EXPOSURE OF RED MATERIAL BY IMPACT CRATERS ON MERCURY: IMPLICATIONS FOR BURIED PLAINS MATERIAL. Carolyn M. Ernst[1], Scott L. Murchie[1], Olivier S. Barnouin-Jha[1], Mark S. Robinson[2], and Brett W. Denevi[2], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 (carolyn.ernst@jhuapl.edu), [2]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287.

Introduction: The MESSENGER spacecraft's Mercury Dual Imaging System (MDIS), which consists of a monochrome, narrow-angle camera (NAC) and an 11-band (400-1000 nm), wide-angle camera (WAC), confirmed that subtle color variations exist on the surface of Mercury [1-4]. The MDIS data have been used to identify several major and minor color units [3,4]. One of these areally minor units is characterized by a relatively red spectrum and an elevated albedo, first noted in Mariner 10 data [5,6]. Some occurrences of the red unit are associated with rimless depressions [3,4,7,8] and are thought to be of pyroclastic origin [4,7-9].

Other occurrences of the same red unit are associated with impact craters [3,4,9]. These deposits can be located on the crater floor, in the rim and wall, or in the ejecta. Examples of such red material were found to be spectrally similar to the moderate- to high-reflectance, relatively red smooth plains (HRP), suggesting that they may represent small deposits of HRP-like material [9] that were buried and subsequently excavated from depth by impacts. The purpose of this investigation is to examine occurrences of the red unit associated with impact craters and to determine their origin(s) and significance. These craters will be used to determine the global extent of these buried deposits and the depths from which they were excavated.

Data Analysis: We use WAC multispectral data to identify occurrences of the red unit from a combination of spectral shape, band ratios, and principal component analysis. Once the units are identified, WAC data are overlaid on NAC mosaics to examine the craters in higher spatial resolution. Craters are classified by size, shape, and location of the associated red material (e.g., walls, floor, ejecta). Relationships of the red unit to landforms (e.g., basins, rimless depressions) are noted.

Estimates of the original burial depth of the excavated red material can be made by assuming that the maximum depth of excavation is approximately equal to 1/10 the transient crater diameter [10,11]. By incorporating the relative location of the observed red unit, we can provide further depth constraints using a combination of ballistics and a point-source model of escaping impact ejecta (Maxwell's Z model [12]).

Results: Figure 1 is a WAC mosaic of a 1150 km by 450-km region beginning at the Rudaki Plains (thought to have filled an old, ~370-km-diameter basin, indicated by the western dashed circle) and extending eastward. These images have the best available spatial resolution for MDIS color images (~460 m/pixel). Figure 1 contains several instances of the red unit in association with craters (indicated by the solid circles): (A) in the rim of a ~70-km-diameter complex crater in the Rudaki Plains; (B) on the floor of a ~36-km-diameter crater; and (C and D) on the floor and in the near-crater ejecta of two ~15-km-diameter craters. Craters B, C, and D lie within a structure that appears to be an old, ~190-km-diameter basin (indicated by the eastern dashed circle). From the estimates of maximum depth of excavation, the red unit has been buried by < 1.5 km of bluer material in the eastern basin area and may extend

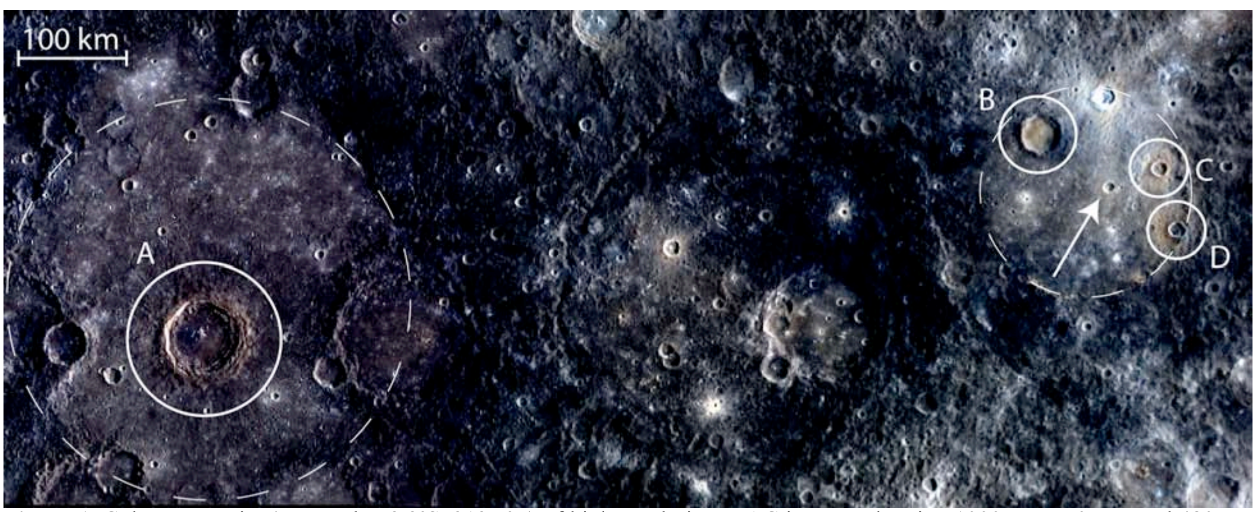

Figure 1. Color composite (centered at 2.2ºS, 313.5ºE) of high-resolution WAC images, showing 1000 nm, 750 nm, and 480 nm in the red, green, and blue image planes, respectively. Solid circles indicate some of the examples of red material associated with impact craters: (A) in the rim of a 90-km-diameter crater; (B) on the floor of a 36-km-diameter crater; and (C and D) in the ejecta and on the floor of two 15-km-diameter craters. The arrow indicates a nearby 11-km-diameter crater that does not seem to have excavated any red material. The dashed circles indicate two old basins.

to > 4 km in the Rudaki Plains (transient crater diameter was calculated from [11,13]).

In the eastern basin, an 11-km-diameter crater (Fig. 1, indicated by the arrow) does not appear to have excavated red material. There are several possible explanations for this observation, including: (1) the red material was buried by >0.7 km of bluer material; (2) the impact was oblique, making the depth of excavation significantly shallower than ~1/10 the crater diameter [10]; or (3) the red unit does not extend beneath this area (this seems less likely, given that the surrounding craters contain red material).

The stratigraphic history of this eastern basin region is quite complex. There are exposures of red material in the basin's southern rim, which must be at a higher elevation than the basin floor. If the red rim material samples the same occurrence of the red unit as exposed in the basin floor, the pre-basin stratigraphy would have included a buried red layer overlying a low-reflectance material (LRM [14]) basement. If the red rim material represents an unrelated occurrence, the pre-basin stratigraphy would have included multiple red layers buried to different depths, overlying an LRM basement. In both stratigraphic scenarios, the basin floor was infilled by intermediate plains (IP), the red rim material was exposed by slumping, and the red floor material was excavated by craters large enough to puncture the overlying intermediate layer.

The combination of WAC and NAC data is integral to this study. A good example is crater D, which has red material in only the western side of its floor/ejecta blanket. From only a WAC image (Fig. 2a), one might infer that the impact occurred at a boundary between the buried red unit and a darker, bluer unit. In a high-resolution (~120 m/pixel) NAC image (Fig. 2b), color differences cannot be distinguished. The combined use of the two images makes it clear that an elevated ridge (the rim of an old basin, marked by arrows) has blocked the crater ejecta in the eastward direction. Excess material lies on the eastern half of the crater floor, likely representing a combination of the deposition of blocked ejecta and slumping from an over-steepened eastern crater wall.

Conclusions: A global view is necessary to determine the source and significance of the red unit exposed in craters. The examination of this small area on Mercury reveals the complex nature of the local stratigraphy and supports the origin of the crust as a massive buildup of volcanic flows with compositions ranging from HRP to IP to low-reflectance blue plains (LBP) [e.g., 14], at least to a depth of ~5 km.

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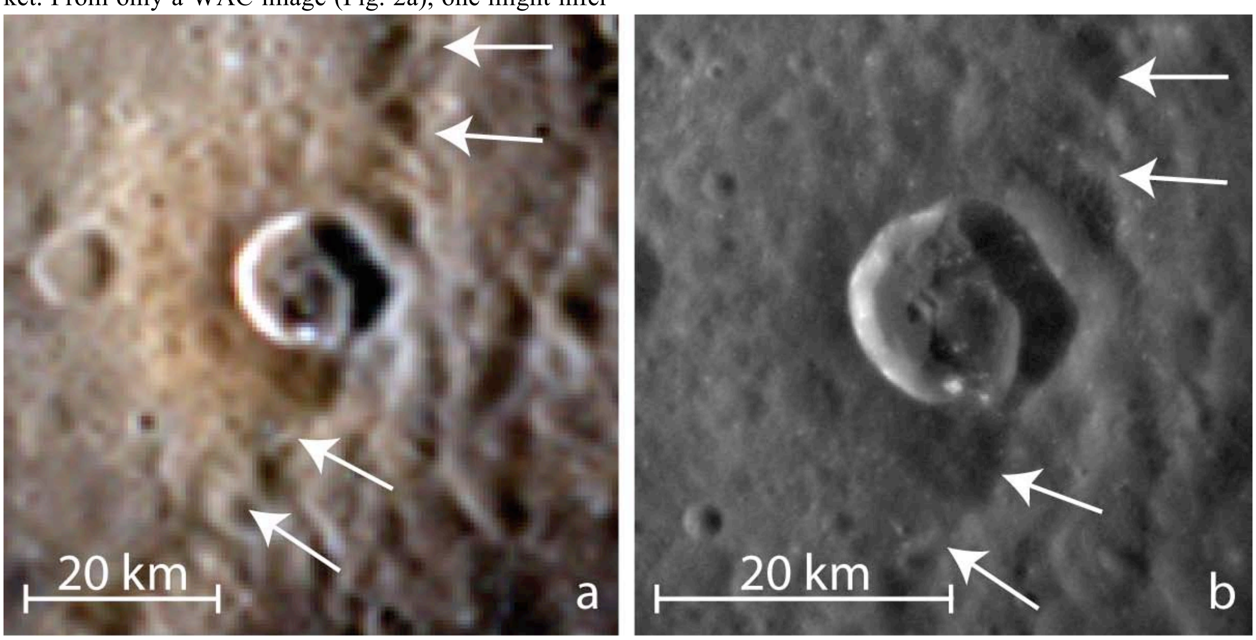

Figure 2. (a) WAC ~460 m/pixel color composite (R=1000 nm, G=750 nm, B=480 nm) and (b) NAC ~120 m/pixel images centered on a 15-km-diameter crater (D from Figure 1) containing red material at 1.6ºS, 325.1ºW. Arrows indicate the presence of a ridge that acted as an obstruction to the ejecta. Some of this blocked ejecta and material from a slumping wall was deposited onto the eastern floor of the crater.