ASTEROID ITOKWA SAMPLE CURATION AND DISTRIBUTION FOR INITIAL ANALYSES AND INTERNATIONAL AO HELD IN THE PLANETARY MATERIAL SAMPLE CURATION FACILITY OF JAXA. M. Abe[1,2], T. Yada[1,2], A. Fujimura[1,2], T. Okada[1,2], 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. Fujimoto[2], M. Yoshikawa[1,2] and J. Kawaguchi[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 (abe@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.

An asteroid explorer Hayabusa 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 characteristic of equilibrated L or LL chondrites, the first direct evidence of asteroid as meteorites origin [3-9].

Hereafter, we review how a series of curation works goes in the facility and sample distribution for initial analyses and international announces of opportunity (AO) of researches.

Methods: Sample recovery, initial description, and preservation:

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 twice of touchdowns onto the surface of asteroid Itokawa. The environment of the facility and processes experienced by the capsule and container is detailed in elsewhere [10].

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. First, we tried to pick up particles directly from the catcher, but we could not recover particles effectively because of a complex structure of the catcher and difficulty in recognizing particles on the inside wall of the catcher, that is machining surface of aluminum alloy. Next, we tried to recover particles by scraping the inside wall of the catcher with a teflon spatula and observed it with a field-emission scanning electron microscope (FE-SEM). With this method, we first recognized small ferromagnesian silicate particles on the edge of the spatula as described in elsewhere [3]. Although this method is effective to recover particles from the catcher, the recovered particles are so small such as less than 10 µm and embedded into the spatula that they are difficult to be extracted from the spatula to be analyzed for further analyses. For effective and available 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 tapped it to let the particles fall on the disk. Then we recovered the disk and picked up the particles on it 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 FE-SEM, which can be sealed with Viton O-ring in the clean chamber of N_2 condition and transferred to SEM without exposing it 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 and backscattered electron 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 FE-SEM-EDX analyses, and transferred onto synthetic quartz slide glasses on which had been carved grids for preservation. Particles showing only ferromagnesian silicate compositions are categorized as 1, those showing ferromagnesian silicate and other mineral such as metals, sulfides and oxides etc. are as 2, and those showing mainly carbon as 3, and those possible artificial material compositions such as Al, quartz glass, stainless steel and etc. as 4. Their images taken by the optical microscopes and the FE-SEM and EDX spectra have been stored in a database together with a series of information such as their history of processes, their categories and their sizes.

Sample distribution for initial analyses and

NASA:

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, which indicates that their majority ranges less than 70 µm in major axes, although the number of picked up particles decreases as their size decreases less than 50µm, probably because of technical difficulty during manipulation. More than 10 of them have been lost during handling.

More than 60 of the category 1, 2 and 3 particles have been chosen for initial analyses to be approved by Hayabusa Sample Allocation Committee (HSAC) and distributed for initial analyses. They have been analyzed by synchrotron X-ray CT and diffraction, FE-SEM, EPMA, STEM, SIMS, INAA, noble gas mass spectrometer, FT-IR, Laser Raman spectrometer, GC-MS, and ToF SIMS. A series of initial analyses is about to finish, and a part of the distributed particles for the initial analyses was returned to the curation facility to be preserved in N_2 condition.

In Dec. 2011, 15 of the particles of category 1 and 2 have been distributed to NASA based on the Memorandum of Understanding (MOU) between Japan and USA for the Hayabusa mission. Each of them was set in the hole of a quartz glass plate one by one and covered with another quartz glass plate. A set of the quartz glass was included in a container made of stainless steel sealed with an Au coated Cu gasket.

Principle of international Announcement of Opportunity (AO) research:

An international AO for sample analyses will be announced by an international AO committee in the end of Jan. 2012. Less than 100 of particles including those returned from initial analyses will be distributed for the first call for international AO. Researchers can access to a website which contains a series of information for the particles available for the AO, and can submit their research plan, together with their previous works related to planetary material science. The submitted research plans will be evaluated by the international AO committee, then plausible plans will be selected for samples distribution.

First sample distribution will start in the end of May, 2012. The samples will be distributed to the researchers basically for rent, not given, so that they will be returned to the JAXA as a series of research works for them will have finished.

References:

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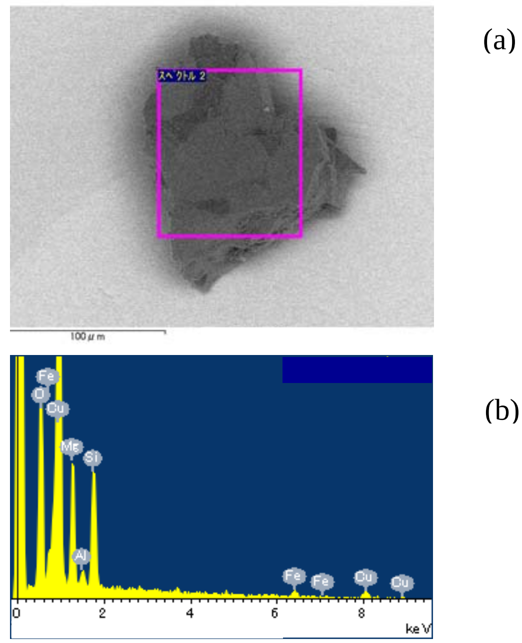

Fig. 1. (a) A backscattered electron image of one of ferromagnesian silicate particles, RA-QD02-0010. It is categorized as 1. Its major axis is around 180 µm. (b) An EDX spectrum of RA-QD02-0010. It shows peaks of Mg, Si, Fe, Al and O, chemical composition comparable to ferromagnesian silicates. A Cu peak results from a background material, SEM holder. These kinds of information are stored in the database in the curation facility.

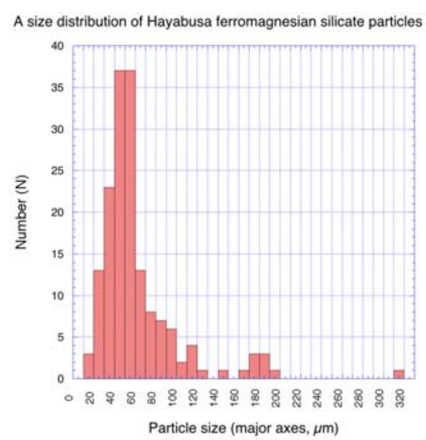

Fig. 2. A size distribution of Hayabusa ferromagnesian silicate particles. It shows a peak in the size range from 50-60 µm. A depletion of particles sized less than 50 µm might result from technical difficulty in manipulation of such small particles.