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Understanding Effects of OAE 2 in the Marginal-marine Environment: A Multi-proxy approach from Bagh Beds, Western India

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The Cenomanian-Turonian (C/T) Oceanic Anoxic Event 2 (OAE 2) at ~94 million years ago was characterized by severe depletion in marine water oxygen levels and extreme perturbations in the carbon cycle at a global scale that lasted for 5 to 6-million years. However, wealth of the data comes mainly from deep marine records, hugely limiting our understanding on the contemporaneous terrestrial environmental conditions. Here, we present major and trace element concentrations, carbon isotope composition of carbonates ($\delta^{13}C_{carb}$) and organic matter ($\delta^{13}C_{bulk}$), organic carbon content (TOC), and biomarker composition from a ~20 m thick well-preserved shallow marine sequence from the Bagh Beds in Uchad, western India in order to investigate the nutrient dynamics, productivity variations and carbon reservoir perturbations in shallow marine as well as in terrestrial environment. Based on litho-stratigraphy, the Uchad section is divided into Lower Cenomanian, Turonian and Upper Coniacian units. A total of ~5‰ increase in the $\delta^{13}C_{carb}$ and 0.07% in TOC values and a sharp 1.7‰ decrease in the $\delta^{13}C_{bulk}$ values in Lower Cenomanian suggest large changes in organic carbon recycling before the advent of OAE 2. Higher terrigenous influx and micro-nutrient supply in the lower parts is also suggested from relatively higher concentrations of Al, Ti, Th, Fe, Zn, Ni and K, although their concentrations decrease rapidly above the C/T boundary. Significant correlation observed between $\delta^{13}C_{bulk}$ and $\delta^{13}C_{carb}$ ($r=0.51$, $p=0.03$) supports an authigenic organic matter production in the shallow marine environment. However, minor enrichments in redox-sensitive elements like Mo, V and U observed above the C/T boundary probably suggest that the shallow marine region was relatively less affected during the initial anoxic phases. Lack of correlation between redox-sensitive elements and Al or Ti concentrations ($r<0.12$) suggest that there is minimal influence of detrital supply on recycling of U, V and Mo. Interestingly, Lower Turonian units show large positive excursions in redox-sensitive elements as well as increases in U/Th, Ni/Co and V/(V+Ni) values, which are succeeded by a major decrease in $\delta^{13}C_{carb}$ values (7.6‰) and increase in the TOC values by 0.15%, thereby suggesting occurrence of a more expanded episode of anoxia in Lower Turonian that perturbed the shallow marine carbon reservoir. Ba/Al ratios are variable throughout the section, although large positive spikes preceding and succeeding the anoxic phases suggest a causal link between organic matter productivity and anoxia.