

Discovery of Antarctic micrometeorites containing tochilinite and pyrrhotite framboid.

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Antarctic micrometeorites (AMMs) collected from recent snow are among the best preserved extraterrestrial material (e.g. Duprat et al. 2007). Some AMMs come from the outer regions of the solar system, therefore to derive information from there, such AMMs are better material than meteorites. We have collected AMMs in Antarctica in corporation with KOPRI (Korea Polar Research Institute) since 2013. In addition, we examined AMMs from a filter recovered by CSNSM (France) with supported from IPEV (Institut Polaire Francais Paul Emile Victor, French polar institute). We investigated mineralogy and chemistry using synchrotron-XRD, FE-SEM/EDS and FE-TEM/EDS. Among the AMMs we studied, we focus on two AMMs, SSP3Q4 and SSP4E5, because we found they retain valuable information.

The synchrotron X-ray diffraction pattern of SSP3Q4 shows clear peaks for tochilinite and cronstedtite. FE-SEM BSE image of a cross section shows blight fibrous material with a composition enriched in S and Fe. These results indicate that SSP3Q4 contains TCIs (Tochilinite Cronstedtite Intergrowths). This is the first occurrence of an AMM that contains pristine TCIs (without thermal decomposition) as a major phase. This AMM provides a direct link between AMMs and CM chondrites. Although many AMMs have been classified related to CM-type chondritic material from their mineralogical feature (e. g., Kurat et al. 1994, Nakamura et al. 2001), TCIs are decomposed by low-temperature heating and therefore had never been found in AMMs as a major phase. This AMM has suffered <300°C heating during atmospheric entry, because tochilinite decomposes at 300°C (Nozaki et al. 2006). This finding indicates that there are AMMs that experienced atmospheric-entry heating as low as <300°C, which suggests that the major fraction of organic matter in such AMMs can survive atmospheric entry without significant structural modification. SSP4E5 is a sulfide-rich hydrous type AMM. XRD analysis shows that the major phyllosilicate is saponite and the sulfide is pyrrhotite. FE-SEM BSE shows that this AMM consists entirely of fine-grained material, like the matrix of carbonaceous chondrites, but ubiquitously contains pyrrhotite. Pyrrhotites mainly occurs in two forms, isolated grains and framboids. The isolated grains are 1~10 μm in size and distributed over the entire area. On the other hand, the framboids are 20~30 μm cluster of ~1 μm sized pyrrhotite particles and occur in two place. Framboidal magnetite is common in hydrous carbonaceous chondrites such as CIs and Tagish Lake, but framboidal pyrrhotite has never been observed in AMMs and primitive meteorites to our knowledge. In addition, the bulk composition of this AMM is also unique: it shows Mg-poor and S-rich composition, probably because saponite is enriched in Fe and submicron-size pyrrhotite is abundant. In the Si-Mg-Fe ternary diagram, the composition falls in a place outside the compositional fields of known hydrous carbonaceous chondrite matrix (CI, CM, CR, Tagish Lake carbonate-poor and carbonate-rich lithology). The presence of framboidal pyrrhotite and its characteristic chemical composition reveal that SSP4E5 is possibly derived from a unique primitive hydrated parent body.

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