Petrological and mineralogical study of a orthopyroxene-rich lodranite Yamato 983119.

*Masahiro YASUTAKE[1,2], Akira Yamaguchi[1,2]

1.SOKENDAI, 2.National Institute of Polar Research

Introduction Primitive achondrites show achondritic textures, but have relatively chondritic bulk chemical features. Acapulcoites and lodranites are a group of primitive achondrites. They suffered few% to <20% partial melting. They are thought that formed in the same parent body which experienced various degree of heating [1]. Therefore they are suitable sample to better understand evolutionary history of a planetesimal.
Yamato (Y) 983119 was collected in Yamato Mountains, Antarctica by JARE39. This meteorite was classified into a lodranite [2]. Although its mg# (molar Mg/(Fe+Mg)) of pyroxene and olivine and O-isotopic compositions are similar to those of acapulcoites and lodranites, it is unusually rich in orthopyroxene (Opx) and poor in olivine. We examined petrology and mineralogy of this meteorite in detail and compared with other acapulcoites and lodranites.
Sample and Methods We analyzed one polished thin section of Y 983119. For comparison, we analyzed thin/thick sections of 3 acapulcoites (Acapulco, Y 74063, Y 981505) and 7 lodranites (Y 74357, Y 791491, Y 791493, Y 981619, Y 981670, Y 981725, Y 981988). These samples are observed by an optical microscope and FE-SEM (JEOL JSM-7100F) at NIPR. Elemental maps were obtained by an EDS-system (Oxford AZtec Energy) equipped with FE-SEM. Modal abundances of each sample were obtained from elemental maps by using of a software ImageJ (NIH). Sizes of the analyzed areas are from ~2 x 4 to 10 x 14 mm. We also performed fabric analysis to reveal lattice-preferred orientation (LPO) of Opx by using EBSD technique. Chemical compositions of constituent minerals were obtained by EPMA (JEOL JXA-8200).
Result Y 983119 has a coarse-grained texture (~0.5-2.0 mm) and composed of Opx (73 vol. %) and plagioclase (14 vol. %), and minor kamacite and taenite (5 vol. %), olivine (4 vol. %), troilite (2 vol. %) and augite (2 vol. %), and traces of phosphate, chromite and schreibersite. Opx has a rounded or tabular shape and some grains have zigzagged rim. Most of them contain numerous augite inclusions (few tens of μm in size) and thin lamellae. There is one rare augite inclusions partly surrounded by K, Al, Si-rich glass in Opx. Olivine and augite show an amoeboid shape. One olivine grain is penetrated by plagioclase and troilite. Plagioclase is distributed interstitially to olivine and Opx grains. Some plagioclase grains enclose olivine and Opx grains. EBSD analysis indicates that Opx grains are randomly oriented.
Compositions of mafic silicates are within the ranges of acapulcoites and lodranites: Opx ($Wo_{2.3}$ $En_{94.2}$ $Fs_{3.6}$), augite ($Wo_{45.4}$ $En_{53.1}$ $Fs_{1.5}$) and olivine ($Fa_{3.0}$). However, the Mg/Mn ratios of Opx are significantly higher (molar Mg/Mn = 189) than the other samples we examined (molar Mg/Mn = ~100-120). Plagioclase has relatively anorthitic composition ($Or_{1.7}$ $Ab_{69.6}$ $An_{28.7}$) than those of the others ($An_{\sim 10-20}$).
We conclude that Y 983119 is classified into acapulcoites and lodranites clan but has unusually high abundance of Opx (73 vol. %) and low abundance of olivine (5 vol. %). This rock might have been cumulates crystallized from melt formed by larger degree of partial melting.
References [1] C. Floss (2000) Meteorit. and Planet. Sci., 35, 1073-1085 [2] Yamaguchi et al., (2012) Meteorite Newsletter, vol. 21

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