

Si isotope fractionation during iron-silica aqueous interaction in the Precambrian ocean

S. M. CHEMTOB^{1*}, J. G. CATALANO¹,
P. S. SAVAGE^{1,2} AND F. MOYNIER^{1,3}

¹Washington University, St. Louis, MO

(*correspondence: chemtob@levee.wustl.edu)

²Durham University, Durham, UK; ³IPGP, Paris, France

Banded iron formations (BIFs), Fe- and Si-rich chemical sediments common in Precambrian successions, are a critical tool for understanding the composition and evolution of the Precambrian ocean [1]. A poorly understood aspect of BIF genesis is the origin of Si and its association with the primary precipitates that formed these units. Si could have been transported to the BIF deposition site by adsorption on hydrous iron oxide surfaces [2]; alternatively, Fe and Si may have coprecipitated as a single phase [3]. Si isotope fractionation may provide a signature of the mechanism(s) involved in BIF genesis, but the fractionation factors (ϵ) for each mechanism are poorly constrained. Previous researchers have calculated ϵ for Si adsorption on ferrihydrite [4]; here we experimentally explore variations in ϵ with adsorption mechanism, polymerization, and Fe-Si coprecipitation.

Silica solutions were prepared with sodium silicate and NaCl (either 1 mM or 0.7 M), then adjusted to pH 8.1. Hematite particles were reacted with silica solutions for 24 hours. Solutions were purified by ion-exchange chromatography and analyzed for $\delta^{30}\text{Si}$ by MC-ICP-MS. Initial results suggest that Si adsorption proceeds first by monomeric adsorption on hematite until surface site saturation (at ~ 145 $\mu\text{mol Si/g hematite}$), followed by polymeric adsorption at higher Si concentrations. For solutions with initial Si concentrations of 125, 800 and 2000 μM , $\Delta^{30}\text{Si}$ was $4.10 \pm 0.27\text{‰}$, $1.12 \pm 0.29\text{‰}$, and $0.53 \pm 0.31\text{‰}$, respectively ($\Delta^{30}\text{Si} = \delta^{30}\text{Si}_{\text{aq, final}} - \delta^{30}\text{Si}_{\text{aq, initial}}$). These measurements imply larger ϵ (-3 to -6‰) than previously reported by [4] and indicate that $\epsilon_{\text{polymeric}}$ is smaller than $\epsilon_{\text{monomeric}}$. Increasing ionic strength had little effect on observed Si isotope fractionation. These ϵ will be compared to those associated with coprecipitation of Fe-Si oxyhydroxides, to be synthesized by base titration of Fe^{3+} -Si solutions and by air oxidation of Fe^{2+} -Si solutions, to assess the range of Si isotope signatures expected in Precambrian oceans.

[1] Klein (2005) *Am. Min.*, **90**, 1473-1499 [2] Fischer and Knoll (2009) *GSA Bull.*, **121**, 222-235 [3] Rasmussen *et al* (2014) *GSA Bull.*, doi:10.1130/B30944.1 [4] Delstanche *et al* (2009) *GCA*, **73**, 923-934