Asteroid Itokawa sample curation and distribution in the Planetary Material Sample Curation Facility of JAXA.

*T. Yada[1,2], A. Fujimura[1,2], M. Abe[2,1], T. Okada[2,1], Y. Ishibashi[1], K. Shirai[2], M. Uesugi[1], Y. Karouji[1], S. Yakame[4], T. Nakamura[5], T. Noguchi[6], R. Okazaki[7], T. Mukai[3], M. Ueno[2,1], M. Yoshikawa[2,1] and J. Kawaguchi[1,2], [1]JAXA's Space Explor. Center and [2]Inst. Space Astronautical Sci., [3]Japan Aerospace Explor. Agency, 3-1-1 Yoshinodai, Chuo, Sagamihara, Kanagawa 252-5210, JAPAN (yada@planeta.sci.isas.jaxa.jp), [4]Dept. Earth Planet. Sci. Grad. Sch. Sci., Univ. Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, JAPAN, [5]Dept. Earth Sci., Grad. Sch. Sci., Tohoku Univ., 6-3, Aramaki Aza Aoba, Aoba-ku, Sendai, Miyagi 980-8578 JAPAN, [6]College Sci., Ibaraki Univ., 2-1-1 Bunkyo, Mito, Ibaraki 310-8512, JAPAN, [7]Dept. Earth Planet. Sci., Grad. Sch. Sci., Kyushu Univ., 6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581, JAPAN.

Introduction:

Meteorites are long thought to originate from asteroids, small bodies mainly orbiting between Mars and Jupiter. However, that can be only clarified by getting asteroid's samples and compare them with the meteorites to certify that they are same.

The Hayabusa spacecraft launched to depart the Earth in 2003, reached to near-Earth asteroid Itokawa and performed sample collections in 2005, and successfully returned its reentry capsule to the Earth in 2010 [1, 2]. The reentry capsule was returned to Japan and processed in the Planetary Material Sample Curation Facility of JAXA, and recovered particles shows the characteristics of equilibrated L or LL chondrites, the first direct evidence of asteroid as meteorites origin [3-8].

Hereafter, we review how a series of curation works goes in the facility and a future plan for sample distribution.

Sample recovery, initial description, preservation and distribution for initial analyses:

As the capsule was discovered and recovered in the Woomera prohibited area in Australia and brought back to Japan, a planetary material sample curation facility of JAXA in Sagamihara. A sample container was extracted from the capsule and introduced into clean chambers to be opened in vacuum, and a sample catcher was extracted from the container in order to recover particles which should have been gathered when the spacecraft had accomplished touchdown onto the surface of asteroid Itokawa. The environment of the facility and processes experienced by the capsule and container is detailed in [9].

Whole the processes to recover the particles have been performed in the clean chamber of highly purified N_2 condition to prevent them from contamination and alteration due to the terrestrial atmosphere. For effective recovery of the particles from the catcher, we set a synthetic quartz glass disk to the opening of the catcher and turned the catcher container upside down and vibrated it to let the particles fall on the disk. Then we recovered the disk and picked up the particles on the disk one by one with an electrostatically controlled micromanipulation system which was developed and installed to the clean chamber for this purpose. The particles have been photographed with two microscopes equipped to the clean chamber when the picked up from the quartz disks.

The picked up particles are set to specially designed sample holders for a field-emission scanning electron microscope (FESEM), which can be sealed with Viton O-ring in the clean chamber of N_2 condition and transferred to SEM without exposing the samples to terrestrial atmosphere. The SEM, Hitachi S-4300SE/N, equips a low vacuum observation mode in order to observe sample of insulator without conductive coating. We observed the particles by images taken by an environmental secondary electron detector (ESED) and backscattered electron (BSE) detector (YAG detector) (Fig. 1a) and analyzed them with an energy dispersive X-ray spectrometer (EDX) to obtain information for their chemical compositions (Fig. 1b). Then the particles were brought back to the clean chamber after the FESEM-EDX analyses, and transferred onto synthetic quartz slide glasses on which had been carved grids for preservation. Particles showing ferromagnesian silicate compositions and those showing possible artificial material compositions such as Al, quartz glass, stainless steel and etc. have been preserved separately by each different slide glass.

Some particles of ferromagnesian silicate compositions have been chosen for initial analyses to be approved by Hayabusa Sample Allocation Committee (HSAC), and then picked up from the slide glasses and transferred to each sample container for initial analyses in order to be distributed to researchers, which resulted in a series of studies mentioned before. Finally, the distributed particles for the initial analyses other than those completely consumed due to the analyses will be returned back to the curation facility to be preserved in N_2 condition.

Present status of recovered particles:

We continue picking up particles from the quartz glass disk both for the catcher room A and B. In total, the number of Hayabusa particles of ferromagnesian silicate compositions counts up to more than 160 so far. Their size distribution is shown in Fig. 2. The length of major axes of the particles are measured based on the BSE images, thus they might not be exactly same as their real major axes. This histogram indicates that the majority of the size of Hayabusa ferromagnesian particles ranges from 50 to 70 µm in major axes, although the number of picked up particles decreases as their sizes decrease less than 50µm, probably because of technical difficulty during manipulation. Among them, more than 60 of them have been distributed for initial analyses.

Plans for further sample distribution:

Now the distribution for initial analyses has been finished. Then some parts of the particles will be distributed to NASA around the end of this year, based on the Memorandum of Understanding (MOU) between Japan and USA for the Hayabusa mission. Finally, an international Announcement of Opportunity (AO) for detail sample analyses will be open to any interested party in the next year.

References:

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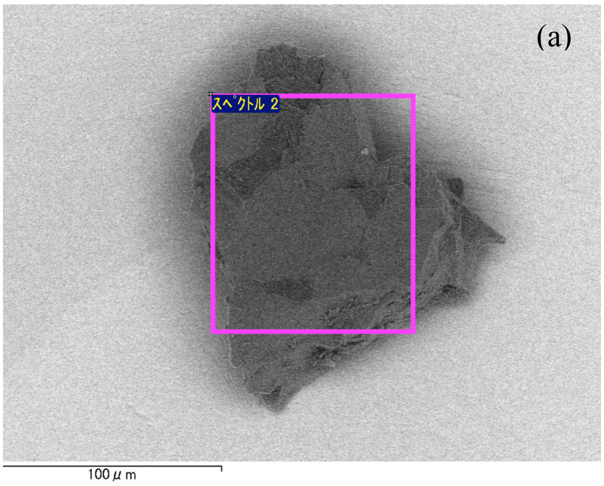

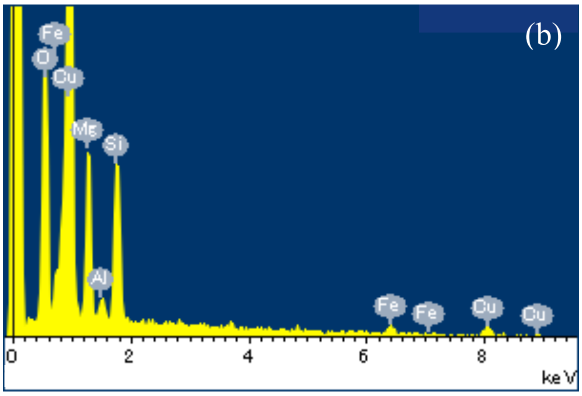

Fig. 1. (a) A backscattered electron image of RA-QD02-0010. Its major axis is around 180 µm. (b) An EDX spectrum of RA-QD02-0010. It shows peaks of Mg, Si, Fe, Al and O, chemical composition comparable to ferromagnesian silicates. Cu peaks result from a background material, the SEM holder.

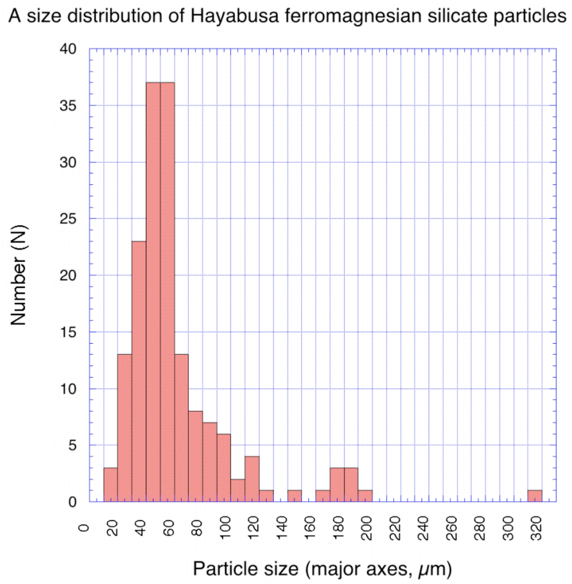

Fig. 2. A size distribution of Hayabusa ferromagnesian silicate particles. It shows a peak in the size range from 50 and 60 µm. A depletion of particles sized less than 50 µm might result from technical difficulty in manipulation of such small particles.