DISTRIBUTIONS AND MORPHOLOGICAL CHARACTERISTICS OF BRIGHT SPOTS ON BOULDERS COVERING THE SURFACE OF ASTEROID ITOKAWA. Hiroto Takeuchi[1] , Hideaki Miyamoto[1] and Motoharu Oku[1], [1] University of Tokyo, Tokyo 113-0033, Japan (s62615@geoph.eps.s.u-tokyo.ac.jp)

Introduction: Hayabusa spacecraft obtained more than 1,500 images of Itokawa [1] including ~10 close-up images, whose resolutions are as high as several to a few tens of mm/pixel. Numerous boulders are found on these high-resolution images, whose geological implications were reported by [2, 3]. Among the most enigmatic features observed on these boulders are conspicuously bright spots found on the surface of some of boulders [2, 4]. Bright spots include the high-brightness dots and scratch-like features (Fig. 1), whose origins are not known. Possible explanations may include remnants of micrometeoroid impacts, scratches due to the frictions of between rocks, and concentrations of chemically different components. In this study, we report morphological characteristics and spatial distributions of bright spots, as a first step to understand the formational origin of bright spots.

Method: We study all of the close-up images, whose resolutions are better than 22mm/pixel (such as ST_2539444467, ST_2539451609, ST_2539437177, ST_2539429953, ST_2539423137, ST_2563511720, ST_2563537820, and ST_25630607030). We carefully map the outlines of bright dots as well as all of the boulders found on these images.

Classification of bright spots: We identify 387 bright spots on the surfaces of 123 boulders. Based on the morphological characteristics of bright spots, we classify them into the following five types; (A) a circular high-albedo spot with sharp boundary, (B) a cluster of high-albedo spots, (C) a circular high-albedo spot with somehow obscured margin, (D) a bright feature with an elongated shape, and (E) a cluster of bright spots seemed to be overlapping each other.

Distributions of bright spots: The distributions of bright spots in each image are shown in Fig. 1. The numbers of bright spots classified into the types A, B, C, D, and E, are 95, 74, 184, 15, and 19, respectively. We note that the types of bright spots are not randomly distributed, because 90% or more bright spots are either type A or C. On the other hand, there are only 12 boulders with type- B, D, or E bright spots, out of total 123 boulders with bright spots.

Except for the highest-resolution images taken at the Muses-C smooth terrain, we find that a higher resolution image generally show a larger number of bright spots. This appears to indicate that there are much more bright spots below the resolution limit. However, because this tendency is observed only for groups A and C, the numbers of other types of bright spots may be independent of the image resolution.

We find that a larger boulder can have a larger number of bright spots of types A and C (Fig. 2).We

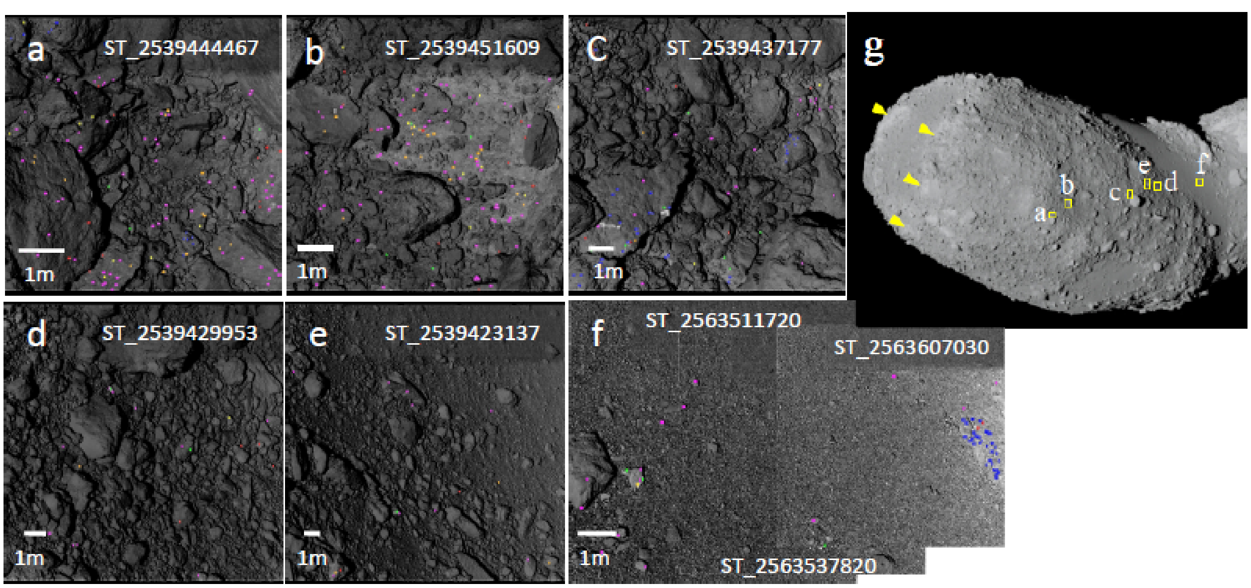

Fig. 1. Close-up images of Itokawa (a-f), whose locations are shown in (g) [2]. Bright spots in types A, B, C, D, and E are shown in yellow, blue, purple, white, and green dots, respectively. The Yellow triangles in (g) indicate bright areas.

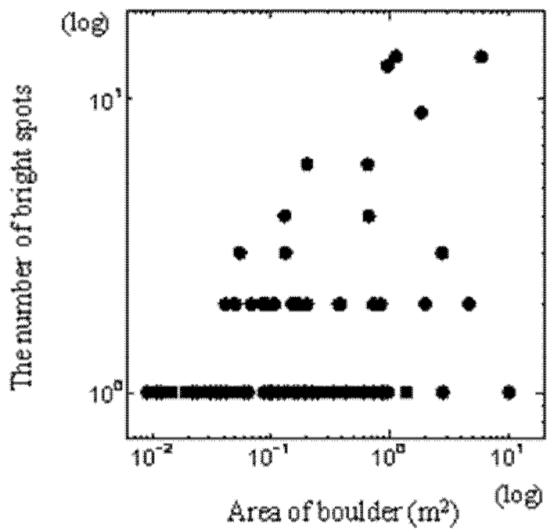

Fig. 2. Area of boulder vs. number ofbright spots of types A and C.

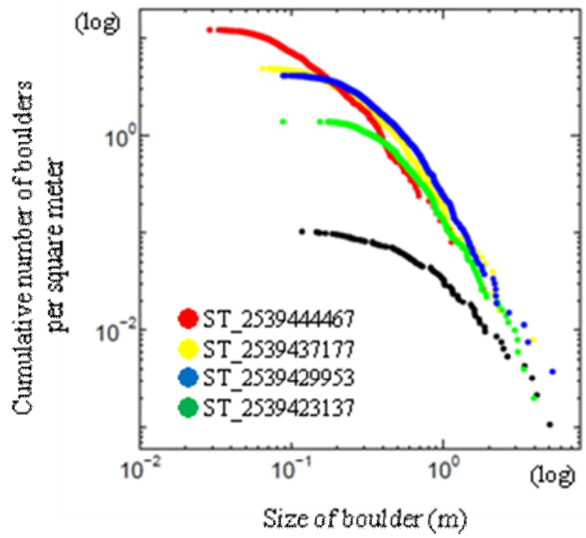

Fig. 3. Black points show boulders with bright spots.

also find that the distributions of bright spots depend on the morphological characteristics of boulders themselves. For example, boulders showing somehow wavy surface structures often accompany numerous bright spots of the group B. We interpret this as a result of different formational episodes of bright spots.

Discussions: We find that the number of types A and C bright spots increases when the resolution of each image is better. This likely indicates that bright spots of types A and C were formed by somehow uniform process regardless their sizes. In this sense, we favor the micrometeoroid impact hypothesis for the origin of the types A and C bright spots rather than scratches or chemical concreasions. The micrometeoroid hypothesis might also be enforced by (1) a larger boulder can have a larger number of bright spots; (2) special distributions of types A and C bright spots appear to be random; and (3) no typical size of bright spots can be defined.

The high brightness of the bright spots might be well explained by finer particles or roughness associated with micrometeoroids impacts. We note that, even though the boulders on the surface of Itokawa are likely homogeneous in chemical compositions [5, 6], the brightness of boulders should be related to space weathering process [7] at some levels. In this case, the surfaces of boulders become generally darker under the influence of space weathering. Thus, if micrometeoroid impacts on the surface of weathered boulder, the fresh internal materials will be exposed to form a conspicuously bright feature [8, 9].

Although the mass of Itokawa is significantly small (3.51×10^{10} kg), Itokawa is an asteroid without atmosphere, which favors to have a higher frequency of the micrometeoroid collisions [e.g., 10-13]. It might be interested to note that smaller boulders appear to be depleted in the cumulative size-frequency distribution plot (Fig. 3). This may indicate that a small boulder of several to tens of centimeters in size may be more easily destroyed by a collision of micrometeoroid.

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