

Ecological and Redox condition changes during the end-Triassic Mass Extinction at St. Audrie' s Bay, UK

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Earth has experienced five mass extinction events, four of which are associated with large igneous provinces. The end-Triassic Mass Extinction (ETE) that occurred ~201 million years ago is such an event associated with intense volcanic activity and the breakup of the super continent Pangea, forming the Central Atlantic Magmatic Province. A focal section in ETE studies is St. Audrie' s Bay, UK where the iconic organic carbon isotope record ($\delta^{13}\text{C}_{\text{org}}$) shows 'initial' and 'main' excursions. Similar isotopic patterns are noted throughout other European sections. The negative $\delta^{13}\text{C}_{\text{org}}$ excursions are typically attributed to the dissociation of methane clathrates with low isotopic signatures that rapidly oxidise to CO_2 before becoming incorporated into the organic carbon cycle and preserved in the geological record. St. Audrie' s Bay is typically cited as a marine section, however evidence of freshwater biota indicates a transition from marine to freshwater close to and during the 'initial' $\delta^{13}\text{C}_{\text{org}}$ excursion (ICIE) with periodic exposure evidenced by desiccation cracks. Four other investigated sections within the UK also show similar ICIEs in both timing and magnitude to St. Audrie' s Bay with evidence of periodic exposure and freshwater biota indicating that the St. Audrie' s Bay $\delta^{13}\text{C}_{\text{org}}$ record and oligohaline record is characteristic of a large area.

Biomarkers, the fossilised lipids that derive from the 3 domains of life, serve as import proxies during mass extinction events indicating changes in redox, environmental and ecological conditions. Hopanes (generally derived from bacteria) and steranes (largely derived from eukaryotes) were investigated prior to and during the ICIE at St. Audrie' s Bay. Largest increases in the homohopane index and C_{28} 28, 30 bis *nor*hopanes, biomarkers associated with increasing redox conditions, do not occur during the ICIE but instead prior to and after the excursion. Unlike other sections during the ETE, these parameters do not co-vary in the same direction suggesting other forces controlling their signal. Largest change in C_{28} 28, 30 bis *nor*hopanes may be attributed to microbial population changes due to changes in sedimentation rates and fluvial inputs, as well as changes in water depth. The Homohopane Index (HI) tracks redox conditions within marine conditions. Evidence of a freshwater transition surrounding the time of the ICIE and aerobic conditions explains the reduction of the HI during the ICIE. 3-Methylhopanes indicative of methanotrophic bacteria show no large increase during the ICIE, and greatest values show no significant change to the $\delta^{13}\text{C}_{\text{org}}$ record. Therefore, this data suggests that the ICIE may not be the sole result of release of isotopically light methane due to the absence of methanotrophic bacteria. Greatest change during the ICIE are shown in the Hopane: Sterane Index, whereby an increase in the abundance of hopanes occurs at the most negative $\delta^{13}\text{C}_{\text{org}}$ value before rapidly shifting to a greater sterane abundance post desiccation. Steranes in the C_{26} to C_{30} range indicate that during the ICIE relative abundances of C_{29} steranes related to the disaster species prasinophytes and C_{26} steranes related to diagenetic products increase whilst those of red (C_{27}) and green (C_{29}) algae show no major changes. Changes in C_{29} steranes appear to be influenced by changes in stratification given by the Gammacerane Index. Greater abundances of hopanes compared to steranes during the lead up to the ICIE in what has already been determined a sub-oxic to aerobic environment indicates greater bacterial activity in a freshwater to lacustrine environment. Furthermore, the decline in methanotroph biomarkers during the ICIE, that may have expected to increase with dissociation of methane clathrates, suggests the initial $\delta^{13}\text{C}_{\text{org}}$ excursion

may be influenced by other factors, possibly the change in environmental conditions.

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