

Origin of isotopically heavy pyrite ($\delta^{34}\text{S} > 20\text{‰}$) in the Paleoproterozoic Zaonega Formation

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The rise in atmospheric oxygen at ~2.3 Ga ago, called the Great Oxidation Event, changed the redox state of Earth's atmosphere-ocean system leading to the oxidative weathering of landmasses and possibly increasing the delivery of sulphate and phosphate into the oceans. The availability of nutrients and increasing seawater sulphate concentrations might have created new environmental niches for microorganisms to thrive in the changing world.

Several recently drilled cores from the ~2.0 Ga Zaonega Fm in NW Russia contain some of the world's best preserved Paleoproterozoic rocks. These exceptionally organic-rich rocks formed in a vent- or seep-influenced depositional setting contemporaneous with voluminous mafic volcanism. Previous S isotope work on the Zaonega Fm has demonstrated a wide range of $\delta^{34}\text{S}$ values with a stratigraphic trend towards highly ^{34}S -enriched sulphides in the upper part, which was interpreted to reflect a global signal and substantial contraction in the seawater sulphate reservoir.

Here we present an extensive new stratigraphic dataset on sulphides throughout the Zaonega Fm, that reveal a trend from light $\delta^{34}\text{S}$ (~-10‰) in the lower part to very heavy $\delta^{34}\text{S}$ (up to ~40‰) in the upper part. Isotopically heaviest pyrite occurs in sections where pseudomorphs after Ca-sulphate are present. The initial change in $\delta^{34}\text{S}$ towards heavier values is accompanied by a negative shift in $\delta^{13}\text{C}_{\text{org}}$ from ~ -25‰ to -40‰ whereas the highest $\delta^{34}\text{S}$ values occur in the upper part where the $\delta^{13}\text{C}_{\text{org}}$ shifts back to ~ -25‰. The new dataset gives insights into assessing the importance of global versus basinal processes (magmatic activity, hydrocarbon seepage, restriction of the basin) recorded in chemostratigraphic trends during this important time in Earth history.