PROPERTIES AND POSSIBLE ORIGIN OF BLACK BOULDERS ON THE ASTEROID ITOKAWA.
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Introduction: Observations of the asteroid 25143 Itokawa by the Hayabusa spacecraft have brought us new views of the small asteroid [1]. Most part of the asteroid surface is covered with numerous boulders of a wide size range. In the global views, the asteroid seems homogeneous. Although close-up images reveal that surface of boulders have wide range of texture variations [2], such a small-scale heterogeneity is averaged out in the global view. Only a certain degree of regional color/brightness variations was observed [Ishiguro], that can be explained as different degrees of space weathering of the surface material.

One and interesting exception has also been found on Itokawa. This "Black Boulder" is a unique boulder with unusually low brightness at the top of the "head" part of the asteroid (Fig. 1) [1]. The darkness of this boulder forms a striking contrast with its surroundings, so it is adopted the boulder as the marker of the prime meridian of the asteroid's standard coordinate system [3]. The Black Boulder has a pyramid-like shape with a 6 x 6 m base, and is rising approximately 6 m in height. The boulder is located at a place where the gravitational potential is highest on the surface of the asteroid [1]. This evidence specifically indicates that the boulder was deposited directly onto its current location and has not since migrated from there [4]. No apparent heterogeneity is observed in the Black Boulder within the image resolution of 0.7 m/pixel.

In this paper, we will describe nature of the black boulder and its similar but smaller relatives. Then their possible origin will be discussed.

Analyses: Figure 2 shows a calibrated w-band (700 nm) image and an image indicating the ratio of the w-band (860 nm) intensity and the p-band (960 nm) intensity. At the w-band, the Black Boulder is about 40% darker than its surrounding material (Fig. 2a), which is a typical material over the asteroid [Ishiguro]. The global variation of Itokawa's albedo is small; ±20% at a visible range in an imaging scale, and ±5% at near infrared spectroscopy with spatial scale of 620 m. Thus, the black boulder is the extreme case. The p/w band ratio of the Black Boulder is larger (Fig. 2b). As the p-band corresponds to 1-micron absorption of mafic minerals, the Black Boulder has a very weak or no absorption feature in the 1-micron region. Three other small boulders with a similar spectral property were also found near the Black Boulder. These are possibly composed of the same material as that of the Black Boulder.

Discussions: Several interpretations can explain the properties of the Black Boulder and its relatives. Both native origin and exotic orign are possible. Space weathering processes darken asteroidal materials and make their mineral absorption bands shallow, so it is consistent with characteristics of the Black Boulder. The problem is that space weathering, caused by the impact of micrometeorites and solar wind irradiation, is a universal process over the entire surface of an asteroid. The Black Boulder is, however, the only boulder with very low brightness among the more than

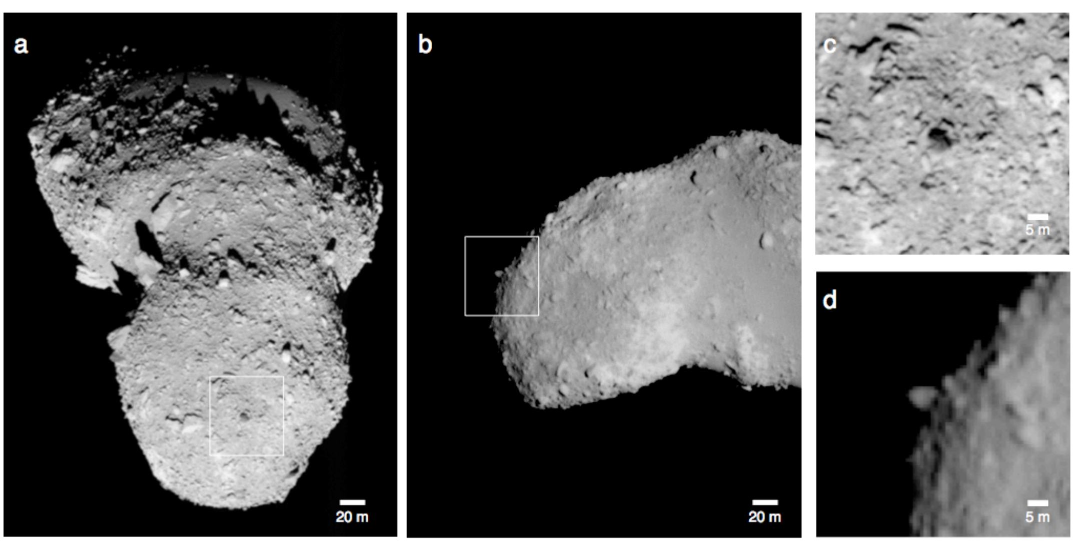
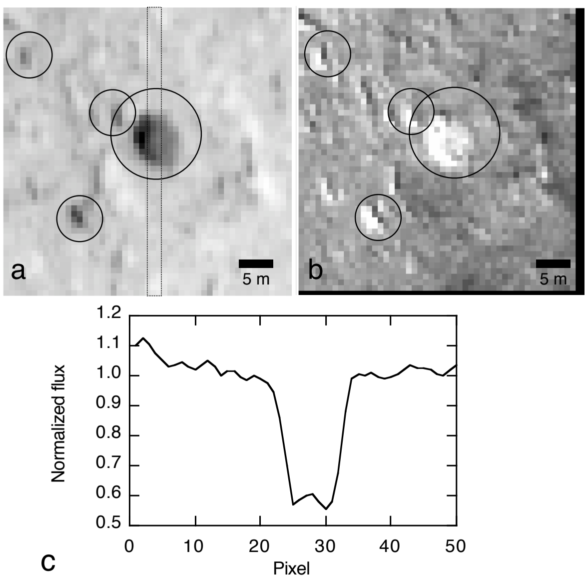


Figure 1. The Black Boulder on the "head" region of Itokawa. a and c, Top view and its blowup image (AMICA image number: ST_2482160259). b and d, Side view and its blowup image (ST_2417551556).

500 boulders of comparable size on the surface of the asteroid. In addition, space weathering generally leads to spectral reddening as well as darkening, as seen over most of Itokawa's surface, while the Black Boulder and its surroundings show a similar spectral slope in the visible region. This suggests other possibilities for explaining the origin of the Black Boulder. Other possible origins of the Black Boulder will be discussed in the presentation.



References: [1] Fujiwara A. et al. (2006) *Science,* 312, 1330. [2] Noguchi T. et al. (2010) *Icarus*, 206, 319. [3] Demura H. et al. (2006) *Science* 312, 1347. [4] Ishiguro M. et al. (2007) *Meteoritics & Planet. Sci.,* 42, 1791-1800. [5] Miyamoto H. et al. (2007) *Science* 316, 1011.

Figure 2. A calibrated w-band image (a) and a ratio image (b) of the p-/w-band of the Black Boulder. These panels show the same region of Fig. 1c. Large circle on each image indicates the Black Boulder, and small three circles indicate small black boulders, of which spectral properties are similar to those of the Black Boulder. c, a line profile of the normalized flux at w-band across the Black Boulder. The footprint of the profile is shown as a dotted rectangle in the panel a. The profile shows the averaged fluxes across the width of 3 pixels from the bottom of the panel (pixel 0) to the top (pixel 50).