SILICON ISOTOPES IN ACHONDRITES AND PLANETARY ACCRETION AND DIFFERENTIATION.

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Inner solar system bodies, including the Earth, Moon, and asteroids, exhibit depletions in moderately volatile elements relative to chondrites [1]. This volatile element depletion has been attributed to either a nebular or parent body process. These processes are expected to each produce characteristic stable isotope signatures, but planetary differentiation may also modify the isotopic composition of geochemical reservoirs. Silicon is one such element at the focus of current planetary science; the Si isotope system has been used to investigate the building blocks of Earth [2, 3] and assess the distribution of Si isotopes in the solar nebula [4].

The Si isotope system has traditionally been used to investigate processes of core formation on Earth [5, 6] and, more recently, planetesimals [7], but new work suggests that the global Si isotope systematics of differentiated bodies cannot be explained by isotope fractionation during metal-silicate equilibration alone [8]. Silicon isotope fractionation has also been proposed to occur either during incomplete condensation from the solar nebula [2] or evaporative mass loss during planetary accretion [8].

Here we present new high-precision Si isotope data for an extended suite of achondrites to assess the processes affecting the Si isotope system during the accretion and early geochemical modification of planetesimals. Angrites are a rare class of achondrites, which crystallized only a few million years after calcium–aluminum-rich inclusions and exhibit significant depletions in volatile elements relative to chondrites [9], making them ideal samples with which to study volatile element depletion in the early solar system. Angrites are enriched in the heavy isotopes of Si relative to chondritic meteorites by 50–100 ppm/amu. We show that the Si isotope composition of angrites cannot be explained by any plausible core formation scenario, but rather reflects isotope fractionation during impact-induced evaporation. Our results indicate that planetesimals initially formed from volatile-rich material and were subsequently depleted in volatile elements during accretion. These results have further implications for the Si content of Earth's core and for dynamics of the Moon-forming event.

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