SIMULTANEOUS DETERMINATION OF Si AND Mg ISOTOPIC COMPOSITION IN METEORITES

Jinia Sikdar and Vinai K. Rai
Physical Research Laboratory, Navrangapura, Ahmedabad, India (jinia@prl.res.in).

Introduction: The variation of Mg/Si ratio among chondrites and Bulk Silicate Earth (BSE) is an enigmatic aspect of cosmo-chemistry. The superchondritic Mg/Si ratio of BSE is thought to reflect the presence of Si in the Earth's core [1]. It has been suggested that Si isotope fractionation between silicate mantle and metallic core has caused BSE to get enriched in heavier Si isotopes compared to chondrites [1-4]. However, high temperature melting, recrystallization and subsequent differentiation are very fundamental process and it is difficult to visualize that a significant isotopic fractionation can be induced at temperature-pressure conditions prevalent in core-mantle boundary, which could account for heavier Si in BSE. The decreasing equilibrium isotopic fractionation factor with increasing temperature also makes this scenario less likely. So, a comprehensive investigation of both Mg and Si isotope fractionation pattern among different primitive and differentiated planetary objects can help us in elucidating the origin of Mg/Si variation and Si isotopic offsets among them.

Experiment: A new chromatographic procedure has been developed for simultaneous purification of Si and Mg from a single aliquot of rock sample using cation exchange resin. Isotopic analyses of both Si and Mg in a number of terrestrial rock samples, 10 ordinary, 3 carbonaceous, 4 enstatite chondrites, 1 aubrite and 8 HED meteorites have been carried out using Neptune Plus High Resolution MC-ICPMS at PRL, India.

Results and Discussion: Terrestrial samples show a limited range in Si isotopic compositions (Mean δ^{30}Si= -0.27±0.02‰, 2SE). The similarity of δ^{30}Si in Ordinary chondrites, Carbonaceous chondrites and HED meteorites (Mean δ^{30}Si= -0.42±0.03‰, 2 s.e) suggests that core formation in 4-Vesta did not induce any Si isotopic fractionation (Fig. 1). Mg and Si have comparable volatilities and hence should fractionate more or less to similar extent in any planetary or impact induced processes. Simultaneous analyses of Si and Mg in same aliquot of E-Chondrites and Aubrite show fairly uniform Mg isotopic composition (Mean δ^{26}Mg= -0.30±0.03‰, 2SE) which is indistinguishable from BSE and ordinary-carbonaceous chondrites, despite of having significantly lighter Si isotopic composition (Mean δ^{30}Si= -0.67±0.04‰, 2SE). This suggests that the Si isotopic fractionation pattern of E-chondrite has been more likely inherited from solar nebula chemistry [5] and is not related to any later stage planetary process such as core formation, giant impact or loss of Si from magma-ocean [6].

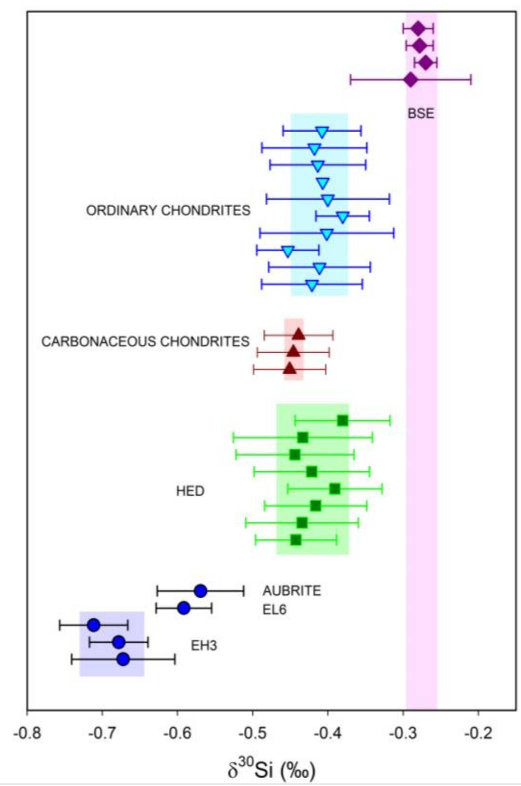

Fig 1. Si isotope analysis of bulk meteorites

References:

[1] Georg, R.B. et al. 2007. Nature 447:1102–1106. [2] Fitoussi, C., Bourdon, B. 2012. Science 335:1477–1480. [3] Zambardi, T. et al. 2013. Geochimica et Cosmochimica Acta. 121: 67-83. [4] Armytage, R.M.G. et al. 2011. Geochimica et Cosmochimica Acta. 75: 3662-3676. [5] Dauphas, N. et al. 2015. Earth and Planetary Science Letters. 427:236–248. [6] Boujibar, A. et al. 2015. Nature Communications. 10. 1038/ncomms9295.