SPACE WEATHERING MAPS OF (101955) BENNU USING A RADIATIVE TRANSFER MODEL. D. Trang[1], B. E. Clark[2], H. H. Kaplan[3], M. S. Thompson[4], S. Ferrone[2], A. A. Simon[5], L. P. Keller[6], H. C. Connolly Jr.[7,8], K. J. Walsh[3], and D. S. Lauretta[8], [1]Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, [2]Ithaca College, [3]Southwest Research Institute, [4]Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, [5]NASA Goddard Space Flight Center, [6]NASA Johnson Space Center, [7]Rowan University, School of Earth and Environment, [8]Lunar and Planetary Laboratory, University of Arizona

Introduction: Space weathering is an important process that affects the surfaces of airless bodies, such as (101955) Bennu. The consequences of this process include physical and chemical changes to materials on the surface, which in turn change spectral characteristics, especially in the visible to near infrared wavelengths [1–5]. These spectral changes are not the same across airless bodies because the changes are dependent on the composition and mineralogy of the surface and even location within the Solar System [e.g., 5, 6]. The main space weathering products responsible for these spectral changes are submicroscopic particles, which consist of two types, nanophase and microphase particles, and affect visible to near-infrared reflectance spectra differently [7–8]. Nanophase particles are particles <33 nm in size and occur in agglutinates and within glassy patinas around regolith particles [9]. In contrast, microphase particles are >33 nm in size and are present only within agglutinates. These spectral differences are best illustrated by lunar samples. In lunar soils, the nanophase and microphase particles consist of metallic iron [e.g., 5]. With increasing abundance of nanophase iron particles in a regolith, its spectrum exhibits a lower overall reflectance in the visible to near infrared, weakened absorption bands, and a reddened continuum slope [7]. In contrast, an increasing abundance of microphase iron only causes decreases in reflectance and not reddening. Because of the spectral differences introduced by these two types of particles, it is possible to model the nanophase and microphase particle abundances of a surface through the radiative transfer technique.

Beyond the Moon, the composition of the nanophase and microphase particles can include other phases because the mineralogy of the surfaces of other planetary bodies is different. For example, the nanophase and microphase particles may consist of amorphous carbon (Mercury) and sulfides (Itokawa) [6, 10]. The mineralogy of Bennu is consistent with carbonaceous chondrites [11,12]. From a number of space weathering experiments on CM chondrites [11, 12], the likely nanophase and microphase mineral phases on Bennu includes iron, magnetite, and sulfides (i.e., pentlandite and troilite) [13].

The goal of this work is to input the predicted nanophase and microphase compositions for Bennu into the radiative transfer technique. Next, we use this technique to model the OSIRIS-REx Visible Infrared Spectrometer (OVIRS) so that we can model the nanophase and microphase particle abundances across the surface. This will result in space weathering maps of the surface of Bennu, which are useful for understanding the degree of space weathering across the surface and its relationship to various regions and geological features.

Methods: We implement a radiative transfer model that was developed by [5] and improved by [8] to model the OVIRS spectra. Although boulders dominantly cover the surface of Bennu [14], to use this model, we needed to assume that the surface of Bennu is covered with a regolith consisting of 45 µm particles, which we call the host particle. This host particle consists of silicates with a constant reflectance of ~3% to keep the nanophase and microphase abundances to realistic values similar to the Moon (<2 wt%). We will be applying this model to the photometrically-corrected OVIRS data obtained during the 12:30pm Equatorial Station of the Detailed Survey mission phase, and therefore used an emission and incidence angle of 0° and 30°, respectively, in our model. Our model uses three different compositions for the nanophase and microphase particles (total of six different particle types), metallic iron, magnetite, and troilite as we do not have optical constants for pentlandite.

Results: We find that we can consistently model the visible to near-infrared reflectance of OVIRS spectra of Bennu (**Fig. 1**). Furthermore, our model shows that space weathering can produce the "bluing", which could explain in part or in full Bennu's global blue visible to near-infrared spectral slope [11]. In our model, we used host particle sizes ranging from 30–50 µm, which increase or decrease the overall reflectance. We observe that using different particle sizes result in similar relative abundances between different nanophase particle compositions. However, the microphase iron abundance and to a lesser extent the microphase troilite abundance increase with smaller host particle sizes and decrease with larger host particle sizes. This is due to the model using the microphase iron particle abundance (which darkens a spectrum) to decrease the overall model reflectance to match the OVIRS spectra. Therefore, although our model does not properly account for host particle grain size, the nanophase abundances can be considered in terms of abundance relative to other nanophase particle abundances. The microphase iron abundance and to a lesser degree, the microphase troilite abundance, are dependent on the host particle size.

Using these submicroscopic particle abundances, we produced nine global maps, three nanophase, three microphase, and three submicroscopic particle abundance maps of each of the three mineral phases, iron, magnetite, and troilite. *According to our model, the primary phases present on Bennu that are due to space weathering are the submicroscopic magnetite and troilite particles.*

Future Work: With these new space weathering maps, we will search for correlations with other Bennu-referenced geospatial quantities to determine how these relative abundances of submicroscopic particles vary with composition, geology, surface features (e.g., craters), and latitude and longitude position.

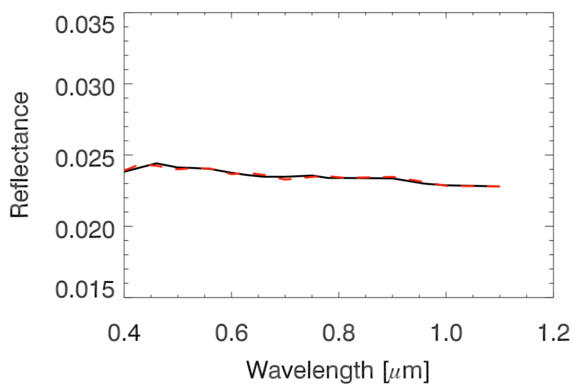

Fig 1: An example of a best-fit model spectrum (red dashed) to an observed OVIRS spectrum (black line) over an area centered at 204.6°E and 8.7°N.

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