BL-3A/2017G632

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

Shota Shimizu*, Tomoki Nakamura, Rina Oike,
Miki Takahashi and Yuma Enokido
Division of Earth Sciences, Graduate School of Science,
Tohoku University, Sendai 980-8576, Miyagi, Japan

1 Introduction

Micrometeorites (MMs) are extraterrestrial materials smaller than 1mm in size that are coming to the Earth from 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 of each MM and identified the mineral composition. 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

X-ray diffraction pattern of SSP3Q4 shows (002) reflection of tochilinite and many sharp peaks of serpentine (Fig.1). From the BSE images taken by FE-SEM/EDS, SSP3Q4 (Fig.2) shows bright and dark fibrous texture. The chemical composition of some points in this sample overlaps that of CM chondrite matrix. Composition of the dark fibrous region is similar to serpentine and that of bright one is similar to a mixture of serpentine and TCI (tochilinite-cronstedtite intergrowth). These analysis shows SSP3Q4 containing TCI.

TCI is produced during aqueous alteration in parent asteroid and decomposed at low temperature ~300°C. It is peculiarly observed in CM chondrites but has never been recognized in CM-chondritic MMs probably because it was decomposed by heating during atmospheric entry. This is the first MM that retains TCI that survived the entry heating.

Comparing diffraction pattern of Fig.1 with that of heated CM chondrite [3], this MM suffered <300°C heating. Average FeO/SiO_2 value in this TCI is 2.3, indicating low degrees of aqueous alteration [4].

We suppose that primitive MMs can reach to the earth that escaped even weak heating in the atmosphere.

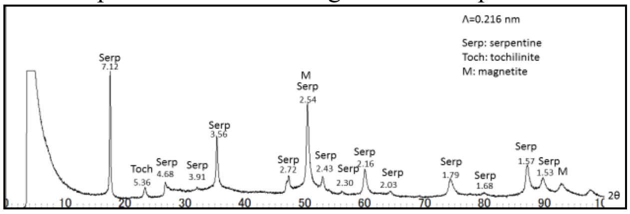

Fig.1 X-ray diffraction pattern of SSP3Q4. The value below the mineral name is D value of each peak.

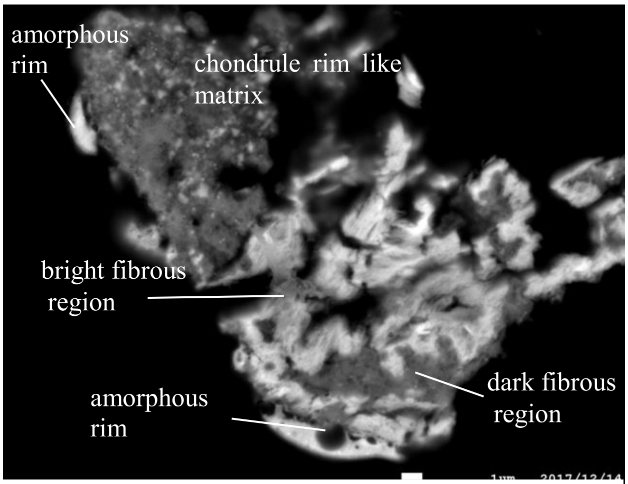

Fig.2 Fe-SEM BSE image of a part of SSP3Q4. In addition to two fibrous regions, overall texture and mineralogy are similar to CM chondrites.

Acknowledgement

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

References

[1] Duprat et al. (2007) Advance in Space Research 39, 605-611.
[2] Noguchi et al. (2015) Earth and Planetary Science Letters 410, 1-11.
[3] Nozaki et al. (2006) Meteoritic and Planetary Science 41, 7, 1095-1114.
[4] Rubin et al. (2007) Geochimica et Cosmochimica Acta, 71(9), 2361-2382.

*shota.shimizu.q4@dc.tohoku.ac.jp