Elucidation of aqueous alteration recorded in Yamato 000749

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It is expected that nakhlites have evidence for a rock-fluid reaction occurred on the Mars. Many kinds of secondary minerals occur in the nakhlites through the rock-fluid reaction. The mineral species, assemblages, compositions and chemical species of the secondary minerals depend on the varied parameters such as temperature and pH of the fluid. Accordingly, nakhlites allow us to elucidate the physicochemical properties of the fluid existed on ancient Martian surface and its origin. One of representative evidence for the rock-fluid reaction is “iddingsite”, which is the alteration texture formed in and around an olivine grain. The petrological and mineralogical features indicate that nakhlites share same source on the Mars. Suga et al. (2017) described the secondary minerals in the iddingsite of nakhlites Yamato (Y) 000593. Based on Cohen et al. (2017), nakhlites Yamato (Y) 000749 was located at the lower portion of the same nakhlites source compared to Y 000593. It is likely that there is heterogeneity on the mode of alteration in the same source. Accordingly, we clarified the mineral species, chemical compositions and chemical species of the iddingsite in Y 000749 by using a combined SEM-Raman-FIB-TEM-STXM technique. Pervasive iddingsite textures were observed along the fractures and grain-boundaries of olivine grains in Y 000749 through FE-SEM observations and Raman spectroscopy analyses. Some portions including iddingsite were extracted and became thin foils by FIB for TEM/STEM and STXM analyses. As a result, laihunite, ferrihydrite, amorphous or poor crystallized silica minerals and minor iron sulfates were identified as a secondary mineral in the iddingsite. Considering the occurrences of the secondary minerals, the formation sequence is as follows; i) laihunite, ii) ferrihydrite + minor iron sulfates, iii) amorphous or poor crystallized silica. Suga et al. (2017) reported that the iddingsite of Y 000593 includes laihunite, opal-A, jarosite, natrojarosite, goethite and ferrihydrite. The alteration is initiated by the formation of ferrihydrite subsequent to laihunite both in Y 000593 and Y 000749, which would occur under high-temperature and -pH conditions (Treiman, 2005). The mode of subsequent alteration after the formation of laihunite and ferrihydrite changes between Y 000593 and Y 000749 because there is difference on the species of secondary minerals formed in the iddingsites. It is likely that the alteration condition is varied even in the same source.

キーワード：火星起源隕石、水質変成、イディングサイト、走査型透過X線顕微鏡、二次鉱物
Keywords: Martian meteorites, Aqueous alteration, Iddingsite, STXM, Secondary minerals

