Establishment of ice sublimation method for detection of soluble organic matter contained in Antarctic micrometeorites in Antarctic glacier ice

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Earth is habitable even in the inner planetary region where volatiles are depleted, so that there should be sources and mechanism to supply them to earth. It has been revealed by the recent exploration of outer planets and comets that volatile components such as water and organics exist abundantly in the outer planetary region, where it is colder than in the inner planetary region. According to the researches, the existence of organic matter cannot be ignored for understanding the nature of small bodies in the outer planetary region (e.g., bodies in Edgeworth Kuiper Belt bodies or Oort Cloud). As means to get samples of that region not in the space but on the Earth, there are Antarctic MicroMeteorites (AMMs) [1]. There are interplanetary dust particles (IDPs) drifting in the interplanetary space, ejected from small solar system bodies such as asteroids and comets. Those dusts are called micrometeorites when they fall to the earth, and they are called AMMs especially when they fall to the Antarctic ice sheets. The size of MMs is defined as less than 2 mm. The accretion rate of MMs reaching the Earth’ s surface has been estimated tens of thousand tons in the previous study, which is about ten times as much as the annual influx of meteorites to the Earth [2]. Since soluble organic matter (SOM) and insoluble organic matter (IOM) are present in the MMs, it is considered that MMs rather than meteorites dominantly contributed to the supply of volatile components to the inner planetary region where they were deficient [3].

In order to understand chemical characteristics of organics in IDPs, we are aiming for the detection of SOM in AMMs. While it is difficult to determine the structure of IOM because they are Kerogen-like macromolecules, the structure of SOM can be determined. Therefore, it can be the key of elucidating the evolution of materials (chemical reaction) in the low temperature environment of the outer solar system specifically. In the previous study, samples were collected by filtering the melted water, so that no molecular species were evidently identified to have originated from primitive MMs [4, 5]. In this study, ice blocks that were collected from an ice sheet in Antarctica were sublimated as it was in order to prevent the leakage of SOM during sample collection. The apparatus for sublimation of ice blocks consists of a vacuum chamber with a sample holding jig and a dish for collecting sublimation residue set in the climate chamber. In order to prevent the ice blocks from melting before it is enough evacuated, the temperature in the climate chamber was set at -10.0 degrees Celsius. The whole apparatus was set and cooled in advance in the climate chamber. After ice blocks were set on the jig in the vacuum chamber, evacuation was started. In order to increase the efficiency of sublimation, the temperature in the climate chamber was set at 40.0 degrees Celsius after the pressure in the chamber reaching about 80 Pa.

About 330 g of Antarctica ice blocks were sublimated experimentally using the above apparatus. The residue was observed with a stereoscopic microscope. Most of the residue was occupied with white aggregated particles. According to the part of the observation by SEM-EDS, it was found that they are composed of Na, Cl, Ca, C, O and other elements. Their chemical compositions indicate that they should be marine or continental aerosols [6]. Particles composed of silicate minerals containing Mg and Fe were also found in the residue. The composition of them is consistent with that of AMMs [7]. However, it needs

to be confirmed whether it is AMM by analytical methods such as μ-FTIR, μ-Raman, DESI-Orbitrap MAS and so on. We are planning to analyze samples in various ways, mainly on the degree of polymerization of insoluble organic matter and identification of soluble organic matter.

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