Evidence of Boulder Mass Movement in the Northern Latitudes of Asteroid Bennu and Implications for its Surface Evolution

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The OSIRIS-REx spacecraft has returned data from the mission's Detailed Survey of the boulder-dominated surface of asteroid (101955) Bennu, which has allowed the creation of a global basemap at a pixel scale of 5 cm (Bennett et al. 2020). With only small (<20-m diameter) patches of smooth regolith, Bennu's surface evolution is likely dominated by boulder mobility. Here, we perform a focused investigation of a region between 295° and 340° longitude, and 15° and 80° N latitude, where a large concentration of boulders is distributed in a pattern indicating a possible mass flow.

We used the Small Body Mapping Tool (SBMT; Ernst et al. 2018) to measure and count boulders, utilizing the 5-cm global basemap projected on the Bennu shape model (Barnouin et al. 2019), with additional images supplemented to view shadowed areas. Using this mosaic, we delineated the hypothesized mass flow region. Within the resulting boundary, there is a large elevation change (50 m), relative to the geoid, in the north-south direction and a minimal elevation change (5 m) in the east-west direction. Within this region, we characterized boulders larger than 1.5 m, using an ellipse to capture their overall shape, size, and orientation in order to provide quantitative information regarding their spatial distribution and physical properties.

The results of the boulder count are combined with gravitational and elevation data from the 80-cm (facet size) shape model. Our preliminary results reveal a relationship between the elevation of the site and the density of boulders present, where a higher density of larger boulders sit at lower elevation in the east-west direction. This implies that mass movement in the east-west direction resulted in the migration of these boulders into their current lower-elevation position. Analysis of boulder orientations, however, shows a preferential alignment with the north-south direction, hinting at sliding movement in that direction. The nature of the flow, such as its origins and history, therefore, are still being investigated.

The method developed here will be further used to model similar flow features that may be present in other regions of Bennu. Such studies could help elucidate the processes that formed the Bennu surface that we see today, both globally and locally (for example, changes following cratering events).

References:
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