Distribution of cracked boulders on (101955) Bennu: searching for evidence of solar-induced thermal stress

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Introduction: NASA asteroid sample return mission OSIRIS-REx arrived at the Near-Earth Asteroid (101955) Bennu on December 3rd, 2018. Initial images of the asteroid, obtained by OSIRIS-REx's PolyCam instrument [1] at spatial resolution of 33 cm/pixel, revealed that the surface is strewn by boulders of different sizes (Fig. 1).

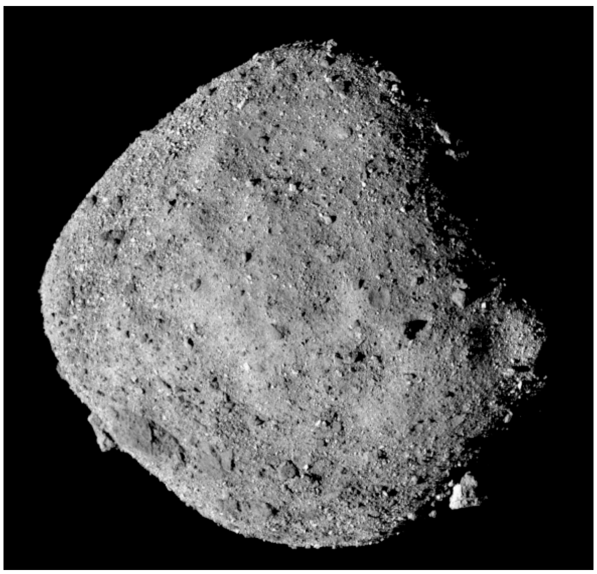

Figure 1: *PolyCam image of Bennu showing its surface covered by many boulders. Adapted from Lauretta et al. AGU fall meeting 2018 presentation.*

The breakdown of surface boulders caused by impacts of micrometeorites [2] and by stress generated by the temperature variations between day and night (thermal cracking) [3,4] has been invoked to explain the presence of finer regolith (cobbles, granules, sand) on the surfaces of smaller asteroids. Other sources of mechanical stress might also play a role, as for instance, those related to the dehydration process of a buried hydrated rock that is exhumed.

However, observational evidence of these processes leading to boulders comminution are scarce on asteroids: they are essentially limited to the discovery of boulders whose morphology suggest that they erode in place and form regolith ponds on surface the asteroid (433) Eros [5].

OSIRIS-REx observations: Visual inspection of PolyCam images shows boulders with different morphology and albedo. Some of them have clear darker features consistent with the presence of fractures (cracks). Other boulders appear to have throughgoing fractures and fracture networks. There are also groups of boulders whose morphology is consistent with in situ desegregation of a parent boulder.

Using the Small Body Mapping Tool (http://sbmt.jhuapl.edu/) [6] we mapped and counted the number of boulders in 4 longitudinal strips that are about 25^0 wide in longitude. From the turnoff of the boulder size frequency distribution, we deduce that the our counted number density should be rather complete for D>5m boulder, where D is the circular equivalent diameter of the rock. In addition, we identified those boulders showing clear evidence of fractures.

Preliminary cracked boulder statistic: Our preliminary boulder mapping indicates that the cracked boulders are only a few percent of the total boulder population.

Interestingly, we also find that, in general, the darker boulders are more likely to show cracks. Moreover, there is evidence of a predominance of cracked boulders in the local northern hemisphere of Bennu compared to the southern, one as shown in Fig 2.

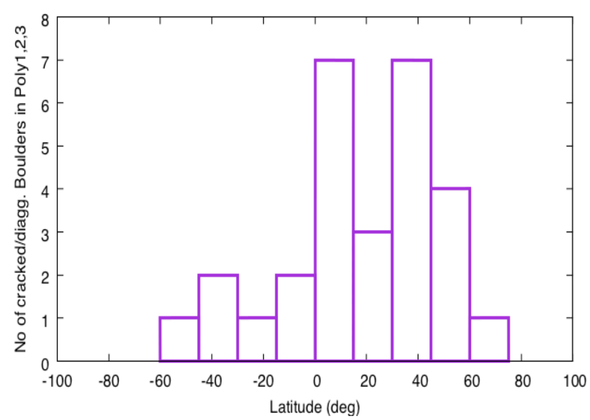

Figure 2: *Latitudinal distribution of the number of boulders showing evidence of fractures and/or disaggregation in the polygonal strips 1,2, and 3.*

Discussion: The apparent asymmetric latitudinal distribution of the cracked boulders is intriguing. It could point to a different age of the northern hemisphere compared to the southern one, or, much less likely, to a different exposure to space weathering agents such as thermal cracking due to solar heating and/or micrometeorite bombardment.

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