MESOSTASIS-RICH LUNAR AND EUCRITIC BASALTS WITH REFERENCE TO
REE-RICH MINERALS. Hiroshi Takeda, H. Mori, Mineralogical Inst., Faculty of
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In order to gain better understanding of the origin of the oldest
elusive rocks found in our solar system, we investigated the most
unequilibrated eucrite clasts in the Yamato-79 collection, pristine KREEP fragment
15386 by electron microprobe, SEM and analytical transmission electron
microscope (ATEM) techniques. Their bulk chemical compositions scatter
around the peritectic point in the plag.-silica-olivine "pseudo-ternary-
liquid" diagram, and similarity in their chemical zoning trends of pyroxene
and in the textures has been emphasized (1). The concentrations of the REE
in KREEP are up to 700 times chondritic abundances (2), and those in
eucrites are about 6-10 times (3). We searched for REE-rich minerals in
their mesostasis portions to understand their REE distribution by ATEM.

The mesostasis-rich coarse-grained basalt was first recognized in the
Y75011 polymict eucrite as a clast (,84), and was examined by ATEM. As a
part of the Polymict Eucrite Consortium study (4), we found similar lithic
clasts in two polymict eucrites, Y790007 and Y790020. A coarse lithic clast
with yellow pigeonite and dark mesostasis about 5 mm in diameter was
separated from the matrix of Y790020. A polished thin section (PTS) was
made from a chip (,91B) with some matrices. The Y790007,61D3 clast 2 mm in
diameter was found in a PTS. They were examined by an electron microprobe.

Three dark brown mesostasis-rich fragments (ca. 1 mm ) of 15386,22, were
mounted in epoxy resin and were sliced into three pieces, one PTS for the
microprobe work, one ion-thinned sample for ATEM, and one for fine powders
for ATEM. After removing pyroxenes and plagioclases from the black powder
under a binocular, we analysed chemical compositions by a thin film
analysis program using theoretical k-factors with the Hitachi H-600 and
Kevex ATEM system. The oxygen contents were determined by stoichiometry.

Y790007 and Y790020 contain cumulate eucrite components. The texture
of two clasts are the same as that of Y75011,84. The chemical zoning from
core to rim facing dark mesostasis (Fig. 1) is identical with that of
Y75011,84 (4). The most Mg-rich pigeonite core has a composition
Ca24Mg69Fe27 close to that of diogenite and zoned towards Ca25Mg15Fe60. The
plagioclase compositions vary from An96 to An84. The dark mesostasis areas
consist of ilmenite, silica, troilite and rare Ca phosphates. In the
Y75011,84 mesostasis, iron-rich olivine, Fa75 was found. A search for
REE-rich minerals has been unsuccessful by ATEM and microprobe.

The mesostasis portions of 15386 are present at acute triangular
interstices (up to 0.4x0.2 mm) between pyroxenes and plagioclases. They are
occasionally penetrated by ilmenite platelets. The modal abundances of
minerals in the fine powder of the 15386 KREEP mesostasis obtained by ATEM
for 107 grains are: Fe-rich, Ca-poor clinopyroxenes (Cpx) 25%, Fe-rich,
Ca-rich Cpx 23, An-rich plagioclase 13, silica (cristobalite) 12, silica +
K-feldspar 3, ilmenite 11, whitlockite 7, troilite 2, iron 1, zirconolite 1,
Ca-rich phase (?) 1. The composition of a whitlockite is: MgO 0.9 wt.%,
P2O5 42, CaO 42, Fe0 4, Y2O3 8, La2O3 0.6, Ce2O3 1.2, Nd2O3 1.1. The
precision expressed by 2 sigma is 1.2 for Y2O3 and 0.4 for Ce2O3. The
compositions of whitlockite are similar to those reported for 14310 by Brown
et al. (5), but the REE content is higher. The microprobe analysis of the
K-rich phase is similar to those of the mesostasis glass in 14310 reported
by Kushiro et al. (6). We could not detect individual grains of REE.
minerals other than witlockite.

The mass balance of REE is difficult to calculate because REE contents of the major phases in 15386 are not known. By employing Ce contents of pyroxenes and plagioclases intermediate between those of 12021 and 12013,15 (7) and modal abundance by Steele et al. (8), we can estimate that majority of the bulk Ce content of 15386 given by Taylor (9), 211 ppm, can be accounted for by Ce contribution of the whitlockite. Much smaller content of Ce reported for eucrites is in line with unsucss at present in finding a REE-rich phase in the eucrite mesostases.

Because chondrite-normalized REE and Ba abundances in pyroxene and plagioclase phases of the Juvinas eucrite are complimentary (13), the bulk sample REE pattern may show unfracionated trend if there is no other major REE-bearing minerals. Since almost equal amounts of pyroxene and plagioclase are precipitating at the peritectic point and the bulk compositions of the solid phases are not much different from that of the liquid, the chondrite-normalized REE pattern may stay almost flat even for a model involving crystal fractionation from a shallow magma ocean.

In summary, (1) basalt clasts in Y790007 and Y790020 are similar to Y75011,84. A search for REE minerals is so far unssseful, and the fact is in line with low REE contents of eucrites. (2) major REE minerals in 15386 KREEP is whitlockite.

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Fig. 1. Pyroxene quadrilaterals of the most unequilibrated mesostasis-rich eucritic basalt clasts in two Yamato polymict eucrites. The chemical zoning trends are shown by a line connecting the solid circles.