

Experimental study on serpentine and smectite formation on chondrite

Ayaka Utsuki¹, Yusuke Seto¹, Kazushige Tomeoka^{1*}, Daisuke Hamane²

¹Kobe Univ., Sci., ²Univ. Tokyo, ISSP

Aqueous alteration is one of the significant processes that occurred widely in the early solar system. Indeed, several groups of carbonaceous chondrites contain abundant hydrous phyllosilicates, most of which formed by aqueous alteration of anhydrous silicates such as olivine. Mineral species of the phyllosilicates is known to be unique for groups of carbonaceous chondrite; CM and CO groups contain serpentine, while CV contains mainly smectite. In CI and CR groups, both serpentine and smectite are found. These differences should be reflected from chemical conditions on their parent body, and yet are still unknown. In the present study, we conducted the hydrothermal alteration experiments using olivines (Fo100, 80, 50, 20, 0) with various pH solutions (pH 0, 7, 10, 14) as starting materials. They were sealed into gold capsules, loaded into a test-tube-type hydrothermal apparatus, and heated at 300°C under 500 bar. Run durations are 1 week and 1 month. All recovered products were analyzed by powder X-ray diffraction (XRD), scanning electron microscope (SEM) equipped with an energy-dispersive X-ray spectrometer (EDS) and transmission electron microscope (TEM). As the results, serpentine was formed in various proportions by replacing Mg-rich olivine (Fo100, 80, 50) irrespective of pH conditions. On the other hand, smectite was formed replacing Fe-rich olivine (Fo20, 0) under alkaline condition (pH 14). Under the present conditions, we did not observe paragenesis of both serpentine and smectite, which might occur replacing Fo20~50 under alkaline conditions. EDS analyses showed that molar ratio of Fe/(Fe+Mg) in those phyllosilicates is significantly lower than that of olivine used as starting material. These results are basically consistent with previous studies [Ohnishi and Tomeoka (2007), MAPS; Zolensky et al. (1989), Icarus] where it has been suggested that aqueous alteration in the parent bodies occurred under high pH condition. The present study would provide more constraints on the aqueous-alteration conditions of the meteorites.

Keywords: carbonaceous chondrite, aqueous alteration, hydrothermal experiments, serpentine, smectite