OVIRS Visible to Near-IR Spectral Results at (101955) Bennu. A.A. Simon[1], D.C. Reuter[1], H.H. Kaplan[1], V.E. Hamilton[2], D.N. DellaGiustina[3], E. Tatsumi[4,5], M.A. Barucci[6], E.A. Cloutis[7] and D.S. Lauretta[3]. [1]NASA Goddard Space Flight Center, Greenbelt, MD, [2]Southwest Research Institute, Boulder, CO, [3]University of Arizona, Lunar and Planetary Lab, Tucson, AZ, [4]Instituto de Astrofísica de Canarias (IAC), La Laguna, Spain; [5]Department of Earth and Planetary Science, University of Tokyo, Tokyo, Japan, [6]LESIA, Observatoire de Paris, Université PSL, CNRS, Université de Paris, Sorbonne Université, Meudon, France, [7]Department of Geography, University of Winnipeg, Canada.

Introduction: The OSIRIS-REx Visible and InfraRed Spectrometer (OVIRS) operates over a wavelength range of ~0.4 to 4.3 µm with a 4-mrad field of view. During the OSIRIS-REx mission, OVIRS collected more than 500,000 spectra of Bennu for spectral characterization of the surface. Constant phase angle observations were dedicated to global mapping at ~20 m resolution. Data with higher resolution (2–4 m) were obtained of the candidate sample sites.

We analyzed low-phase-angle (12:30 pm local solar time) global data for surface color trends, surface temperatures, and the band depths of absorption features associated with hydrated minerals, carbon-bearing materials, iron oxides, and pyroxenes.

Spectral Slope and Color: Bennu has an overall blue spectral slope at low phase angles, consistent with its classification as a B-type asteroid (Fig. 1). Maps of the spectral slope from 0.5 to 1.5 µm show a slightly less blue equator (Fig. 2) and several locations with much redder spectra. In particular, the large boulder on Bennu, known as Roc Saxum, is among the reddest features on the surface [1,2]. Multivariate statistics from 0.5 to 2.5 µm show that 98% of the surface has a spectral slope similar to the global average [3].

Spectral Absorption Features: The most notable absorption feature in Bennu's spectrum is the 2.7-µm hydrated phyllosilicate band [4] seen in all spectra (Fig. 1), including global, spatially-unresolved spectra. It shows band depth variations of ±2% on the surface, once the temperature dependence is removed [2].

Spatially resolved spectra show a number of other spectral features. Weak features are visible in nearly every spectrum at 0.55, 1.05, 1.4, 1.8, and 2.3 µm (Fig. 3). These features may be attributable to iron oxides (magnetite or goethite), phyllosilicates, and carbonates [5]. Several bright boulders also show strong spectral signatures of pyroxene [6]. The pyroxene signatures can be seen even though the bright boulders encompass only a small fraction of the OVIRS spot (Fig. 3B, bottom).

An additional absorption is seen at 3.4 µm in nearly all spectra and represents carbon-bearing materials: carbonates, organics, or a mixture of both [2,7] (Fig 4). Images of many boulders show apparent bright veins of carbonates [7], but the spectral shape can vary over these regions, as well. However, the presence of carbonates is consistent with past aqueous alteration on Bennu and the presence of the hydrated phyllosilicates and iron oxides.

Summary: Detailed studies of OVIRS spectra of Bennu reveal small variations in spectral slope and absorption band depths across the surface. Several bright, exogenic boulders have the spectral signature of pyroxene and represent the only composition that is dramatically distinct from the average. Hydrated minerals are globally present, and there is spectral evidence of iron oxides, phyllosilicates, and carbon-bearing materials spread across the surface. Spectral maps from the OVIRS instrument were used to assess the sample collection site and will be an important tool to link the returned sample composition to the asteroid surface. We expect the returned OSIRIS-REx samples to contain the minerals and chemicals identified here.

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References: [1] DellaGiustina, D.N. et al. (2020) *Science, 370,* eabc3660. [2] Simon, A.A. et al. (2020) *Science, 370,* eabc3522. [3] Barucci, M.A. (2020) *A&A, 637*, L4. [4] Hamilton, V.E. et al. (2019) *Nat. Astron., 3*, 332-340. [5] Simon et al. *A&A*, accepted. [6] DellaGiustina et al. (2020) *Nat. Astron*. [7] Kaplan et al. (2020) *Science, 370*, eabc3557.

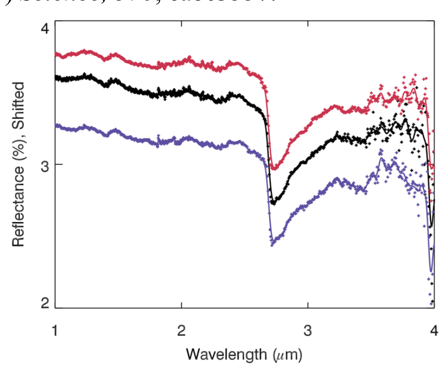

Fig 1. Bennu spectral slopes. Black is the global average spectrum, and red and blue spectra are for redder or bluer spectral units. All show the 2.7-µm feature [2].

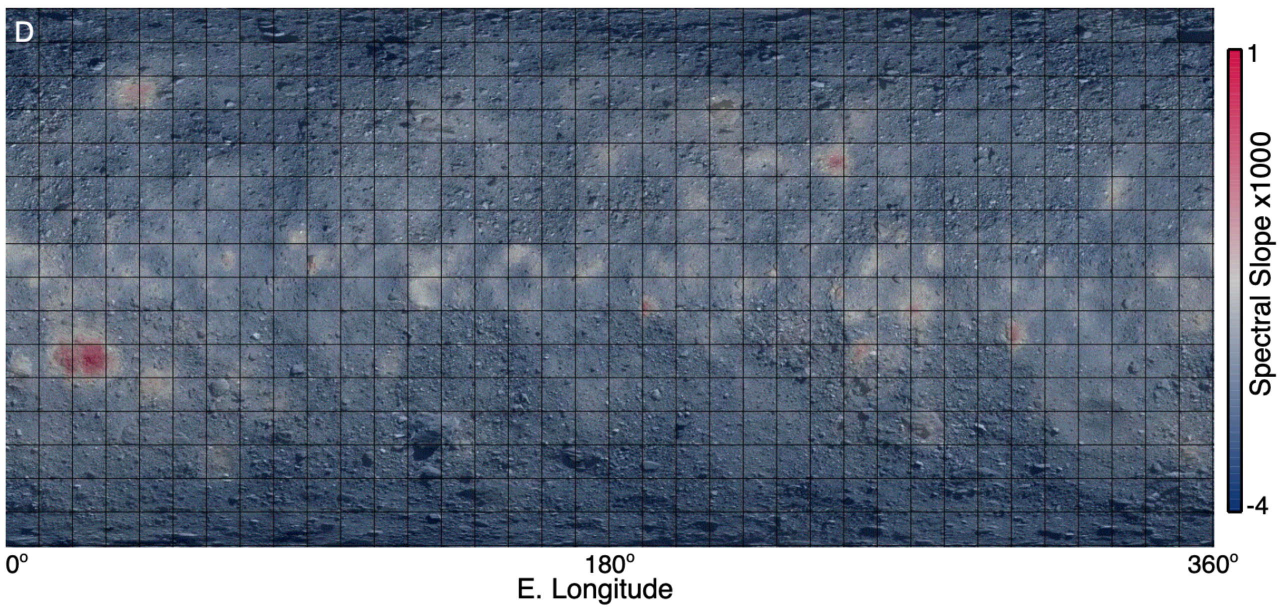

Fig. 2. Bennu's spectral slope from 0.5 to 1.5 µm [2].

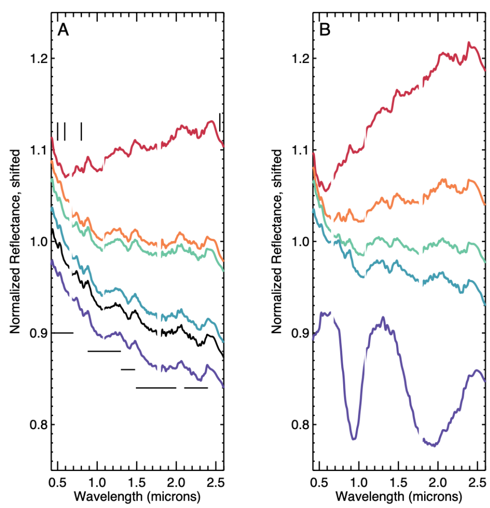

Fig. 3A: Low phase, low spatial resolution (~20 m) spectra of locations with different spectral slopes and common absorption features (colored arbitrarily; black = Bennu global average). B: High spatial resolution spectra (~5 m) of the same locations; the bottom curve shows the distinct spectral signature of pyroxene and has been reduce by a factor of 2 to fit [5].

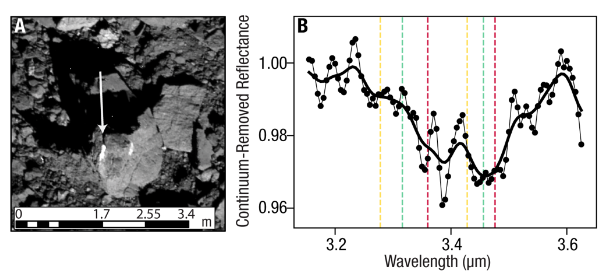

Fig. 4A: A dark boulder with apparent bright veins in the Nightingale crater region. B: Spectrum over this boulder showing spectral shape attributed to the mineral carbonate [8].