

Carbon isotope fractionation of organic carbon during simulated diagenesis of banded iron formations

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Precambrian banded iron formations (BIFs) provide unique archives of the early Earth. However, post-depositional alteration and metamorphic processes influence the chemistry and mineralogy of BIFs and make the interpretation of primary sedimentary processes challenging. Anoxygenic phototrophic or microaerophilic Fe(II)-oxidizers may have played a key role in the precipitation of the primary BIF precipitates, i.e. Fe(III) (oxyhydr)oxides. Although, the organic carbon content in BIFs is very low, the negative $\delta^{13}\text{C}$ values in BIF carbonates could stem from biomass-derived carbon. However, it is unknown i) whether abiotic oxidation of organic carbon coupled to Fe(III) reduction induced by pressure and heat can oxidize the organic carbon from primary BIF sediments to CO_2 and ii) whether this leads to negative $\delta^{13}\text{C}$ values in carbonates.

To answer these questions, we simulated diagenesis experimentally in gold capsules at 1.2 kbar and 170 °C with ferrihydrite or hematite mixed with either untreated or p/T-pretreated bacterial biomass, which simulates partially degraded sedimented organic carbon. We identified and quantified the gases formed, quantified and characterized the residual kerogen phase and determined the $\delta^{13}\text{C}$ values for both gaseous and solid-phase C-fractions.

We found that the carbon in gases and kerogen becomes isotopically lighter when biomass is oxidized abiotically by Fe(III), and Fe(II) carbonates are formed. These results are in agreement with the possible formation of ^{13}C -depleted carbonates in BIFs during diagenesis.