

Isotope Fingerprints of Earth's Accretion and the Moon Forming Impact

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Most isotope variations follow the laws of mass-dependent fractionation. Departures from those laws are called isotope anomalies and often correspond to incomplete homogenization of the products of stellar nucleosynthesis in the solar system. Mass-dependent isotope signatures cannot easily and directly trace the nature of Earth's accreting material because planetary differentiation processes like core formation, partial melting and magmatic differentiation can fractionate stable isotope ratios. A virtue of isotopic anomalies is that they can see through nebular and planetary processes as they remain undisturbed even when stable isotope ratios are fractionated mass-dependently.

Isotopic anomalies have been found in bulk planetary materials for a variety of elements with various geochemical affinities, including O, Ca, Ti, Cr, Ni, Mo, and Ru [1]. Those anomalies are very useful to test scenarios of planetary formation. A striking feature of Earth's isotopic composition is its similarity to E-chondrites [2-4]. To reproduce the isotopic compositions of the elements listed above, one needs at least ~70% of an E-chondrite isotope component in the Earth [4]. One difficulty, however, with E-chondrites being the major constituent of the Earth is that they have low $\delta^{30}\text{Si}$ values and Mg/Si ratios, which would take unreasonable amount of isotopically heavy Si to be hidden in the deep Earth to be reconciled with Earth's mantle $\delta^{30}\text{Si}$ value and Mg/Si ratio. One solution to this problem is that the Earth and E-chondrites were sourced from the same nebular reservoir [4] but that the Earth incorporated a larger contribution of a refractory forsteritic component and E-chondrites represent the volatile-rich complement to that [7]. Further aspects where isotopic anomalies provide insights into the nature of Earth's accreting material will be discussed.

References: [1] Dauphas N. & Schauble E. (2016) AREPS 44, in press. [2] Javoy M. et al. (2010) EPSL 293, 259-268. [3] Warren P.H. (2011) EPSL 311, 93-100. [4] Dauphas N. et al. (2014) 407, 96-108. [5] Javoy M. et al. (2010) EPSL 293, 259-268. [6] Fitoussi C. & Bourdon B. (2012) Science 335, 1477-1480. [7] Dauphas N. et al. (2015) EPSL 427, 236-248.