PETROLOGICAL AND PETROFABRIC STUDY OF ROBERTS MASSIF 04239 COMPARED TO TAFASSASSET AND BRACHINITES.

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Introduction: Primitive achondrites are generally thought to be the transitional materials between chondrites and achondrites [e.g., 1]. This suggests that studying primitive achondrites has possibilities to a better understanding of the asteroidal differentiation in variable degrees. Brachinites are one of important primitive achondrite groups to know the initial planetary differentiation because it has a very old ^{53}Mn-^{53}Cr age of 4564.8 ± 0.5 Ma (Brachina: the type specimen of brachinite) and is suggested to have formed at the early stage of differentiation [2]. However, there has been no consensus on the origin of brachinites [e.g., 3-5]. Additionally, there are numerous ungrouped achondrites with generally similar petrologic, compositional and isotopic characteristics to brachinites ("brachinite-like") [e.g., 3]. These brachinite-like meteorites are very important to understand the variation of the formation processes of brachinites. Here, we chose Roberts Massif (RBT) 04239 as such a sample. RBT 04239 is an olivine-rich ungrouped meteorite weighing only ~12 g [6]. It was suggested that RBT 04239 had some similarities to Divnoe (brachinite-like meteorite) but was still classified as an ungrouped achondrite [e.g., 7]. RBT 04239 could be key to understand the relationship between brachinites and brachinite-like meteorites. There is, however, only one petrological report on RBT 04239 [7]. Therefore, we performed a detailed petrological and petrofabric study of RBT 04239 compared to brachinites and other brachinite-like meteorites, especially Tafassasset.

Samples and Methods: We studied a polished thick section of RBT 04239 (RBT 04239,20) supplied from the Meteorite Working Group. The section was examined by JEOL JSM-7100F scanning electron microscope (SEM) with an energy dispersive spectrometers (EDS) and an electron backscatter diffraction (EBSD) detector at NIPR. For the measurement of the crystallographic preferred orientation (CPO) of olivine grains, we employed SEM-EBSD and obtained crystal orientation stereographic nets using HKL's CHANNEL 5 software. X-Ray elemental distribution maps were acquired by JEOL JXA-8530F electron microprobe (EPMA) at the University of Tokyo. We also studied a thin section of Tafassasset by the same methods.

Results: RBT 04239 is mostly composed of olivine ranging ~50-300 μm in size. The X-ray elemental maps acquired by EPMA do not show clear chemical zoning in each olivine grain. Other constituent minerals are clinopyroxene, orthopyroxene, plagioclase, chromite, troilite and Fe-Ni metal. Characteristically, relict chondrules are observed and some of them are barred chondrules. We measured EBSD patterns (one point per one olivine grain: total 164 grains) to analyze CPO of olivine crystals. RBT 04239 has a weak CPO pattern of olivine. The M-index which quantifies the strength of the fabric recorded is ~0.14 [8]. The three crystallographic axes (*a*, *b* and *c* axis) broadly concentrate on one direction, respectively. On the other hand, Tafassasset shows very weak CPO pattern of olivine (total 244 grains) whose M-index is ~0.12.

Discussion: Our petrological observations of RBT 04239 are consistent with the previous study [7]. They compared RBT 04239 to Tafassasset and brachinites. Tafassasset is considered to have a mineralogical relationship to CR chondrites and primitive achondrites (brachinites in particular) [e.g., 9,10]. It is suggested that RBT 04239 represented a primitive material that evolved to yield the materials like Tafassasset and brachinites [7]. Tafassasset and RBT 04239, however, are indicated to be more chondritic materials than brachinites from the viewpoint of the existence of relict chondrules. Moreover, we found that both Tafassasset and RBT 04239 have weaker olivine CPO patterns compared to the ones found in brachinites and brachinite-like meteorites [e.g., 11]. RBT 04239, Tafassasset and brachinites are similar in that they commonly have olivine petrofabrics instead of merely having similar mineral compositions. Therefore, RBT 04239 and Tafassasset are suggested to be originated from the chondritic materials (CR-like?) and to have experienced the differentiation processes like that of brachinites (including brachinite-like meteorites) [e.g., 4]. The olivine CPO patterns found in brachinites and brachinite-like meteorites are not the same, suggesting that the formation processes of brachinite and brachinite-like meteorites are not simple. It is required to further investigate the precise relationship between RBT 04239 and brachinites to better understand the formation processes of brachinites and brachinite-like meteorites.

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