

Preliminary analysis of nucleosynthetic Sr isotope anomalies in amoeboid olivine aggregates from the Allende meteorite

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Recent innovations in mass spectrometric technology revealed that chondrites and their components possess distinct stable isotope ratios from the terrestrial values for various heavy elements including Ti, Cr, Sr, Mo, Ru, Ba, and Nd [1,2]. The isotopic variabilities, which are recognized as nucleosynthetic isotope anomalies in meteorites, suggest that the isotopic compositions of these elements were not homogeneous in the early Solar System as was previously believed. In particular, the extent of nucleosynthetic isotope anomalies in calcium and aluminum rich inclusions (CAIs) from carbonaceous chondrites, the oldest substance that condensed from a gaseous reservoir in the early Solar System, are larger than those in bulk aliquots of chondrites. Most recently, Myojo et al. [3] discovered that different groups of CAIs from the Allende meteorites show variable $^{84}\text{Sr}/^{86}\text{Sr}$ ratios, indicating the presence of multiple CAI source reservoirs with distinct isotopic compositions in the early Solar System.

In contrast to CAIs, little is known regarding nucleosynthetic isotope anomalies in amoeboid olivine aggregates (AOAs) from carbonaceous chondrites. AOAs are mostly composed of olivine with small refractory minerals including spinel and calcic pyroxene [4]. Their highly irregular shapes indicate that they are unmelted aggregates that condensed from a gaseous reservoir, although the bulk chemical compositions of AOAs are distinct from those of CAIs. Rather, their chemical compositions straddle CAIs and chondrules, making AOAs intriguing target to investigate the isotopic evolution for heavy elements in the early Solar System.

In this study, we report the $^{84}\text{Sr}/^{86}\text{Sr}$ ratios in AOAs from the Allende meteorite. Unlike CAIs and chondrules, it is difficult to sample irregular shaped AOAs by handpicking without including the other components such as matrix. To overcome this problem, we collected the powdered AOA sample by the micro-milling technique [3]. Additionally, we ablated the same AOA sample by a femto-second laser with He gas flow to capture the aerosol sample with a membrane filter. The collected samples were dissolved with acid, followed by the separation of Sr by extraction chromatography using Sr Resin (Eichrom). The $^{84}\text{Sr}/^{86}\text{Sr}$ ratios in the AOA samples were measured by TIMS (TRITON plus, Thermo Fisher Scientific) with the dynamic multicollection method. The obtained $^{84}\text{Sr}/^{86}\text{Sr}$ ratios are reported as $\mu^{84}\text{Sr}$ notation that represents the 10^6 relative deviation from a standard material, NIST 987. The two AOA samples showed positive $\mu^{84}\text{Sr}$ values (micro-milling: 70 ± 156 ppm; laser ablation: 108 ± 91 ppm). This result indicates that refractory inclusions in the AOA sample possess nucleosynthetic Sr isotope anomalies akin to those in Type B CAIs [3]. Therefore, the refractory inclusions in AOAs would have condensed from a gaseous reservoir from which the precursor of type B CAIs have condensed.

References: [1] Dauphas, N. and Schauble, E.A. (2016) *Ann. Rev. Earth Planet. Sci.* **44**, 709. [2] Yokoyama, T and Walker, R.J. (2016) *Rev. Mineral. Geochem.* **81**, 107. [3] Myojo, K. et al. (2018) *Astrophys. J.* **853**, 48. [4] MacPherson, G. (2014) *Treatise Geochem.* **1**, 139.

