

Mineralogical and H isotope study of jarosites in Yamato 000593 nakhlite

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Introduction: Potassium hydrous sulfate jarosite, $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$, was found in several martian meteorites, nakhlite [1], and shergottite [2]. Jarosite is thought to form under existence of water, oxidizing and acidic conditions on Earth [3], and it has been identified on the martian surface by an *in-situ* Mössbauer spectroscopy [4]. Jarosites in martian meteorites act as an indicator of aqueous activity and aqueous alteration processes on Mars. However, Noguchi et al. [5] studied two nakhlites of Y000593 and Y000749 by a microtextural observation with TEM, and they pointed out that jarosites could be formed by terrestrial weathering processes. Therefore, it is necessary to understand origin and nature of jarosite in martian meteorites by systematic investigations of a textural observation and an isotopic study.

Hydrogen isotopic composition in mineral and glass may serve as a good tracer to decipher aqueous processes and water-rock interaction during its formation. Greenwood et al. [2] and Ross et al. [6] conducted hydrogen isotopic measurement of jarosites in shergottites with SIMS for understanding of origin of jarosites. δD of jarosites ranged from -488 to -476‰ in RBT 04262 and -386 to -325‰ in QUE 94201 that is broadly consistent with terrestrial value within the analytical errors (δD in terrestrial water = -480 to +130‰). Therefore, it was difficult to distinguish that jarosite in shergottites was martian origin. Recent study by Hallis et al. [7] has performed a hydrogen isotope analysis in olivine alteration phases (iddingsite-like vein) in four nakhlites. They found wide variation in δD (-252 to +1,165‰) due to the hydrogen isotopic exchange between surrounding terrestrial atmosphere and the vein materials.

In this study we report preliminary results of major chemistry and occurrence of jarosites by an optical microscope, SEM and EPMA, and hydrogen isotopic composition in jarosites in Y000593 nakhlite by SIMS.

Experiment: Polished thin section of Y000593 (Y000593,62-1) was provided by the NIPR Antarctic meteorite collections. We conducted petrological and mineralogical observations by an optical microscope, and a scanning electron microscope (Hitachi High-technologies SU1510 at Kochi Institute for Core Sample Research, JAMSTEC) for BSE and SE images both before and after SIMS measurements. We obtained X-ray elemental map by a JOEL JXA 8200 EPMA at Kochi University. Hydrogen isotope analyses of jarosites were performed using IMS-6f SIMS at Kochi Institute for Core Sample Research, JAMSTEC. The section was coated with a thin carbon film (~20 nm) prior to SEM, EPMA and SIMS analyses. A 0.4 nA Cs^+ primary ion beam with a diameter of ~10 μm was used. Negative secondary ions of ^1H , ^2D , and ^{18}O were measured by a single electron multiplier (EM) detector in peak-switching mode at a mass resolution of $M/\Delta M = \sim 600$. An electron-flooding gun was applied for preventing from an electrostatic charging effect during a SIMS analysis. Instrumental mass fractionation was corrected using an *in-house* synthetic basaltic glass with 0.94 in H_2O wt.% and known D/H ratio.

Results and Discussion: We found several jarosites along with iddingsite veins in the Y000593,62-1 section by observations of optical microscope and SEM, EPMA analyses. Figure 1 shows typical structure of iddingsite veins along with olivine cracks. Jarosite veins were often ~5 μm in width. Jarosite veins are similar in size, structure and chemical compositions to the previous observations of nakhlite [5, 7].

We measured hydrogen isotopic composition of 7 jarosites in the section. In preliminary results, δD in jarosites showed wide variations of -142 to +164‰. These are broadly consistent with a previous report by Hallis et al. [7]. However, we could not find high δD value (~+1,000‰). Jarosites in vein were smaller than SIMS pot size so the δD may be mixing with surrounding phases (i.e., olivine, pyroxene or other alteration products in vein). Another explanation may be a hydrogen isotopic exchange during terrestrial weathering [7]. To make this point clear, we will conduct a high-resolution hydrogen isotope imaging of jarosites in iddingsite veins with NanoSIMS.

References: [1] Vicenzi E.P. et al. (2007) *LPSC XXXVIII*, abst#2335. [2] Greenwood J.P. et al. (2009) *LPSC XL*, abst#2528. [3] Hong J.K. and Herd C.D.K. (2012) *University of Alberta*. [4] Klingelhöfer G. et al. (2004) *Science* **306**, 1740. [5] Noguchi T. et al. (2009) *JGR* **114**, E10. [6] Ross D.K. et al. (2010) *LPSC XLI*, abst#1154. [7] Hallis L.J. et al. (2012) *GCA* **97**, 105-119.

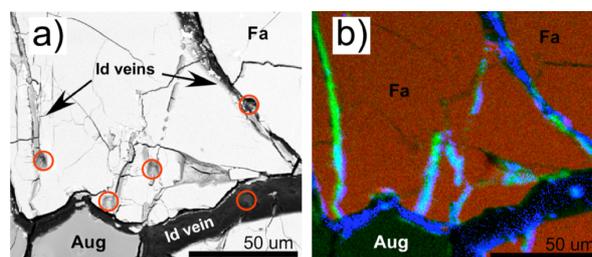


Fig. 1. Typical iddingsite veins along with olivine fracture in Y 000593. (a) BSE image, (b) Combined elemental map in Fe (red), K (green) and S (blue). Jarosite is in iddingsite veins, and represents pale blue. Red circles in (a) are SIMS analysis spots. Fa: fayalite, Aug: augite, Id: iddingsite.