CHARACTERIZATION OF BRIGHT FLAKES ON ASTEROID BENNU.

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Introduction: NASA's OSIRIS-REx asteroid sample return mission has explored the near-Earth, carbonaceous asteroid (101955) Bennu with its remote sensing instruments. Close observations of Bennu revealed that the surface shows variation in albedo [1]. The global average geometric albedo is dark, 4.4±0.2% [2], which is consistent with Bennu's carbonaceous composition suggested by spectral data [3, 4]. However, further investigation has found that there are several types of brighter materials on Bennu's surface. Six unusually bright boulders (about 10 – 30% normal albedo) exhibit a spectral absorption feature that corresponds to pyroxene and were found to spectrally resemble the eucrite meteorites from asteroid (4) Vesta [5]. Also, bright carbonate veins were observed near the OSIRIS-REx sample site, Nightingale. Uninterrupted veins up to 150 cm long suggest that fluid flow and hydrothermal deposition would have occurred on kilometer scales for thousands to millions of years on Bennu's parent body [6].

In addition to those bright features, there are smaller, flake-like clasts (Figure) found usually on the surface of boulders, which appear brighter than the host rocks and the average terrain. Some flakes seem to be embedded in the host rocks, and others seem to be sitting on top of them. We investigate and characterize the flakes by their global distribution, shape, size, composition, and morphology. Based on the previous observations mentioned above, the flakes might consist of carbonates or eucritic pyroxene. If they are carbonates, it is possible that they are partially buried veins, or fragments of veins that were broken down by the catastrophic disruption of the parent body and/or subsequent impacts.

A previous study mapped the distribution of carbonate materials at the Nightingale sample site, three other regions of interest that were investigated for sampling, and Minokawa Crater, using the spectral feature around 3.4 µm and corresponding images [7]. As a follow-up to that work, we use images with higher resolution to investigate whether any of the carbonate signature comes from flakes.

Methods: To date, we have performed detailed characterization on the flake on Gargoyle Saxum (Figure) using OCAMS PolyCam [8] images with pixel scales of 2–5 cm/pix that had been converted into reflectance [9]. A digital terrain model (DTM) of the host rock including the flake was created using the lidar data obtained by the OSIRIS-REx Laser Altimeter (OLA [10]). All seven lidar scans available were registered using a Poisson reconstruction method to cover the entire surface of the host boulder [11]. The PolyCam images were registered to the DTM using reconstructed SPICE kernels in USGS's Integrated Software for Imagers and Spectrometers 3 (ISIS3) [9]. Dimensions of the flake were identified with polylines on ArcMap, part of ESRI's geospatial information system software. Lengths of the polylines were calculated using the (x, y, z) coordinates of endpoints determined from body-fixed x, y, z geometry in the backplanes. Normal albedo was calculated using the method described in [12, 13].

Initial Results and Discussion: The longest dimension of the flake on Gargoyle Saxum is about 1.7 m. It is shaped like a plate, and located right next to a void space that has a similar shape. Its normal albedo is 8.7±0.7%. Carbonate veins on Bennu have normal albedo of about 10–19% [6]. If the flake consists of carbonate, it could be mixed with some darkening agent to decrease the normal albedo. Investigating formation scenarios of bright flakes — such as whether they are part of breccias, whether they were fragmented by impacts, and whether they formed on Bennu or the parent body — will provide more context to the history and evolution of Bennu's materials.

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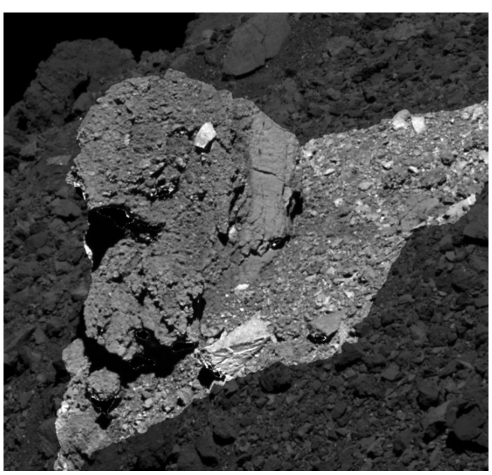

Figure. *A bright flake is visible on the surface of a dark boulder, Gargoyle Saxum. The boulder and surrounding area are photometrically corrected to display normal albedo.*