High pressure and temperature silicon isotope fractionation between metal and silicate

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The Si stable isotope fractionation between metal and silicate has been investigated experimentally in order to better constrain the amount of silicon present in the Earth’s core. Experiments at 1800°C were conducted at 1 GPa, while those at 2000 and 2200°C were performed at 7 GPa. All experiments were in MgO capsules so that no silicon was lost during the run and the three-isotope technique was used to demonstrate equilibrium. The isotope analyses were measured by laser ablation MC-ICPMS as spatial resolution is a key parameter in analyzing experiments.

The temperature dependent silicon isotope fractionation is $\Delta^{30}\text{Si}_{\text{silicate-metal}} = 7.45 \pm 0.41 \times 10^{9}/T^2$ shown in the figure above, experimental data points shown in circles along with best fit line (solid) and theoretical curve (dashed, [2]). The current experiments have: 1. duplicated our previous results [1] performed in a graphite capsule (triangle in figure above), demonstrating that several weight percent carbon in iron metal does not change the silicon isotope fractionation factor, as predicted; 2. shown that the silicon stable isotope fractionation between metal and silicate is insensitive to the structure and composition of the silicate as the fractionation between silicate melt and olivine is insignificant; and 3. shown that there is no pressure effect on isotope fractionation between 1 and 7 GPa (to within analytical uncertainty).