MODELING OF SEDIMENT DEPOSITION ON ASTEROID BENNU'S PARENT BODY. K. Ishimaru[1], D. S. Lauretta[1], N. Porter[1], D. R. Golish[1], M. M. Al Asad[2], R.-L. Ballouz[1], O. S. Barnouin[3], K. N. Burke[1], M. G. Daly[4], D. N. DellaGiustina[1], B. Rizk[1], and K. J. Walsh[5]. [1]Lunar and Planetary Laboratory, University of Arizona, 1629 E University Blvd, Tucson, AZ, 85721, USA, [2]Department of Earth Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, British Columbia, Canada, [3]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA, [4]The Centre for Research in Earth and Space Science, York University, Toronto, Ontario, Canada, [5]Southwest Research Institute, Boulder, CO, USA. (kana@email.arizona.edu)

Introduction: Asteroid Bennu is a carbonaceous near-Earth asteroid explored by the OSIRIS-REx mission, which discovered that Bennu's surface is covered with boulders up to a hundred meters in long axis [1]. Bennu is a top-shaped, rubble-pile asteroid with diameter about 500 m [2]. Because of its small size, the collisional lifetime of Bennu is much shorter than the age of the solar system [3]; therefore, Bennu is thought to be an accumulation of fragments of a larger (~100-km-diameter) parent body that was catastrophically disrupted [2]. The presence of carbonate veins at centimeter to meter scales in boulders on Bennu indicates that large-scale (meters to kilometers) fluid flow took place on the parent body [4]. In high-resolution images (<6 cm/pix) of the surface of Bennu acquired by the OSIRIS-REx Camera Suite (OCAMS) [5], we discovered some boulders that exhibit multiple, apparently layered textures that are divided by linear boundaries [6]. The layered structures could have formed by sedimentation in the fluid flow, intrusion of distinct material, or brecciation. In this work, we focused on sedimentation, and we modeled the fluid flow velocity using parameters from observations of the boulders.

Methods: Layered boulders were identified in a global mosaic of Bennu that was projected on a lidar-based global shape model (OLA v16; [7–9]) using the Small Body Mapping Tool [10]. Detailed observation and measurements of layered boulders were performed using OCAMS PolyCam [5] images with pixel scales of 2–5 cm/pix that had been converted into reflectance [11]. All the lidar scans available (typically 10 or more scans for each boulder) were registered using a Poisson reconstruction method to create a digital terrain model (DTM) covering the entire surface of the boulder. The PolyCam images were registered to the corresponding DTM using reconstructed SPICE kernels in USGS's ISIS3 software [11]. Normal albedo was calculated using the method described in [12, 13].

Three large boulders—Gargoyle Saxum and two unnamed objects designated KLR1 and KLR2 here—were selected for detailed analyses of clast size and layer thickness using ArcMap. We assumed that the clast-size distribution represents the energy of the depositional environment. Based on the formulation presented in [14], settling velocities of multiple particle size classes were calculated under microgravity conditions on a 100-km-diameter parent body [15].

Results: The normal albedo and texture of layered units can be divided into two groups: one is rough and dark (4–5% normal albedo), and the other is smooth and comparatively bright (5–7% normal albedo), similar to the variation in the broader boulder population [16]. The layers are ~1–10 m thick. Clast size frequency distribution follows a power law relation. Slopes of power law fits of the three boulders range from -3.2 to -4.2. There were no clasts identified in Gargoyle's brighter unit. Particle size in the brighter unit is smaller than the resolution limit, which is about 1 cm or smaller. The two size classes suggest that the layers formed via sequential deposition with distinct settling velocities.

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