THE NATURE OF ITOKAWA REVEALED BY HAYABUSA. M. Yoshikawa[1], A. Fujiwara[2], J. Kawaguchi[2], D. K. Yeomans[3], J. Saito[4], M. Abe[2], T. Okada[2], T. Mukai[5], and Hayabusa Science Team, [1]Japan Aerospace Exploration Agency (JAXA: 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, JAPAN, e-mail:makoto@isas.jaxa.jp), [2]JAXA, [3]JPL, [4]PASCO Corporation, [5]Kobe University.

Introduction: The Hayabusa spacecraft, which was launched on 9 May 2003, arrived at Asteroid Itokawa on 12 September 2005. The size of Itokawa is about 535m in length, so it is the smallest celestial object that manmade spacecraft has ever visited. We were surprised to see the images of Itokawa taken by Hayabusa, because the view of Itokawa was totally unexpected. The surface of Itokawa is covered with numerous boulders and we could not find clear craters on it. After that, many scientists and researchers have studied about Itokawa, and now we know many interesting things about Itokawa. In this paper, we summarize what we know about Itokawa up to now.

Surface Features: Hayabusa carried out precise scientific observations of Itokawa for about two months. Hayabusa has an optical camera called Asteroid Multi-band Imaging Camera (AMICA, view angle 5.7 degrees with 8 band-pass filters) and it took about 1,600 optical images.

The surface of Itokawa is basically divided into two parts, smooth terrain and rough terrain. The smooth terrain was covered by regolith. The particles of regolith are basically sub-cm sized gravels, not powder-like grains. There are no regolith on the surface of the rough terrain. On this tiny object we found many geographical and geological features, such as landslide-like structures, craters, cracked boulders, and facet, which is a relatively flat plane-like surface.

These features as well as the existence of numerous boulders indicate the collisional history of Itokawa. We think that the regolith was created by collisions of meteorites. Since the escape velocity is 15 cm/s or so, small particles created by collisions are ejected into the interplanetary space. But some of them remain on the surface and they move to the low potential area when Itokawa was shaken by collisions of meteorites.

Surface Material: Hayabusa has Near-Infrared Spectrometer called NIRS (view angle 0.1 degrees, wavelength 0.8 - 2.1 micron) and X-ray Fluorescence Spectrometer called XRS (view angle 3.5 degrees, energy resolution of 160eV at 5.9keV) and we took many spectral data in both near infrared and X-ray. By analyzing these data, we concluded that the surface material of Itokawa is similar to LL-chondrite of ordinary chondrite.

We also found that there is color difference on the surface. Some parts on the surface are relatively brighter than the other parts. This color difference was caused by space weathering, and from the spectrum analysis, we found that the brighter regions are bluer and darker regions are redder. The feature by the space weathering were analyzed all over the surface by using the data of AMICA and NIRS. In spite of the color difference, the mineralogical material is the same all over the surface.

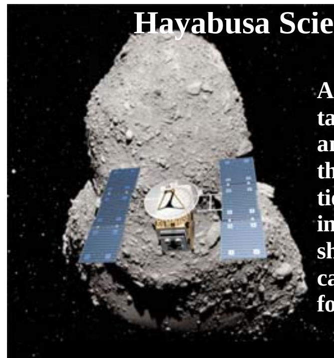
Internal Structure: The mass of Itokawa was estimated by the orbit analysis of Hayabusa by using tracking data and the data of LIDAR, which is Laser altimeter. From the estimated mass and the volume, the bulk density was calculated as 1.9g/cm^3. Since the density of the ordinary chondrite is 3.2g/cm^3 or so, the low density of Itokawa indicates the macroporosity of about 40%. From these results, we concluded that Itokawa was a rubble-pile asteroid and the evolution scenario of Itokawa was also considered.

Future: The analyses about Itokawa are still ongoing, and such effects like Yarkovsky and YORP are studied now. The origin and evolution of Itokawa is also an interesting problem. Itokawa is just a common small S-type asteroid, but it has given us a lot of information, which is important to study our solar system.

Hayabusa is now on the way back to the earth and it will come back in June 2010. We hope that some materials from the surface of Itokawa were captured in the capsule of Hayabusa.

We are now planning post-Hayabusa missions, named Hyabusa-2 and Hyaubusa-Mk2. Hayabusa-Mk2 is now called Marco Polo, which is the joint mission of JAXA and ESA. By these missions, we want to explore C or D-type asteroids, or dormant comets. By these new missions, we hope we can understand the origin and evolution of the solar system and the life.

Hayabusa Science Data Archives:



All the science data taken by Hayabusa, the ancillary data related to the spacecraft operation, and some other information such as the shape model of Itokawa can be accessed form following Web site:

http://hayabusa.sci.isas.jaxa.jp