NEUTRON CAPTURE RECORDS OF MESOSIDERITES

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Introduction: Mesosiderites are stony-iron meteorites composed of approximately equal fractions of metallic Fe-Ni and silicates. The silicates have mostly basaltic, gabbroic, and pyroxenitic components, and are petrologically similar to eucrites and howardites. The cosmic-ray exposure ages of mesosiderites are intermediate between those of stony and iron meteorites, and vary from <10 to 340 Ma [1], and they are long enough to study their exposure history from the accumulation of the cosmogenic products [2-4]. Our interest is to use the neutron irradiation records in mesosiderites (1) to determine the dependence of the thermal neutron production rate on the chemical composition of the target, and (2) to investigate a possibility of the initial irradiation record of mesosiderite silicates on the parent body before formation of the mesosiderites.

Experiments: Six mesosiderites, Dalgaranga, Estherville, Morristown, NWA1242, NWA2932, and Vaca Muerta, were used in this study. Silicate inclusions, each with a mass of 0.2-0.3 g, collected from each sample were digested individually using an HF-$HClO_4$ mixture. The sample was then evaporated to dryness and dissolved in 1 mL of 2 M HCl. The Sm and Gd fractions were chemically separated using a conventional ion exchange method [5]. The isotopic compositions of Sm and Gd were determined using a VG54-30 thermal ionization mass spectrometer equipped with seven Faraday cup collectors.

Results and Discussion: All six samples showed significant $^{150}Sm/^{149}Sm$ and $^{158}Gd/^{157}Gd$ isotopic shifts from neutron capture reactions corresponding to neutron fluences of $(1.3\text{-}21.8)\times10^{15}$ n cm^{-2}. Among the six mesosiderites used in this study, the thermal neutron capture record of the Vaca Muerta silicates differed from those of the other mesosiderites, and showed a larger fluence of neutrons than expected based on its cosmic-ray exposure age. The thermal neutron fluence of the Vaca Muerta silicates was 0.67×10^{16} n cm^{-2}, i.e., larger than the expected value (1.51×10^{16} n cm^{-2}). The parameter for the degree of neutron thermalization, $\varepsilon_{Sm}/\varepsilon_{Gd}$, also revealed a significant difference between the thermal neutron production conditions in Vaca Muerta (0.76) and the other mesosiderites (0.93-1.20). These results suggest a two-stage irradiation occurred for the silicates of Vaca Muerta on the surface of the parent body (>50 Ma) and during its transit to earth (138 Ma). Our model is consistent with the results of the ^{81}Kr-Kr CRE ages of the Vaca Muerta pebble, which were estimated to be >60 Ma in the first CRE age before the second-stage irradiation [6].

References: [1] Terribilini D. et al. 2000. *Meteoritics & Planetary Science* 35: 617-628. [2] Begemann F. et al. 1976. *Geochimica et Cosmochimica Acta* 40: 353-368. [3] Albrecht A. et al. 2000. *Meteoritics & Planetary Science* 35: 975-986. [4] Welten K. et al. 2001. *Meteoritics & Planetary Science* 36: 939-946. [5] Hidaka H. and Yoneda S. 2007. *Geochimica et Cosmochimica Acta* 71: 1074-1086. [6] Bajo K. and Nagao K. 2011. *Meteoritics & Planetary Science*, in press.