

TECHNOLOGIES FOR FUTURE ASTEROID EXPLORATION: WHAT WE LEARNED FROM HAYABUSA MISSION. M. Yoshikawa¹, H. Yano², J. Kawaguchi², A. Fujiwara², M. Abe², T. Iwata², Y. Kawakatsu², S. Tanaka², O. Mori², T. Yoshimitsu², Y. Takagi³, H. Demura⁴, T. Noguchi⁵, H. Miyamoto⁶, ¹Japan Aerospace Exploration Agency (3-1-1, Yoshinodai, Sagami-hara, Kanagawa 229-8510, Japan, makoto@isas.jaxa.jp), ²Japan Aerospace Exploration Agency, ³Toho Gakuen University, ⁴The University of Aizu, ⁵Ibaraki University, ⁶The University of Tokyo.

Introduction: Hayabusa spacecraft, which is the asteroid sample return mission of Japan, finally arrived at its destination Asteroid (25143) Itokawa in September 2005. We were surprised to see the image of Itokawa, because we found a lot of boulders instead of craters (Fig.1, left). We discovered many new things about the very small-sized asteroid Itokawa from the in situ observations. Also we have had many experiences and learned a lot about exploration of small asteroid. Although Hayabusa is still on the way to the Earth, we are now considering future asteroid sample return missions.

Hayabusa Mission Over View: Hayabusa was launched in May 2003, and after executing the Earth Swingby in May 2004, it arrived at Itokawa in September 2005. At first, Hayabusa observed Itokawa in detail by using four science instruments, the mass was estimated, and the shape model was created. Then in November 2005, several rehearsals descents and two touchdowns were done. First touch down was not performed as planned sequence, but second touch down was almost perfect. However, after this touch down, some troubles occurred and the departure from the asteroid was delayed. Therefore the return of Hayabusa to the earth is delayed three years, and it will be in 2010. Although we are not sure whether some surface materials were collected or not, we are now working to send Hayabusa back to the earth.

Next Missions: We have been considering the post Hayabusa mission much before Hayabusa's arrival to the asteroid^[1]. This is because we think that asteroid is the key object to understand the origin and evolution of the solar system. Since the results of Hayabusa were very impressive and important from the point of the planetary science, we are now attempting to start next mission as soon as possible. We call the next mission as Hayabusa-2. This spacecraft is basically the same as Hayabusa. Of course we modify several points where there were problems. But the model is almost same, so we can save time to manufacture it, and we are hoping that we can launch it in 2010 or 2011. The target is again small near earth asteroid but C-type. So we look forward to seeing how the small C-type asteroid looks like (Fig.1, right).

Also, we are considering another sample return mission, which we call it as "Hayabusa Mark-II" tenta-

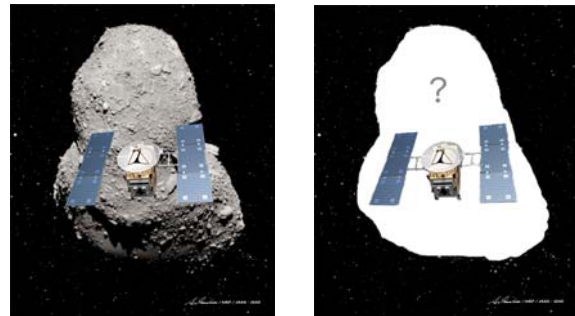


Fig.1 Composite image of Hayabusa and Itokawa (left), and Hayabusa-2 and a certain C-type asteroid (right).



Fig.2 One of the examples of Hayabusa Mark-II.

tively. Hayabusa Mark-II is not the copy of Hayabusa, but it is much-advanced mission both in the sampling and the remote sensing. For example, we want to challenge sampling with preserving depth profile and to get much more detailed data of the sampling sight. In addition, we also investigate the possibility of sample returns from two different asteroids by one spacecraft (Fig. 2).

We believe that the exploration of asteroids will provide us a lot of new discoveries and we are happy to discuss about the international collaborations for missions to small bodies in the solar system, because there are lots of them and we can know their real nature after we explore at least several of them.

References: [1] H. Yano, M. Abe, A. Fujiwara, T. Iwata, J. Kawaguchi, Y. Kawakatsu, O. Mori, S. Tanaka, M. Yoshikawa, T. Yoshimitsu, H. Demura, H. Miyamoto, T. Noguchi, Y. Takagi and the JAXA/ISAS Minor Body Exploration Working Group. (2006) COSPAR 2006, B0.4-0020-06.