GEOLOGIC FEATURE MAPPING ON ASTEROID (101955) BENNU TO INFORM SAMPLE SITE SELECTION ON THE OSIRIS-REX MISSION.

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Introduction: The OSIRIS-REx asteroid sample-return mission is currently investigating the primitive B-type asteroid (101955) Bennu [1]. Preliminary analyses of Bennu show it to be a rubble pile asteroid rich in hydrated materials and boulders [2-5]. Geologic analyses of Bennu showed that it has experienced a diverse history which has created various geologic features including impact craters, linear features, and boulders [5, 6]. At the time of the meeting the mission will be in its Orbital B phase [1]. Current observations will feed forward to inform sample site selection occurring in July 2019, with sample collection in July 2020. It is a priority to collect a sample of surface regolith that can address fundamental scientific questions about the origin and evolution of Bennu.

Sample Site Selection: The ongoing remote sensing analyses and geologic mapping all feed forward to support the sample-return objective of the mission. Coordinated observations will contribute to four thematic maps that each address a different aspect of sampling logistics: Deliverability, Safety, Sampleability, and Science Value [1]. *Deliverability* addresses whether the spacecraft can maneuver to a given sample location; *Safety* ensures the spacecraft and sampling head will not become damaged during contact with the surface that would prevent successful sample return; *Sampleability* addresses whether a sample site will permit at least 60 g of regolith to be collected; and *Science Value* ensures the sample site contains materials that provide maximum likelihood of returning pristine carbonaceous regolith [1].

Geologic Feature Mapping: Global mapping of geologic features is critical for both Sampleability and Science Value. The Sampleability map identifies optimal sampling locations by quantifying the expected mass of regolith that would be collected there [1]. Critical to this assessment is the identification of deposits of regolith on the surface, as well as the distribution of resolvable particles at all sizes (cobbles to boulders). Regolith deposits are generally free of large particles too large to be ingested by the sample head, and are important for initial sample site assessment. Maps of boulder locations are useful for first-look assessments of potential sample sites, while calculations of the size-frequency distribution of particles will help generate average grain size maps at sample site-scale resolution.

Inputs to the Science Value map include global maps of four types: (Chemical Composition, Mineralogy, Geological Features, and Temperature) to identify a sample region that contains fresh surface material that has not experienced extensive space weathering and/or impact events [7]. Geologic feature maps are used as a proxy to indicate potential freshness of a region, and are ranked in order of priority: proximity to an active particle ejection site is of highest priority, as that region may contain very recently exposed material; the next-highest priority is space weathering; then particle size-frequency distribution (mapped as rocks); brittle deformation (mapped as linear features); and finally crater materials [7]. The four Science Value inputs will then be integrated to create a "treasure map" – an aid in sample site assessment.

Teams of researchers are currently tasked with identifying and mapping the distribution of geologic features on Bennu. Mapped features include boulders, craters, linear features, regolith, and particle ejection sites (these locations are determined by following particle motion vectors back to the surface, and up to now the surface locations are not unusual in any way). Current geologic feature maps show a diverse suite of geologic features that are globally distributed (Figure 1) [6], indicating a prolonged geologic history with low resurfacing rates. The high concentration of crater candidates on the equator suggest that the equatorial ridge may be one of the oldest regions on the surface [6], while several longitudinal ridges and grooves suggest that Bennu contains a degree of internal strength and cohesion [5]. The source and nature of particle ejection events are being actively investigated [8]. We are currently assessing specific areas on the surface of Bennu to determine locations of abundant regolith ingestible by the sampling mechanism (≤2 cm) and for Science Value. Primary and secondary sites will be selected by the Science and System Engineering teams in mid-July 2019. Hence, this is a very active time for creating 2D and 3D maps of a multitude of asteroid properties.

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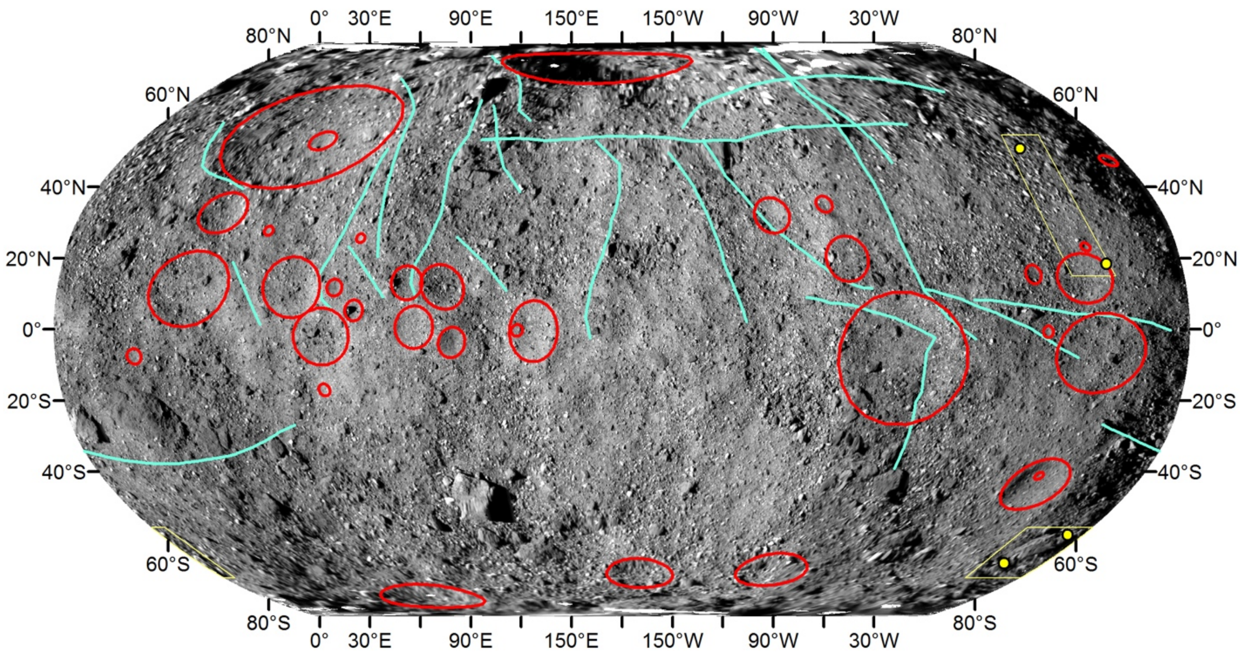

Figure 1. Mapped distribution of geologic features on Bennu. Cyan: linear features, red: crater candidates, yellow: particle ejection sites.