Another dichotomy on Itokawa: Bright and dark regions as evidence of space weathering

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HAYABUSA (formerly MUSES-C) is an engineering spacecraft by the Institute of Space and Astronautical Science of Japan Aerospace Exploration Agency (ISAS/JAXA) aiming at sample return from asteroid (25413) Itokawa. Between September and November 2005, HAYABUSA observed Itokawa by Asteroid Multiband Imaging CAmera (AMICA). A filter wheel of AMICA has a wide bandpass filter and ECAS-equivalent seven narrowband filters: 380 (ul), 430 (b), 550 (v), 700 (w), 860 (x), 960 (p), and 1010 nm (zs) (Nakamura et al., 2001) . AMICA observed the whole surface of Itokawa with the solar phase angle around 10 degree from the Home Position (HP) (7km) with nominal resolution 70cm. The highest resolution during touch down phase is better than 1cm.

In addition to dichotomy of rough and smooth areas (Saito et al., 2006), another most interesting surface feature of Itokawa is the heterogeneity in both color and brightness. The brightness difference is approximately 10-20% on distance images and as high as 30% on close-up images. Even from the observation from HP, some area (e.g. elevated area to the west of Tsukuba) is 20-30% brighter than nearby darker areas. Brighter areas are usually observed at local high zones and gravitationally steep zones. Local high zones include rims of facets which would be remnant structures of large impacts. Note that steep zones are not always bright. Steep slopes making up the neck at the other side of Yatsugatake are covered by dark boulder-rich materials. In general, brighter areas are bluer in color and darker areas are redder.

Figure shows the Muses Sea area on Itokawa. Shirakami is one of the distinct bright regions on Itokawa. Here, the brightest area (a) has a very steep slope, which is steeper than a typical angle of repose of granular materials. In fact few numbers of boulders were found here. The elevated zone (b) consists of boulder-covered dark areas (10m-scale patched areas) and boulder-poor bright areas. Typical boulder size on the dark patched area is about 1m. On the other hand the proximal darker area (c) is covered continuously with numerous boulders. Lineations probably of boulder imbrications trends from zone c to zone b. Here at Shirakami, bright surface was formed by removal of the superposed dark boulder rich layer. Zone a is a totally excavated whereas zone b is partly excavated due to boulder movements. Yatsugatake (d) is a distinct ridge between the MUSES Sea and Shirakami. The top of Yatsutagake is made up of bright zone (d), which might be also explained by excavation of a darker superposed layer. At the foot of Shirakami and Yatsugatake (d) extends a darker and boulder-rich zone (denoted by e). But no distinct flow front or talus structure is recognized, which might imply further complexities. Note that gravitational sliding of regolith materials with different brightness was also observed on Eros (Thomas et al., 2002).

In comparison with color observation and experimental data (Sasaki et al., 2001; 2006), we interpret that the darker materials experienced more space weathering than brighter materials. Probably a part of dark weathered boulder-rich surfaces were removed by shaking caused by impacts or planetary encounters, leading to exposure of underlying relatively fresh bright area.

Figure Muses Sea area on Itokawa where detailed feature of Yatsugatake-Shirakami region is involved. The smooth area is Muses Sea, where landing operations of Hayabusa were performed. Yatsugatake is a bright rough ridge to the west of Muses Sea. Shirakami is one of the distinct bright regions on Itokawa.

References

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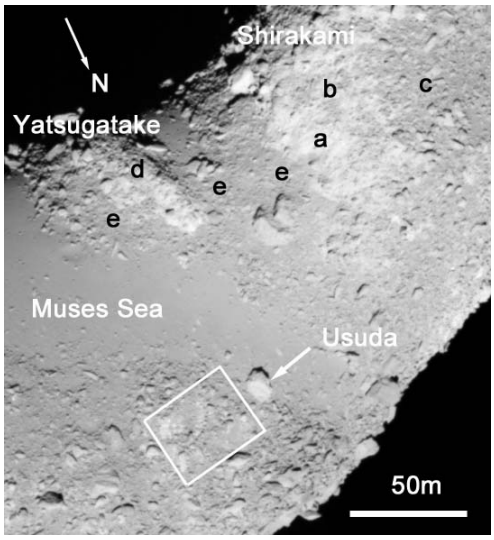
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