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Diverse formation history recorded in two reduced-type carbonaceous chondrites RBT04143 and QUE97186

Hatsumi Ishida[1*], Tomoki Nakamura[1], Hitoshi Miura[1], Yuki Kakazu[2]

[1]Tohoku University, [2]Kyushu University

We have carried out mineralogical and oxygen isotopic analysis on two reduced-type carbonaceous chondrites, RBT04143, QUE97186, in order to estimate their formation and evolution processes.

According to polarized optical microscope observation, RBT04143 has porous matrix and rounded chondrules. On the other hand, the matrix of QUE97186 is highly compacted with porosity much lower than RBT04143 and chondrules are flattened to high aspect ratios and show a preferred orientation. This texture strongly suggests that the meteorite has experienced shock impact on the meteorite parent body. Olivine and pyroxene in QUE97186 chondrules show undulatory extinctions and planar deformation fractures. This result indicates that the meteorite experienced shock pressure around 20GPa based on the comparison to the results of previous shock recovery experiments (Nakamura et al., 2001) and polarizing microscope analysis (Stoffller et al., 1991).

To estimate the intensity of thermal metamorphism, we measured Fa# in fine-grained matrix olivine using FE-EPMA. As a result, Fa# in QUE97186 ranges from 40 to 60 but Fa# in RBT04143 shows a wider range (0 to 90). The wide Fa# variation in RBT04143 indicates that small silicate particles in the solar nebula have an extreme wide range of Fe/Mg ratios and RBT04143 has undergone least degrees of aqueous alteration and thermal metamorphism. Meanwhile, the narrow range of Fa# in QUE97186 is likely due to shock heating.

That the fine-grained matrix olivine escaped thermal metamorphism indicates CAI and chondrule in RBT04143 preserves the records of processes taken place in the early solar nebula. Oxygen isotope ratios of a type-B CAI and a type-II chondrule were measured by a secondary ion mass spectrometer (SIMS CAMECA ims-6f). The type-B CAI consists of melilite, fassaite, and diopside and these crystals locate from inner core to outer rim. The inner melilite shows 16O-poor composition, but outer diopside shows 16O-rich, suggesting that oxygen isotope exchange occurred between a nebula gas and the CAI at a temperature below melting point at which diffusion rates varies greatly between these minerals.

There are some relict Mg-rich olivine grains in the Type-II chondrule. Oxygen isotope ratios of Fe-rich olivine are homogeneous but the relict Mg-rich olivine is enriched in 16O. This indicates that the Mg-rich olivine preserves isotope composition of precursor grains, but other phases were melted and exchange oxygen with a nebula gas during heating.

Matrix in QUE97186 preserves evidence of impact. Some sulfides in the matrix are partially molten due to shock heating and the matrix was heated to temperature over 1170C. During cooling from this temperature, Fa# of fine-grained matrix olivine became homogenized. So as to estimate the cooling rate, simulation of changes of Fa# with time by considering size distribution of fine-grained olivine and Fe-Mg diffusion rates is in progress.

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