Mineralogical and petrological study of orthopyroxene-rich lithology in the Yamato 983119 lodranite

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Introduction: Primitive achondrites are one group of achondrite which have both chondritic and achondritic features. It is generally accepted that primitive achondrites are derived from small planetesimals that did not suffer large scale magmatism. Acapulcoite-lodranite family is the second largest group of primitive achondrites. Acapulcoites and lodranites experienced <20 % partial melting of chondritic precursors [1]. Because acapulcoites and lodranites show various stage of evolution, they are very suitable meteorites to better understand early metamorphism and magmatism of planetesimals.

Yamato (Y) 983119 was collected from bare ice field near the Yamato Mountains, Antarctica by JARE 39. Preliminary mineral chemical composition and O-isotopic composition study lead its classification as a lodranite. We found an orthopyroxene (Opx)-rich region in Y 983119 unlike other lodranites. Here we report mineralogy and petrology of Y 983119. Further, we discuss relationship with other acapulcoites and lodranites and the formation processes of Y 983119.

Samples and Methods: We prepare one thin section (,51-2) and two thick sections (,35 and ,51) of Y 983119. Textures of the sections were observed by an optical microscope and FE-SEM (JEOL JSM7100F) equipped with EDS (Oxford instruments AZtec Energy). Compositions of constituent minerals were determined by using an EPMA (JEOL JXA8200). Modal abundances of each sections were estimated from X-ray elemental maps obtained by SEM-EDS.

Results and discussion: Y 983119 shows a coarse-grained texture consisting of Opx, olivine, plagioclase and metal (Fig. 1). Most of olivine show corroded grain shapes. Opx grains have thin lamellae of augite and numerous inclusions. Plagioclase and augite occur interstitially and some of them include Opx grains. Some rare trapped melt inclusions in Opx and olivine consist of plagioclase, augite, alkali-feldspar, baddeleyite (ZrO_2) and silica-rich phase. Modal abundances are heterogeneous among subsamples. Y 983119,35 has relatively normal modal abundance: Opx (44 vol. %), olivine (30 vol. %), plagioclase (8.7 vol. %) and Fe,Ni-metal (14 vol. %). On the other hand, Y 983119,51 and ,51-2 have modal abundances rich in Opx: Opx (71-73 vol. %), olivine (4.2-4.7 vol. %), plagioclase (13-14 vol. %) and Fe,Ni-metal (4.0-5.2 vol. %). Volume ratios of silicates of Y 983119,35 is plotted on the boundary of olivine gabbro/norite and ultramafic rock of classification scheme of mafic-ultramafic rock [2]. On the other hand, the ratios of Y 983119,51 and ,51-2 are plotted on the range of norite. The modes of Opx are much higher than those of other lodranites,

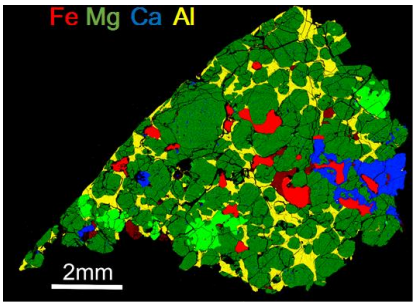

Fig. 1. Combined elemental map of Y 983119, 51. Opx, dark green; olivine, light green; plagioclase, yellow; augite, blue; metal phases, red.

Mineral compositions of Y 983119 are nearly homogenous among the sections studied here. Major compositions of all constituent minerals are on the boundaries of compositional ranges of acapulcoites and lodranites: olivine, Fo_{97}; Opx, $Wo_{2.3}En_{94}$; augite, $Wo_{45}En_{53}$; plagioclase, $Or_{1.7}Ab_{70}$. These compositions are similar with those of some lodranites such as Gibson (olivine, Fo_{97}; Opx, $Wo_{2.1}En_{92}$) [1]. Few olivine grains in Y 983119,35 show normal zoning ($Fo_{94\text{-}97}$) along rim and cracks with increasing of FeO and decreasing of CaO and MgO.

All major mineral compositions and correlation between Fo# and O-isotopic compositions are consistent with classification of Y 983119 as a lodranite. However, the lithology in Y 983119 is unusually rich in Opx. Only one unique meteorite Frontier Mountain (FRO) 93001 has modal abundance rich in Opx [3]. FRO 93001 has chemical compositions of olivine and Opx different from those of Y 983119. Therefore, we suggest that Y 983119 is a unique lodranite rich in Opx.

The plausible formation process for the Opx-rich lithology is high-degree of partial melting and crystal accumulation. Folco et al. [3] imply that higher degree of melting of acapulcoite model composition more than 35 wt. % (about 80 wt. %) at 1600°C and under reducing conditions could make Opx-rich and olivine-poor modal abundance with magnesian composition. In fact, Mg/Mn rations of olivine (Mg/Mn = ~280-320) and Opx (Mg/Mn = ~170-190) in Y 983119 are higher than other acapulcoites and lodranites (olivine, Mg/Mn = ~140-250; Opx, Mg/Mn = ~100-120). Goodrich and Delaney [4] indicate that higher Mg/Mn ratio result from higher-degree of partial melting. Therefore, we suggest that Y 983119 represents one of the most melted lithology of acapulcoite-lodranite parent planetesimal.

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