MESOSTASIS-RICH LUNAR AND EUCRITIC BASALTS WITH REFERENCE TO REE-RICH MINERALS. Hiroshi Takeda, H. Mori, Mineralogical Inst., Faculty of Science, Univ. of Tokyo, Hongo, Tokyo 113, Japan, M. Miyamoto, NASA Johnson Space Center, Houston, Texas 77058, and T. Ishii, Ocean Research Inst., Univ. of Tokyo, Minamidai, Nakano-ku, Tokyo 164, Japan.

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 $Ca_4Mg_{69}Fe_{27}$ close to that of diogenite and zoned towards $Ca_{25}Mg_{15}Fe_{60}$. The plagioclase compositions vary from An_{90} to An_{84}. The dark mesostasis areas consist of ilmenite, silica, troilite and rare Ca phosphates. In the Y75011,84 mesostasis, iron-rich olivine, Fa_{75} 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.%, P_2O_5 42, CaO 42, FeO 4, Y_2O_3 8, La_2O_3 0.6, Ce_2O_3 1.2, Nd_2O_3 1.1. The precision expressed by 2 sigma is 1.2 for Y_2O_3 and 0.4 for Ce_2O_3. 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

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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 empolying 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 unsuccess 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 unfractionated 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 unsuccessful, 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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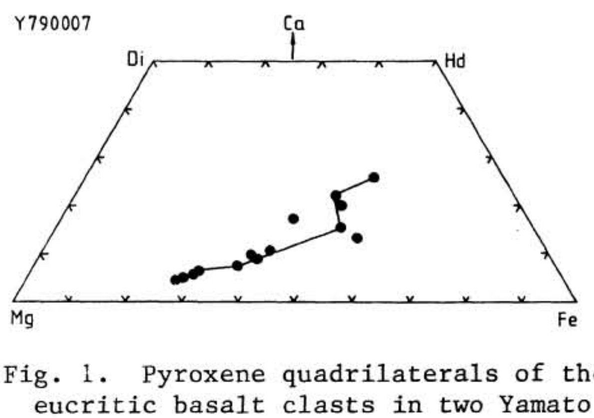

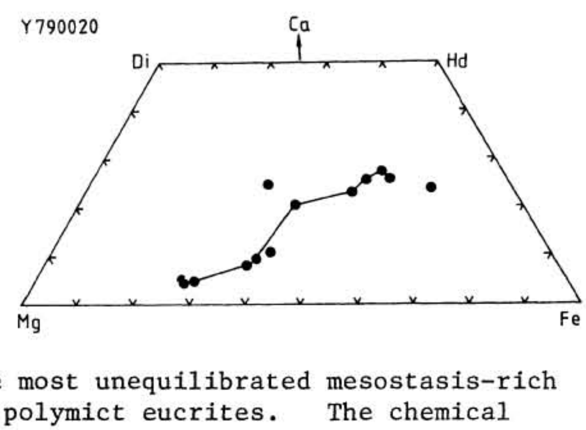

Fig. 1. Pyroxene quadrilaterals of the most unequilibrated mesostasis-rich eucritic basalt clasts in two Yamato polymict eucrites. The chemical zoning trends are shown by a line connecting the solid circles.