PETROLOGY AND MINERALOGY OF RBT 04262: IMPLICATIONS FOR STRATIGRAPHY OF THE LHERZOLITIC SHERGOTTITE IGNEOUS BLOCK. T. Mikouchi, T. Kurihara, and M. Miyamoto, Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, JAPAN (mikouchi@eps.s.u-tokyo.ac.jp).

Introduction: RBT04262 (and paired RBT04261) was initially reported as an olivine-phyric shergottite [1], but our study shows that it is closer to a lherzolitic shergottite group. The current collection of lherzolitic shergottites shows similar mineralogy and ages within the group, suggesting that they were derived from a common igneous body on Mars [e.g., 2]. Because RBT04262 shows slightly different petrology and mineralogy from previously known lherzolitic shergottites, its discovery helps us reconstructing an igneous block of lherzolitic shergottites, which suggests stratigraphy similar to nakhlites [e.g., 3-4].

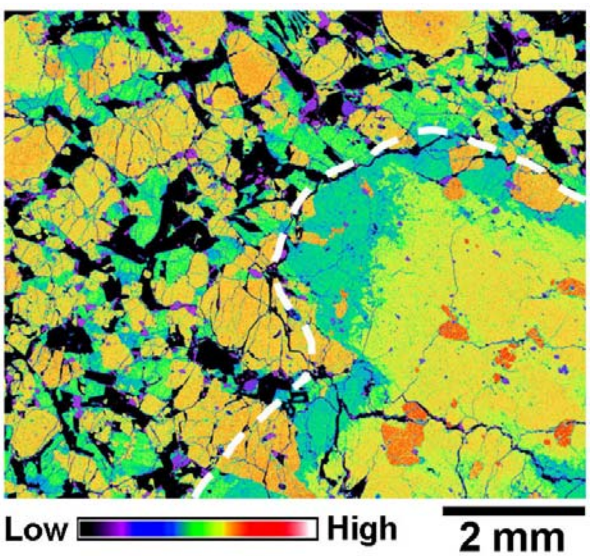

Fig. 1 Mg X-ray map of RBT04262. Large pyroxene oikocrysts are present on the right side of the map. Olivine is orange to yellow, low-Ca pyroxene is yellow to green, and maskelynite is dark. The boundary between two areas is shown by the white dotted line.

Petrography: RBT04262 is composed of subequal amounts of poikilitic and non-poikilitic areas (Fig. 1). The modal abundances of minerals are 43 % low-Ca pyroxene, 30 % olivine, 13 % plagioclase (maskelynite), 10 % augite, 2 % Cr-spinels, 1 % Ca phosphates, and 1 % others. The poikilitic areas, reaching 5 mm in size, are composed of pyroxene oikocrysts enclosing small olivine grains (~0.5 mm). Most areas of pyroxene oikocrysts are low-Ca pyroxene, and thick augite rims (~1 mm wide) are present at their edges. Kaersutite-bearing magmatic inclusions are found in the pyroxene oikocrysts. In non-poikilitic areas, olivine, maskelynite and pyroxene are major constituents with minor amounts of Ca phosphates, chromite with Ti-rich rims, ilmenite, and Fe(-Ni) sulfide. Pyroxene and maskelynite grains in non-poikilitic areas are smaller than olivine, and occasionally show intergrown textures. K-rich feldspar is also present associated with maskelynite. Shock metamorphism is extensive (e.g., complete maskelynitization of plagioclase, mosaic and patchy extinction of olivine), but no shock melt was observed in the PTS studied.

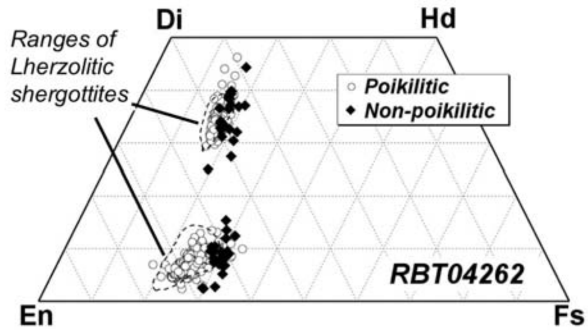

Fig. 2. Pyroxene composition of RBT04262. Ranges of pyroxenes from lherzolitic shergottites are also shown.

Mineral Compositions: Pyroxene oikocrysts in poikilitic areas are low-Ca pyroxene ($En_{73}Wo_5$ to $En_{60}Wo_{10}$) in the core regions (Fig. 2). Augite in poikilitic areas is $En_{52}Wo_{30}$-$En_{45}Wo_{40}$. Pyroxenes in non-poikilitic areas are mostly pigeonite with small amounts of augite and slightly higher in Fe contents than those in poikilitic areas ($En_{62}Wo_7$-$En_{58}Wo_{12}$ and $En_{50}Wo_{30}$-$En_{44}Wo_{39}$). The pair of low-Ca pyroxene and augite in both areas gives equilibration temperature of ~1150 ^oC [5]. Minor element contents (Al, Ti and Cr) of pyroxenes between two areas are also clearly different. The olivine grains in poikilitic areas are more Mg-rich and show wider compositional variation (Fa_{28-39}) than those in non-poikilitic areas (Fa_{32-41}) (Fig. 3). Most individual grains are nearly homogeneous in Fe-Mg, but show decrease of CaO from cores (0.3 wt%) to rims (0.1 wt%). Maskelynite is $An_{58}Or_3$ to $An_{30}Or_7$. K-rich feldspar is $An_{10}Or_{25}$ to An_2Or_{70}. Chromite in poikilitic areas is generally homogeneous, but in non-poikilitic areas extensive chemical zoning is observed towards the rim of ulvöspinel-rich component. Ilmenite contains 4 wt% MgO.

Classification: The presence of millimeter-sized pyroxene oikocrysts in RBT04262 and its general mineralogy show that it is a new member of lherzolitic shergottites, although it was first reported as olivine-phyric shergottite [1]. RBT04262 experienced a similar crystallization history to other lherzolitic shergottites [2]. (1) initial formation of poikilitic areas, (2) accumulation, and (3) crystallization of intercumulus melt forming non-poikilitic areas. However, the high abundance of plagioclase (13 %) indicates that it is not a "lherzolite" *sensu stricto*. Because olivine and pyroxene show chemical zoning, it is unlikely that it is a plutonic rock. Thus, RBT04262 is a "basalt" showing close affinities to lherzolitic shergottites, and we may need to reconsider the naming of this Martian meteorite group.

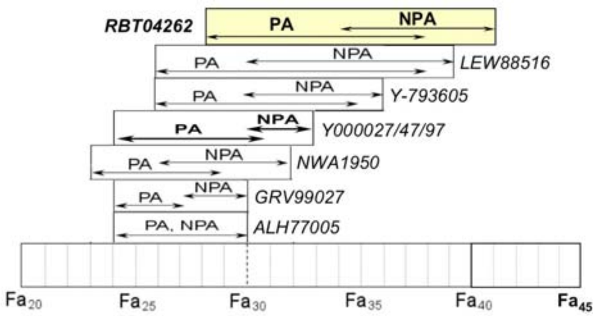

Fig. 3 Olivine compositions of lherzolitic shergottites. PA: poikilitic area. NPA: non-poikilitic area.

Variation of Lherzolitic Shergottites: The discovery of RBT04262 has increased the total number of "lherzolitic" shergottites nine [6]. When we compare these samples, olivine composition shows clear difference among them (Fig. 3). In contrast, pyroxene compositions do not significantly differ (Fig. 2). We expect that fast Fe-Mg diffusion rate of olivine compared to pyroxene produced compositional difference. Such different olivine compositions can be due to different cooling rates during non-poikilitic area crystallization. This situation is similar to the case for nakhlites since all nakhlites show similar mineralogy and ages within the group. It is suggested that slightly different mineralogy of each nakhlite was due to different cooling rate caused by different location in a single cooling magma with different accumulation density of augite [3-4].

Stratigraphy of the Lherzolitic Shergottite Igneous Block: If we employ a similar model for lherzolitic shergottites, there may be a correlation between cooling rate and abundance of intercumulus melt. The samples located at upper levels of igneous block should show a less compact cumulus network than those at deeper levels, thus having abundant non-poikilitic areas. The intercumulus melt compositions should be also more evolved than those at deeper levels. Because all lherzolitic shergottites have similar abundance of non-poikilitic areas except for NWA2646 and RBT04262, the relationship between abundance of intercumulus melt and cooling rate was not clear for them. RBT04262 has the most Fe-rich olivine composition in non-poikilitic areas (Fig. 3), and the abundance of non-poikilitic areas is the highest among lherzolitic shergottites. The RBT04262 plagioclase is also more albitic than the others. Thus, RBT04262 may be located near the upper region of the igneous block where the abundance of cumulus phases was smaller (Fig. 4). Therefore, it is probable that the igneous block of lherzolitic shergottites showed a stratigraphical distribution similar to nakhlites, although most samples were located at a similar location or level of the block. Since interstitial melts could be present without cumulus phases at further upper levels, more evolved melts may have a petrogenetic relationship to other Martian meteorite groups with young crystallization ages (e.g., basaltic shergottites).

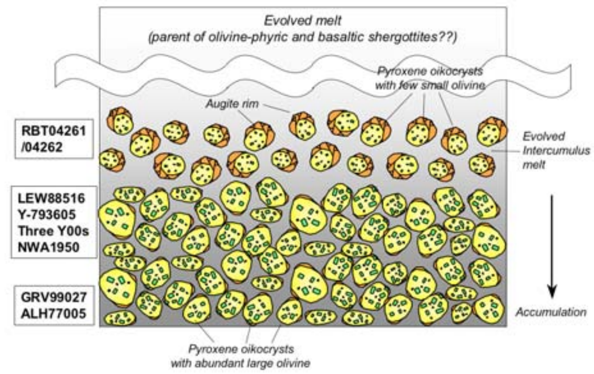

Fig. 4. Schematic illustration showing stratigraphy of the igneous block of lherzolitic shergottites.

We calculated cooling rates (1300-700 and 1200-700 ^{o}C) of olivine in non-poikilitic areas of RBT04262 and ALH77005 by using Ca chemical zoning, which shows systematic decrease from cores to rims. We assumed that olivine had initially homogeneous Ca contents and interaction with the intercumulus melt decreased the Ca content towards the rim. We obtained similar cooling rates for both ALH77005 and RBT04262, and could not resolve the depth difference between them. The obtained cooling rates are 0.03-0.09 ^{o}C/hour, corresponding to the burial depth of only 4-5 m. Although this calculation bears some uncertainty depending upon initial conditions, the presence of Ca zoning suggests a relatively fast cooling environment for lherzolitic shergottites.

References: [1] *Antarct. Meteorite Newsl.* (2007) *30 (1)*. [2] Mikouchi T. (2005) *Meteoritics & Planet. Sci.*, *40*, 1621-1634. [3] Mikouchi T. et al. (2003) *Antarct. Meteorite Res.*, *16*, 34-57. [4] Day J. M. D. et al. (2006) *Meteoritics & Planet. Sci.*, *41*, 581-606. [5] Lindsley D. H. and Andersen D. J. (1983) *Proc. 13th LPSC*, A887-A906. [6] Meyer C. (2007) The Mars Meteorite Compendium, NASA-JSC.