HOW CARBON MAY AFFECT SPACE WEATHERING PRODUCTS ON MERCURY AND C-TYPE ASTEROIDS: AN EXPERIMENTAL APPROACH.

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Introduction: When observed in the visible-to-near infrared (VNIR), Mercury's surface reveals a distinct lack of diagnostic absorption bands caused by Fe-bearing silicates [e.g., 1]. MESSENGER Gamma Ray and Neutron Spectrometer (GRNS) and X-Ray Spectrometer (XRS) measurements agree: The surface was found to have an Fe abundance of 1-2 wt. %, and less than 1 wt. % of Fe on Mercury exists as FeO [2, 3]. Iron is known to be a surface darkening agent on airless bodies like the Moon, but the immature lunar highlands, which are similarly low Fe (3 wt. %) to Mercury's low reflectance material (LRM) [4], are 1.6 times brighter [5]. These albedo differences and the lack of Fe-bearing silicate features in Mercury spectra make the traditional picture of space weathering as observed on lunar and S-type asteroid surfaces an unlikely explanation for the darkening of Mercury's surface. What, then, is causing the surface to be so dark?

Multiple investigations have suggested that carbon could be a possible darkening agent [4, 6], and that this carbon is likely endogenous to Mercury [4, 7]. Could this carbon also be a component in space-weathering products? If carbon-related space weathering is causing the observed darkening of the Mercurian surface, what do the possible space weathering products and effects tell us about Mercury's formation and geologic evolution?

To answer these questions, we aim to simulate the effects of space weathering on Mercurian analogs that contain little to no iron. These silicate analogs will be mixed with various C-bearing opaques in order to understand how different forms of carbon may impact simulated space weathering results.

Methods: We will simulate space weathering via micrometeorite bombardment at the laser space-weathering laboratory at Washington University. This simulated environment system allows for irradiation of sample at ultra-high vacuum pressures (10^{-9} torr) and uses two Continuum Surelite I-20 Nd:YAG lasers of differing pulse widths to recreate the thermal conditions of a micrometeorite impact [8]. This experimental setup allows for the uniform weathering of a sample.

We have chosen three silicate analogs and three C-bearing opaques for this work. San Carlos olivine, synthetic pure enstatite, and synthetic pure forsterite will be mixed with 5 wt. % of anthracitic coal, graphene, or carbon black in accordance with the maximum surface abundances of carbon outlined in Klima et al. 2018 [4].

We will analyze our mixtures via VNIR, shortwave infrared (SWIR), and mid-infrared (MIR) reflectance spectroscopy pre- and post-irradiation to see how any spectral slopes and features may change with weathering. Pre-irradiation spectra of our mixtures are shown in **Figure 1**. After irradiation, we will perform reflectance and emission spectroscopy under near-surface environment conditions [9] to further investigate spectral differences [10]. Transmission electron microscopy will be conducted to investigate the formation of typical space weathering products: Agglutinates, amorphous rims on silicate particles, and nanophase opaques embedded within these amorphous rims [11]. These results will be put into context with existing telescopic and remote-sensing data in hopes of preparing the BepiColombo team for MErcury Radiometer and Thermal Infrared Spectrometer (MERTIS) [12] measurements of Mercury to begin in early 2026. Our results may also be compositionally relevant to C-type asteroids.

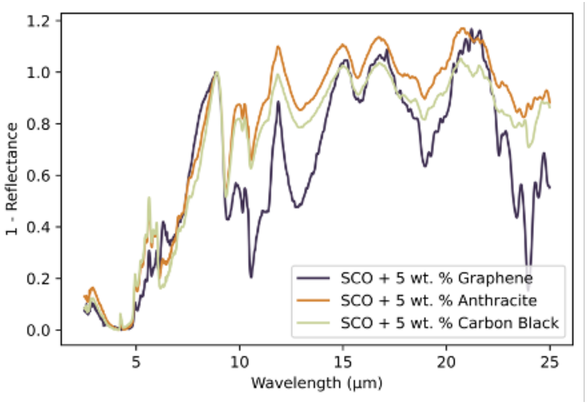

Figure 1. Pre-irradiation MIR reflectance measurements of our San Carlos olivine mixtures, normalized to their respective Christiansen feature positions.

References: [1] Warell et al. (2006). *Icarus,* 180(2), 281-291. [2] Murchie et al. (2015). *Icarus,* 254, 287-305. [3] Nittler and Weider (2019). *Elements,* 15(1), 33-38. [4] Klima et al. (2018). *Geophysical Research Letters,* 45(7), 2945-2953. [5] Braden et al. (2011). *EPSC Abstract.* [6] Bruck Syal, Schultz, and Riner (2015). *Nature Geoscience,* 8, 352-356. [7] Vander Kaaden and McCubbin (2015). *JGR: Planets,* 120(2), 195-209. [8] Gillis-Davis (2022). *EPSC Abstract.* [9] Donaldson Hanna et al. (2021). *JGR: Planets,* 126(2). [10] Lucey et al. (2017). *Icarus,* 283, 343-351. [11] Pieters and Noble (2016). *JGR: Planets*, 121(10), 1865-1884. [12] Benkhoff et al. (2021), *Space Science Reviews,* 217(90).