SILICON ISOTOPES IN ANGRITES AND CLUES TO PLANETARY FORMATION.

E. A. Pringle[1,2], P. S. Savage[2,3], J. Badro[1], J.-A. Barrat[4], and F. Moynier[1]. [1]IPGP, Paris, France. [2]Washington University, St. Louis, MO. [3]Durham University, Durham, UK. [4]Université de Brest, Plouzané, France. E-mail: pringle@ipgp.fr.

Stable isotope systems are important tracers for determining the physical and chemical conditions during planetary formation. Silicon is one such element at the focus of current planetary science; recently the Si isotope system has been used to investigate the building blocks of Earth [1, 2] and assess the distribution of Si isotopes in the solar nebula [3]. Furthermore, since metal-silicate differentiation has been shown to result in Si isotope fractionation [4, 5], several previous studies have investigated the effect of core formation on Si isotopes in the Earth and, more recently, planetesimals. Specifically, heavy Si isotope enrichments in basalts from both Earth [6, 7] and the asteroid 4-Vesta [8] relative to chondrites were interpreted as evidence for the incorporation of isotopically light Si into the cores of these bodies.

Here we present new high-precision Si isotope data for a suite of achondrites, including five angrites (D'Orbigny, NWA1296, NWA2999, NWA4590, and NWA4931) and one ureilite (Kenna). The ureilite has a Si isotope composition indistiguishable from chondritic, indicating that processes during the accretion and differentiation of its parent body did not fractionate Si isotopes. In contrast, angrites exhibit among the largest Si isotope fractionations observed to date in basaltic materials with resprect to chondrites (on average, δ^{30}Si = −0.33 ± 0.12 ‰ [2 sd], i.e., Si isotope compositions similar to terrestrial basalts).

Angrites are among the oldest and most volatile-depleted differentiated rocks in the solar system. There are two major processes that could have resulted in the observed Si isotope composition of angrites: (1) partitioning of isotopically light Si into the metal phase during core formation or (2) volatility driven Si isotope fractionation, e.g. during the angrite parent body devolatilization event. However, the pressure, temperature, and oxygen fugacity conditions required to partition sufficient Si into the core of the angrite parent body indicate that Si isotope fractionation during core formation may be an unlikely explanation for the heavy Si isotope enrichment in angrites. Therefore, volatility processes may better explain the Si isotope compositions observed in angrites, and the Si isotope system may be affected by multiple processes during planetary accretion and differentiation.

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