OSIRIS-REx SAMPLE SCIENCE AND THE GEOLOGY OF ACTIVE ASTEROID BENNU

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Introduction: The OSIRIS-REx spacecraft went into orbit about (101955) Bennu on 31 December 2018 [1]. Data from the Approach, Orbital A, and Detailed Survey–Baseball Diamond mission phases have provided valuable insights into the geomorphological nature and the geological and dynamical processes that shaped the surface. Herein we report on the surface geology of Bennu with a goal of contextualizing the nature of the future returned sample.

The Surface Geology of Asteroid Bennu: Bennu has a top-like shape, i.e., spheroidal with an equatorial bulge [1-4]. The surface contains numerous candidate craters, many ≥ 50m in diameter. The larger craters are concentrated on or near the equator, suggesting that the ridge is an old feature of the asteroid, perhaps a relic of its original formation in the main belt due to catastrophic disruption [2,4].

The surface is littered with a diverse population of boulders [2,3] varying in normal albedo (suggestive of real compositional differences) and > 200 with an apparent diameter of over 10 m. Many boulders appear to be breccias, some of which may have or are being weathering *in situ* [2]. The boulders have interesting features: some have surface textures that are rough, similar to that of aa lava. Others appear to have textures with linear patterns that appear to be cleavage, perhaps thermally derived, and/or the product of an exfoliation process and many appear to be breccias [1-3]. Some areas on the surface have concentration of boulders, including several low-topography areas that are nearly completely covered. In a few regions, evidence of mass movement is observed, suggestive of a geologically active surface where boulder (and potentially finer regolith) movement is changing the site-specific surface expression. Fine-particulate regolith exists on Bennu [2,3], mostly between boulders or in small areas of ponding including small candidate impact craters (~ 5–20 m in diameter). However, the low abundance of regolith contrasts with the ground-based interpretation of the thermal inertia, which suggested a mean particle size of centimeters [3]. Albedo differences among boulders suggest compositional differences. Spectral data provide further insight into Bennu's composition: (1) a 2.74-µm absorption feature is suggestive of abundant hydrated phases; (2) ~ 18- and 29.4-µm features indicate magnetite; and (3) the overall spectrum, visible through thermal infrared, is similar to that of CM chondrites [5].

Active Asteroid Bennu: After orbital insertion, visual observation using the OSIRIS-REx NavCam revealed that particles, centimeters to 10s of centimeters in diameter, were being ejected from Bennu [6]. To date, at least three major events and numerous minor events have been documented. These events appear to be restricted to particles, however, it may not be possible to detect of a major volatile component or very fine particles associated with the ejection events so caution is warranted on concluding cm-sized particles alone are being ejected. During the ejection events, some particles are completely lost from the Bennu environment, while others apparently re-impact, sometimes after a short-lived (few days) orbit around the asteroid. The exact cause of the particle ejection events is the focus of current research as is the exact geographical location of each event.

Implications for Sample Science: We do not yet know the discrete composition of boulders with different albedos, but, based on the current resolution of the observations, we suggest that the major component of Bennu is CM chondrite–like in bulk composition. Particle ejections events may be a newly recognized means of getting samples to Earth. Thus, we may have samples of Bennu in our collections and it is possible that they are, or are similar to, CM chondrites. Finally, the mission is in the process of selecting a primary and secondary site for sample collection wtih detailed geologic characterization of these sites starting in late summer 2019, details to be reported.

References: [1] Lauretta D. S. and DellaGiustina D. N. et al. (2019) *Nature* 568:55–60. [2] Walsh K. J. et al. (2019) *Nature Geoscience* 12:242–246. [3] DellaGiustina D. N. and Emery J. P. et al. (2019) *Nature Astronomy* 3:341–351. [4] Barnouin O. S. et al. (2019) *Nature Geoscience* 12:247–255. [5] Hamilton V. E. et al. (2019) *Nature Astronomy* 3:332–340. [6] Lauretta D. S. et al. (2019) *LPSC 50*, Abstract #2608. This abstract and the OSIRIS-REx mission is supported by NASA under Contract NNM10AA11C to the University of Arizona.