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Tracing glacial weathering and pyrite oxidation using rare earth elements in sedimentary iron oxides

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Sulfide weathering plays a crucial role in driving the long-term carbon cycle on Earth, and thus its historical reconstruction is essential for a better understanding of the global carbon-climate feedback. In this study, we analyzed the abundance of rare earth elements (REE) within authigenic Fe-(oxyhydr)oxide phases in glacimarine sediments retrieved from the continental shelf offshore northern Svalbard, spanning over the last 16,300 years, to evaluate their potential as a novel tracer of sulfide weathering in source areas. The shale-normalized REE concentrations mostly showed strong mid-REE enrichment patterns over the entire period, characterized by a concavity index (CI) greater than 2.5. Such a high CI value distinctly deviates from typical measurements in authigenic phases of global marine/river sediments ($1.0 < CI < 2.5$) and exclusively occurs in acid mine drainage, minesoil leachates, or some authigenic river sediments known to be affected by intense sulfide weathering. In this context, we argue that the pronounced mid-REE enrichments with $CI > 2.5$ observed in northern Svalbard have resulted from prevailing sulfide oxidation linked to glacial weathering. This finding underscores a new approach of REE signatures in the authigenic phases of marine sediments for the past reconstruction of sulfide weathering over the geological time scale.