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Preferential ^{30}Si uptake during coprecipitation of Fe(III)(oxyhydr)oxide

Christoffer Hemmingsson (1), Catherine Hirst (2), Xiaole Sun (3), Iain Pitcairn (1), and Ernest Chi Fru (4)

(1) Department of Geological Sciences, Stockholm University, Stockholm, Sweden, (2) Department of Geoscience, Swedish Museum of Natural History, Stockholm, Sweden, (3) Baltic Sea Centre, Stockholm University, Sweden, (4) School of Earth and Ocean Sciences, Cardiff University, Cardiff, United Kingdom

Banded Iron Formations (BIF) with interlayered chert bands common in the Archean and Proterozoic stratigraphy can be used to investigate Precambrian oceanic conditions and Si isotope systematics. Constraining the sources of Si in the BIF-related chert bands (i.e. continentally weathered or hydrothermally supplied Si) and the mechanisms through which these layers form are critical for understanding of the Precambrian Si isotope system. Adsorption experiments with Fe(III)(oxyhydr)oxides suggest that light Si isotopes should be removed from the water column during the precipitation of Fe-rich BIF layers. It would therefore be expected that the remaining heavy Si isotopes in the water column would be recorded in chert layers in BIFs or elsewhere. However, cherts in BIFs show a light Si isotope signature and the lack of any other contemporaneous heavy Si isotope deposition indicate a missing heavy Si isotope pool. We present results from Fe(III)(oxyhydr)oxide coprecipitation experiments in conditions mimicking the Fe- and Si-rich Early Proterozoic oceans. Fe(III)(oxyhydr)oxide was coprecipitated in 30 minute experiments from solutions with elevated Fe, Si, P and As (to test matrix effects of dissolved phosphate and arsenic on Si isotope fractionation) at pH 7 and 8. Si isotopes were measured on dissolved mineral and supernatant from coprecipitation experiments on a Multi-Collector ICP-MS (at the Vegacenter, Museum of Natural History, Stockholm, Sweden). We show that, contrary to previously published adsorption experimental data, the coprecipitation of Fe(III)(oxyhydr)oxide removes heavy Si isotopes from solution with δ^{30}Si values up to +0.994 (2SD: 0.111) ‰ in the mineral fraction. Important fractionation effects are demonstrated for pH, Si/Fe ratios and the elemental composition of the precipitation matrix with the strongest fractionation effect observed at pH 7, higher Si/Fe ratios and combined phosphate and arsenic matrix effect. This coprecipitation data, together with literature data on Si isotope distribution in BIFs, provides a new mechanism to explain the ubiquitous light Si isotope signature of BIF-related chert and is consistent with the progressive enrichment of heavy Si isotopes in Proterozoic BIF successions.