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X-Ray Computed Tomography of Samples from Asteroid Bennu: Textural Analysis and Sulfide Segmentation for Lithology Characterization

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On September 24, 2023, samples of asteroid (101955) Bennu were delivered to Earth by NASA's OSIRIS-REx mission [1]. Among the mission's goals are characterization of the mineralogy and composition of the sample, understanding hydrothermal alteration processes that occurred on Bennu's parent body, and comparing sample lithologies to remote observations of Bennu [2]. To contribute to addressing these objectives, we use X-ray computed tomography (XCT), a non-destructive 3D imaging technique, to perform a comprehensive textural characterization of millimeter-scale Bennu particles [3].

Initial analyses identified three distinct particle morphologies within the sample, under consideration as candidate lithologies [4,5]. These morphologies are visually evident in larger stones; we use XCT textural analysis to classify smaller particles and compare characteristics of each morphology [4,5]. Given the apparent relationship between these three morphologies and boulder populations observed on Bennu [4,5], this analysis is particularly relevant in comparing laboratory characterization with remote sensing data. Bennu's distinct boulder populations are expected to have differing physical properties, including density, so we investigate whether these differences are evident on smaller scales [6].

Our study emphasizes the abundance, orientation and distribution of sulfide minerals determined from XCT data, as these characteristics are a useful basis for comparing candidate lithologies. Additionally, we use sulfide data in crystallization models [7] to constrain the mechanism and environment of sulfide crystallization, making these minerals particularly useful in understanding hydrothermal alteration processes that occurred on Bennu's parent body. We will next use these data to inform the selection of sulfide grains for compositional analysis, as their compositions and textures help to constrain formation conditions and subsequent alteration [3,8].

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References

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