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Micrometeorites discovered from surface snow near the Dome Fuji station, Antarctica

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Introduction: Vast majority of Antarctic micrometeorites (AMMs) were derived from asteroids experienced heavy aqueous alteration. However, until recently, AMMs that are similar to chondritic porous interplanetary dust particles (CP IDPs) have not been recognized. Yada et al. [1] analyzed ultracarbonaceous AMMs found by our group and found that it contains a high abundance of presolar silicates (about 1200 ppm) that is the second highest value found among extraterrestrial material. AMMs have been collected from fine-grained deposit from water formed by melting of bare ice. Recently some porous AMMs were discovered among fine-grained samples collected by melting snow near Dome C Station by European researchers [2]. In this study, we report characteristics of AMMs collected from fine-grained precipitate after filtering of melted snow collected near Dome Fuji Station.

Samples and methods: Surface unconsolidated snow collected in the vicinity of Dome Fuji Station was returned to the National Institute of Polar Research in 2004. It was transferred to a clean room (class 1000) at Ibaraki University. During transfer, the snow sample was kept well below 0 oC. The snow was melted and filtered by using a multiple suction filtration in the clean room. It took about 2 months to filter the entire snow sample. 746 fine-grained residual particles were picked up and placed on platinum plates under a stereomicroscope in a clean bench (class 100) in the clean room. The particles were observed by SEM and chemical compositions were measured by EDS equipped on the SEM to find AMMs. After SEM/EDS observation and analysis, micro-Raman spectroscopy was performed at Ibaraki University to investigate carbonaceous materials and coexisting minerals in the AMMs. Bulk mineralogy of 8 AMMs was determined by synchrotron radiation X-ray diffraction (SR-XRD) at KEK-PF and SPring-8. 3D-structure of one highly-porous AMM was investigated by micro-CT at SPring-8 [3].

Result and discussion: Forty-nine particles were recognized as AMMs based on their morphology and surface chemistry. Partially melted AMMs and cosmic spherules occupy 8 and 18 %, respectively. This result presents a beautiful contrast to AMMs collected from melted ice. They contain 37 % scoreaceous AMMs (weakly to heavily melted) and 48 % spherules. The majority of the AMMs experienced very weak to slight heating. Most of them have highly porous morphology comparable to CP IDPs. We found only one AMM containing framboidal aggregates of magnetite, which is common to AMMs derived from asteroids. SR-XRD data of 8 AMMs indicates that all of them contain abundant primary olivine and low-Ca pyroxene with small amounts of kamacite and/or taenite, and in some cases, magnetite. It is clear that the proportion of CP IDP-like particles among AMMs collected from surface snow is incredibly higher than that in AMMs collected from bare ice. Raman spectroscopy of the AMMs shows that 29 % of them have remarkable Raman shift bands of amorphous carbon (D and G bands) and 49 % of them do not show the bands. However, EDS spectra of these AMMs show that area intensity of the D and G bands does not correlate with intensity of C Kalpha normalized by that of O Kalpha in the AMM and CI (Orgueil). Wopenka [4] stated that highly disordered carbonaceous materials in IDPs do not show the D and G bands. Our data support his statement because about 80% of ultracarbonaceous AMMs (larger than x 10 of (intensity of C Kalpha/that of O Kalpha)CI) do not show the D and G bands. On the contrary, AMMs having remarkable D and G bands are concentrated around x 0.9 to 5 of (intensity of C Kalpha/that of O Kalpha)CI. These differences may be related to their origins.

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References: [1] Yada et al. (2006) LPSC, [2] Duprat et al. (2004) LPSC, [3] Tsuchiyama et al. (2006) LPSC, [4] Wopenka (1988) EPSL.