

RECOVERY, TRANSPORTATION AND ACCEPTANCE TO THE CURATION FACILITY OF THE HAYABUSA RE-ENTRY CAPSULE. M. Abe^{1,2}, A. Fujimura^{1,2}, H. Yano^{1,2}, C. Okamoto², T. Okada^{1,2}, T. Yada², Y. Ishibashi², K. Shirai², T. Nakamura³, T. Noguchi⁴, R. Okazaki⁵, M. E. Zolensky⁶, S. A. Sandford⁷, T. Ireland⁸, M. Ueno¹, T. Mukai⁹, M. Yoshikawa^{1,2}, T. Yamada^{1,2}, H. Kuninaka^{1,2}, and J. Kawaguchi^{1,2}, ¹Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (3-1-1 Yoshinodai, Chuo-ku, Sagami-hara-shi, Kanagawa-ken 252-5210, Japan; abe@planeta.sci.isas.jaxa.jp), ²JAXA Space Exploration Center, Japan Aerospace Exploration Agency (3-1-1 Yoshinodai, Chuo-ku, Sagami-hara-shi, Kanagawa-ken 252-5210, Japan), ³Tohoku University (Department of Earth and Planetary Materials Science, Faculty of Science, Tohoku University, Aramaki, Aoba, Sendai, Miyagi 980-8578, Japan), ⁴Ibaraki University (The College of Science, Ibaraki University, 2-1-1 Bunkyo, Mito 310-8512, Ibaraki, Japan), ⁵Kyushu University (Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University, Hakozaki, Fukuoka 812-8581, Japan), ⁶Johnson Space Center, National Aeronautics and Space Administration (Astromaterials Research and Exploration Science, KT, NASA Johnson Space Center, Houston, TX 77058, USA), ⁷Ames Research Center, NASA (Astrophysics Branch, Mail Stop 245-6, Bldg N245, Room 112, NASA-Ames Research Center, Moffett Field, CA 94035, USA), ⁸Australian National University (Research School of Earth Sciences, College of Physical and Mathematical Sciences, The Australian National University, Canberra ACT 0200, Australia), ⁹Japan Aerospace Exploration Agency.

Introduction: The 'Hayabusa' re-entry capsule instrument module (I/M) was safely delivered into the clean room of Sagami-hara Planetary Sample Curation Facility in JAXA on June 18, 2010. After executing computed tomographic (CT) scanning, removal of heat shield, and surface cleaning of sample container, the sample container was enclosed into the clean chamber. After opening the sample container and residual gas sampling in the clean chamber, optical observation, sample recovery, sample separation for initial analysis will be performed. This curation work is continuing for several months with some selected member of Hayabusa Asteroidal Sample Preliminary Examination Team (HASPET). We hereby report the 'Hayabusa' capsule recovery operation, and transportation and acceptance to the curation facility of its I/M which include the sample container.

Capsule recovery operation: On June 13, 2010, the Hayabusa spacecraft and its re-entry capsule returned to the Earth, and separation of the capsule occurred at 19:51 (JST). At 22:51, both the spacecraft and the capsule entered the Earth's atmosphere and the spacecraft was burned up. After the thermal shields separated from the re-entry capsule and parachute deployed at 22:56, the capsule landed on the ground and began sending out a radio beacon at 23:08. A helicopter, assisted by information from four direction finding ground sites, discovered the capsule at 23:56. The landing point was almost the exact center of predicted ellipse within the Woomera Prohibited Area (WPA), thanks to mild wind. The final recovery of the capsule was performed on the following day, June 14, including special safety operations at the landing point.

At the landing point, acquisition of scientific documentary photography, collection of the circumference soil samples, environmental measurements such as GPS positioning, temperature and humidity, and

packaging the capsule into the temporarily plastic bag and initial/temporary transportation box for the recovery activity only were performed (Fig. 1). The recovery capsule was then transported to the WPA Instrument Building where both the headquarters (HQ) of the Hayabusa capsule recovery team and Quick Look Facility (QLF) for this purpose were temporarily installed. One day was spent on the removal of the explosive device and the battery in the capsule. The next day was spent on the removal of contaminants adhering to the capsule and the packing the capsule into the another clean transportation box for internal transport (Fig. 2). The surface cleaning of the capsule and packing operation were both executed in the temporary cleanroom at the QLF installed in the building. The transportation box has a purge function of pure nitrogen gas, and can ease the shock under transportation. On the afternoon of June 17, the remaining capsule I/M was flown from Woomera's Airfield in Australia, which is the nearest airport from the WPA, to Haneda Airport in Japan in a direct flight (Fig. 3).



Fig. 1: The re-entry capsule at the landing site before its recovery.



Fig. 2: The re-entry capsule after safety operation at the headquarters building.



Fig. 3: Arrival in Japan of the capsule transportation box

Curation work: Since the sample container was not allowed to be opened for inspection at the airport, special considerations were carried out in quarantine and customs procedures. The transportation box was carried into the Sagamiyara Planetary Sample Curation Facility in JAXA at 2:00 on June 18.

After opening the transportation box on which the sealed permission documents issued by the quarantine officer of Australia, the capsule I/M was removed from the transportation box and photographically documented. This procedure was followed by X ray CT imaging of the capsule I/M.

After taking the CT images, the sample container was removed from the capsule I/M using a milling machine in the clean room. It was now 34 hours after domestic arrival. After that, surface cleaning and evaluation of the sample container took an additional 21 hours. For surface cleaning of the sample container, besides dry nitrogen gas spraying and wiping with cloth, a small vacuum cleaner, dry ice snow blasting machine and atmospheric pressure plasma equipment were used. Observation by optical microscope, contact angle measurement, and FTIR measurements were carried out for evaluation after cleaning.

After cleaning of the sample container, using the container opening jigs, the container opening system with the sample container was installed to the clean chamber. Installation of the sample container to the clean chamber (Fig. 4), in which the gas environment was controlled, was completed in 63 hours after domestic arrival.

The sample container had been sealed with double Viton O-rings, but as expected, terrestrial air slowly leaked inside. Since the concentration of terrestrial air in the container would increase with time, the sample container was placed into a ultra pure nitrogen atmosphere as soon as was reasonably possible. Since all day continuous operation was carried out after the domestic arrival, the sample container was able to be installed into the clean chamber within one week after parachute deployment.

Fortunately the work of the curation facility is being conducted as shown in the scheduled flowchart (Fig. 5). This is because the capsule functioned and landed nominally on as planned despite the three-year-delay of its Earth return and was recovered in the shortest possible duration under a nearly ideal condition, and the sample container was not damaged at all.



Fig. 4: Clean chamber of the Sagamiyara Planetary Sample Curation Facility in JAXA.

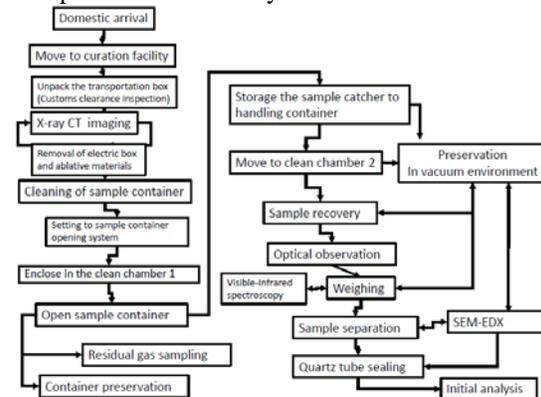


Fig. 5: Flowchart of processing of the Hayabusa sample container from domestic arrival to preliminary analysis of the sample