

Triple silicon isotopic fractionation between silicates and metal in Enstatite Chondrites

H. X. Sun¹, M. Chaussidon¹ and F. Moynier¹, ¹Université Paris Cité, Institut de Physique du Globe de Paris, CNRS, 75238 Paris, France (sun@ipgp.fr)

Introduction: Enstatite chondrites (EC) is a group of meteorites with unique mineralogy and petrology dominated by enstatite, various sulfides and metals. The high abundance of sulfides and nearly ~2% of Si in metal indicate that EC were formed under reducing conditions. Most isotopic evidence, except silicon, suggest that the Earth and Enstatite chondrites share a common precursor component. The slightly heavier Si isotopic composition of bulk silicate Earth ($\delta^{30}\text{Si}_{\text{BSE}} \approx -0.3\text{‰}$) relative to EC ($\delta^{30}\text{Si}_{\text{EC}} \approx -0.5\text{‰}$) could be partly due to Si isotopic fractionation during core-mantle differentiation. However, the Si content calculated for the Earth's core, using equilibrium fractionation factors and data from meteorites and experiments, cannot explain the Earth's $\delta^{30}\text{Si}_{\text{BSE}}$. In this study, we use high precision measurements of triple silicon isotopes to further study the mechanism of Si silicate-metal fractionation in EC.

Sample and analytical Methods: Itqiy (EH7) is a coarse-grained meteorite composed of enstatite ($\text{Mg\#} > 98$), metal and sulfides. The metal contains 1~3 wt% of Si while there is only <0.1 wt% Si in sulfide [1]. Enstatite and metal grains were separated and handpicked under the microscope after having been coarsely crushed in a metal mortar. The enstatite grains were fused in 10 aliquots were fused in with NaOH flux at 730°C in Ag crucibles. The fusion cakes were dissolved by MQ and acidified to pH=1 by HNO₃. Eight aliquots of metals were dissolved in 0.5 N HNO₃ followed by dilution to reach a HNO₃ concentration of 0.1N. Each aliquot contains 2 or 3 enstatite or metal grains. The solution was loaded in AG50-X12 resin to remove the matrix and the Si isotopic ratio were measured with a Neptune-Plus MC-ICP-MS at IPGP. The chemistry and tuning on the Neptune-Plus were modified to decrease the interference effect [2] and improve the analytical precision, which allows to identify small deviations between equilibrium and kinetic mass-dependent fractionation.

Result: The $\delta^{30}\text{Si}_{\text{Enstatite}}$ values of Itqiy range from -0.253 ± 0.028 to -0.877 ± 0.082 ‰ (2se) with an average of -0.578 ± 0.119 ‰ (2se, n = 10). The $\delta^{30}\text{Si}_{\text{Metal}}$ is lighter than $\delta^{30}\text{Si}_{\text{Enstatite}}$ and ranges from -3.385 ± 0.065 to -3.905 ± 0.044 ‰ (2se) with an average of -3.603 ± 0.121 ‰ (2se, n = 8). The fractionation between the silicate and metal with propagated 2se is 3.025 ± 0.170 . These isotopic compositions are consistent with a previous study [3].

Discussion: The linear regression between $\delta^{29}\text{Si}$ and $\delta^{30}\text{Si}$ values of silicate and metal gives a slope of 0.5114 ± 0.0091 (2se). This slope is lower than the theoretical β_{eq} (0.5178) for equilibrium isotopic fractionation at high temperature [4] and, similarly with what is observed for O isotopes, this might be due to a lower equilibrium temperature. However, the presence of ~0.65‰ variation in $\delta^{30}\text{Si}_{\text{Enstatite}}$ implies an isotopic heterogeneity within silicates, which is unexpected considering petrology [1]. Furthermore, the triple Si isotope slopes for silicates only (0.6813 ± 0.0605 , 2se) is distinct from what is expected for any mass-dependent isotopic fractionation law. The reason for that is not yet well understood but it could reflect the presence in the matrix of presolar materials [5] with variable Si isotopic anomalies and having undergone partial isotopic exchange with silicates and metal during partial melting and impact metamorphism of Itqiy.

References: [1] Patzer A. et al. 2001. *Meteoritics & Planetary Science* 36:1495-1505. [2] Sun H. et al. *submitted*. [3] Moynier F. et al. 2020. *Earth and Planetary Science Letters* 549:116468. [4] Young E. D. et al. 2002. *Geochimica et Cosmochimica Acta* 66(6):1095-1104. [5] Lin Y. et al. 2002. *The Astrophysical Journal* 575:257-263.

