Does sulfur isotope fractionation in natural sediments record sulfate reducing activity?

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Sulfur isotope fractionation has been extensively used as a tool for tracing prokaryotic life in early Archaean rocks [1]. In addition to diagnosing sulfate reduction as a metabolic process, the degree of isotope fractionation can potentially provide information on sulfate reduction rates (SRR) and environmental conditions on the early Earth. Biogeochemical controls on $\delta^{34}S$ values are complex, however. Therefore, more measurements are required for natural microbial populations under variable environmental co nditions.

This study aims to clarify the links between sulfur isotope fractionation, SRR and environmental parameters using natural sediments in flow through reactor experiments [2,3]. Experiments were performed on 2 cm thick slices of intact sandy sediment collected near a brackish intertidal marsh along the Western Scheldt estuary in The Netherlands. The effect of temperature on SRR and isotopic fractionation was investigated from 10 to 50°C. Furthermore the effects of organic substrate (acetate) addition and proximity to organic matter were investigated.

Initial results show that both temperature and the availability of organic matter exert major controls on the SRR, with the highest rates observed at 30°C and closest to vegetated tidal marsh. However, the relationships for isotope fractionation are more complex. At low (10°C) and high (50°C) temperatures and at low SRR (<20 nmol cm^{-3} h^{-1}) a clear inverse trend between SRR and sulfur isotope fractionation was observed, regardless of whether acetate was supplied or not. However, at 20°C and 30°C, larger ranges in the fractionation factor (ε) were found across the whole range of SRR (1 to 50 nmol cm^{-3} h^{-1}). The relationship between SRR and fractionation was not controlled by proximity to the vegetation. Our results thus suggest that in the natural sediments where SRR are often low, the magnitude of $\delta^{34}S$ can be linked to SRR and hence the activity of sulfate reducing microorganisms. Sulfur isotopes may thus provide a link to microbial metabolism in the early Archaean providing that sulphate was not limiting.

References

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