PETROLOGY AND MINERALOGY OF MICROMETEORITES FROM TOTTUKI COAST IN ANTARCTICA. N. Imae[1], E. Dobrica[2], C. Engrand[2], J. Duprat[2], and N. Iwata[3], [1]National Institute of Polar Research, Kaga 1-chome, Itabashi-ku, Tokyo 173-8515, Japan, imae@nipr.ac.jp, [2]C.S.N.S.M., Bat 104, 91405 Orsay-Campus, France, [3]Department of Earth and Environmental Sciences, Yamagata University, 1-4-12, Kojirakawa, Yamagata 990-8560.

Introduction: Antarctic micrometeorites have been collected from several sampling sites: bare icefields near the Cap-Prudhomme [1] and Tottuki [2] coasts, surface snows at the top of the Antarctic icesheet at Dome C [3] and Dome F [4], the meteorite icefield around the Yamato mountains [5], the South Pole water well [6], aeolian deposits [7], and sediments at the top of Transantarctic mountains [8]. There could be local and secular variations of the nature and composition of micrometeorites. Thus it is important to recognize the petrological mineralogical characteristics in a sampling field for micrometeorite and to compare the differences and similarities with micrometeorites from different fields.

Abundant micrometeorites have been successfully recovered from the bare icefield of the Tottuki coast by the 41st Japanese Antarctic Research Expedition (JARE-41) in 2000 using the in-situ collection method by melting of ~50 m^3 of ice and filtering ~40 m^3 of water [2,9]. Micrometeorites similar to interplanetary dust particles collected at stratosphere have been found [10], and other kinds of micrometeorites have also been also collected effectively. In the present study, we studied micrometeorites identified from a filter in order to characterize the micrometeorites from the Tottuki bare icefield petrologically and mineralogically in detail.

Experiments: We used "the number 1 filter" of 100-238 μm [2]. The 150 micrometeorite candidates were picked up under an optical microscope, and each was set on glass holder in NIPR. After taking photographs of each candidate under an optical microscope, they were mounted on carbon tape in Orsay (France) for scannning electron microscopy (SEM) of their external surfaces. Fragile and scoriaceous particles are divided into two, one fragment was mounted on the carbon tape, and the other one was stored. 20-30 candidates in average were put on a single stub, and 6 stubs were prepared. After the carbon coating for stubs, the extraterrestrial (or terrestrial) nature of the particles was determined using SEM-EDS (PHILIPS XL30) in Department of Geology in Orsay. The identification criterion at the first stage is based both on the external texture and the EDS spectra [e.g., 3].

After the SEM-EDS analyses, the six stubs were mounted into epoxy resin to make polished sections using polishing steps of 12 μm, 6 μm, 3 μm, and 0.25 μm. We studied the polished section with an electron microprobe (CAMECA SX100) in Paris VI University, at 15 kV and 10 nA with focused beam for minerals and defocused beam (10 μm) for bulk compositions. Bulk compositions were determined for fine-grained micrometeorites of 9 cosmic spherules and one scoriaceous micrometeorite.

Here we will use names as TT001b001, where "TT" denotes Tottuki, "00" the last 2 digit of the millennium year for the collection, "1" the number of the filter, and "b" characterizes the present size fraction (100-238 μm). Different filter sizes yielded size ranges from "a" (> 238 μm) to "d" (10-40 μm). The last three digits represent the grain number.

Results: SEM-EDS and EMPA studies suggest that 52 grains are extraterrestrial among 150 candidates. Based on classification of [11], these particles are classified into 37 stony melted micrometeorites (cosmic spherules), 13 scoreaceous micrometeorites, 1 coarse-grained unmelted micrometeorite, and 1 fine-grained unmelted micrometeorite. Typical terrestrial particles are rust grains, stainless steel spherules, organics, and mineral fragments.

Stony cosmic spherules are the most abundant. They are subdivided into glassy, porphyritic olivine, barred olivine, and fine-grained or micro porphyritic olivines coexisting with magnetite (Fig. 1a). Two stony cosmic spherules (one glassy and one porphyritic olivine type) exhibiting iron oxide similar to ferrihydrite that was described by [12] were found (TT001b118, Fig. 1b). Unmelted and scoriaceous micrometeorites are shown in Figs. 1c and 1d, respectively. No metallic type I cosmic spherules were found.

The constituent phases for the 52 micrometeorites and cosmic spherules are olivine, low Ca pyroxene, magnetite, Cr-bearing magnetite, iron oxide, a silica mineral, and glass. The most common and abundant mineral is olivine, including primary and secondary. Primary olivines occur as relict mineral in the core of porphyritic olivines in two stony spherules (TT001b108, Figs. 1a and 2) with the forsteritic composition of $Fa_{99.05}$ (Fig. 2). Barred olivines and microporphyrictic olivines in cosmic spherule with the ferroan composition (Fa_{10-48}) (Fig. 2) are of secondary origin. They crystallized from the melt formed during the atmospheric entry heating. The secondary olivine tends to include small amount of NiO (≥0.2-0.3 wt%), whereas relict olivine do not contain NiO (Fig. 2). The unmelted micrometeorite TT001b005 consists of coarse-grained enstatite (Fig. 1c) with a small compositional range is small to be $En_{96\text{-}96.7}Fs_{3\text{-}3.5}Wo_{0.4\text{-}0.5}$.

Discussion: The forsteritic relict olivine in T001b108 (CS) and the unmelted enstatite in T001b005 suggest that the primary materials of these micrometeorites were unequilibrated chondritic material. The unique texture of TT001b118 (Fig. 1b) is very similar to a micrometeorite from Cap-Prudhomme [1,12], suggesting the separation of silicate-metallic phases during the atmospheric entry heating. Bulk compositions for 9 cosmic spherules and a scoriaceous micrometeorite (Fig. 3) suggest that (1) Mg/Si ratios are nearly chondritic but more variable than meteoritic chondrites (0.8-1.3), and (2) the Na loss for the scoriaceous micrometeorite is much smaller than that of cosmic spherules, but a small amount of Na is detected for cosmic spherules.

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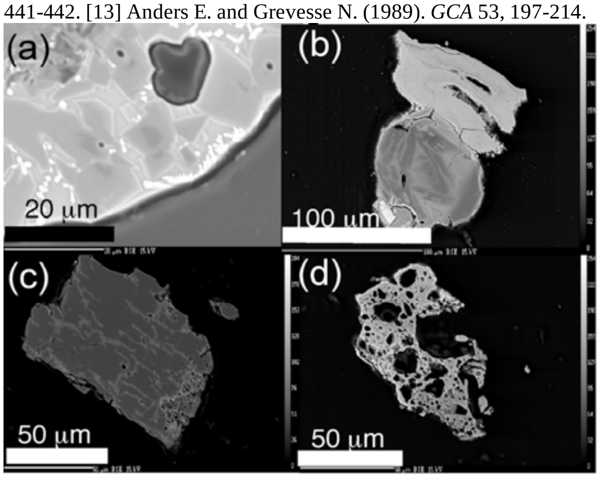

Fig. 1. (a) High magnification image of a cosmic spherule (TT001b108), consisting of porphyritic olivines, magnetite, and glass. There are relict forsteritic olivine cores in porphyritic olivines, that survived atmospheric entry heating. (b) Cosmic spherule TT001b118 with accompanying iron oxide. (c) Unmelted micrometeorite (TT001b005) consisting of enstatite. The interior of the enstatite partially decomposes into phases with ferroan, Ca-rich, and aluminous composition. (d) A scoriaceous micrometeorite (TT001b001).

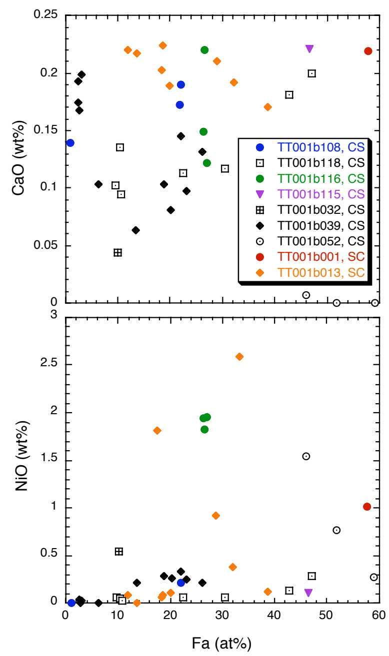

Fig. 2. Composition of olivines. CS = cosmic spherule. SC = scoriaceous micrometeorite.

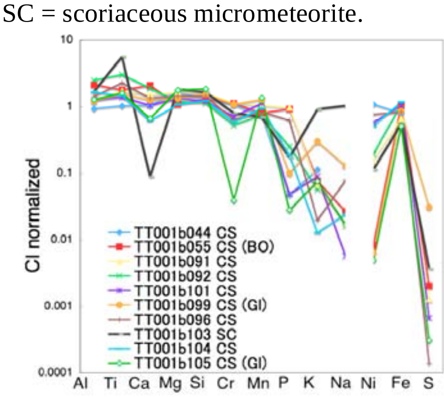

Fig. 3. Bulk compositions of 9 cosmic spherules and one scoriaceous micrometeorite normalized to the CI chondrite [13]. CS = cosmic spherule. BO = barred olivine. Gl = glass. SC = scoriaceous micrometeorite. We find that the loss of alkalis elements for scoriaceous micrometeorite (TT001b103) is much less than those for cosmic spherules.