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

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1 Introduction

Micrometeorites (MMs) are extraterrestrial material, 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 other fields on the earth. 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 of each MMs.

2 Experiments

Surface snow was collected at around Talos Dome and Dome C in Antarctica by the KOPRI (Korea Polar Research Institute), in November 2015, and the IPEV (Institut Polaire Francais Paul Emile Victor), in January 2016, respectively. After melting and filtering of the snow, by using SEM/EDS, we identified MMs which have chemical composition close to solar elemental abundance. Then each MM was attached to the top of carbon fiber (5um in diameter) with glycol phthalate. Irradiating it to synchrotron X-rays at beamline 3A, we obtained X-ray diffraction pattern and identified the mineral composition of each MM. Then the MM was embedded in epoxy resin and sliced to 70nm thick ultra-thin sections by ultra-microtome for FE-TEM/EDS analysis, and remaining portion of the MM exposed on epoxy surface was coated by carbon deposition to be observed by FE-SEM/EDS.

3 Results and Discussion

SSP4E5 is an unmelted MM and has S-rich composition relative to solar abundance. X-ray diffraction pattern of SSP4E5 shows broad (001) reflection of saponite and many sharp peaks of pyrrhotite, FeS-Fe_7S_8 (Fig.1). The mineral composition differs from any type of carbonaceous chondrites. Framboidal aggregates of pyrrhotite are found in this MM (Fig. 2) and this is the first report of this type of aggregates in meteorites. Selected-area electron diffraction by TEM indicates that the pyrrhotite grains are mostly hexagonal structure (Fig. 3). The aggregates appear to have formed during aqueous alteration, similar to the framboid aggregates of magnetite [3], but formation conditions and mechanism are not identified so far. This MM is a part of aqueously-altered primitive body with S-rich solution, which are responsible for the S-excess of the bulk MM and abundant aggregates of pyrrhotite.

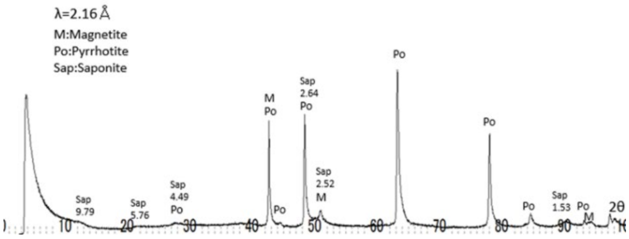

Fig.1 X-ray diffraction pattern of SSP4E5. The value below "sap" is D value of each peak.

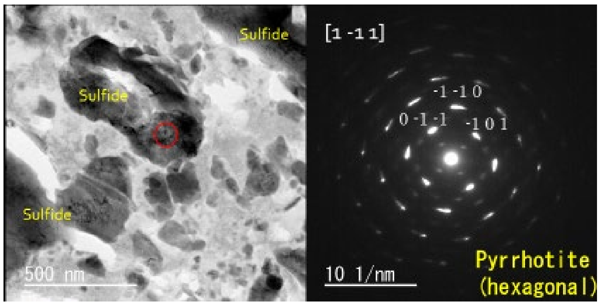

Fig.2 FE-SEM BSE image of a part of SSP4E5, showing framboidal iron sulphides (FeS-Fe_7S_8).

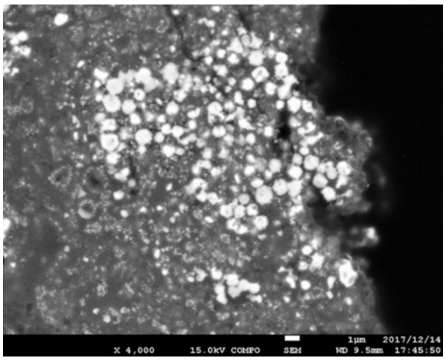

Fig.3 Diffraction pattern of pyrrhotite inSSP4E5. This grain shows hexagonal structure.

Acknowledgement

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References

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[2] Noguchi et al. (2015) Earth and Planetary Science Letters 410, 1-11.
[3] Kimura et al. (2013) Nature communications, 4, 2649.

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