Aqueous Alteration of Y-000593
Deduced from Chemical Speciation

HIROKI SUGA1*, N. SAGO1, M. MIYAHARA1, T. OHIGASHI2, A. YAMAGUCHI3, AND E. OHTANI4

1 Hiroshima University, Japan. (*correspondence: hiro-suga@hiroshima-u.ac.jp)
2 USOR Synchrotron, 3 NIPR., 4 Tohoku University.

A member of nakhlites, Yamato (Y-) 000593 and Millar Range (MIL) 03346, have a remarkable amount of jarosite ([KFe3(SO4)2(OH)6])-bearing iddingsite which is observed in and around the olivine grain as a representative alteration textures [1-3]. Iron sulfates including jarosite were detected on several provinces of Mars’s surface such as Meridiani plume, strongly suggesting the existence of surface (or subsurface) liquid water (high acidic brine) at least one period in the Martian history [4, 5]. These jarosite-bearing nakhlites therefore would become a keystone for direct linkage between Martian meteorites and Martian surface materials.

We have tried to describe secondary minerals in the Y-000593 for elucidating environment on the Mars during a wet-period by using a microscopic speciation technique; a FIB-assisted STXM, combined with TEM/STEM observation.

As a remarkable finding of our research, natrojarosite [NaFe3(SO4)2(OH)6] was identified from the iddingsite. The presence of natrojarosite, one of the quad phases of jarosite [6], suggests that Y-000593 experienced low pH (= 1-4), low temperature (80-240 °C), and SO4-rich aqueous alteration process. Iddingsite can form below 500 °C, and most of them form between 50 and 100 °C [7], which is consistent with the alteration temperature of Y-000593 deduced from the existence of natrojarosite. Y-000593 is a better sample than the other siderite ([FeCO3])-bearing near-surface nakhlites (mid pH (= 6-8), low temperature (150-200 °C) in [8]) to understand the late-stage acid-sulfate alteration event. Our analyses also revealed the alteration process from original olivine to laihunite ([Fe5+Fe3+2(SiO4)3] (a nonstoichiometric distorted olivine-type mineral); Fe5+/Fe3+ ratio gradually decreases from olivine to laihunite, which probably corresponds to the difference of superlattices of laihunite (2M and 3M phase) [9]. We found mismatch on the formation temperatures between natrojarosite and laihunite (400-800 °C in [10]). The discrepancy may indicate that these minerals were formed different alteration events; i.e., laihunite was formed before the late-stage acid-sulfate alteration event.