BL-3A/2016G123

X-ray diffraction analysis of primitive micrometeorites recovered from Antarctic surface snow

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1 Introduction

Micrometeorites (MMs) are extraterrestrial materials smaller than 1mm in size, that retain information about primitive bodies formed in the early solar system. MMs recovered from the Antarctic surface snow are much less affected by terrestrial weathering than those from Antarctic blue ice fields [1], and it has been reported that the snow-MMs include samples that originate from comets [2]. In order to investigate bulk mineralogy of snow-MMs, we performed synchrotron X-ray diffraction analysis on each MMs.

2 Experiments

Surface snow (~700kg) were collected at around Talos Dome in Antarctica by the Korea Polar Research Institute in November 2015. After melting and filtering of the snow, we identified MMs which have chemical composition close to the sun by using SEM/EDS. Then the MMs were attached to the top of carbon fiber (5um diameter) with glycol phthalate. Irradiating to synchrotron X-ray for one hour at beamline 3A, we obtained X-ray diffraction pattern and identified the mineral composition of each MM. Then the MMs were embedded in epoxy resin and sliced to 70nm thick ultra-tin sections by microtome for FE-TEM/EDS analysis, and remaining MMs on epoxy surface were coated by carbon deposition to be observed by FE-SEM/EDS.

3 Results and Discussion

X-ray diffraction pattern of ROP23O10 shows that this MM consists of crystalline olivine and pyroxene (Fig.1). The relatively large crystal located at the top of ROP23O10 is pure forsterite and the small crystal at central part is augite (Fig.2). On the other hand, fine-grained portions show chemical composition close to serpentine, while serpentine was not identified in the X-ray diffraction pattern. Therefore, original serpentine was dehydrated and decomposed to olivine by heating. Quantitative elemental analysis by FE-SEM/EDS shows that FeO contents of fine-grained olivines are low (Fe/(Mg+Fe)=0.25~0.30) and correspond with compositional range of CM chondrite matrix. (Fig. 2).

According to heating experiments of Murchison CM chondirte [3], the temperature at which matrix serpentine decomposes to well-crystalline secondary olivine is estimated to be 900℃ to 1000℃. Consequently, there is a possibility that ROP23O10 also experienced similar heating when entered the atmosphere. We conclude that ROP23O10 was originated from a small body made of primitive material similar to CM chondrites whose serpentine was dehydrated and decomposed by heating above 900 ° C when entered the atmosphere.

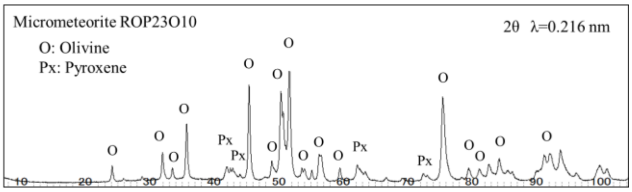

Fig.1: X-ray diffraction pattern of ROP23O10.

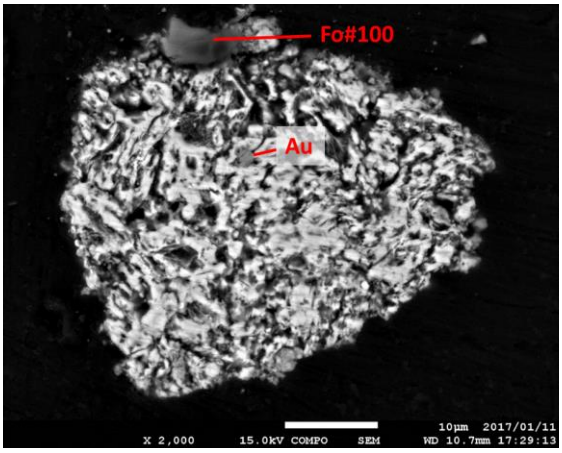

Fig.2: FE-SEM backscatter electron image of ROP23O10. All the fibrous bright crystals in this sample are low-FeO olivine. Fo = Forsterite, Au = Augite.

Acknowledgement

We thank Dr. Nakao for technical support during X-ray diffraction analysis.

References

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