HYDROTHERMAL EXPERIMENTS OF ENSTATITE WITH Fe AND SiO2: EVALUATION OF EFFECTS OF METAL AND GLASS ON AQUEOUS ALTERATION OF CHONDRULES IN CV AND CR CHONDRITES.

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Introduction: Carbonaceous chondrites of types 1-3 contain various amounts of hydrous phyllosilicates. The phyllosilicates differ among the different types of chondrite [1-3]; e.g., saponite forms in CV chondrites, whereas serpentine forms in CR chondrites. Our recent hydrothermal alteration experiments of enstatite [4] suggested that the differences in phyllosilicate mineralogy mainly resulted from different pH of aqueous solution.

Some CV chondrites and most CR chondrites show evidence of limited degree of aqueous alteration [e.g., 1-3]. Previous studies [e.g., 1-3] showed that mesostasis glass, Fe-Ni metal and enstatite in chondrules in those chondrites were more preferentially involved in aqueous alteration than other major constituents. This raises the possibility that the reactions of these phases at an early stage of alteration gave some influence on alteration conditions, thus on alteration products.

In order to test this possibility, we conducted hydrothermal experiments of the three different sets of powdered starting materials: (1) orthoenstatite (OEN) and Fe metal (9/1 in weight ratio), (2) OEN and Fe metal (5/5), and (3) OEN and SiO2 (9/1). Each set of the starting materials was reacted with aqueous solutions of pH 12 (0.01-N NaOH), 13 (0.1-N NaOH) and 14 (1-N NaOH) at 300°C for 168 h (see [4] for experimental details). The recovered samples were studied using XRD, SEM and TEM.

Results: Experiments 1 (OEN/Fe = 9/1): At pH 12, small XRD peaks of serpentine are detected. At pH 13 and 14, XRD peaks of not only serpentine but also saponite are found. Experiments 2 (OEN/Fe = 5/5): At pH 12 and 13, large XRD peaks of only serpentine are detected. At pH 14, large XRD peaks of both serpentine and saponite are detected. Under the same pH conditions, intensities of serpentine peaks are larger than those in the products of experiments 1. Experiments 3 (OEN/SiO2 = 9/1): At all pHs (12, 13 and 14), XRD peaks of saponite are detected, and their intensities increase with increasing pH. No serpentine peaks are found.

Discussion: The results of our experiments showed that aqueous alteration of enstatite depends on not only pH but also Fe and SiO2 contents of the solutions. In the Fe-bearing systems, there are two tendencies: (1) the proportion of serpentine and saponite increases with decreasing pH, and (2) the amounts of serpentine increase with increasing Fe contents. In the SiO2-bearing system, only saponite forms and the amounts of saponite increase with increasing pH. These results suggest that, in CR chondrites, enstatite was altered under low alkaline conditions, and the dissolution of Fe-Ni metal facilitated the formation of serpentine. In CV chondrites, enstatite was altered under more alkaline conditions, and the dissolution of SiO2 glass facilitated the formation of saponite.