

**OXYGEN ISOTOPES AND RARE EARTH ELEMENT ABUNDANCES OF REFRACTORY INCLUSIONS IN THE NINGQIANG METEORITE.** H. Hiyagon<sup>1</sup>, A. Yamakawa<sup>1</sup>, Y. Lin<sup>2</sup> and M. Kimura<sup>3</sup>. <sup>1</sup>Department of Earth & Planetary Science, Graduate School of Science, The University of Tokyo, Tokyo 113-0033, Japan. E-mail: hiyagon@eps.s.u-tokyo.ac.jp. <sup>2</sup>Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing 100029, China. <sup>3</sup>Faculty of Science, Ibaraki University, Mito 310, Japan.

**Introduction:** As a part of the systematic study of refractory inclusions in the Ningqiang meteorite [1], we conducted ion microprobe analyses of oxygen isotopes and rare earth element (REE) abundances for selected inclusions of various bulk chemical compositions.

**Samples and analytical method:** So far, we analyzed the following inclusions: NQJ3-3-4 is a hibonite-bearing fluffy type A (FTA) inclusion, NQJ3-3-1.4 and NQJ3-5-9 are hibonite-bearing compact type A (CTA) inclusions, NQJ3-5-8, NQW1-1 and NQW1-16 are hibonite-free FTA inclusions, and NQW1-5 is a spinel-pyroxene-rich inclusion.

Oxygen isotopes and REE analyses were carried out using a CAMECA ims-6f ion microprobe at the University of Tokyo. The analytical conditions for O-isotopes are similar to those described in [2]. REE analyses were performed using an O<sup>-</sup> primary beam of -22.5 keV energy, ~25 $\mu$ m in diameter and ~1nA beam intensity. Positive secondary ions were accelerated at 10keV. An energy filtering method was applied to reduce contributions of complex molecular ions. Synthetic REE standards were used to determine relative sensitivity factors for REE<sup>+</sup> and Ca<sup>+</sup> and production ratios of REEO<sup>+</sup>/REE<sup>+</sup>.

**Results: Oxygen Isotopes.** All the O isotope data are plotted along the CCAM line on the three-isotope diagram. They seem to be mineralogically controlled but show no correlation with the bulk chemical compositions of inclusions. Spinel, fassaite, olivine (in the rim) and diopside (in the rim) show highly <sup>16</sup>O-rich compositions with  $\delta^{17}\text{O} \sim \delta^{18}\text{O}$  from -50 to -40 permil (for the first three) and from -40 to -30 permil (for diopside), respectively. One datum of perovskite (NQJ3-3-4), in contrast, shows a <sup>16</sup>O-poor composition ( $\delta^{17}\text{O} = +3.2$  and  $\delta^{18}\text{O} = +10.4$  permil). Melilite shows wide variations with  $\delta^{17}\text{O} \sim \delta^{18}\text{O}$  near -40 permil (NQJ3-5-9) to >0 permil (NQJ3-3-4), suggesting partial equilibration with a <sup>16</sup>O-poor reservoir, possibly a nebular gas.

**REE abundances.** Most of the inclusions so far analyzed show almost flat REE patterns with some Eu anomalies (Group V or I or III [3]) except for NQW1-16, which shows depletion of HREE (Gd to Er and Lu) relative to LREE (La to Sm) (Group II). At present, we cannot find any systematic correlation between REE patterns and bulk chemical composition or petrographic type of the inclusions, possibly due to limited number of analyses. We will carry out more analyses to better understand the conditions and formation mechanisms of refractory inclusions.

**References:** [1] Lin Y. and Kimura M. 2003. *Geochim. Cosmochim. Acta* 67:2251-2267. [2] Hiyagon H. and Hashimoto A. 1999. *Science* 238:828-831. [3] Mason B. and Martin P. M. 1977. *Smithsonian Contrib. Earth Sci.* 19:84-95.