Assessing biodiversity crisis at the Triassic - Jurassic boundary interval using redox sensitive trace metals and carbon isotopes from marine sediments

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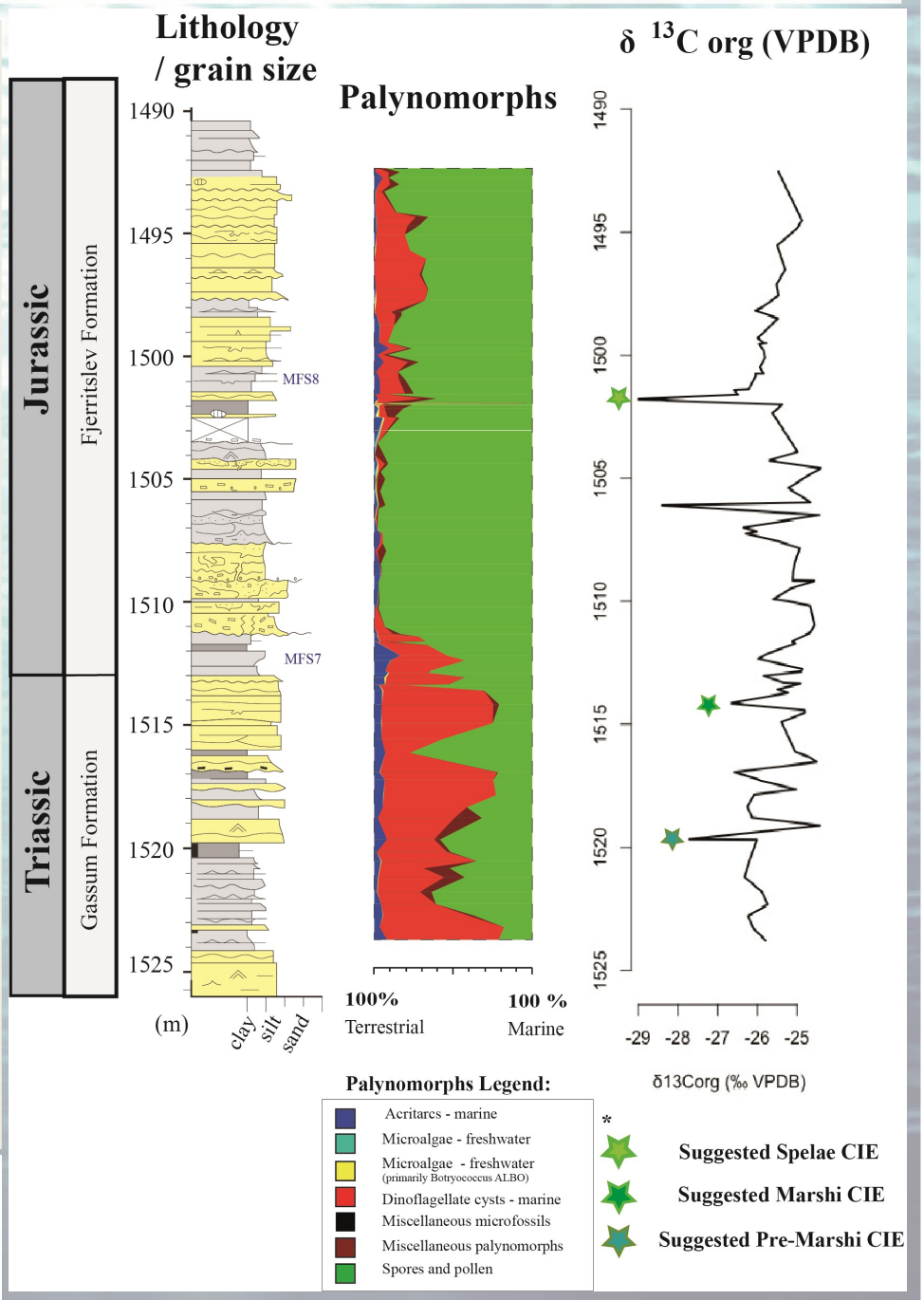
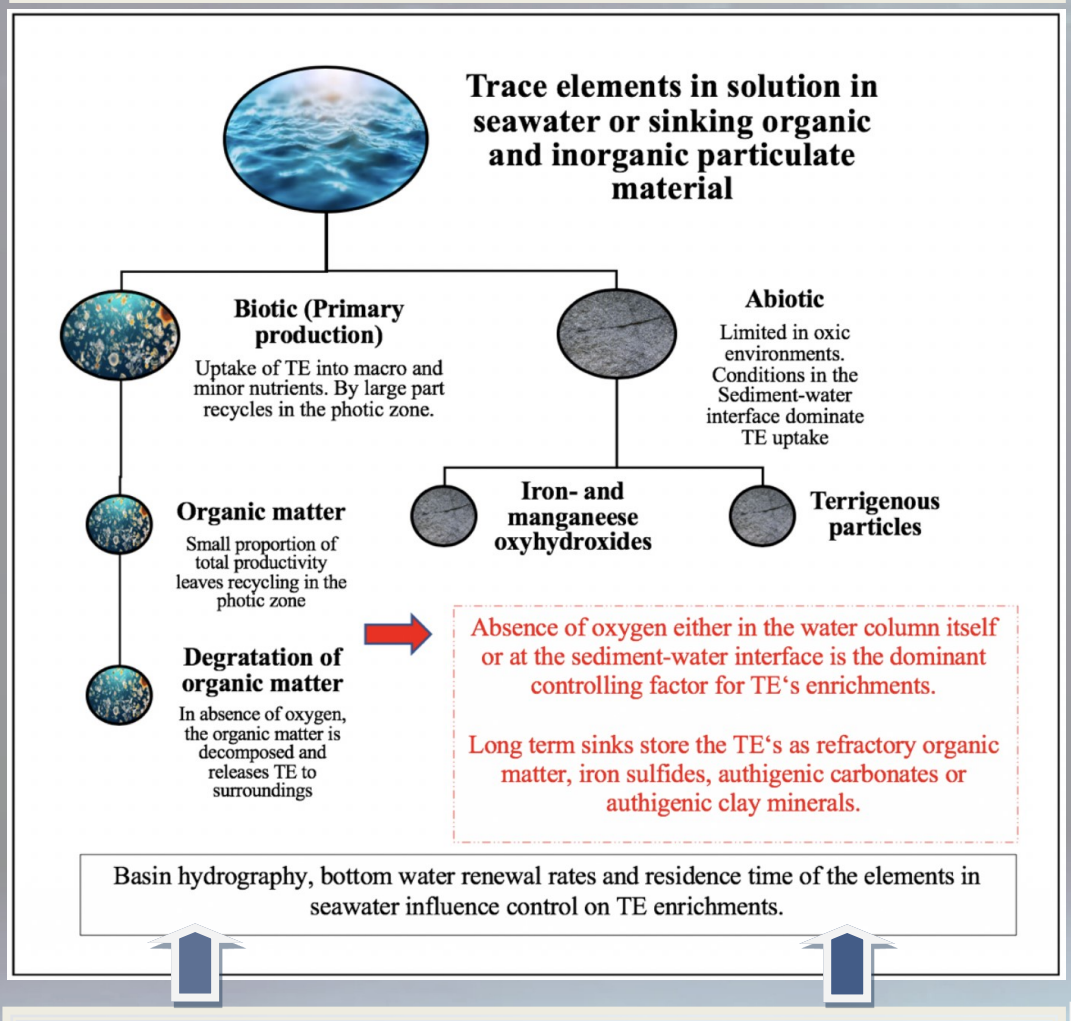
The Triassic-Jurassic boundary (TJB) interval has been associated to a significant mass extinction event in correlation to extensive volcanism of a large igneous province, CAMP that resulted from the break-up of the of the supercontinent Pangea. During that time an epeiric shallow sea was already established within the interior of Pangea, the Tethys ocean. The biodiversity crisis was severe, especially in the marine realm impacting primary producers as well as higher tropic level organisms greatly. Additionally, the recovery of species was slow and prolonged. Synchronous to the mass extinction and CAMP volcanism, the rock record indicates major perturbations in the carbon cycle.

Following CAMP, significant amounts of greenhouse gases as of carbon dioxide (CO_2) and methane (CH_4) and other volatiles are suggested to have been released into the atmosphere, impacting the biosphere, with subsequent global warming and raised temperatures. It has been suggested that anoxic conditions developed in the shallow seas of the Tethys in response to the emissions of the CAMP, and indicators of anoxic conditions have been described from successions from the epicontinental sea around the TJB boundary.

For this reason this study was initiated with attempt to address redox conditions of the European epicontinental seas during this time interval, to gain further insight into the oxygen conditions that prevailed during time of deposition of sedimentary successions, one from the Danish Basin – Stenlille and one from the north German Lower Saxony basin – Schandelah. Stenlille successions comprise shallow marine to coastal sandstones, mudstones and shales and Schandelah comprises a range from deltaic sand and siltstone deposits, to a shallow marine sandy and silty beds with shale intervals. As well as looking into the oxygen conditions, the $\delta^{13}C$ isotopic signature of the organic fraction was determined for Stenlille.



A stratigraphic profile demonstrating lithological variations of the Stenlille (well 4) (Lindström et al. 2019) alongside assemlage chart of marine versus terrestrial palynomorphs (Lindström in prep.). And the results from this study combined with former gathered GEUS data. Note the ambundance level of dinoflagellate cysts (red) towards the end of the Triassic interval.



The method used for evaluating redox conditions is based on that enrichment is controlled by few dominating factors. A schema that illustrates the main pathways for trace elemental accumulation from either being delivered into a solution in the water column of the seas or within detrital fractions, through the water column and eventually to be deposited into sediments is illustrated above.

The main conclusions from this study after evaluation of trace elements show that the redox state during accumulation of the sedimentary successions at both localities was in near all cases ranging from subxic to oxic, and euxinic levels were in general not observed.

Enrichment of nickel and mercury show a covariation to the negative carbon isotope excursion of the TJB boundary, both in Stenlille 4 and Schandelah. That could indicate a volcanogenic origin, and would be interesting to see if those observations will be made from other successions around this time interval in the future.

The results of the $\delta^{13}C$ isotopes gathered from organic matter in Stenlille 4, demonstrate a similar pattern that has been observed at other localities during the TJB interval. Emphasizing that towards the end of the Triassic, perturbations in the carbon cycle were prominent.

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