EGU Galileo Conferences
GC5-Mass-48, 2019
Mass extinctions, recovery and resilience

Metal-induced malformations in fossil plankton ground-truth a sedex-fueled mechanism for early Palaeozoic mass extinctions

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Upper Ordovician and Silurian (mass-)extinction events are no longer considered a direct consequence of glacial episodes. This once-popular cause-and-effect relationship has been critically challenged by an accumulating body of stratigraphic and proxy data that demonstrate misalignment between the faunal turnovers and the climatic perturbations. Proposed alternative triggers of these catastrophic extinctions, such as sedex-induced ocean anoxia and the associated remobilisation of toxic metals, though seemingly plausible, must be ground-truthed against the fossil record.

Our collaborative research has repeatedly demonstrated that malformed (teratological) fossil microplankton occur throughout the early phases of several Ordovician-Silurian extinctions. By analogy with metal-induced malformations in modern plankton, teratology in these ancient organisms might be a new, independent proxy for monitoring the metal concentration of Palaeozoic oceans. In order to test this supposition, we are using a suite of analytical techniques, including ToF-SIMS, LA-ICP-MS, electron microprobe analysis and multiscale XRF to quantify the major and trace element composition of microfossils and their host rocks through Ordovician-Silurian events.

This presentation summarises data from multiple stratigraphic sections, including through the end-Ordovician mass extinction, that support the hypothesis that global anoxia and the associated cycling of toxic metals was a key factor during these events. Moreover, the suite of metals observed, their stratigraphic order of appearance, their correspondence with other isotopic systematics and, crucially, their effects on the biology support our model that this flood of redox-sensitive metals in the ocean can be traced back to dramatic brine exhalations that also deposited the world's largest mineral deposits on the seafloor.