CRATER COUNTING ON ASTEROID 25143 ITOKAWA: Preliminary results. C. Honda[1], R. Nakamura[2], M. Ishiguro[1,3], J. Saito[1], T. Hashimoto[1], T. Kubota[1], A. M. Nakamura[4], N. Hirata[4], K. Hiraoka[4], H. Demura[5], T. Michikami[6], [1]Institute of Space and Astronautical Sciences, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa, 229-8510, Japan (chonda@planeta.sci.isas.jaxa.jp), [2]National Institute of Advanced Science and Technology, [3]Seoul University, [4]Kobe University, [5]University of Aizu, [6]Fukushima National College of Technology.

Introduction: On September 12th, 2005, the Hayabusa spacecraft arrived at the destination, a tiny (< 1 km) S-type asteroid 25143 Itokawa [1]. The onboard Asteroid Multiband Imaging Camera (AMICA) scrutinized the surface from the Home Position (HP), which is about 7 km sunwards of Itokawa. One of the most interesting characteristics is the dichotomy of the surface roughness. We classified the rocky regions covered by numerous boulders as “rough terrains” and the flatter regions, possibly mantled by finer regolith particles, as “smooth terrains” [2]. While the smooth terrains may have experienced large-scale resurfacing by regolith transportation, rough terrains show no clear indications of regolith. The lack of thick regolith layer would increase the degradation time of small craters through ineffective covering and erosion by ejecta blanket. Consequently, we expect that the rough terrains, which cover about 80 percent of Itokawa’s surface, are appropriate regions to study crater population statistics.

Based on numerical integration of Itokawa’s “clone” orbits, Michel and Yoshikawa [3] calculated the typical lifetime of Itokawa as a Near-Earth Asteroids to be several million years. On the other hand, the collisional lifetime of Itokawa in the main belt is estimated to range between 10 and 100 million years [4]. Then, the cumulative crater size-frequency distribution (CSFD) on Itokawa would reflect those of sub-meter sized bodies in the main asteroid belt rather than the interior regions. In this presentation, we report preliminary results of crater counting on Itokawa and the potential to investigate unseen small bodies, which links asteroids and interplanetary dust particles.

Observations and data analysis: Owing to the almost perpendicular rotation axis to the ecliptic plane, we could image the entire surface of Itokawa from HP with a constant spatial resolution of 70 cm/pixel and the nominal phase angle of 10 degree. We mainly used a complete series of the v-band images obtained on September 29th and 30th, which uniformly samples the 12 hours rotation period of Itokawa with roughly 4 minutes interval. The sequential data set allowed us to continuously track a low-latitude point from the terminator to limb. It is well known that low sun-elevation images are suited to examine the detailed surface topography, such as small degraded craters. Then, we carefully inspect the sequence, paying special attention to the terminator regions. As explained later, the gradual change of the illumination condition and viewing geometry is very important for correct identification and accurate size estimate of craters. The Polar regions were explored between October 16th and 25th, when the Hayabusa spacecraft went to excursion out of the ecliptic plane [1]. Moreover, we used additional images taken above the equator, but at different phase angles or lower altitudes.

After onboard subtraction of the smear and bias, AMICA images are downlinked to the Earth and archived at ISAS/JAXA as FITS files [5]. Using an image processing software, we adjust the contrast of the images on display and overlay ellipses on an identified crater. The apparent pixel size of the crater in diameter is converted to the actual diameter by using the range data from LIDAR [6] and geometric properties of AMICA [5]. Although we have determined the accurate co-alignment with AMICA and LIDAR [5], the location of the target crater doesn’t necessarily coincide with that of LIDAR’s footprint.

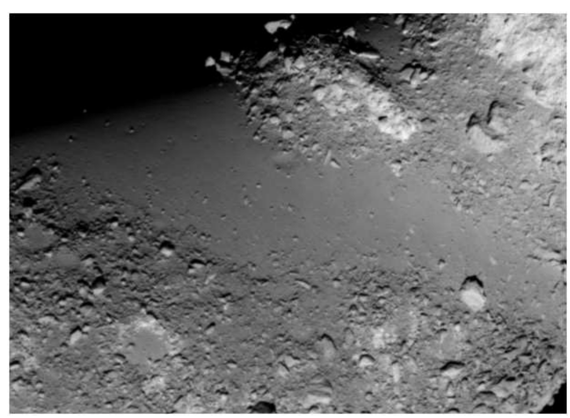

Figure 1: *A v-band image around the vicinity of south pole of Itokawa (ST_2474731509) taken at 00:45:14 on October 20th (UTC). A large smooth terrain (Muses-Sea) covers the middle of this image and a relatively large crater with bright inner wall (Komaba) can be seen at the lower left.*

This discrepancy could yield errors in the size estimate. For the current preliminary analysis, however, we do not account for the effect because it is expected to be not critical for the crater population statistics within the limited filed of view (~5.7°) of AMICA. Once we identify a crater at a terminator, we follow the movement and select several images preferred for the size estimate, namely with low emission angle and proximity to LIDAR's footprint. The variance among different images can be regarded as the size uncertainty in diameter.

As shown in figure 1, many circular depressions are present on both rough and smooth terrains, but few exhibits bowl-like shape. First, we picked up all the circular depressions as candidates of impact craters. Although we cannot guarantee the complete sampling, it is unlikely that we overlooked significant number of candidates because even subtle depressions can be recognized through the limb profile of Itokawa. Since not all of the candidates are impact craters, we need to establish some selection criteria to distinguish true impact craters from misleading features.

Some large negative depressions on Itokawa, such as Little Woomera (98 m in diameter), show very small depth to diameter ratios and irregular bright rims [7]. We categorize them as "craters", not as "facets" for the current analysis. Another major ambiguous group is depressions on smooth terrains associated with a nearby boulder. Conceivably, these pairs of boulder and depression are resulted from mechanical sorting within regolith layer or low-velocity primary (or secondary) impacts after the formation of smooth terrains. Then, we do not include such small depressions in the final list of impact craters. The inner wall of some circular depressions on rough terrains looks bright (figure 1) possibly due to the excavation of fresh unweathered materials [1]. So we employed the high albedo and bluer color in the low phase angle images as supplementary indicators of impact craters.

Based on these criteria, four of us independently carried out a census of craters to assure the objectivity of the identification process. The comparison would prevent false detections of ambiguous features under specific illumination conditions and reduce the possible bias of individual for certain types of morphology (e.g., partially filled floors, bright rim,,, etc.).

Preliminary results: Even if we count all the circular depression, the total number of possible craters is less than one hundred. Dividing the total number by the surface area of Itokawa [8], we derived the crater spatial population. It is far below the empirical saturation equilibrium for the small craters, simply suggesting young surface age of Itokawa [2]. The lack of "fresh" bowl-shaped crates could be attributed to armoring by abundant boulders [7, 9]. We will examine regional variations of the spatial distribution (smooth/rough, head/body, eastern/western, and northern/southern) and their possible correlation with those of boulders [10].

From the cumulative CSFD, the power-law indices can be derived and then converted to those for the projectiles with scaling laws [11]. We compare the projectile size-frequency distribution with those of boulders on Itokawa [10], larger main belt asteroids, smaller interplanetary dust and prediction by numerical models [4]. While the influx of projectiles and surface age of Itokawa cannot be determined independently, we will put some consistent constraints on their combination. Their implications on the history of Itokawa, crater chronology and asteroid collisional/orbital evolution, will be discussed.

The rough terrains on Itokawa are dissimilar to previously explored asteroids because of the abundant boulders, few craters and thin regolith. It should be reminded, however, that high-resolution images of Eros look like rough terrains of Itokawa in the similar spatial scale. Chapman et al. [9] considered three possibilities to explain the appearance, (a) selective crater erasure by resurfacing (b) inhibition of crater formation through armoring by boulders (c) paucity of small projectiles. We will discuss which scenario is the most plausible in case of Itokawa.

References: [1] Fujiwara A. et al. (to bo submitted to Science), [2] Saito J. et al. (to be submitted to Science), [3] Michel P. and Yoshikawa, M. (2005) *Icarus, 179*, 291-296, [4] O'brien and Greenberg (2005), *Icarus, 178*, 179-212, [5] Nakamura, R. et al (submitted to GRL), [6] Mukai T. et al. (2002), *Adv. in Space Res., 29*, 1231-1235, [7] Hirata N. et al. (in this volume), [8] Demura H. et al. (in this volume), [9] Chapman et al. (2002) *Icarus, 155*, 104-118, [10] Michikami T. et al. (in this volume), [11] Richardson et al. (2005) *Icarus, 179*, 325-349.