

## Tracking redox reactions in Saanich Inlet from the water column to early diagenetic pyrite formation

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Geochemical proxies used widely to reconstruct global paleodepositional systems require further calibration and validation in a wider range of oxygen-poor settings. The redox threshold values associated with various proxies (e.g., Fe-speciation, trace-metal enrichments) can vary considerably among depositional systems and, for this reason, geochemical proxies should be scrutinized in multiple modern depositional systems of diverse redox characteristics—both stable and dynamic. Here, we provide a detailed study of Saanich Inlet, a semi-restricted fjord-like basin noted for high-frequency redox variation. Bottom water and sediment samples were collected in July 2019 when complete anoxia developed below 130 m water depth. We present data from the seasonally anoxic basin (200 m) and the oxygenated margin (100 m) to compare how spatiotemporal variations in redox condition impact the cycling of iron, sulfur, and trace metals in the bottom waters as recorded in bulk sediments, porewaters, and pyrite.

We examined key biogeochemical drivers of early diagenetic reactions mainly via stable sulfur isotopes ( $\delta^{34}\text{S}$ ), trace metal content, and iron-speciation. Additionally, we performed <sup>57</sup>Fe Mössbauer Spectroscopy analysis of iron mineralogical phases to cross-validate with widely used wet-chemical sequential Fe extraction methods. Given that Mössbauer Spectroscopy measures minerals directly rather than the response of a mineral to a chemical reagent, it offers an independent analytical method that can characterize and quantify different iron (oxyhydr)oxides, sulfides, sulfates, carbonates, silicates, amorphous colloids, and nanoparticles. The result is direct qualitative and quantitative estimates of the precipitation pathways and transformations of redox-sensitive iron phases. Additionally, this technique offers important novel insights into the dominant pyrite precursor pathway (i.e.,  $\text{FeS}_x$  species), a question long debated in the field. Chiefly, this study enables a direct comparison between biogeochemically dynamic oxic and anoxic environments along a transect recording differing depositional redox but similar detrital inputs. Most specifically, this novel calibration combining water column, solid phase, porewater, and pyrite data will provide new insights into the early diagenetic reactions that define the pyrite trace element compositions and Fe speciation data that are often used to interpret ancient environments.