Silicon isotope fractionation of silica sinter in geothermal fields of southern Tibet, China

WEI WANG [1, 3], HAI-ZHEN WEI [2*], SHAO-YONG JIANG [1*]

[1]China University of Geosciences, Wuhan 430074, PR China, shyjiang@cug.edu.cn

[2]Nanjing University, Nanjing 210023, PR China, haizhenwei@nju.edu.cn

[3]GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany

The Mediterranean-Himalayan geothermal belt of Southern Tibet is one of the most active geothermal regions in the world. Siliceous hot spring deposits (sinters) formed in this area and the phase transformation from opal-A to opal-CT to chalcedony has been observed. The opal-A shows a $\delta^{30}Si$ value of -0.57‰ to +0.09‰, whereas the opal-CT shows lower $\delta^{30}Si$ value from -1.80‰ to -0.7‰, which may record a rapid dissolution-reprecipitation process, during the early dissolution stage the light ^{28}Si is preferentially released from the reactive surface layer of opal-A into the geothermal water, and it subsequently incorparates into the re-precipitated opal-CT, leading to light ^{28}Si isotope enrichment in the opal-CT.

Silica sinters of various crystallization forms developed in the studied area for miles, with a slow dehydration and recrystallization process possibly of hundreds of years. The $\delta^{30}Si$ values show a negative trend with diagenesis (the $\delta^{30}Si$ from opal to chalcedony are from +0.09‰ to -0.96‰), which is most likely controlled by kinetic fractionation during dissolution-reprecipitation process. The temperature of silicification is probably close to the surface spring temperature (70°C to 90°C) or slightly higher due to the shallow burial depth. Accoring to Rayleigh fractionation, the $\Delta^{30}Si_{chalcedony\text{-}fluid}$ ($\delta^{30}Si_{chalcedony}$-$\delta^{30}Si_{fluid}$) is estimated to be between -0.19 to -0.33‰, which is smaller than $\Delta^{30}Si_{quartz\text{-}fluid}$ at low temperature (e.g. -1.8 to -2.1‰, 20 to 50°C[1]). The initial $\delta^{30}Si$ value of the diagentic fluid is around -0.60‰, indicating the diagenetic fluid may derive from mixing of high $\delta^{30}Si$ geothermal water (around 0.2‰) with low $\delta^{30}Si$ water (via opal dissolution).

Our data have not only provide new information for silicon isotope fractionation in modern hot spring system, they also have wider implications for constraining the conditions of chert formation during the early Archean, such as the paleo-ocean temperature and diagenetic effects.

[1]Chen et al., 2016, Chemical Geology 423, 61-73. http://dx.doi.org/10.1016/j.chemgeo.2016.01.008.