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Reflectance spectroscopy (0.250–2.500 µm) of an unsorted particulate sample from asteroid (101955) Bennu

EDWARD CLOUTIS[1], DANIEL APPLIN[1], VICTORIA HAMILTON[2], RALPH MILLIKEN[3], TAKAHIRO HIROI[3], PROF. HAROLD C. CONNOLLY JR., PHD[4] AND DANTE LAURETTA[5]

[1]University of Winnipeg
[2]Southwest Research Institute
[3]Brown University
[4]Rowan University
[5]University of Arizona

Presenting Author: e.cloutis@uwinnipeg.ca

The OSIRIS-REx spacecraft returned a sample of near-Earth asteroid (101955) Bennu to Earth in September 2023 [1]. As part of the mission's sample analysis program [2], we conducted 0.250–2.500 µm reflectance spectroscopy of a ~200 mg unsorted particulate sample (OREX-800029-0). The sample consists largely of dark particles, ranging in size from below the resolution limit of our imaging system (<~5 µm) to ~2 mm.

Reflectance spectra were acquired using an ASD LabSpec 4 Hi-Res spectrophotometer (0.350–2.500 µm) and OceanInsight Maya2000 instrument (0.250–0.400 µm). The sample was placed into a 15 mm diameter aluminum cup. We were able to measured spot sizes as low as 1.8 mm, enabling characterization of larger particles and subsets of the bulk sample.

Visual examination of larger particles (>~1.5 mm) suggested three categories: angular, hummocky, and mottled. Four particles nearly filled our instruments' field of view and are considered as representatives of these groups. The one mottled particle had the highest reflectance and showed a weak absorption near 2.3 µm that could be attributable to carbonates. The one angular particle showed a flatter spectral slope than the two other categories. All large particle and bulk sample spectra exhibited a broad absorption feature centered near 1 µm — plausibly attributable to Fe-bearing phyllosilicates and/or magnetite, and a flattening spectral slope beyond 0.7 µm. None of the particle or bulk powder spectra showed clear evidence of any additional predicted absorption features [3]. Our lab spectra are similar to the spacecraft's spectra in terms of low reflectance and generally featureless spectra [e.g., 3,4]. However, no particle or bulk powder spectra showed the blue slope characteristic of global-average Bennu: we attribute this to expected spectral differences between boulders (abundant on Bennu) versus powders [5].

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