GADOLINIUM AND DYSPROSIUM ISOTOPIC COMPOSITIONS IN STARDUST SiC GRAINS FROM THE MURCHISON METEORITE.

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Introduction: Knowing both the rates of the nuclear reactions involved in the neutron capture process and the details of stellar structure are fundamental to understand how neutron capture processes operate in stars. Both the nuclear reaction rates and the stellar models, however, bear considerable uncertainties, which ultimately affect abundance predictions. Several studies have shown that presolar grain data have the potential to constrain nuclear reaction rates and stellar models [e.g., 1-2]. Combined measurements of neutron capture isotopes in presolar SiC grains with theoretical stellar model predictions of *s*-process nucleosynthesis have provided valuable insights into nucleosynthetic process and nuclear physics of reaction rates. Here we report the results of Gd and Dy isotopic analyses performed in large stardust SiC grains (LS+LU fraction) extracted from the Murchison carbonaceous chondrite [3]. In addition to the individual grains, we also analysed a SiC-enriched bulk sample (KJB fraction). We have compared the SiC data with new theoretical predictions of the evolution of Gd and Dy isotopic ratios in the envelopes of low-mass AGB stars with a range of stellar masses and metallicities [4].

Experimental: Single SiC grains were analyzed for their C, N, and Si isotopic compositions with a Cameca NanoSIMS at Washington University. Gd (^{155,156,157,158,160}Gd) and Dy (^{161,162,163,164}Dy) isotopic measurements were carried out with the SHRIMP-RG at the Australian National University. We performed both "bulk analyses" on an aggregate of many grains from the KJB fraction and "single-grain analyses" on grains from the LS+LU fractions. SHRIMP-RG measurements were performed with an O_2^- primary beam of 2–5 nA focused to sputter an area of ~20 µm in diameter. Secondary ions were extracted at 10 keV and measured by single collector analysis on the ETP^{TM} multiplier in magnetic peak-jumping mode. We systematically bracketed the unknowns by a suite of standard reference materials (NIST-610 silicate glass and a SiC ceramic doped with heavy elements; [5]). The measurement of Gd^+ and Dy^+ isotopes in stardust SiC grains is challenging because of potential isobaric interferences. The use of a small energy offset (~24 eV) has proved to be quite successful in suppressing complex molecular interferences without significantly compromising the intensity of the atomic species [5]. For this work, Gd and Dy measurements were carried out on the SHRIMP-RG by combining high-mass resolution ($m/\Delta m \sim 8000$ at 10% peak height) with energy filtering. Corrections were made for interferences from ^{156,158,160}Dy and ^{162,164}Er.

Results and Discussion: On the basis of their C-, N-, and Si-isotopic compositions, the single SiC grains are classified as mainstream grains, and are believed to have condensed in the outflows of low mass carbon-rich AGB stars with close-to-solar metallicity. There is an overall match between the SiC data (bulk and single grains) and the theoretical AGB model predictions. The SiC grains appear to be depleted in ^{155,156,157,160}Gd relative to ^{158}Gd and depleted in ^{161,162,163}Dy relative to ^{164}Dy, as expected for *s*-process nucleosynthesis in AGB stars. Similar to Eu isotopes [2], the ^{152}Gd/^{154}Gd ratio is strongly dependent on the ^{151}Sm branching point. Because of the temperature-sensitive branching at ^{151}Sm, ^{152}Gd may be the best *s*-process thermometer [6]. Unfortunately, because of the presence of Sm isobars at masses 152 and 154, measurement of ^{152,154}Gd was compromised. Dysprosium isotopic compositions are highly discrepant with previous Dy isotopic measurements carried out on presolar SiC aggregates by TIMS [7], but our measurements are consistent with model predictions. Comparisons between Gd and Dy grain data and *s*-process model predictions for the envelope compositions of low-mass AGB stars show that a single choice of stellar mass and metallicity cannot account for the range of isotopic ratios observed in the SiC grains.

References: [1] Ávila J. N. et al. 2012. *Astrophysical Journal* 744:49. [2] Ávila J. N. et al. 2013. *Astrophysical Journal Letters* 768:L18. [3] Amari S. et al. 1994. *Geochimica et Cosmochimica Acta* 58:459. [4] Karakas A. and Lugaro M. 2016. *Astrophysical Journal*, accepted. [5] Ávila J. N. et al. 2013. *Geochimica et Cosmochimica Acta* 120:628. [6] Wisshak K. et al. 1995. *Physical Review* C 52:2762. [7] Richter S. et al. 1994. *Meteoritics* 29:522.