Brightness and Color Variations on the Surface of 162173 Ryugu: Space Weathering, Thermal Fatigue and Mass Movement

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162173 Ryugu is a dark body with overall visible albedo is 4.6% and photometry standard reflectance is lower than 2% (Tatsumi et al., 2018, DPS&AGU). Ryugu is the one of the darkest body in the solar system. However, there is striking brightness (and associated) color difference on the surface. Bright, large boulders are on polar regions and smaller ones with similar brightness are scattered globally. Regionally, the equatorial ridge and some of undulated crater rim zones are brighter. Some boulders shows brightness variation within their surface, suggesting brightness/color difference may not be due to compositional variation but to the differences of space weathering maturity. Two types of space weathering are advocated for carbonaceous asteroids: darkening (and reddening) or brightening (and bluing) with time. On Ryugu, probably thermal fatigue and/or local impacts should have brightened the boulder surface (i.e., large boulders on both poles). Ridge/crater brightness can be ascribed to movement of fine darker materials to potentially lower region. In high-resolution images (<1m), Ryugu's surface is covered with fine (and darker) regolith materials that would cover and bury boulders. Like the large boulders on both poles, bright boulders usually have smooth surface and brightness is affected by darker regolith and shadow (Fig.1). There observed also darker boulders with rough/undulated surface, which would have experienced longer exposure and thus more erosion and weathering. We can observe the relation between brightness and surface roughness also in close-up images (Figs.2). In the left figure, there is a large (40m) relatively darker boulders with rough and layered surface. This is partially covered with much darker regolith materials. In the right figure, we observe bright layered boulders with smooth surface. Some feature (e.g., Fig. 3) would be explained by conglomerate or breccia, rather than regolith coverage.

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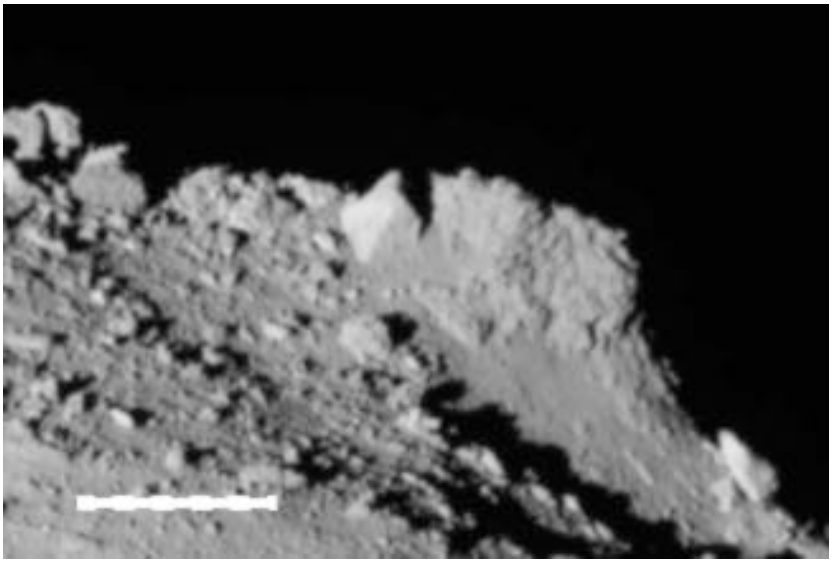
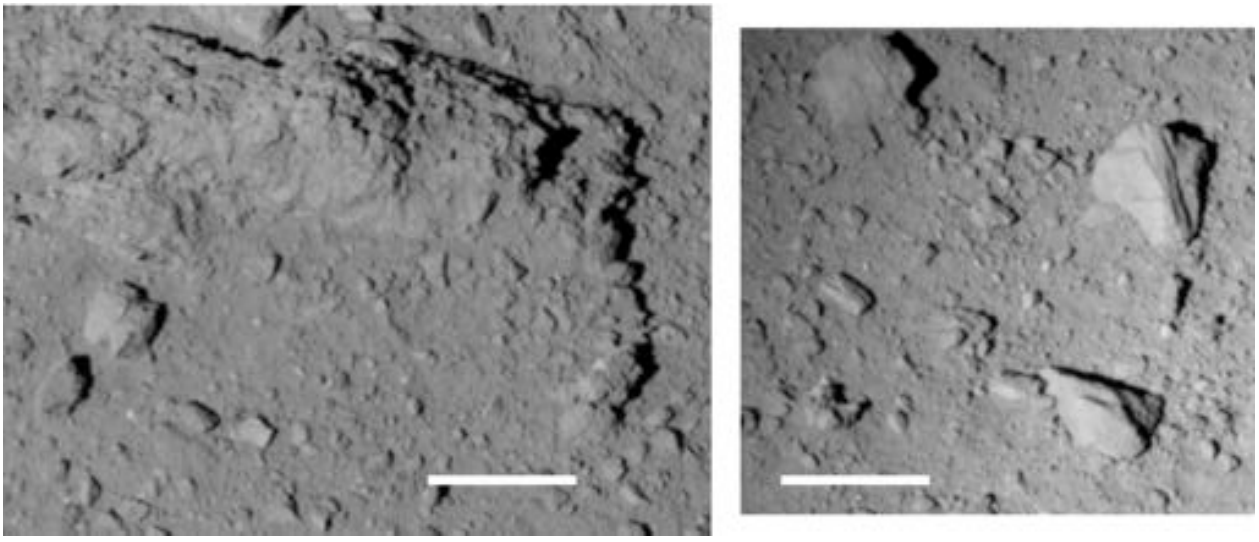


Figure1 Bright/smooth and dark/rough boulders on the polar region of Ryugu, Both are partly covered by darker regolith. The length of the white scale is 50m.



Figures 2 The surface of Ryugu where ONC-T camera captured from about 1km height. Length of white scales is 10m.

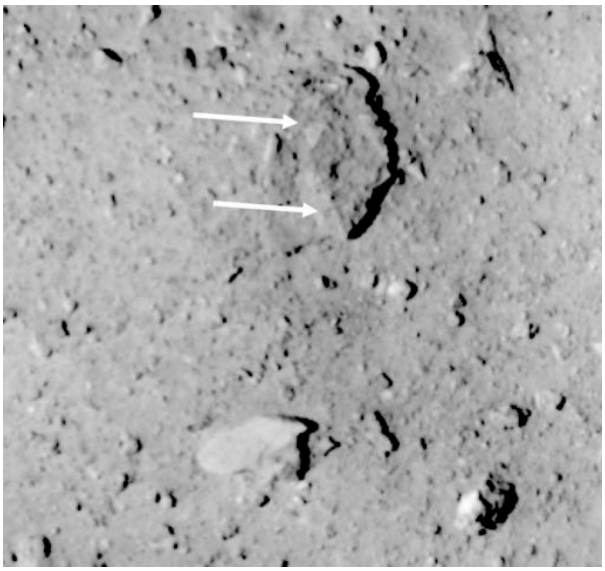


Figure 3 The surface of Ryugu (at relatively boulder poor region). Arrows show possible breccia