

**NOBLE GASES RECOVERED FROM THE HAYABUSA SAMPLE CONTAINER.** R. Okazaki<sup>1</sup>, K. Nagao<sup>2</sup>, Y.N. Miura<sup>3</sup>, T. Osawa<sup>4</sup>, K. Bajo<sup>2</sup>, S. Matsuda<sup>2</sup>, T. Nakamura<sup>5</sup>, K. Shirai<sup>6</sup>, M. Abe<sup>7,6</sup>, T. Yada<sup>6,7</sup>, T. Noguchi<sup>8</sup>, Y. Ishibashi<sup>6</sup>, A. Fujimura<sup>7,6</sup>, T. Mukai<sup>9</sup>, M. Ueno<sup>7</sup>, T. Okada<sup>7,6</sup>, M. Yoshikawa<sup>7,6</sup>, J. Kawaguchi<sup>7,6</sup>, <sup>1</sup>Department of Earth and Planetary Sciences, Kyushu University (Higashi-ku, Fukuoka, Japan; okazaki@geo.kyushu-u.ac.jp), <sup>2</sup>Geochemical Research Center, The University of Tokyo (Bunkyo-ku, Tokyo, Japan), <sup>3</sup>Earthquake Research Institute, The University of Tokyo (Bunkyo-ku, Tokyo, Japan), <sup>4</sup>Japan Atomic Energy Agency (Tokai-mura, Ibaraki, Japan), <sup>5</sup>Department of Earth and Planetary Material Sciences, Tohoku University (Aoba-ku, Sendai, Japan), <sup>6</sup>JAXA Space Exploration Center, Japan Aerospace Exploration Agency (3-1-1 Yoshinodai, Chuo-ku, Sagamihara-shi, Kanagawa-ken 252-5210, Japan), <sup>7</sup>Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (3-1-1 Yoshinodai, Chuo-ku, Sagamihara-shi, Kanagawa-ken 252-5210, Japan), <sup>8</sup>The collage of Science at Ibaraki University (Bunkyo 2-1-1, Mito, Ibaraki 310-8512, Japan), <sup>9</sup>Japan Aerospace Exploration Agency (3-1-1 Yoshinodai, Chuo-ku, Sagamihara-shi, Kanagawa-ken 252-5210, Japan).

**Introduction:** After global observations of asteroid 25143 Itokawa, the Hayabusa spacecraft has carried out two touchdowns at the Muses Sea in November 2005. After the two touchdowns, the Hayabusa sample container has been sealed using double O-rings made of fluoropolymer elastomer (Viton). The sampling site is the smooth terrain of the Muses Sea, composed of fine-grained regolith material [1]. Hence, it is reasonable to expect that the grains stored in the sample container include solar wind volatiles, such as hydrogen, nitrogen, oxygen, and noble gas isotopes [e.g., 2]. If the container had been completely sealed up, volatile elements and molecules should have been accumulated in it.

Noble gases collected from the Hayabusa container have been investigated in this study. The main objective is to determine the isotopic and elemental compositions of solar wind noble gases implanted on the uppermost surface of the Itokawa grains due to the low kinetic energy of solar wind.

**Gas collection from the sample container:** The sample capsule was successfully landed, recovered on the earth on June 13th, 2010, and transported to the curation facility of JAXA. The sample container was recovered from the sample capsule and was installed in a clean chamber (~260 L in volume). Before opening the sample container, the inner pressure of the sample container was estimated in order to prevent particles from flying out to the outside of the container due to gas flow generated by pressure difference from the clean chamber. The pressure of the chamber was regulated using ultrahigh purity N<sub>2</sub> (called ELF-N<sub>2</sub>) in which noble gas abundances have been measured in advance (Fig. 1). The ambient gas was collected in gas tanks (1.2 L in volume), connected to the clean chamber, during the operation. The procedure of the estimation work is described in [3] in detail.

The pressure of the container was estimated to be less than  $5 \times 10^4$  Pa at most, and then the sample container was opened under vacuum ( $\sim 10^{-3}$  Pa) in the chamber on June 22nd. The pressure of the chamber

came up to ~4 Pa, beyond the pressure expected based on prior testing for the sample container seal with double Viton O-rings. This chamber pressure corresponds to 5,000 Pa of the pressure of the sample container assuming 0.2 L for the volume. Gas released from the sample container was stored in the gas tanks. For comparison, gas in the chamber was collected before opening, as well.

**Noble gas analysis:** Noble gases collected in the gas tanks and of ELF-N<sub>2</sub> were measured with the modified VG 5400 mass spectrometer (MS-III) at the Geochemical Research Center, the University of Tokyo.

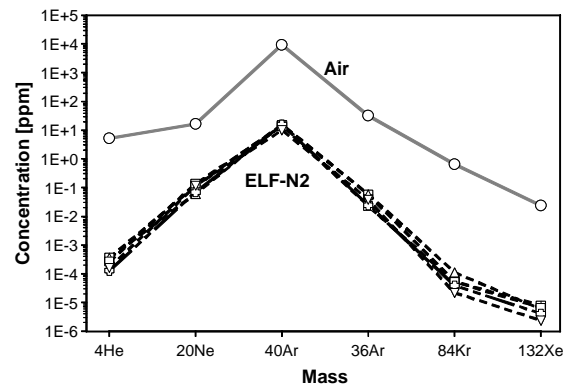


Fig. 1. Concentrations of noble gases in the ultrahigh purity N<sub>2</sub> (ELF-N<sub>2</sub>).

Concentrations of noble gases in the ELF-N<sub>2</sub> are shown in Fig. 1. The He abundance corresponds to  $\sim 10^{-9}$  cm<sup>3</sup>STP in ELF-N<sub>2</sub> of 260 L and 1 Pa. The He concentration in ELF-N<sub>2</sub> is two orders of magnitude lower than solar He, assuming that 10% of solar He would be released from 1 microgram of Itokawa regolith sample containing 1 cm<sup>3</sup>STP/g of solar He.

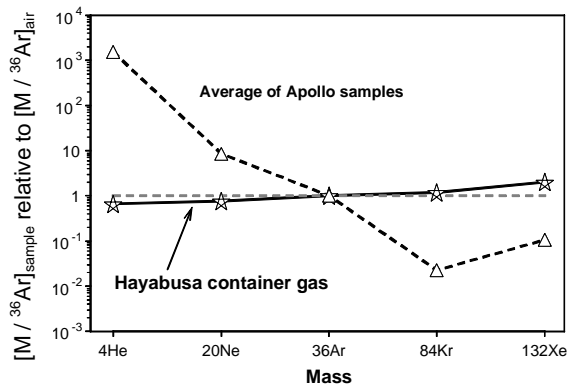


Fig. 2. Elemental ratios of noble gases in the Hayabusa sample container, normalized to terrestrial atmosphere. The solar wind composition in Apollo samples is shown for comparison [4].

Elemental (Fig. 2) and isotopic ratios of noble gas collected from the sample container are essentially identical to those of terrestrial atmosphere, showing no sign of the enrichment of solar He as reported in lunar samples (Fig. 2). Two possibilities are considered: 1) the sample grains experienced very low temperature elevation during the atmosphere entry, or 2) only a negligible amount ( $<10^{-8}$  g) of Itokawa samples is contained in the container. The second explanation seems unlikely because 1,500 rocky grains (mostly 10 micron in size) have been identified in the container by the curation work [5], which correspond to about 1 microgram. Hence, it is concluded that the Hayabusa capsule was less heated during the atmosphere entry, indicating that pristine asteroid materials have been recovered from Itokawa in the Hayabusa mission.

**References:** [1] Yano H. et al. (2006) *Science*, 312, 1350–1353. [2] Taylor L.A. (1990) *Eng. Constr. Oper. Space II; Proc. Space 90*, 68-77. [3] Fujimura A. et al. (2011b) *in this volume*. [4] Fegley B. and Swindle T. D. (1993) *In Res. Near-Earth Space. Univ. Ariz. Press*, p367-426. [5] [http://www.jaxa.jp/press/2010/11/20101116\\_hayabusa\\_e.html](http://www.jaxa.jp/press/2010/11/20101116_hayabusa_e.html).