

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

PAUL FROSSARD^{1,2}, JAMES M. J. BALL¹, MATTIAS EK¹,
MANUELA A. FEHR¹, MARIA SCHÖNBÄCHLER¹,
JESSICA J. BARNES³, ANN N. NGUYEN⁴, PROF. HAROLD
C. CONNOLLY JR., PHD^{5,6,7} AND DANTE S. LAURETTA⁵

¹ETH Zürich

²University of Copenhagen

³Lunar and Planetary Laboratory, University of Arizona

⁴NASA Johnson Space Center

⁵University of Arizona

⁶American Museum of Natural History

⁷Rowan University

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 ¹⁴⁴Sm can be used to trace the extinct *p*-nuclide ¹⁴⁶Sm that decays into ¹⁴²Nd (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 are scarce, and high-precision measurements are required to constrain the origin of *p*-process heterogeneity. Here we report Nd and Sm isotope data of an aliquot (OREX-800117-110) of a homogenised aggregate sample (total mass of 1.288 g) from asteroid Bennu returned by the OSIRIS-REx mission [3]. In addition, we present Sm isotope data from 34 chondrites covering most groups.

Significant variations in the ¹⁴⁴Sm/¹⁵²Sm ratio are observed from +31 ± 17 down to -154 ± 17 parts per million. The data from 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. Furthermore, our improved analytical procedure [5] allows to resolve a deviation of the ¹⁴⁴Sm/¹⁵²Sm ratio in ordinary chondrites (OC) relative to Earth and enstatite chondrites. The lack of calcium-aluminium-rich inclusions in OC indicates another endmember required to explain *p*-process in chondrites [6]. Our data also suggests that the *p*-process contribution to the isotope ¹⁴²Nd is underestimated by nucleosynthetic models. Taken together, the chondrite and Bennu data shows anticorrelated trends between Sm isotope compositions and those of lighter elements (e.g., Ti and Sr), which suggest a pervasive effect of thermal processing on the various carriers of nucleosynthetic variations in the nebular cloud.

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[1] Mezger et al. (2020) Space Science Reviews 216, 27. [2] Caro et al. (2003) Nature 423, 428-432. [3] Lauretta & Connolly