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Mineralogical variation among CV3 carbonaceous chondrites

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Carbonaceous chondrites are the most primitive meteorites and they are the best sample to study the formation of the early solar system. CV3carbonaceous chondrites escape intensive alteration, but they experienced low but variable degrees of secondary alteration. They are classified into reduced and oxidized type. Oxidized type is further subdivided to OxA and OxB type based on the abundance of FeNi-metal and magnetite, or Ni content in sulfide. Reduced type is the most primitive meteorite in the CV3 chondrites, because it has undergone least degrees of aqueous alteration and thermal metamorphism. For this reason, in order to understand primitive dust characteristics of the solar nebula in the CV-chondrite forming regions, it is very important to distinguish primitive CV3s from altered CV3s. In this study, we characterized six CV3 chondrites from the viewpoints of mineralogy and mineral chemistry using optical and electron microscopes and synchrotron radiation X-ray diffraction method (S-XRD). S-XRD was performed at photon factory of KEK on a small matrix lump (200 micron) taken from each meteorite.

We classified six CV3 meteorites based on the existing classification scheme proposed by McSween et al.,1977, Krot et al.,1995 and Krot et al.,1998. As a result, four samples (LAP02206, LAP02228, LAP04843, GRA06101) were classified to OxA type, and two samples (RBT04143, QUE97186) were classified to reduced type. OxA type samples have many mineralogical characteristics in common: matrix consists mainly of distinct lath-shape olivine that is generally larger than matrix olivine in reduced-type samples, and the periphery of chondrules shows Fe-Mg zoning and frequently replaced by Fe-rich olivine with a Fe/Mg ratio identical to matrix olivine. These results are consistent with previous studies suggesting that OxA samples experienced weak thermal metamorphism (Krot et al.,1995 and Krot et al.,1998).

The results of detailed analysis of the two reduced-type samples indicate that they have formed through different processes. QUE97186 shows chondrule flattening and a preferred orientation. This texture strongly suggests that it experienced shock impact on the meteorite parent body. The average aspect ratio of chondrules is 1.6. This suggests that the meteorite experienced shock pressure around 20GPa based on the comparison to the results of previous shock recovery experiments (Nakamura et al., 2001). The post-shock residual heat seems to be responsible for the narrow Fe/Mg ratios of matrix olivine in this meteorite. On the other hand, RBT04143 is a breccia consisting of two types of lithologies: one is reduced-type material and the other one is very weakly altered OxA-type material. Therefore, the most primitive material found in the present study is the reduced-type material in the RBT04143 CV3 chondrite. Oxygen isotope analysis of both OxA and reduced type are in progress.

Keywords: Carbonaceous chondrites, CV3