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The Global Distribution of Boulder Orientations on (101955) Bennu

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Abstract

Catastrophic impacts and other high-energy events affecting small-body surfaces organize surface boulders and rock fragments more randomly than a series of small-scale events such as local low-energy impacts, distant larger impacts, and thermal quakes. Each of the latter may induce movement of individual rocks or localized mass wasting. Differences in input energies lead to differences in surface effects. This points to a way, using the global-coverage, high-resolution images from the OSIRIS-REx spacecraft [4], to attempt to glean insight into the types and frequencies of processes experienced by (101955) Bennu. Here, we look at global distributions in the orientations of surface rocks, which we will examine as potentially being a relic of the processes that Bennu's surface has experienced.

1. Introduction

The power that small-scale events have to affect the surface depends on many factors including their frequency, Bennu's seismic efficiency, and how often their effects are erased by high-energy events. By examining the surface for energetic signatures of surface-altering events, we hope to be able to say more about its history.

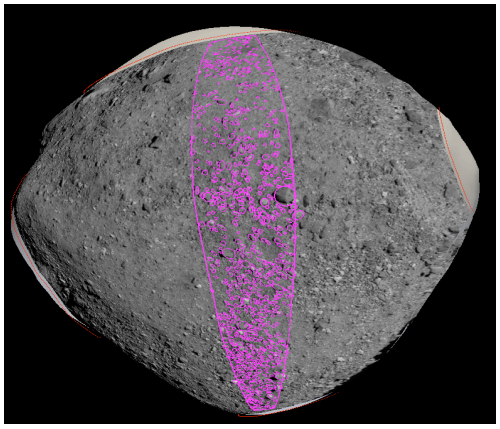

Figure 1: Surface region of Bennu and boulder counts considered in [8,9], counted by [5] using the Small Body Mapping Tool [3] for image taken 1 Dec by OCAMS PolyCam [6] (33 cm/px).

2. First Results

Using resolved image data from the Preliminary Survey mission phase [2], we have examined boulder orientation patterns as potential signatures of small-scale events [8,9]. For a region that spans 20° of longitude and about 100° of latitude (around 5% of the surface), we counted boulders by fitting ellipses [10,5] using the Small Body Mapping Tool [3] (Fig. 1). This region was chosen to include some specific features of interest and may or may not be

representative of the surface as a whole. We will present on results using much more data, including counts that span most of the surface.

The preliminary dataset shown in this abstract suggests a trend for boulders to be oriented with their long ends along the north-south direction (Fig. 2, cyan), which corresponds to the global sloping direction that points towards the equator. Further, this figure shows that if we weight the "value" of each boulder by its elongation, the case for this preferential boulder orientation becomes stronger (Fig. 2, purple). Going further, and using the local dynamical slopes from the OSIRIS-REx Radio Science Working Group based upon shape models from the Altimetry Working Group [7,1], we showed how boulders align themselves in relation to the local dynamic slope.

Global results that cover much more of the surface will be presented and their implications on the types of processes that Bennu has experienced will be discussed.

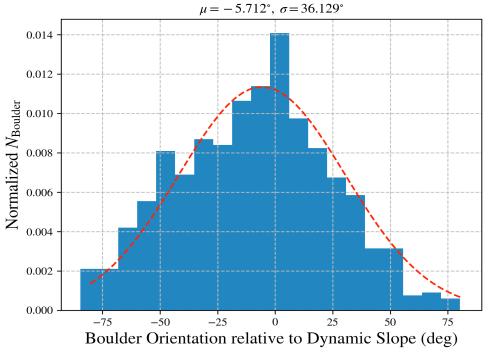

Figure 2: Boulder orientations relative to the local dynamic slope from counts shown in Fig. 1. Orientation angle is defined as the clockwise offset from perfect alignment with local slope (0°).

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