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The impact of global events in the Deep Sea biosphere: An integrated ichnological, geochemical and stratigraphical approach

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Here the effects of the K-Pg event and the PETM on benthic macrofauna communities are constrained using an ichnological approach. In most basins, the mass extinction witnessed at the K-Pg boundary is not recognised in deep sea trace fossil communities. On a global scale, trace fossil diversity actually experiences a diversity burst following the K-Pg event, culminating in a Phanerozoic peak in diversity during the earliest Eocene. This diversity peak of deep sea trace fossil communities is inconsistent with the Palaeocene – Eocene boundary extinction of 50% of benthic foraminifera taxa. . Initial climate cooling following the K-Pg event was soon replaced by a disorderly period in the Earth's climate history whereby the background 'greenhouse' conditions were punctuated by a number of rapid, transient hyperthermal events. The most prominent of these events was the Palaeocene-Eocene Thermal Maximum (PETM). Sea surface temperatures and bottom temperatures soared by as much as 10°C in as little as 1000 years. Extensive research has been published concerning the biotic and geochemical effect of the PETM. Detailed ichnological data obtained from 9 localities in the Basque basin, northeast Spain, spanning the mid Palaeocene-early Eocene is presented here. This data not only allows the effects of the PETM on benthic macrofauna communities to be measured but also allows rigorous testing of the utility of trace fossil assemblages in determining submarine fan environments of deposition during periods of climatic extremes. The Basque Basin provides an ideal natural laboratory to study this period of Earth's history as there are many K-Pg and PETM outcrops, usually rich in trace fossils. High resolution clay mineralogical analyses have been conducted utilising XRD, FT-IR and field based spectral gamma ray (SGR) measurements to provide an insight into weathering patterns on the continental hinterland in an attempt to correlate changes in terriginous sediment supply with changes in ichnological diversity and bioturbation intensity. A strong depositional environment control on trace fossil assemblages has been recognised with the Nereites, Palaeodictyon and Ophiomorpha rudis subichnofacies of the Nereites ichnofacies being indicative of mud rich distal fan, sand rich outer-fan and proximal-axial fan environments respectively, during the early Eocene. However occurrences of Ophiomorpha and Scolicia in outer fan and off axis environments become much more common following the PETM and are correlated with several 'spikes' of kaolinite. An increase in the abundance of kaolinite is a common diagnostic feature of the PETM at many deep ODP/IODP sites as well as outcrop studies, on a global scale. Commonly, this increase is interpreted to be indicative of a switch in the climate to warmer and more humid conditions. Sedimentological and paynological evidence in the Basque region suggests that the climate was in fact semi-arid. It is proposed here that increases in kaolinite in the Basque region are possibly the result of reworking of older kaolinite rich regolith due to enhanced weathering and runoff during high magnitude storm events following the PETM. Concentrations of kaolinite therefore act as a proxy for weathering/erosion rates and provide a supplementary proxy dataset to support 13C and 18O climate interpretations.