Compositional Variation of Phyllosilicates Produced by Alteration Experiments of the Primitive Materials Under Reducing Conditions

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Carbonaceous chondrites are the most primitive planetary materials which consist of various disequilibrium assemblages of minerals derived from various stages of the early solar system. Especially, hydrous phyllosilicate minerals in CM chondrites are the first products of aqueous alteration on the meteorite parent body, and those show huge compositional variation. Origin of the compositional variation and its homogenization processes in the phyllosilicate minerals may have essential information on the timescale of the aqueous alteration processes on the parent body. In this study, we carried out aqueous alteration experiments of heterogeneous starting materials with fluid containing ethanol to keep reducing conditions representative to the early solar system remaining the solar nebula gas.

We have carried out aqueous alteration experiments of synthetic olivine (Fo55) with synthetic fayalite or enstatite. Fo55 olivine represents the Mg/(Mg + Fe) molar ratio of the solar abundance. Fayalite or enstatite represents Fe-rich or Fe-poor components in the heterogeneous parent body, respectively. Experimental fluids are ethanol solutions with 0.5, 2.5 or 10.0 vol. %. Experimental temperatures are 100, 150, 200, 250 and 300 degrees C with vapor pressure, and 400 and 500 degrees C with 100MPa. Run durations are 3 to 12 weeks.

Run products are analyzed by XRD to identify crystalline phases and SEM / EDS to observe compositional variations of the phyllosilicates. In the run products with both of the starting materials assemblage, serpentine produced in the early stage of the alteration experiments have more Mg-rich composition than the starting materials. Compositional variations of serpentine are wider in the early stage, then it is getting narrower to almost Fe-free and serpentine evolved to Fe-free talc. Hydrous alteration processes under reducing conditions can produce Mg-rich variation of phyllosilicate minerals occurred in CM and CI chondrites. Fe-rich variation in those chondrites may require more oxidized conditions than that of this study.