

Hydrothermal alteration experiments of synthetic amorphous silicates with CI chondritic composition: systems with and without FeO

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Carbonaceous chondrites are the most primitive meteorites and record the information of the early solar system. Among them, CI, CM, CR and TL chondrites experienced strong aqueous alterations on their parent bodies. Therefore, a study of the alteration process is important for understanding the evolution of materials in the early solar system. In order to investigate the aqueous alteration process, many hydrothermal experiments have been performed using crystalline silicates, such as olivine and enstatite, or chondrites themselves as the starting materials (e.g., [1]). On the other hand, interstellar silicates are considered to be amorphous based on infrared astronomical observations [2]. In addition, Acfer094, the unique carbonaceous chondrite, contains many primitive amorphous silicates in the matrix. Therefore, it is important to investigate the aqueous alteration of amorphous silicates.

In this study, in order to understand the aqueous alteration process and its conditions on the chondrite parent bodies, we have carried out hydrothermal alteration experiments of synthetic amorphous silicates with the CI chondritic composition.

Two types of starting materials were synthesized by sol-gel method. The first one is FeO-free amorphous silicate with the CI chondritic composition ($\text{Na}_2\text{O-MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-CaO-NiO}$). This amorphous silicate was heated at 750°C for 20 hours for preparing a mixture of amorphous and crystalline silicates (forsterite), which was also used as starting materials. A mixture of the starting material and pure water was put in an inner reaction vessel of Teflon with an outer stainless steel jacket (SUS-316). The vessel was heated in an electric furnace at 100-200°C for 24-504 hours. Run products were analyzed using X-ray diffraction, field-emission scanning electron microscopy equipped with energy-dispersive X-ray spectroscopy and infrared spectroscopy. Saponite, serpentine and calcite were formed. Saponite was formed from amorphous silicates, then serpentine was formed by reaction of saponite and forsterite. We have already reported the results partly [3].

The other starting material is FeO-bearing amorphous silicate with the CI chondritic composition ($\text{Na}_2\text{O-MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-CaO-FeO-NiO}$; assuming that a part of Fe was excluded as FeS and not contained in the amorphous silicate). In this experiment, we used a double-tube of Ag-Pd alloy (inner tube) and Au (outer tube) as a reaction vessel. A mixture of starting material (amorphous silicates, amorphous silicates with iron metal or amorphous silicates with iron sulfide) was put in the outer tube with pure water or 1N ammonia water. Wustite and magnetite powders were put in the inner tube to buffer the oxygen partial pressure in the vessel. The vessel was heated in an electric furnace at 300°C for 5 and 30 days. Serpentine and calcite were formed as in the Fe-free system. In addition magnetite was formed from amorphous silicate.

We will discuss the difference and resemblance of the mineralogical evolution and alteration conditions between the FeO-free and FeO-bearing starting materials of this experiment, and apply the results to the alteration processes and their conditions of chondrites on the parent bodies.

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[2] Kemper et al. (2004) *Astrophysical Journal* 609:826-837.

[3] Noguchi et al. (2007) *The Japanese Society for Planetary Science fall meeting 2007(abst):76*.