The silicon isotope composition of the silicate Earth: revisiting the enstatite chondrite connection

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The very similar mix of nucleosynthetic isotopic components in refractory and other elements indicates that Earth and enstatite chondrites (EC) have a kinship. However, mass fractions of lithophile elements and their ratios in the bulk silicate Earth (BSE) cannot be easily reconciled with EC or mixtures of EC with other chondrites. The BSE displays enrichments of the heavy isotopes of Si compared to chondrites, suggestive of mass dependent fractionation during planetary accretion and differentiation. Experimental studies indicate that stable Si isotope fractionation at the high P-T conditions of core formation should be very small. Thus, it has been suggested that evaporative mass loss from planetesimal precursors of the Earth may account for at least some of the heavy isotope enrichments in the BSE. An alternative view posits that the heavy Si isotope compositions of Earth, Mars and HED meteorites were inherited from gas-solid fractionation during condensation in the solar nebula.

We have explored the nebular fractionation hypothesis further by *in situ* study of $\delta^{30/28}$Si in silicates and metal in unequilibrated EH3 chondrites. EC have the lowest $\delta^{30/28}$Si (-0.6 to -0.7‰) of all studied planetary materials and are complementary to reservoirs enriched in heavy Si isotopes such as BSE (-0.29‰), with CI (-0.44‰) and other chondrites in-between. $\delta^{30/28}$Si in EH3 silicates range between -1.1 and -0.35 ‰ (with a mean of all silicates at -0.56 ±0.17‰, 1 s.d.), reflecting different histories of the silicates. These results and mass balance suggest that EH3 metal ($\delta^{30/28}$Si typically around -6.0‰) with its low Si content only partially controls bulk rock $\delta^{30/28}$Si values of EH3. Isotopically light silicates also play an important role in the mass balance. Assuming that EC originally formed from a CI chondrite like reservoir, the low $\delta^{30/28}$Si and Mg/Si of EC and their silicates and their depletion in refractory elements require the loss of refractory silicates and oxides from the EC formation region. Such material should be enriched both in refractory elements and in heavy Si isotopes and might have contributed to the chemically reduced precursors of the Earth.