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Trace Metal – Pyrite Interactions During Early-Diagenesis: Calibrating The Paleoproxy

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Several studies have observed that framboidal pyrite forming during early diagenesis can incorporate trace metals in ways that may help us track changes in seawater chemistry and microbiological activity. However, knowledge gaps in the physical and chemical processes occurring during pyrite formation and concomitant trace metal incorporation limit our understanding and use of pyrite as a paleoredox proxy.

Here, we provide a detailed study on the efficacy of pyrite at tracking water column conditions from Saanich Inlet, BC, Canada, a semi-restricted fjord-like basin noted for high-frequency redox variation. We present data from the seasonally anoxic basin and the relatively oxygenated margin to compare how spatiotemporal variations in redox conditions impact the cycling of trace metals as recorded in bottom waters, porewaters, bulk sediments, and pyrite. Trace metal signatures in pyrite were investigated via LA-ICP-MS measurements. This approach allows for precise characterization regarding how trace metal geochemistry in pyrite responds to changes in redox conditions.

This study enables a direct comparison between in-situ analyses of trace metals in pyrite to bulk data and the degrees to which both approaches track water column conditions versus progressive stages of early diagenesis over the upper 40 cm of burial. Importantly, the results enable detailed comparison for pyrite formation and trace metal enrichments under variable redox environments by investigating a transect from oxic to sulfidic bottom waters with similar detrital sources. Further, our calibration using parallel pyrite and porewater data will allow for a novel understanding of how and when trace metals are incorporated into pyrite and what important information they may archive over geologic timescale, including water redox conditions and trace metal bioavailability for subsurface microbial communities.