

Triple silicon isotope constraints on the formation of Precambrian cherts

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Cherts are pervasive in Precambrian and have significance in reconstructing paleo-environmental conditions. Cherts are an assemblage of different forms of sedimentary silica processed through diagenesis. They exhibit, for a given age and at micrometer scale, a large range of isotopic (O and Si) compositions. The inferences made from these isotopic compositions on Precambrian seawater temperatures depend on the models assumed for the mode of formation of cherts. Here we develop high precision silicon isotope measurements by Multicollector - Inductively Coupled Plasma - Mass Spectrometry to reach 2 standard error of ± 3 -8 ppm (e.g., 2 se = 3 ppm for 43 measurements in BHVO-2) on deviations from the slope in triple Si isotope diagram. This allows to tentatively identify the mechanism of Si isotopic fractionation and whether silica in chert was formed through equilibrium or kinetic processes. Triple silicon isotope data are reported here for cherts from Bitter Springs formation (0.85 Ga), Jixian group (from 1.3 to 1.5 Ga), Warrawoona group (3.5 Ga) and Onverwacht group (3.5 Ga).

8 samples from Jixian group show large variations of mass-dependent Si isotopic compositions ($\delta^{30}\text{Si}$ from 0.17 to 2.93 ‰) in agreement with previous ion probe data, and define an apparent mass fractionation law with a slope of 0.5119 ± 0.0011 , intermediate between equilibrium (0.5178) and kinetic (0.5092) processes. We developed a model that explains these data by the formation of Jixian cherts from a mixture of amorphous silica precipitated at equilibrium with seawater and quartz precipitated kinetically from hydrothermal fluid. Correlations between Si and O isotopic compositions and trace element contents support this interpretation. By using Si isotopic fractionations measured between quartz and hydrothermal fluid and between amorphous silica and water, we can reconstruct the $\delta^{30}\text{Si}$ of seawater in Jixian basin to be $\approx +2.5\text{‰}$. The Si isotopic composition of cherts from other localities have slopes that deviate from kinetic and equilibrium, indicating complex dissolution and recrystallization of silica in pore waters during diagenesis. These new data allow to scrutinize the origin of cherts and better decipher primary and secondary processes at the origin of O and Si isotopic variations.