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OSIRIS-REx and CosmoQuest: Using Citizen Science for Active Mission Operations and Beyond

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Abstract

From the first spacecraft images of asteroid (101955) Bennu in September 2018 through the dedicated global imaging campaigns in the early months of 2019, the OSIRIS-REx mission has imaged the surface of a near-Earth asteroid in unprecedented detail. In order to globally map and classify Bennu in a short timeframe that is driven by the operational needs of the mission, OSIRIS-REx is utilizing crowd-sourced, citizen science gathered data. These data will be used to inform mission operation decisions and contribute to ongoing science investigations beyond the requirements of sample acquisition.

1. Introduction

The Origins Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) Mission, a NASA funded, sample retrieval mission, arrived at asteroid (101955) Bennu in December 2018 and began a series of specialized campaigns to globally resolve the physical properties of the asteroid's surface [2]. In order to collect and return a pristine sample of Bennu's regolith, the OSIRIS-REx mission must globally classify potentially hazardous surface features and identify potentially sampleable regions of interest (areas with material that can be ingested into the TAGSAM sample head and no boulders large enough to interfere with the sampling maneuver) [4].

Bennu is a rubble pile asteroid [3] whose surface is covered almost entirely with boulders ≥ 21cm. To aid in global mapping, the OSIRIS-REx Image Processing Working Group (IPWG) and CosmoQuest have designed a unique Citizen Science project where we collect and use crowdsourced feature identification data during active mission operation. These data will be incorporated with in-house, expert produced boulder mapping data and will be used to inform mission decisions as well as contribute to current and future scientific analysis.

2. Bennu Mappers

Bennu Mappers is a fully online, web application (figure 1) with a simple set of tools that allows anyone with an interest in science and space exploration the opportunity to participate in the mapping efforts of the asteroid's surface. Users are able to mark the circumference of craters, the longest axis of boulders, and the center point of boulders that are at or close to the resolution limit of the images.

The first major dedicated Bennu Mappers campaign runs from May 2019 until July 2019 and the results of this effort feed into a thematic map of hazards and regions of interest, an input product that informs another map that shows surface sampleability (areas with material that is able to be ingested by the TAGSAM head). The campaign ends when two potential sample sites are selected by the Mission.

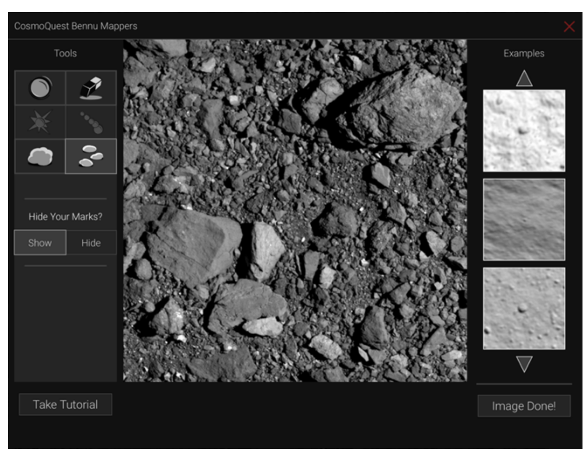

Figure 1: The Bennu Mappers web interface.

3. Continuing Science

Once the potential sample sites are selected, Bennu Mappers begins its second dedicated campaign aimed at globally mapping every boulder ≥ 21cm over 80% of the asteroid's surface. These data can then be used for long term scientific study and will be input into the global and local Particle Size Frequency Distributions (PSFDs) [1]. This global census of boulders can also be used to analyze trends in the surface material by looking at the distribution of boulder sizes, their locations and orientations, and other physical qualities such as albedo variation and shape (roundness). These trends will inform our understanding of the material makeup of the asteroid as well as the underlying geologic processes that drive the shape and surface composition of Bennu.

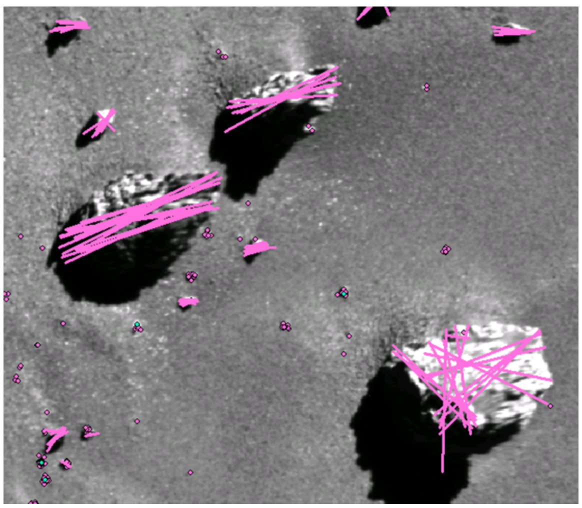

Figure 2: Bennu Mappers output from a testing dataset showing a local mosaic from comet 67P/Churyumov–Gerasimenko. By analyzing the raw user marks, we can glean additional clues to the morphology of individual boulders. The two large boulders in the upper left of the figure have easily identified longest axes and therefore the marks are highly uniform. The boulder in the lower right is rounder and the longest axis is not as obvious. The variability in the user marks reflect that the boulder is rounder and less elongated.

Acknowledgements

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References

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