Petrogenesis of Yamato-75032 type diogenites

Akira Yamaguchi[1], Jean-Alix Barrat[2] and Naoki Shirai[3]
[1]*National Institute of Polar Research*
[2]*UBO-IUEM*
[3]*Tokyo Metropolitan University*

Introduction

HED (howardites, eucrites, diogenite) meteorites are the largest group of differentiated achondrites, probably originated from Vesta. Eucrites are basalts or gabbros mainly composed of low-Ca pyroxene-plagioclase, and diogenites are mainly orthopyroxenites. The petrologic relationship between eucrites and diogenites are a subject of debate. Classically, diogenites are believed to be cumulate rocks crystallized from a magma ocean, whereas eucrites are residual liquids (e.g., Takeda 1979). However, from the diversity of the bulk REE abundances, Barrat et al. (2008; 2010) suggested that most diogenites crystallized from melts produced by remelting of early magma ocean cumulates.

Y-75032 type diogenites (type B) are ferroan diogenites. They have pyroxenes with their FeO/MgO values between those of cumulate eucrites and normal diogenites and are rich in incompatible elements (Takeda and Mori 1986; Mittlefehldt and Lindstrom 1993). This type is one of the typical diogenites found near the Yamato Mountains. The study of Y-75032 type diogenites provides the key to understand the petrogenetic relationship between eucrites and diogenites. We performed a geochemical study of Y-75032 type diogenites, other diogenites, and cumulate eucrites to better understand the petrogenetic relationship between eucrites and diogenites.

Aanalytical methods

We examined Y-75032 type diogenites by an optical and a FE-SEM-EDS and an EPMA. We also examined other ferroan diogenites Dho 700 and A-881839 (Yamaguchi et al. 2011; Barrat et al. 2010) and cumulate eucrites (Y 980433, Moore County, Moama) for comparison. We determined bulk major and trace element compositions of pyroxene and plagioclase of Y-75032 and Y 980433 by an EPMA with ~30 µm beam diameter and averages of 10-35 analyses and LA-ICP-MS (Thermo Element XR equipped with LSX-213 Laser) at NIPR with line mode (a few mm long) and a beam 50-100 µm in beam diameter.

Results and Discussion

Y-75032 type diogenites are breccias mainly composed of angular to subrounded fragments of pyroxenes (Mg' = ~66-68) with minor plagioclase (glass), tridymite (glass), and chromite, cemented by dark impact melts (e.g., Takeda and Mori 1986). We focused on relatively unbrecciated portion of Y-75032 where pyroxene is in igneous contact with plagioclase (glass). The thick section of Y-75032 (,71-2) mainly consists of low-Ca pyroxene which contains augite occur as chains of blebs (<~30-50 µm) in many cases, lamellae and large (~200-300 µm) irregular nodules in some cases. Bulk compositions of pyroxene vary due to the heterogeneous distribution of augite ($Wo_{3.4-10.3}En_{62.2-66.1}$, $(La)_n$ = 0.1-1.2). They show light REE depletions ($(La/Sm)_n$ = 0.16-0.64) with negative Eu anomalies (Eu/Eu^* = 0.09-0.59). Pyroxenes in the Y-75032 type diogenites are richer in TiO_2, compared to those of ferroan diogenites, Dho 700 and A-881839, and typical digenites, and are similar to those of cumulate eucrites. The Yb abundances of Y-75032 pyroxenes are between those of cumulate eucrites and normal diogenites.

We are attempting to estimate the compositions of parental liquid of Y-75032. It is crucial to identify the crystallizing (liquidus) phases (i.e., pigeonite or orthopyroxene) when making geochemical modeling. Bulk chemical compositions of pyroxenes in Y-75032 type diogenites (Y-75032 and Y-791199) vary from covering the range of orthopyroxene and pigeonite at the inferred crystallization temperatures. Takeda and Mori (1985) suggested that many of pyroxenes in Y-75032 type diogenites crystallized as low-Ca pigeonite and some as orthopyroxene on the basis of texture. If the parental liquid is eucritic, Y-75032 type diogenites are pyroxene-rich cumulate eucrites rather than diogenites from the geochemical point of view. We will present the results at the symposium.

References

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