Early evolution of CV reduced-type parent body. H. Ishida[1], T. Nakamura[1], H. Miura[1] and Y. Kakazu[1], [1]Department of Earth and Planetary Materials Science, Tohoku University, 6-3 Aramaki, Aoba-ku, Sendai, Miyagi 980-8578, Japan.

Introduction:

CV3 carbonaceous chondrites are classified into reduced and oxidized types based on the degrees of secondary alteration. The Oxidized type is further subdivided to the Oxidized-Allende (OxA) and the Oxidized-Bali (OxB) subgroup [1]. The OxB type experienced a moderate degree of aqueous alteration and a minor thermal metamorphism. On the other hand, the OxA type is more extensively altered and metamorphosed than the OxB type. The reduced type is the most primitive meteorite among CV3 chondrites, because it has undergone the least degrees of aqueous alteration and thermal metamorphism [2]. We classified six CV3 meteorites based on the existing classification scheme [1-4]. As a result, four samples, GRA 06101, LAP 04843, LAP 02206 and LAP 2228 were classified into OxA type and two samples, QUE 97186 and RBT 04143 were classified into reduced type. In this report, we examine petrologic characteristics of the two reduced type CV3 meteorites in order to understand their formation and evolution process.

Samples and methods:

We studied polished sections of two reduced type CV3 carbonaceous chondrites (QUE 97186 and RBT 04143) using an optical microscope, a scanning electron microscope (SEM/EDS), a field emission scanning electron microscope (FE-SEM/EDS), an electron probe micro analyzer (EPMA/WDS) and a field emission electron probe micro analyzer (FE-EPMA/WDS). In order to investigate bulk mineralogy, pieces of matrices of ～200μm in size were taken from individual meteorites. The X-ray diffraction (XRD) analysis was performed and exposed to X-ray for diffraction at the High Energy Accelerator Research Organization. The X-rays of ultrahigh intensity allowed us to obtain clear XRD pattern.

Result and Discussion:

The matrix in RBT04143 consists mainly of fine-grained olivine (<1μm), abundant metal, sulfide and low- and high- Ca pyroxene, like in Vigarano (Fig. 1a) [1]. Although, phyllosilicates have been reported in matrix of Vigarano, they are absent in RBT04143 based on the results of XRD. Thus, RBT04143 has undergone the least degrees of aqueous alteration. Detailed observation of chondrules in RBT04143 by FE-SEM showed that there are no FeO-rich rims at the edge of chondrules (Fig. 2a). Because the FeO-rich rims are formed by Fe-Mg diffusion during thermal metamorphism, RBT04143 escaped intensive thermal metamorphism. While reduced-type chondrites are the most primitive meteorite in the CV3, a lot of them experienced shock metamorphism and weak secondary alteration. RBT04143 escaped shock metamorphism. Because the metamorphic grade of RBT04143 appears to be lower than most of the other reduced-type chondrites, RBT04143 might be one of the best samples to study the characteristics of dust in the solar nebula.

QUE97186 has a highly compacted matrix due to the shock metamorphism (Fig. 1b). Chondrules are flattened to high aspect ratios and show a preferred orientation (Fig. 2b). The average aspect ratio is 1.59±0.15 (n=10). According to an optical microscope observation of a thin section, olivines and pyroxenes in many chondrules show undulatory extinctions and planar deformation fractures. These results indicate that QUE97186 experienced shock metamorphism around 20 GPa on the meteorite parent body [5-6].

Fe and Mg mutually diffuse when they experienced thermal metamorphism. In order to estimate the intensity of thermal metamorphism, we measured the Fa# of individual fine-grained matrices olivine using FE-EPMA. As a result, matrix of RBT04143 shows a wide range of Fa# from 0 to 85 but matrix of QUE97186 shows a narrow range of Fa# from 45 to 60 due to shock heating (Fig. 3). We calculated the cooling rate from the shock residual temperature so as to estimate the size of the shock heating region. Observation of a thin section of QUE97186 shows that troilite grains in matrix are partially melted. It suggests that peak shock temperature exceeded Fe-Fes eutectic temperature of 988℃. Because Fe and Mg diffuse through the lattice and the grain boundary of crystals, the diffusion length was evaluated by considering both mechanisms. As a result, we estimated that the size of shock heating region is smaller than 10m. This result indicates that the shock impact on the reduced-type QUE97186 parent body was a local-scale event.

References:

[1] McSween. (1977) *GCA*, 41, 1777-1790. [2] Weisberg and Prinz. (1998) *Meteorit. Planet. Sci.*, 33, 1087-1099. [3] Krot et al. (1995) *Meteorit. Planet. Sci.*, 30, 748-775. [4] Krot et al. (1998) *Meteorit. Planet. Sci.*, 33, 1065-1085. [5] Stoffler et al. (1991) *GCA*, 55, 3845-3867. [6] Nakamura et al. (2000) *Icarus*, 146, 289-300. [7] Yurimoto and Wasson. (2002) *GCA*, 66, 1777-1790. [8] Mishin and Herzig. (1999) *Mater. Sci. Eng.*, 260, 55-71. [9] Dohmen and

Chakrabory. (2007) *Phys. Chem. Minerals.*, 34, 409-430.

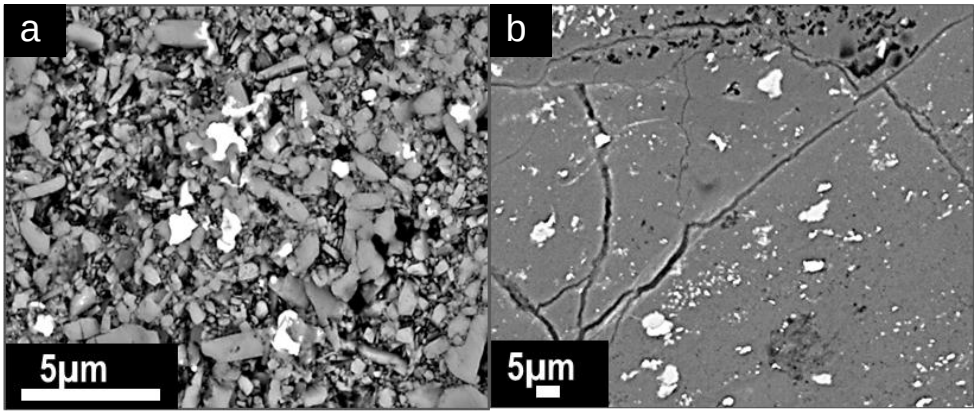

Fig. 1. Back scattered electron images of matrices in (a) RBT04143 and (b) QUE97186. (a) The matrix in RBT04143 consists mainly of fine-grained (<1μm) olivine. (b) The matrix in QUE97186 is compacted due to shock metamorphism.

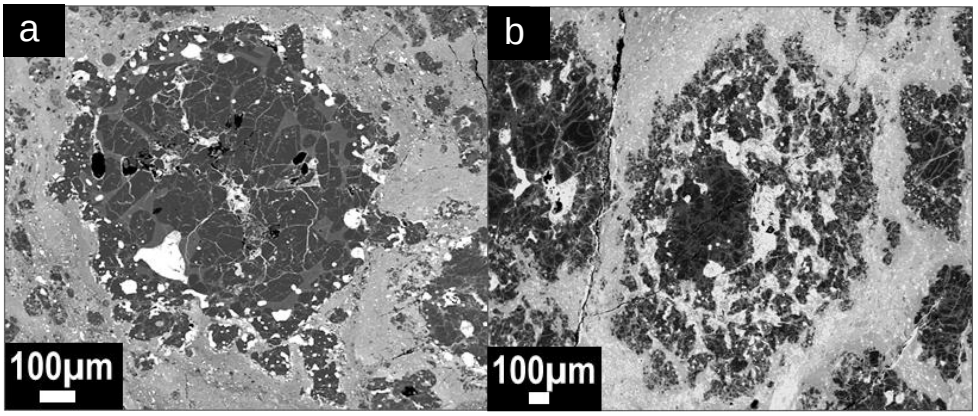

Fig. 2. Back scattered electron images of chondrules in (a) RBT04143 and (b) QUE97186. (a) Type I porphyritic olivine-pyroxene chondrule. It is roughly circular in shape. There are no FeO-rich rims at the edge of a chondrule. (b) The chondrule is flattened to a high aspect ratio by shock metamorphism.

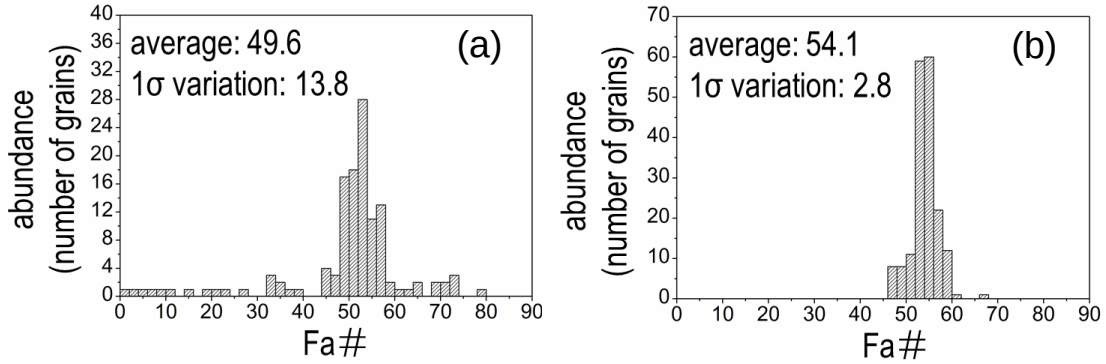

Fig. 3. Histograms of fayalite concentrations of matrix in (a) RBT4143 and (b) QUE97186 determined by a field emission electron probe micro analyzer. (a) The Fa# of matrix olivine in RBT04143 has a wide range. (b) The Fa# of matrix olivine in QUE97186 is more homogeneous than RBT04143 due to shock heating.