Natural silicon isotope fractionation between hot spring waters and associated siliceous sinter deposits in Cistern Spring, Yellowstone National Park, Wyoming, U.S.A.

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The δ^{30}Si values of the waters within Cistern Spring (Norris Geyser Basin) at Yellowstone National Park show small variations, ranging from 0.15±0.06‰ and 82°C at the vent to 0.70±0.03‰ and 20°C at the distal end. In contrast, there is a considerable range of δ^{30}Si values for the siliceous sinters (from -2.25±0.04‰ to -4.79±0.04‰). These δ^{30}Si values for hot spring siliceous sinters are lower than the values in previous studies of Geysir geothermal field, Iceland [1]. There is no correlation between the δ^{30}Si values of the sinters and the concentration of dissolved silica in the waters. The silica concentrations stay relatively constant (~460ppm), indicating the precipitation of opaline sinters only represents a small portion of the total dissolved silica. The δ^{30}Si values of the sinters become progressively more negative downflow, with decreasing water temperatures. Precipitation of opaline sinters occurs during cooling of mineralized waters [2], which is accompanied by significant Si isotope fractionation. The apparent silica-water isotope fractionation factor ($\Delta^{30}Si_{silica-water}$) decreases from -2.40‰ at the vent (82°C) to -5.49‰ 10 meters downflow (34°C). Previous studies in Iceland hot springs and laboratory experiments showed similar temperature dependent relationship, but with much smaller fractionation [1, 3]. The saturation indices of silica have similar ranges for both Cistern Spring and Icelandic hot springs. But one of the major differences between the two systems is the water depth. The flow in Cistern Spring is approximitaly 1 cm deep at the most, significantly shallower than the Icelandic hot springs [1], resulting in a much lower precipitation rate. The low precipitation rate of Cistern Spring is most likely the predominant driver for such significant Si isotope fractionation.

[1] Geilert *et al.* (2015) *GCA* **164**, 403-427. [2] Guidry and Chafetz (2002) *Sedimentology* **49**, 1253-1267. [3] Geilert *et al.* (2014) *GCA* **142**, 95-114.