The Sm isotope compositions of chondrites and Bennu: implications for *p*-process heterogeneity

P. Frossard[1,2*], J. M. J. Ball[1], M. Ek[1], M. A. Fehr[1], M. Schönbächler[1], J. J. Barnes[3], A. N. Nguyen[4], H. C. Connolly Jr[3,5,6] and D. S. Lauretta[3]

*(paul.frossard@sund.ku.dk)

[1]Institute of Geochemistry and Petrology, ETH Zürich, 8092 Zürich, Switzerland
[2]Centre for Star and Planet Formation, Globe Institute, University of Copenhagen, 1350 Copenhagen, Denmark
[3]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA
[4]NASA Johnson Space Center, Houston, TX, USA
[5]Department of Geology, Rowan University, Glassboro, NJ, USA
[6]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY, USA

Heterogeneities in the nucleosynthetic isotope composition of planetary materials provide information on their genetic relationships [1]. Among the different nucleosynthetic processes, the variations of *p*-process nuclides in meteorites can constrain the contribution of explosive nucleosynthesis to the protoplanetary disc. Moreover, the *p*-nuclide ^{144}Sm can be used to trace the extinct *p*-nuclide ^{146}Sm that decays into ^{142}Nd (half-life of 92 Myr), which is crucial for determining the timing of early silicate differentiation on rocky bodies [e.g. 2]. However, Sm isotope data is scarce and high precision measurements are required to place constraints on the origin of *p*-process heterogeneity. Here we report Nd and Sm isotope data of the homogenised aggregate sample OREX-800117-110 (total mass of 1.288 g) from the B-type asteroid Bennu sampled by the OSIRIS-REx mission. In addition, we present Sm isotope data from 34 chondrites of most groups.

Significant variations in the ^{144}Sm/^{152}Sm ratio are observed from +31 ± 17 down to −154 ± 17 parts per million. The data for OREX-800117-110 confirm other reports [3,4] that samples returned from Bennu share strong similarities with CI chondrites, and as such represent an important baseline for many cosmochemical interpretations. Our improved analytical procedure [5] allows us to identify, for the first time, a deviation of the ratio ^{144}Sm/^{152}Sm in ordinary chondrites (OC) from the terrestrial composition and enstatite chondrites. Another endmember besides refractory inclusions [6] is required to explain *p*-process in chondrites because of the lack of CAI in OC. Our data also suggests that the *p*-process contribution to the isotope ^{142}Nd is underestimated by nucleosynthetic models. The consistently anticorrelated trends between Sm isotope compositions and lighter elements such as Ti and Sr suggest the pervasive effect of thermal processing on the various carriers of nucleosynthetic variations in the nebular cloud.

Supported by NASA under Contract NNM10AA11C and Award NNH09ZDA007O.

[1] Mezger et al. (2020) Space Science Reviews 216, 27. [2] Caro et al. (2003) Nature 423, 428-432. [3] Lauretta et al., (2025) MAPS 59, 2453-2486. [4] Schönbächler et al., (2025) this conference. [5] Frossard et al. (2025) JAAS 40, 146. [6] Brennecka et al. (2013) PNAS 110, 17241-17246.