

Aqueous alteration processes of primitive planetary materials with redox conditions controlled by fluid compositions

*Hiroshi Isobe¹, Misato Tokunaga¹, Koyo Horiguchi¹

1.Department of Earth and Environmental Sciences, Graduate School of Science and Technology, Kumamoto University

Abundance, occurrence, compositions and textures of carbonate minerals and phyllosilicates in carbonaceous chondrites show huge variety depending on aqueous alteration processes in the early solar system. Redox conditions in aqueous alteration processes should be controlled by fluid compositions based on the solar nebula. On the surface of planetesimals and protoplanets, excess H₂O may be derived by accumulation of ice-dominated planetesimals. In this study, hydrothermal alteration experiments of Allende meteorite were carried out with fluids containing H₂O, CO₂ and hydrocarbons.

Hydrocarbon-rich fluid prohibited production of carbonate and phyllosilicate minerals. Excess H₂O components promote production of phyllosilicates above 200 degree C. and carbonate minerals at 150 degree C and temporally above 200 degree C. Hydrocarbon-poor fluid estimated on protoplanets can produce Mg-Fe carbonate under 200 degree C and Mg-Ca carbonate over 200 degree C. Phyllosilicate is Fe-rich under 200 degree C and Mg-rich over 200 degree C.

Redox conditions calculated by thermodynamic parameters show higher fO₂ in H₂O-rich fluid compositions in this study. This estimation is concordant with experimental results on reactivity of metal components and compositions of carbonate and phyllosilicate minerals. Water components strongly promote production of carbonate and phyllosilicates. It is quite distinctive that production of carbonate minerals is stimulated by H₂O rather than CO₂ compositions in aqueous alteration processes.

Keywords: Aqueous alteration, carbonate, phyllosilicate, oxygen fugacity