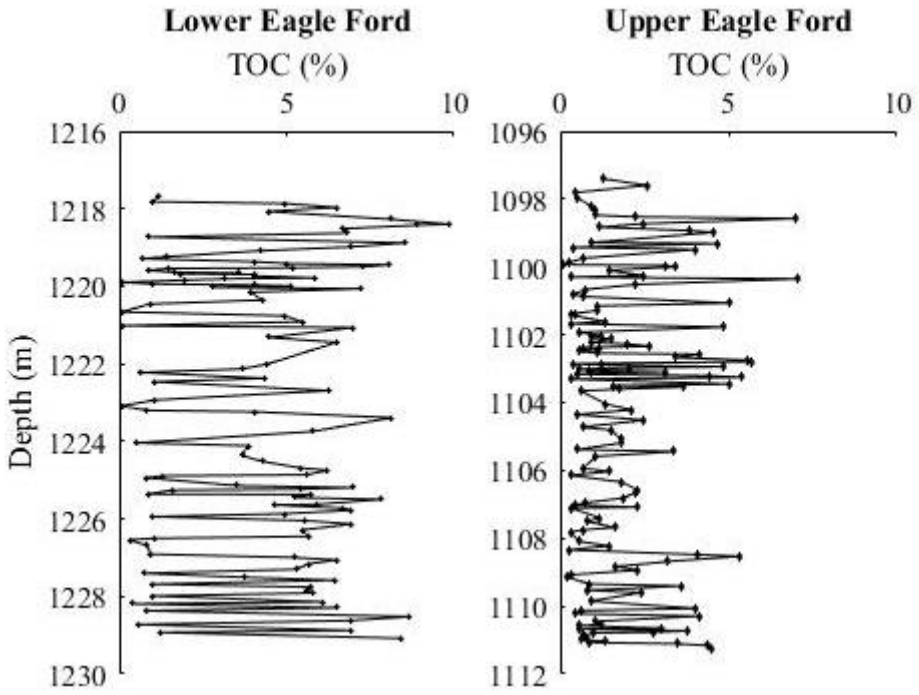

***Figure 1**. TOC records of core sections from the Lower (pre-OAE2) and Upper (post-OAE2) Eagle Ford of the Maverick Basin core, showing the observed range and variability of TOC fluctuations; the Upper and Lower Eagle Ford display similar periodicities but different amplitudes.*

References

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