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The mineralogy and mineral chemistry of micrometeorites recovered from Antarctic snow

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Cosmic dust is extraterrestrial particles smaller than 1mm. It occupies ninety percent of the mass of extraterrestrial material coming to the Earth. Every year 4 tons of cosmic dust is accreting, but only small fraction survives heating upon atmosphere entry. Cosmic dust is supplied by both asteroids and comets, which is in contrast to meteorites that originate mainly from asteroids. In this study, I studied Antarctic micrometeorites (AMMs) recovered from the surface snow in order to characterize bulk mineralogy and major element abundances and to elucidate mineralogical characteristics of their parental objects. AMMs were usually recovered from blue ice fields, and they are old dust having been present in space more than 30000 years from now. On the other hand, AMMs used in this study are contemporary dust being present in the interplanetary space, because they fell to the Earth with snow a few years ago.

135kg snow was melted and dark-colored particles were hand-picked from filters collecting particles from snow-melt water. The identification of AMMS is based on major element (Fe, Mg, Si) abundance of the sample surfaces obtained by using a scanning electron microscope equipped with energy dispersive spectrometer (SEM / EDS). The bulk mineralogy was determined by synchrotron X-ray diffraction using Gandolfi camera. For observation of internal texture, individual AMMs were embedded in glycol phthalate and polished to have flat surfaces. After being carbon coated, they were analyzed using an electron probe microanalyzer (EPMA).

33 particles were identified as AMMs. AMMs are divided into three groups based on the degree of melting: unmelt AMMs that were not melting, scoria AMMs that experienced partial melting, and spherule AMMs that experienced total melting. In this study, most particles were classified to unmelt AMMs. According to the results of X-ray diffraction analysis, there are two types of AMMs. One is rich in olivine and pyroxene, and another is rich in phyllosilicate. EPMA analysis indicates that the average bulk major element abundances of those AMMs are generally similar to solar abundance although decreases in some certain elements occur because of evaporation during entry heating and terrestrial alteration.

Based on the results of a series of analyses, parent objects of AMMs recovered from surface snow are estimated. OTP1I11 consists mainly of micron-size olivine and low-Ca pyroxene with wide ranges of Fe/Mg rations. The mineralogy is not similar to any kinds of chondrites and therefore it might originate from a comet. It is expected that we can know the range of variation of constitute minerals in a single comet in the future study of this sample, because the OTP1I11 is much larger than anhydrous IDPs that also might originate from comets. OTP1H13 might originate from an asteroid experienced thermal metamorphism and similar to equilibrated H chondrites. OTP4F6 might originate from an asteroid experienced aqueous alteration is similar to CM chondrites. 9 samples are rich in saponite and pyrrhotite with minor amounts of serpentine and carbonate. Their mineralogy is similar to each other and thus they might come from a single parent object and were broken up on the Earth. Their mineralogy is not similar to any other meteorites and IDPs.

Therefore, it is possible that those AMMs are a new type of extraterrestrial material.

Keywords: Antarctic micrometeorites, Mineralogy