Unique hydrous micrometeorites found from the snow near the Dome Fuji Station: primitive materials with characteristics different from major types of carbonaceous chondrites. K. Sakamoto[1], T. Nakamura[1], T. Noguchi[2], and A. Tsuchiyama[3], [1] Department of Earth and Planetary Science, Faculty of Science, Kyushu University, Hakozaki, Fukuoka 812-8581, Japan (kanako@geo.kyushu-u.ac.jp), [2]Department of Materials and Biological Sciences, Ibaraki University, 2-1-1 Bunkyo, Mito 310-8512, Japan, [3] Department of Earth and Space Science, Graduate School of Science, Osaka University, Toyonaka 560-0043, Japan.

Introduction: Micrometeorites (MMs) from Antarctic surface are preserved intact mineralogical and chemical characteristics due to very low alteration degrees compared with sample from Antarctic blue ice field [1]. The snow MMs are characterized by a high content of Fe-sulfides and an undepleted CI elemental abundance pattern of their fine-grained matrix [1]. In addition, the snow MMs, we found in the present study, accreted onto the earth during last two years, whereas blue-ice MMs fell several tens of thousand years ago [2]. Therefore, the snow MMs represents current dust conditions of the interplanetary space near the earth. Following to the French science team [1], our Japanese team was succeeded to recover MMs from surface snow at DF80 site, 7 km south from Dome Fuji Station [3], owing to the efforts provided by the members of the 47th and 46th Japan Antarctic Research Expedition Team.

Experimental procedures: Snow was cryogenically-preserved and transferred to the National Institute of Polar Research, and then transferred from the institute to a class 1000 clean room at Ibaraki University. In the clean room, the snow was melted gently. Formed water, approximately 7.4 kg, was filtered to collect fine-grained particles. MMs candidates were picked up under a stereobionocular, which sets in a class 100 clean bench in the clean room. The candidates were examined by scanning electron microscope equipped with energy dispersive spectrometer to identify MMs.

Then we have investigated bulk mineralogy of individual MMs by synchrotron radiation X-ray diffraction using Gandolfi camera. Micro-texture was observed by FE-SEM/EDS (JEOL JSM-7001F, Oxford INCA Energy 250) and bulk composition was obtained using spot beam by an electron probe analyzer. Oxygen isotope measurements with SIMS and high resolution imaging using transmission electron microscopy are currently in progress.

Results and discussion: We hand-picked from filters 110 particles of MM candidates and identified 11 particles as true MMs. Six of them (SK series) show very similar mineralogy and morphology, and thus they might have been originally a part of a larger dust clump. They are very porous aggregates of fine-grained mineral phases (Fig. 1a). In the rest of the paper, we concentrate to describe and discuss the mineralogy of SK series.

They have following mineralogical features in common: (1) major minerals are pyrrhotite, phyllosilicates and Fe-Mg carbonate, (2) phyllosilicates are serpentine and saponite and the former tends to be higher in abundance than the latter, (3) pyrrhotite is the dominant sulfide, (4) Fe-Mg carbonate has high Mg/Fe ratios, (5) magnetite is very minor or absent, and (6) anhydrous silicates are absent. X-ray diffraction (XRD) pattern taken from one of SK series is shown in Figure 2a. SK series have experienced weak heating at temperature lower than 500°C during atmospheric entry. Because the decomposition temperatures for Fe-Mg carbonate, serpentine, and saponite are 500 to 600, 600, and 700°C, respectively [5].

FE-SEM observation revealed that there are fine- and coarse-grained phyllosilicates. Coarse-grained phyllosilicates are about 100nm. Fine-grained phyllosilicates are incomprehensible in SEM images. Most pyrrhotite is round or subround, ranging typically from several tens nm to several hundred nm, but occasionally up to 1μm in size. Platy morphology rarely occurs. Furthermore, one of SK series has a large pyrrhotite grain that accounts for approximately half of the MM. Carbonate from 500nm to 1μm in size is commonly observed. In back-scattered images, most carbonate forms globules with cores made of low-Z material or vacancy (Fig. 1b). It is known that carbonate and pyrrhotite are soluble in water and therefore their survival confirms that SK series from surface snow experienced a very low degree of weathering process at Antarctica.

Electron-probe analysis of a polished surface of one MM showed that it has bulk elemental composition close to CI (Fig. 1c), but minor depletions in the elements Al, Ca and Ni and an enrichment in K are observed (Fig. 1d). Compositions of snow MMs recovered by the French team [1] are much closer to the CI reference value, suggesting that short-residence in snow does not result in any depletion or elevation of particular elements. Therefore, the deviation from CI values observed in SK series is indigenous features established before falling to the snow. Ca depletion is probably due to the dissolution in solution during aqueous alteration on the meteorite parent body, analogous to the same Ca depletion observed in the matrix of Tagish Lake meteorite [6] (Fig. 1d). On the other hand, K enrichment is observed in an entire portion of the MM, but the reason for the enrichment cannot be made clear at present, because phases responsible for the enrichment were not identified.

The presence of abundant phyllosilicates and carbonates and the absence of anhydrous silicates clearly indicate that SK series come from a parental object where aqueous alteration was prevailed. Carbonaceous chondrites are known to exhibit a variety of mineralogy of hydrous phases, but those that contain both saponite and serpentine are very minor. Among matrix samples from major types of carbonaceous chondrites that we have X-rayed for diffraction (CI, CM, CV, CR and Tagish Lake meteorite of both carbonate-rich and -poor lithology [e. g., [7]]), only two types, CI chondrite (Fig. 2b) and Tagish Lake with carbonate-poor lithology (Fig. 2c), contain both saponite and serpentine.

As shown in XRD patterns (Figs. 2a~c), phyllosilicate mineralogy is similar between SK series and the two meteorite matrices. However, the followings differ between them: (1) Tagish Lake carbonate-poor lithology contains pyrrhotite, but it is less abundant than SK series. Pyrrhotite is not detected from Orgueil CI chondrite. (2) While magnetite is very minor or absent in SK series, it is very abundant in the two chondrites. (3) All three contain carbonate, but carbonate mineralogy is different. Dolomite and Mg-Fe carbonate are the main carbonate phases in the two chondrites and SK series, respectively. Orgueil CI chondrite also contains calcite. (4) Most Fe-sulfides analyzed are pyrrhotite in SK series, but Tagish Lake carbonate-poor lithology contains both pentlandite and pyrrhotite.

SK series bear similarities in phyllosilicate mineralogy to Tagish Lake carbonate-poor lithology and CI chondrite, but are distinct in non-phyllosilicate mineralogy from both. Therefore, SK series originated from a hydrated parental object with mineralogy different from major types of carbonaceous chondrites.

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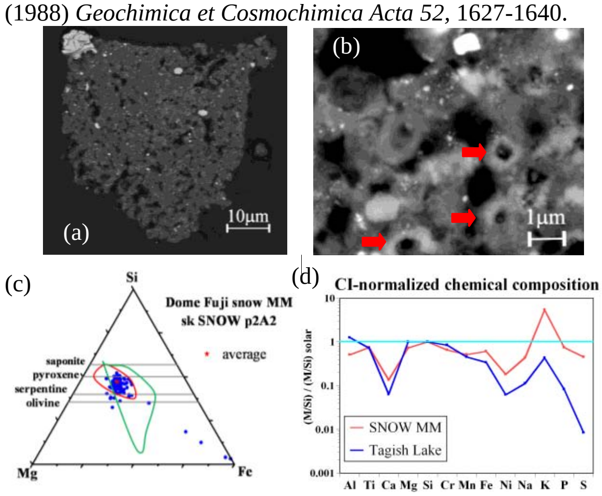

Fig. 1 Micrometeorite SK series; sk SNOW p2A2. (a) A BSE image of a cross-section, showing that it is a porous aggregate. (b) A BSE image of globules. Some of them are indicated by arrows. (c) Bulk chemical composition. Red line is CI compositional field [8], and green line is Tagish Lake compositional field [7]. (d) CI-normalized bulk chemical composition (Tagish Lake data from [6]).

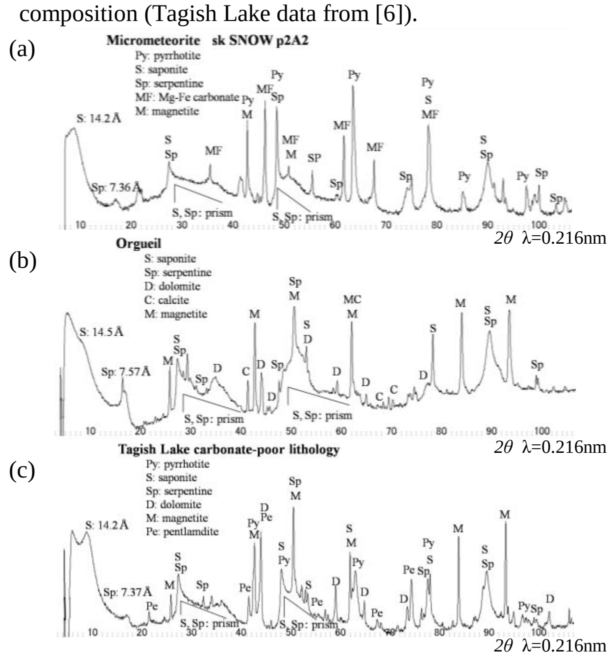

Fig.2 XRD pattern: (a) Micrometeorite SK series; sk SNOW p2A2 (b) Orgueil CI chondrite. (c) Tagish Lake carbonate-poor lithology.