

Report of the Hayabusa Subcommittee

Members

Professor S. R. Taylor (Chair)
Dr A. Bevan
Dr T. Esat
Dr T. Ireland
Dr M. Norman
Professor M. Walter

Participation

In 2004, TRI, SRT, and TE participated in a Hayabusa Science Workshop that was designed to allow participants in the program to present aspects of analysis that would have a bearing on the returned samples. Following the Lunar and Planetary Science Conference (Houston, TX) TRI agreed to participate in the Hayabusa Science Team. During 2005, TRI participated in two meetings in Tokyo, once in March for updates largely concerning mission operations, and secondly in September for participation in discussions concerning the sample site selection.

The Mission

The Hayabusa spacecraft (code named MUSES-C by JAXA) arrived at asteroid Itokawa (1998SF36) on the 12th of September 2005. Hayabusa then spent 1.5 months at altitudes of 7 to 20 km to allow global imaging and spectral observations. Shape modelling was one of the most important objectives because combined with the mass, this establishes terminal velocity for the landings. Itokawa is 550 m x 298 m x 224 m. It has a peanut shape with one lobe called the 'Head', the other the 'Body', and are connected through the 'Neck'. In both the Head and Body block-rich rough terrains predominate (the largest block being ca. 50 m), but a smooth terrain associated with low gravitations/centrifugal potential occurs in the waist minimum and has been called Muses Sea. After completion of the imaging phase, two potential landing sites were proposed. These were (A) Muses Sea, or part of the Neck where a smooth area of approximately 60 m was observed, or (B) the largest facet of the rough terrain of the body called Little Woomera which was around 60 m x 100 m.

Two touchdown rehearsals were carried out on Nov 4 and 12 and produced high resolution images of the candidate sites. During the first rehearsal, the remote observer Minerva was deployed, but did not land on the asteroid. From the images, the Operation Team concluded that Little Woomera contained too many large blocks to conduct a safe descent and landing. Thus the second rehearsal and the two touchdown attempts were carried out at Muses Sea.

Close-up images from altitudes of 80-63 m above the surface reveal grains sizes from sub centimetre to 2 m, although the terrain is dominated by well size sorted gravels. The first touchdown attempt, TD1, was carried out on 19 Nov. During the descent, apparently 17 m above the asteroid surface, the fan beam sensor detected an obstacle. The emergency ascent was autonomously cancelled and the spacecraft continued to free fall to the surface. However, it appears that the projectile-firing protocol was locked out because of the obstacle detection, and when the sampler horn touched the surface, the projectile was not fired. Hayabusa bounced from the surface but then touched down and remained on the surface for c. 40 minutes. There is a possibility that some slow regolith grains (below escape velocity of ~20 cm/s) were

uplifted by the tip of the horn and they might have reached to the sample canister during the TD1 landing that lasted over half an hour. Therefore, the hatch of the canister was closed to secure potentially collected samples. Hayabusa returned to Gate position (c. 7 km).

At the second touch down on Nov 25, the procedures went as planned with detection of deformation of the sampling horn and a command to fire two projectiles into the surface. The spacecraft then ascended. However, after receiving data from the onboard recorder, it was found that the spacecraft might have issued a safeguard command for the projectiles ~4 minutes before the touch down (21) which would have overridden the fire command.. At this stage it remains unclear whether a sample was collected during TD2 but the canister was closed in any case.

On Nov 26 and 27 communication was lost with Hayabusa. Signals were finally received on the low gain antenna indicating a major change in attitude and a high spin rate. This probably resulted from a chemical fuel leak. The xenon thruster was used to compensate the aberrant motion and spin had been reduced to a 6 minute period before another event on Dec 8. At this stage it was clear that Hayabusa would not meet the departure window to return to Earth in 2007. In addition, use of the Xe fuel for spin cancellation also affects the amount available for the return trip. As such, it was decided to park Hayabusa, further waiting for dampening of aberrant rotation effects, and put off the return to Earth to 2007 with a Woomera landing in June 2010.

A set of papers is being prepared for Science Magazine, and a session has been organised at the Lunar and Planetary Science Conference in Houston to present data from the asteroid landing.

Data in this report comes from the Hayabusa web page (<http://www.hayabusa.isas.jaxa.jp/>) and the Science paper prepared and submitted by Dr Hajime Yano.

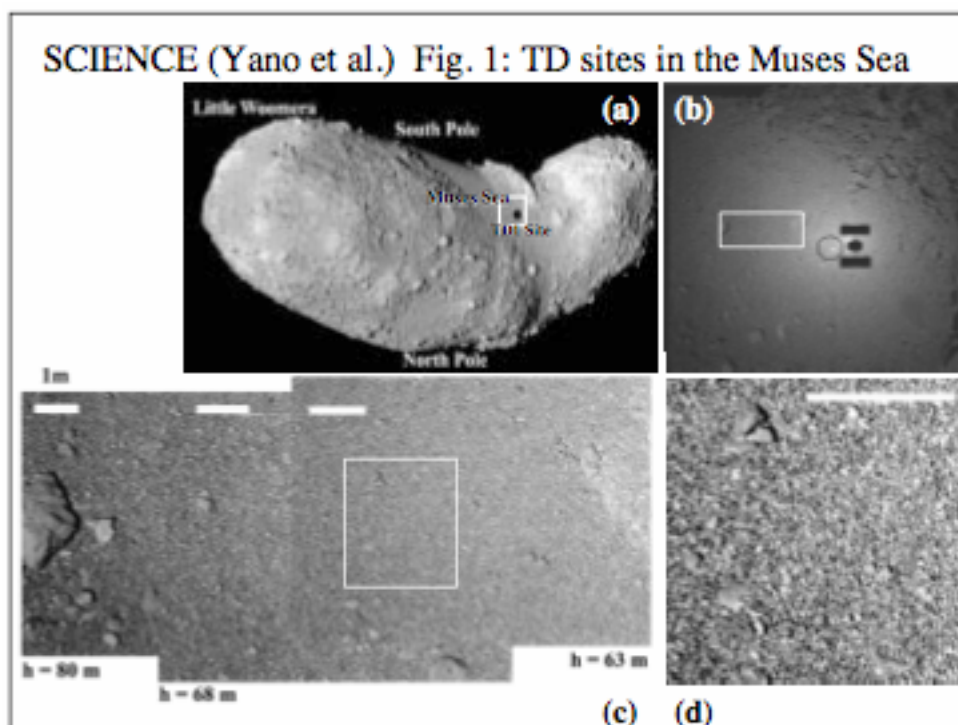


Figure 1: Location of the Muses Sea smooth terrain including the first touch down site on Itokawa. The square in figure (a) indicates the size of figure (b); the rectangle in figure (b) indicates the size of figure (c); the rectangle in figure (c) indicates the size of figure (d). White bars in figures (c) and (d) all scale in 1m. In figure (b), the circle next to Hayabusa's shadow shows the target marker landed on the Muses Sea. Figure (c) is a composite of three close-up images taken from 80m, 68m and 63 m altitudes, according to LIDAR measurements. The spatial resolutions are 0.8-0.6 cm/pixel. As can be seen, the Muses Sea is composed of numerous, size-sorted granular materials from several cm to sub-cm scales. (From Yano et al. (2006) paper submitted to *Science*.)