Ti-BEARING OXIDE MINERALS IN LUNAR METEORITE Y793169 WITH THE VLT AFFINITY; Hiroshi Takeda, Tomoko Arai and Kazuto Saiki, Mineralogical Inst., Faculty of Science, Univ. of Tokyo, Hongo, Tokyo 113, Japan.

Lunar meteorite, Yamato 793169 previously classified as a VLT mare basalt contains considerable amounts of Ti-bearing oxides in the mesostasis area (2 vol. %). Mineralogical study of these oxides revealed that they are isolated grains of ilmenite, ulvöspinel and chromite, which are formed at the last stage of crystallization. Ti/(Ti+Al+Cr) and Cr/(Cr+Al) versus Fe/(Mg+Fe) variations of these phases are not in the same trends as in the low Ti pigeonite basalts of Apollo 12 and 15 in spite of its higher TiO_2 contents.

Among four lunar meteorites proposed to be samples of mare regions of the Moon, EET87521 and Y793274 are breccias rich in lunar mare components [1-3], but Y793169 and A881757 are crystalline rocks composed of Fe-rich pigeonite and plagioclase with affinity to the VLT basalts [4], despite their higher bulk TiO_2 contents than the limit for VLT [5].

We investigated polished thin sections (PTS) Y793169,51-3 and A881757,51-4 (Asuka-31) supplied by the National Institute of Polar Research (NIPR). Both samples were allocated as parts of two consortium studies [6]. Mineral chemistries and textures were examined by an electron probe micro-analyzer (EPMA) and scanning electron microscope (SEM), JEOL 840A with X-ray chemical map analysis (CMA) utilities. Modal abundances of minerals in Y793169 were obtained from colored back scattered electron (BSE) image of SEM for a particular mineral by a computer and by point analysis for minerals with a similar BSE intensity.

The Y793169,51-3 PTS is a crystalline subophitic basalt with Fe-rich pyroxene, plagioclase and dark mesostasis portions. Mineralogy and petrography have been reported as a part of the consortium study [6]. Modal abundances of minerals are: pyroxene 56 vol. % (Mg-rich 34 %, Fe-rich 22 %), plagioclase 42 %, ilmenite 1 %, ulvöspinel 1 %, fayalite, chromite and silica mineral (<0.1 %). Although this basalt has been classified as a VLT basalt [4], the amounts of ilmenite and ulvöspinel in the mesostases are fairly large (ca. 2 vol. %). The bulk composition computed from the modal abundance data and their average mineral compositions gives 1.8 wt % TiO_2. The Cr-Ti-Fe spinels found in the mesostases in Y793169 are chromite and Cr-bearing ulvöspinel. Ulvöspinel is as important as ilmenite for higher concentration of TiO_2 than VLT. Chemical variations of ulvöspinel and chromite in Y793169 are compared with the Apollo and Luna spinels [7].

Our previous study showed that crystallization trends of zoned pyroxenes in Y793169 and A881757 are similar to those of the the VLT basalts but are different from known mare basalts including Apollo 12 and 15 low-Ti basalts [7], in spite of their higher TiO_2 concentration (TiO_2 for A881757 is 2.5 wt. %) [5] than previously known and the presence of fair amounts of ilmenite (or ulvöspinel) of these two rocks. Although A881757 is classified as a VLT basalt, abundant dark mesostasis portions contain fair amounts of ilmenite (6 vol. %) [4]. The Apollo 12 and 15 pigeonite basalts contain large phenocrysts of pigeonite in fined-grained matrices of pyroxene and plagioclase [7]. Among the groups, 12064 shows texture and pyroxene chemical zoning trend comparable to those of Y793169 [7]. The Ti/(Ti+Cr) versus Fe/(Fe+Mg) trend of Y793169 and A881757 pyroxenes are intermediate between the Apollo 15 basalts and the Apollo 17 VLT basalts [6].
The characterization of their bulk chemistries in the TiO_2 versus Mg/(Mg+Fe)

diagram indicates that these two rocks plot closer to the VLT field than to the low-Ti basalts [9].

The Ti/(Ti+Cr+Al) versus Fe/(Fe+Mg) variation (Fig. 1) of Y793169 indicates that the Y793169 spinel trends represent only very last stage of the local differentiation of the mare basalt. The Cr/(Cr+Al) versus Fe/(Fe+Mg) trend (Fig. 1) has some resemblances to Apollo 12 ilmenite basalts and feldspathic basalts [7], but the Cr/(Cr+Al) ratios of Y793169 are little lower than those of the Apollo 12 low-Ti basalt, and the Y793169 trend represents only for that of the Fe-rich end. It is to be noted that the low-Ti basalt trends represent those of core to rim variation during crystal growth, whereas the Y793169 trends are shown by the coexisting three Ti-bearing phases, precipitation of which took place at the last stage of the small-scale differentiation. Mineralogy of Y793169 and A881757 suggests the term VLT or low-Ti basalt may not be appropriate for such basalts.

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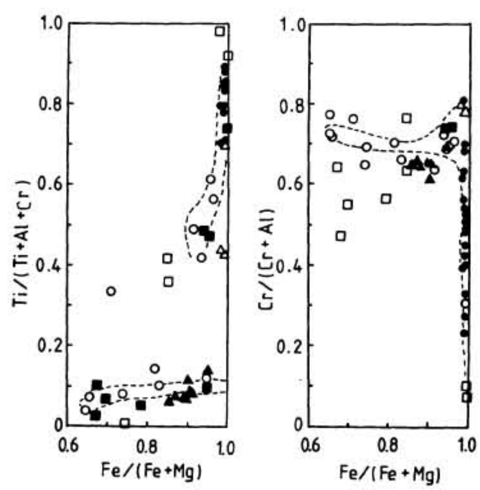

Fig. 1. Ti/Ti+Al+Cr and Cr/(Cr+Al) vs. Fe/(Fe+Mg) variation diagrams for spinels from major mare basalt groups [4,7], and Y793169. Solid circles: Y793169 ulvöspinel, solid triangle: Y793169 chromite; open triangles: EET87521 and A881757; open squares: Apollo 11 and 17; open circles: Apollo 12 and 15 (dotted lines for pigeonite basalts); and solid squares: Apollo 14 and Luna 16.