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Preliminary examination of Hayabusa asteroidal samples: Overview by university consortium team

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The Hayabusa spacecraft arrived at S-type Asteroid 25143 Itokawa in November 2006, and reveal astounding features of the small asteroid [1]. Near-infrared spectral shape indicates that the surface of this body has a material similar to that of LL5 or LL6 chondrites [2]. Many small particles (at least >1500 particles; mostly <10 micron and some larger particles of >~100 micron) were successfully collected from MUSES-C region. Tentative analysis with SEM/EDX at the curation facility of JAXA showed that olivine (Fa28;/-4), low-Ca pyroxene (Fs23+/-6), high-Ca pyroxene (Fs12+/-9Wo38+/-6), plagioclase (Ab86+/-7) are identified as major phases with minor amounts of Fe-Ni metal, chromite, Ca phosphate, silica minerals and K-bearing halite [3]. About fifty particles of 30-150 microns were allocated for the preliminary examination (PE) by university consortium team.

The basic goals of PE are as follows. (1) Characterization of the surface material of Itokawa, such as classification, formation age, and formation process and conditions. (2) Understanding of processes on a preexisting parent body of Itokawa and accretion into Itokawa, such as examination of brecciation, degrees of impact, etc. (3) Understanding of interaction with space environment, such as space weathering, and isotopic compositions of oxygen and noble gases of the solar wind. (4) Finding foreign substances fallen onto the surface, such as carbonaceous and organic materials and differentiated materials (granitic materials and halite).

The policies of PE are follows. (1) As the sample is not suffered from terrestrial contamination, we make maximum consideration to avoid terrestrial contamination, and obtain data that cannot be obtained from meteorites, such as space weathering, solar wind isotopic compositions, and organic materials. (2) We have to obtain as much data as possible effectively even from a small amount of samples by systematic analyses from non-destructive to destructive ways with minimum contamination in upstream analysis.

We have seven sub-teams; (1) mineralogy and petrology, (2) 3-D structures, (3) elemental compositions, (4) isotopic and minor elemental compositions, (5) noble gas, (6) carbonaceous matter, and (7) organic compounds. PE flow chart is mainly divided into two parts: mainstream and individual analysis flows for specific purposes. In the mainstream, allocated particles have been already measured by non-destructive analyses at Spring-8 and KEK, Japan. 3-D structures, mineral compositions and elemental compositions will be determined by micro-tomography, XRD and XRF, respectively. Based on the non-destructive information, each particle will be cut for later destructive analyses by TEM, SEM, EPMA and SIMS. If carbon is present in the cross section, organic analyses will be made with X-PEEM/XANES and TOF-SIMS.

The following three individual analysis flows are scheduled. (i) Carbonaceous matter on the surfaces will be examined by micro-Raman/IR/fluorescence. Organic materials will be extracted form the particles and analyzed. After the extraction, the residual solid particles will move to the elemental analysis by INAA. If radioactivity is lower than the threshold, the particles will move to the mainstream. (ii) Noble gas analysis will be made using mass spectrometry without exposing particles into the air. (iii) Space weathering will be examined with a TEM. The samples were prepared carefully to avoid oxidation of Fe metal nano-grains. Potted butts will move to the mainstream. Any suitable sample for isotopic analysis of solar wind oxygen, such as a large single particle of metallic iron or iron sulfide, has not been found at this moment. Result of each analysis will be presented by CoIs of the sub-team in this conference.

[1] Fujiwara A. et al. (2006) Science, 312, 1330-1334. [2] Abe M. et al. Science, 312, 1334-1338. [3] Nakamura T. et al. (2011) abstract in 42nd LPSC.

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