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Recovery after the end-Permian biotic crisis in the Boreal Sea

Grice, K.[1], Melendez, I.[1], Foster, CB.[2] and Twitchett, R.J.[3]
[1]Western Australian Organic and Isotope Geochemistry Centre, Curtin University, Perth, Australia.
k.grice@curtin.edu.au
[2] Geoscience Australia, GPO Box 378, Canberra, ACT 2601, Australia
[3] Department of Earth Sciences, The Natural History Museum, London, SW7 5BD, UK

Global warming, attributed to emissions of CO_2 from the Siberian Traps Large Igneous Province (STLIP), is widely accepted as explaining the environmental changes associated with the Late Permian-Triassic mass extinction event and recovery. As temperatures and CO_2 levels rose, a cascading series of warming-related environmental effects, including expanding shelf and oceanic anoxia, reduced ocean circulation, elevated weathering rates and nutrient influx, have been invoked as triggering marine ecosystem collapse and controlling the pace and pattern of ecosystem recovery.

Significant disruptions to the carbon cycle during this critical interval have been inferred from large fluctuations in the carbon isotope record, but the causes of these fluctuations are debated. Favored models related to volcanic out-gassing from STLIP and/or injection of large amounts of isotopically light methane do not fully explain the carbon isotopic records. Other possible explanations include elevated microbial respiration rates, reduction of organic carbon burial, ocean anoxia and ocean stratification/turnover, and modeling has supported a positive feedback with temperature.

The timing, patterns and magnitude of ecological recovery in the marine and terrestrial realm during the Early Triassic vary with depositional environment, paleolatitude and region. Local environmental factors, such as the intensity and duration of shelf anoxia, seem to have a direct control over the patterns of recovery in some locations. Most studies have, however, focused on the paleotropics, especially of the Paleotethys Ocean, and there is a demonstrable bias in our understanding of the ecological and environmental changes that occurred in extra-tropical regions during the Early Triassic. The geological record is an archive of natural experimental data recording ecosystem-level responses to global warming over long timescales. Fossil data indicate that the northern extra-tropical regions were key biodiversity hotspots during the Early Triassic hothouse, yet there are no detailed biogeochemical records spanning the entire hothouse interval at these paleolatitudes.

Using a multidisciplinary suite of proxy data from high-resolution samples from Spitsbergen, Svalbard, this study provides the first comprehensive documentation of changes in the major biogeochemical cycles spanning the Early Triassic from the northern mid-paleolatitudes. Combining biomarker and compound specific isotope analyses with sedimentology, paleontology and bulk isotope geochemistry ($\delta^{13}C_{carbonate}$, $\delta^{13}C_{org}$, $\delta^{34}S$, $\delta D_{kerogen}$, $\delta^{34}S_{total\ sulfur}$, $\delta^{34}S_{pyrite}$) enables fundamental new insights into the critical environmental changes that have been postulated to have directly affected the patterns and processes of post-extinction recovery in marine ecosystems.