THE OSIRIS-REx SCIENCE VALUE MAP OF ASTEROID BENNU.

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Introduction: The OSIRIS-REx mission is carrying out an intensive remote sensing campaign at asteroid Bennu in preparation for surface sample acquisition in July 2020 [1]. Sample site selection will be guided by four maps of the asteroid surface: the Safety Map, Deliverability Map, Sampleability Map, and Science Value Map (SVM) [2]. The SVM is a quantitative measure of the suitability of sampleable surface regolith for addressing the science goals of the mission [2].

Science Value. A primary goal of the OSIRIS-REx mission is to test hypotheses on the origin, geological history, and dynamical evolution of Bennu through analyses of the returned sample [2]. The best scientific value area for sample collection would encompass the diversity of chemistry, mineralogy, and geology of Bennu, allowing for tests of these hypotheses. Remote optical imaging and spectral mapping by the OVIRS and OTES instruments are yielding dozens of maps that are being used to assess science value. Of particular interest will be surface regions showing evidence of organics, hydrated minerals, chemical and mineralogical diversity, and the presence of freshly exposed materials and volatiles.

Here we present the early observations of Bennu that are being used to assess the relative science value of candidate sampling sites. At this writing, the Detailed Survey phase of the mission has just begun. Results of these observations will be discussed at the Meteoritical Society Meeting.

SVM visualization: Owing to the mission's tight operational schedule, these diverse data products need to be combined quickly in a simple and flexible manner. We developed a visualization tool that combines spectral and geological remote sensing maps into an integrated SVM and projects the SVM onto the Bennu 3D shape model and global image mosaic. Each remote sensing map is converted to a score map, where values of each facet on the shape model are assigned a value from 0 to 1, based on confidence of detection of that map element. The science value score is determined by selection and weighting of inputs to the SVM and is user-adjustable.

Early observations: Global-scale imaging and spectral observations confirmed that Bennu is hydrated and volatile-rich [3]. However, the surface is more rugged than expected and shows large albedo variations that are not yet understood. Observations of impact craters suggest that the surface is on the order of 100–1,000 million years old, and smaller craters have been erased by mass movement [4]. Unexpected observations of particle ejection events in the Orbital A phase show that Bennu remains geologically active, although the cause of these events has not yet been determined.

Geology science value. With Bennu's old age, most of the surface regolith has probably undergone extensive space weathering. Small craters are thought to be younger; thus fresher, scientifically valuable subsurface material should be found within them. Particle ejections *may* be volatile driven, and if so, source areas would be of high science value. The abundant boulders on Bennu show diversity in morphology that may relate to both intrinsic properties and geological history on the surface. Both rounded and angular boulders are observed, showing various types of fracturing and layering. Collecting fragments from a variety of rock types would be of high science value.

Mineralogy science value. Hydrated minerals are a priority target for collection and appear to be abundant on Bennu [4]. Early observations further suggest the presence of magnetite [1], a common byproduct of aqueous alteration in meteorites. So far, the spectra suggest an affinity to CM carbonaceous chondrites. Collection of material having such diagnostic minerals is a key goal of the mission because it allows for testing of hypotheses, such whether Bennu is analogous to carbonaceous chondrite meteorites.

Chemistry science value. The chemistry science value is primarily related to the abundance and type of organic matter. Spectra acquired during the Detailed Survey phase are expected to have sufficient sensitivity to detect organic features. Any positive spectral detection of organics would mark a potential sample site as having high science value.

Sample site selection: The top candidate sample sites are now being evaluated, with refinements made as new observations and compositional maps are made available. The early observations of Bennu show a fascinating body that has scientifically valuable material everywhere on its surface.

References: [1] Lauretta D. S. et al. (2019) *Nature* 568:55–60. [2] Lauretta, D. S., et al. (2017) *Space Science Reviews* 212: 925-984. [3] Hamilton V. E. (2019) *Nature Astronomy* 3:332–340. [4] Walsh K. J. et al. (2019) *Nature Geoscience* 12:242–246.