MORPHOLOGY OF CRATERS ON ITOKAWA AND ITS POSSIBLE IMPLICATION.

N. Hirata[1], O. S. Barnouin-Jha[2], C. Honda[3], R. Nakamura[4] , A. M. Nakamura[1], H. Demura[5], T. Michikami[6], M. Ishiguro[3,7], T. Hashimoto[3], T. Kubota[3], and J. Saito[3], [1]Graduate School of Science and Technology, Kobe University, 1-1 Rokko-dai, Kobe, Hyogo, 678-8501, Japan (narunaru@kobe-u.ac.jp), [2]Applied Physics Laboratory, The Johns Hopkins University, [3]Institute of Space and Astronautical Sciences, Japan Aerospace Exploration Agency, [4]National Institute of Advanced Science and Technology, [5]University of Aizu, [6]Fukushima National College of Technology, [7]Seoul University.

Introduction: High-resolution observations of the asteroid 25143 Itokawa by the HAYABUSA spacecraft reveal various features on the asteroid surface. These possess unfamiliar morphologies relative to those found on previously explored asteroids that could indicate a unique cratering process and subsequent geological modification. We describe the wide range of crater morphologies on Itokawa, and discuss their possible implications for the origin and internal structure of the asteroid, and for the characteristic cratering process on its surface.

Large craters: More than ten facets are recognized on the shape of Itokawa through a preliminarily investigation. Some of them possess very evident circular rims and mildly depressed topography. Little Woomera, a facet at the 'tail' of the asteroid with a diameter of about 50 m provides a good example of one of the largest of these circular depressions on the asteroid (Figure 1). The rims are not only morphologically evident, but are also prominent due to their brightness relative to the surrounding material.

The depth to diameter ratios of the circular depressions are small, in striking contrast to other large and deep craters on other asteroids. At the moment, it would be too hasty to judge whether the low depth-to-diameter ratios of the large circular depressions are the result of the primary cratering process, or a consequence of subsequent modification. Preliminary analyzes suggest, however, that shallowing by debris filling at Little Woomera seems to be limited. Close observations of Little Woomera show that only a small portion of its floor is covered with fine materials. A greater part is made up of boulder-rich and rough terrain similar to other regions on the asteroid's surface. If the original depth of Little Woomera is actually shallow, the impact event that formed Little Woomera may look as if it is an impact to a hard and cohesive rock. This insight is inconsistent with relatively lower value (~ 2300 +/- 300 kg/m^3) of a preliminary estimated density of Itokawa than other S-type asteroids [1]. Impacts into a more porous target, however, seem unlikely since this tends to form deeper craters [2]. In any case, the diameter to depth ratios of large craters and their distribution would give important information either on the internal structure of the asteroid or on its pre-existing surface curvature [3].

Medium Craters: Even though most craters and possible crater candidates are inconspicuous and difficult to identify in camera images, a few medium sized craters are fairly evident. The diameter of these craters is ~ 21 m for Komaba crater (Figure 2), ~ 36 m for Fuchinobe crater (Figure 3). They are much smaller than most facets, and larger than most typical boulders. Thus, they are easily recognizable as local circular depressions that are not lost among the numerous boulders on the surface of the asteroid. Both of them also possess considerable fill of fine sediment, and their smooth floors stand out in rough terrain of the asteroid. In many they resemble “ponds” present on the surface of the asteroid 433 Eros. The smooth floor is a characteristic feature of these craters not seen in larger craters such as Little Woomera. Uchinoura region is another evident circular smooth-floored basin (Figure 4). In preliminary low-resolution images of Uchinoura, this feature was regarded as a single large crater with a diameter of 65 m, but it can be also interpreted as a cluster of three or four medium-sized craters in high-resolution images. Detailed investigations of these middle-sized craters, in particular whether their fill is flat relative to gravity, will provide considerable insight into how these craters form, and what processes may be responsible for the displacement of the regolith.

Small craters: The morphology of small craters on the rough terrain of Itokawa remains generally unclear. A rapid analyzes indicates that their number per unit area is limited. Careful investigations may be required to identify real impact craters from other pits and depression present on the surface [4]. The apparent paucity of small craters is previously reported on the asteroid Eros [5]. Chapman et al. [5] discusses on some of reasons for these observations. These can be split into two main reasons. The first is external in nature and includes: (1a) Paucity of smaller impactors due to the Yarkovsky effect, and (1b) Relative younger age of the asteroid surface. The second reason is that post-cratering processes could erase small craters by impact-induced seismic shaking. A third possibility not discussed by

Chapman et al. could be due a reduction in recognizable craters as a consequence of impacts into a surface armored by large boulders.

Although seismic shaking is a convincing process by which to erase small craters on Eros, a very rough terrain like that of Itokawa suggests that armoring and morphological concealing of craters by boulders may be a major reason for the apparent paucity of small craters on Itokawa. Recent impact experiments show that an impact on a boulder-dominant target forms an irregular ejecta curtain and crater shape [6]. The irregularity is particularly notable at low velocity impacts. Even if a crater forms on the boulder-dominant target, its recognition as a crater could be difficult. In the case that the crater depth is comparable to the surface irregularities resulting from boulders, their morphological concealment should be evident. If some of these small craters are buried with regolith, their concealment could be enhanced. We will attempt to determine and classify the morphological concealment of craters on Itokawa through photogeological technique and surface shape modeling. Such an analysis may give additional insights into the sub-surface structure and surface transport mechanisms of regolith on Itokawa.

Craters are useful in other ways. In Figure 2, a small bawl-shaped crater with a diameter of 10 m, Kamisunagawa, is seen on Muses Sea. Kamisunagawa is the only example of simple bawl-shaped craters, which are familiar on other air-less small bodies but uncommon on Itokawa. The depth of Kamisunagawa gives a constraint on the lower limit of the thickness of a regolith layer of Muses Sea.

References:

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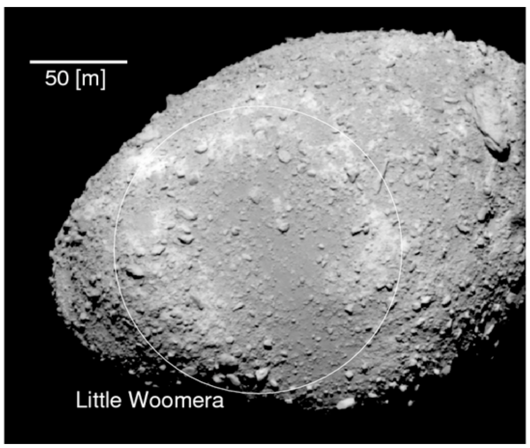

Figure 1. Little Woomera crater (ST_2474385791).

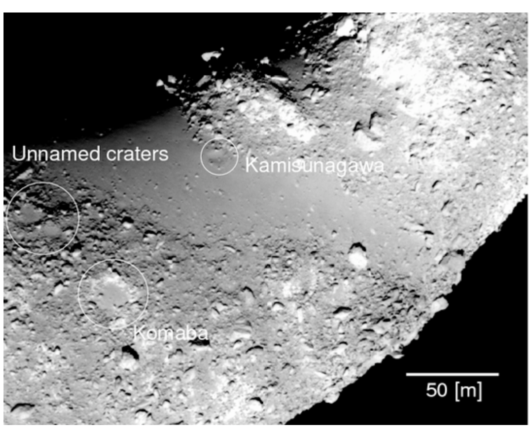

Figure 2. Komaba crater and unnamed small craters in rough terrain and Kamisunagawa crater in Muses-Sea (ST_2474731509).

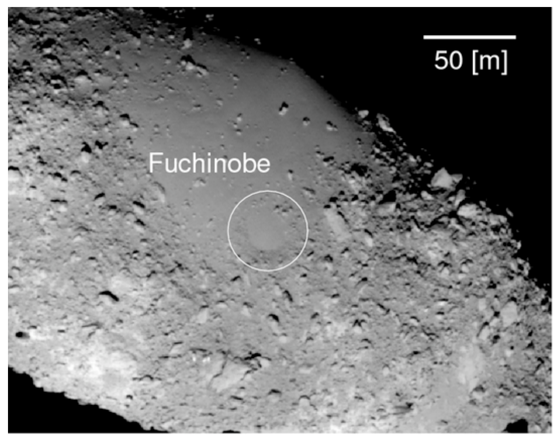

Figure 3. Fuchinobe crater (ST_2483892126).

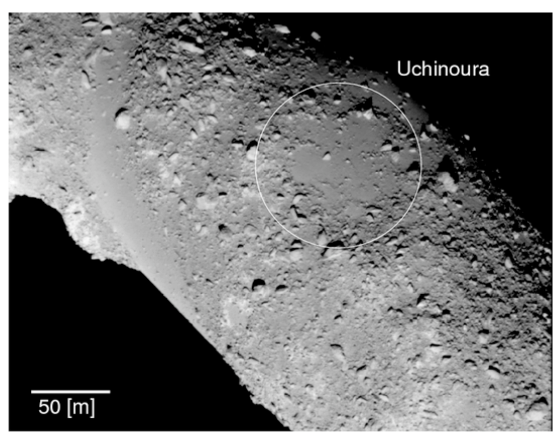

Figure 4. Uchinoura region (ST_2481672682).