Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS025-15 会場:101 時間:5 月 23 日 18:00-18:15

LL コンドライト中に含まれるアルカリ元素に富む岩片
Alkali-rich Fragments in LL-chondritic Breccias

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Alkaline elements, Na, K, Rb, and Cs, are classified as moderately volatile elements, and large fractionations are expected as a result of evaporation/condensation processes.

K-rich igneous fragments were identified in brecciated LL-chonderites, Kraehenberg (LL5) [1], Bhola (LL3-6) [2], and Yamato (Y)-74442 (LL4) [3,4], and show characteristic fractionation patterns (e.g., Na˜0.5 x CI, K˜12 x CI, Rb˜45 x CI, and Cs˜70 x CI [5]). In order to understand fractionation processes of moderately volatile elements as well as origin of alkali-rich fragments in chondritic breccias, we have undertaken mineralogical and petrological studies on K-rich fragments in Kraehenberg, Bhola, and Y-74442. Rb-Sr isotopic studies on the K-rich fragments in Bhola and Y-74442 are in progress.

Kraehenberg, Bhola, and Y-74442 consist of mineral fragments, K-rich fragments, impact-melt clasts, and chondrules. Kraehenberg and Bhola contain large K-rich fragments (1-2 cm in size). Small K-rich fragments (1-2 mm in size) are heterogeneously distributed in Bhola and Y-74442. These K-rich fragments show quenched textures and are composed largely of olivine (50-100 um in size) and groundmass of brown glasses which are highly enriched in alkaline elements. The boundaries between K-rich fragments and their hosts are sharp, and no reaction relation is observed along the boundaries. Dendritic Ca-pyroxene and chromite (˜1 um in size) along with troilite (˜10 um in size) are commonly observed in the groundmass of K-rich glasses. Tiny Fe-Ni metal grains are identified together with troilite in K-rich glasses.

Chemical compositions of olivine in the K-rich fragments fall within the compositional range of equilibrated LL-chondrites (Fa26-32 [6]). Data points of groundmass glasses of the K-rich fragments are overlapped when plotted on a ternary diagram of Na+K+Al-oxides, Ca+Mg+Fe-oxides, and SiO2. These K-rich fragments are almost identical to their host matrix in major element compositions except Na and K.

Although grain sizes of olivine are somewhat different, textures and constituent phases of the K-rich fragments in Kraehenberg, Bhola, and Y-74442 are indistinguishable.

Abundances of Rb in the whole-rock (WR) samples of Bhola and Y-74442 [7] (50-100 mg in weight) are three to ten times of chondrites, suggesting that K-rich fragments are heterogeneously distributed.

Similarities in textures, chemical compositions, and fractionation patterns of K-rich fragments in LL chondritic breccias suggest that they might be formed from identical precursor materials with related processes.

Alkaline elements are also classified as large ion lithophiles and are partitioned into residual phases during crystallization. The K-rich fragments in Kraehenberg and Bhola possess flat REE patterns, which are different from the GRA 06128/06129 meteorites (alkali-rich early planetary objects showing LREE/HREE fractionations [8]). Geochemistry (i.e., solid/liquid fractionation process) could not be responsible for the enrichments of heavier alkalis in the Kraehenberg, Bhola, and Y-74442 fragments. Taking into account the lack of K isotopic fractionation [9] and the old formation ages of ˜4.56 Ga [1,10], an alkali-rich component of the K-rich fragments could have formed during the early stages of solar system evolution.

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キーワード: 角礫岩コンドライト, アルカリ元素
Keywords: chondrite, breccia, alkali elements