CARBON ON MERCURY'S SURFACE – ORIGIN, DISTRIBUTION AND CONCENTRATION. Rachel L. Klima (Rachel.Klima@jhuapl.edu)[1], David T. Blewett[1], Brett W. Denevi[1], Carolyn M. Ernst[1], Scott L. Murchie[1], Patrick N. Peplowski[1], Virange Perera[1] and Kathleen Vander Kaaden[2]. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA [2]Jacobs, NASA JSC, Houston, TX 77058, USA.

Introduction: Distinctive low-reflectance material (LRM) was first observed on Mercury in Mariner 10 flyby images [1]. Visible to near-infrared reflectance spectra of LRM are flatter than the average reflectance spectrum of Mercury, which is strongly red sloped (increasing in reflectance with wavelength). From Mariner 10 and early MErcury, Surface, Space, ENvironment, GEochemistry, and Ranging (MESSENGER) flyby observations, it was suggested that a higher content of ilmenite, ulvöspinel, carbon, or iron metal could cause both the characteristic dark, flat spectrum of LRM and the globally low reflectance of Mercury [1,2]. Once MESSENGER entered orbit, low Fe and Ti abundances measured by the X-Ray and Gamma-Ray Spectrometers ruled out ilmenite, and ulvöspinel as important surface constituents [3,4] and implied that LRM was darkened by a different phase, such as carbon or small amounts of micro- or nanophase iron or iron sulfide dispersed in a silicate matrix. Low-altitude thermal neutron measurements of three LRM-rich regions confirmed an enhancement of 1–3 wt% carbon over the global abundance, supporting the hypothesis that LRM is darkened by carbon [5].

Carbon on Mercury: Two explanations for carbon on Mercury's surface had been proposed. The first suggests that carbon could be exogenic, delivered gradually by comets over Mercury's history [6]. The second is an endogenic origin: any carbon that did not partition into the core of the planet would crystallize as graphite, and would have risen to the surface creating a primordial graphite flotation crust [7]. Across the surface of Mercury, LRM shows clear evidence of having been excavated from depth [8–10]. In cases where it is not clearly associated with specific craters, it occurs in patchy spots within broad regions of heavily cratered, ancient terrain where the ejecta from numerous small craters overlap [11–12]. This evidence, from global-scale mapping efforts, supports the hypothesis that this carbon is sourced from the remnants of a magma ocean flotation crust.

Extrapolating the Carbon Content of LRM: In [5], the 600-nm band depth ratio described above was found to correlate with abundance of carbon as measured during low-altitude neutron detector measurements. Although there were only three locations that could be measured, within uncertainty, there is a clear linear relationship between the average ~600 nm band depth for each LRM deposit. Based on the derived band-depth to carbon relationship, we estimated carbon contents for several LRM deposits (Fig. 1). Our results suggest that some regions may contain as much as 5 wt% carbon above the global mean, a value consistent with the carbon content required to produce their low reflectances [9].

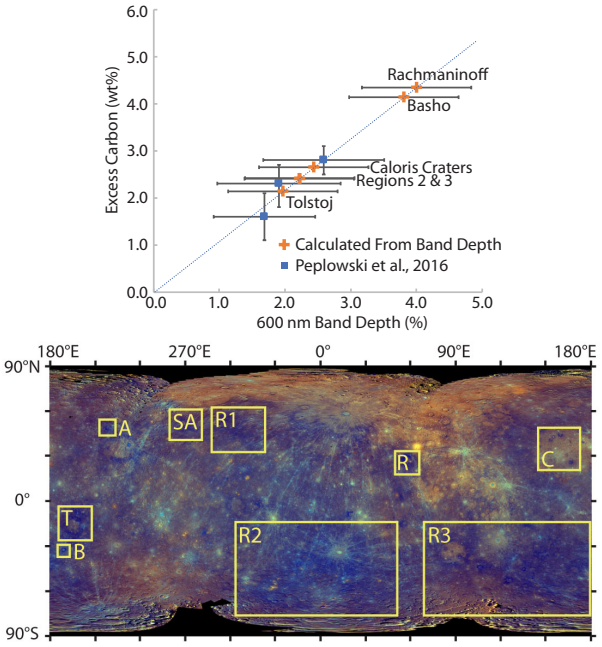


Fig. 1. (top) Extrapolated carbon content for different regions of the surface. Blue squares were measured directly in [5], orange plusses were calculated from the derived band depth relationship. **(bottom)** Enhanced color composite of Mercury with R=PC1, G=PC2, B=430/1000 nm slope. Locations of LRM-enriched craters measured in [5] A-Akutagawa, SA-Sholem-Aleichem, and R1-region LRM-A are shown, along with derived values for B-Basho, T-Tolstoj, R-Rachmaninoff and C-Craters within Caloris and two additional regional enhancements (R2, R3).

Implications: The geophysical and geochemical implications of the carbon abundances measured from orbit and extrapolated to the planet as a whole are yet to be investigated. For example, if LRM is derived from a graphite flotation crust, what could be forming the hollows that are found in association with LRM? Can we estimate the depth and thickness of the LRM layer? How would a graphite floatation crust have affected the thermal and chemical evolution of Mercury's magma ocean?

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