P066-006 Room: 303 Time: May 26 10:15-10:30

Diamond formation in the parent bodies of carbonaceous chondrites

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There are interstellar dusts consisting of silicates,interstellar organic materials, ices in the molecular cloud. The interstellar dusts are the raw material of planetary systems. Planetesimals are formed from interstellar dusts, and meteorites' parent bodies are formed from the planetesimals. The interstellar dusts are altered by aqueous alteration and the subsequent thermal metamorphism in the meteorites' parent bodies. These alteration processes change the chemical composition and the structure of the interstellar dusts. Therefore it is very important to understand the alteration processes of the interstellar dusts. Many alteration experiments have been performed using silicates. However, no experiment has been conducted on organic materials. It is therefore highly desirable to perform alteration experiments using organic materials. In this study, we performed experiments involving interstellar organic material analogs to study the alteration of interstellar organic materials in the parent bodies of carbonaceous chondrite.

We performed experiments involving aqueous alteration and subsequent thermal metamorphism to discuss the alteration processes of the interstellar organic materials in the parent bodies of carbonaceous chondrite. The interstellar organic material analogs (200 mg) and water (300 mg) in the Teflon vessel, which was set in a stainless steel high pressure reactor with full of water, was heated (373, 473 K) over seven days. After each experiment, samples were freeze-dried under vacuum at 243 K. The freeze-dried samples were then heated in a vacuum at temperatures between 323 and 873 K. After heating, the weights of the heated residues were measured, and elemental compositions of the residues were analyzed using elemental analyzers. We also analyzed the heated residues using an FTIR, a transmission electron microscope, and a Raman spectrometer.

The relationship between interstellar organic materials and organic materials in carbonaceous chondrites became clear. Both temperatures of aqueous alteration and the subsequent thermal alteration of the interstellar organic materials on the parent bodies reflected C and N contents of carbonaceous chondrites. We found that diamond was formed by the aqueous alteration and the subsequent thermal metamorphism on the carbonaceous chondrites' parent bodies of the interstellar organic materials. Our results have important implications for the origin of diamond in meteorites.