A MAP OF THE INTRA-EJECTA DARK PLAINS OF THE CALORIS BASIN, MERCURY. D.L. Buczkowski and K.D. Seelos, Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, Debra.Buczkowski@jhuapl.edu.

Introduction: Two Mercury quadrangles based on Mariner 10 data cover the Caloris basin (Fig. 1): H-8 Tolstoj [1] and H-3 Shakespeare [2]. The dark annulus identified in MESSENGER data corresponds well to the mapped location of certain formations [3], primarily the Odin Formation. The Odin Formation is described in the quadrangle maps as a unit of low, closely spaced knobs separated by a smooth, plains-like material and was interpreted as ejecta from the Caloris impact. Schaber and McCauley [1980] observed that the intra-ejecta plains in the Odin Formation resemble the Smooth Plains unit that was also prevalent in the H-8 and H-3 quadrangles outside of Caloris. They state that these plains were included as part of the Odin Formation for mapping convenience.

Crater counts based on MESSENGER imagery indicate that the Odin intra-ejecta plains are younger than the Caloris floor plains within the basin [4,5]. This is inconsistent with the intra-ejecta plains being Caloris ejecta but is consistent with the plains being fingers of the smooth plains unit embaying the Odin ejecta knobs.

However, the intra-ejecta plains are not the same color as the smooth plains in Mercury Dual Imaging System (MDIS) data [3]; while the smooth plains are bright, the intra-ejecta plains are the same dark color as the ejecta knobs. A possible explanation is that the Odin knobs and intra-ejecta dark plains represent two facies of dark basement material excavated by the Caloris impact. Alternately, the intra-ejecta plains could represent a dark volcanic flow, distinct from the bright smooth plains volcanic flow; however, it would have to be a volcanic flow restricted to a region circumferential to the basin. A third possibility is that the intra-ejecta dark plains are a pre-Caloris smooth material (possibly the Intercrater Plains unit) darkened by a thin layer of superposed dark Odin material.

This abstract outlines the progress associated with a mapping project of the Caloris basin, intended to improve our knowledge of the geology and geologic history of the basin, and thus facilitate an understanding of the thermal evolution of this region of Mercury.

Previous Caloris basin mapping: A detailed analysis of the Odin Formation performed by [5] noted that the unit is easily recognizable circum-Caloris in the MESSENGER data and concluded that the Odin Formation knobs are Caloris ejecta blocks that have been mostly embayed and buried by younger volcanic deposits. They found that MDIS color data supported this hypothesis and divided the formation into two subunits: knobby plains and smooth plains.

High-resolution mapping of the intra-ejecta dark plains: We are using high resolution imaging data from the MDIS instrument to create a new geomorphic map of the dark annulus around the Caloris basin. We also utilize a principle component map [3] to distinguish subtle differences in the color data. In the principle component map green represents the second principle component (PC2), which reflects variations between light and dark materials. Meanwhile, red is the inverted PC2 and blue is the ratio of normalized reflectance at 480/1000 nm, which highlights fresh ejecta.

We are mapping all contacts between bright and dark materials within the intra-ejecta plains, as determined in the principle component map, as sub-units of the Odin Formation (Fig 2a). All knobs are mapped individually and their color (either dark or bright) is noted (Fig 2b). Ejecta blankets from local craters (both extent and color) are mapped separately (Fig 2a).

All craters are mapped according to a newly devised crater classification scheme. The crater classification used in the Tolstoj and Shakespeare quadrangles [1,2] and formalized in 1981 [6] was based on degree of crater degradation. Our classification scheme includes both degradation state and level and type of infilling. Current classifications include: 1) blue and pristine, 2) fresh but not blue, 3) intact rim and superposed, 4) intact rim and embayed, 5) degraded rim and superposed, 6) degraded rim and embayed, 7) very degraded and superposed, 8) very degraded and embayed and 9) little to no rim.

Observations: The Odin Formation shows two distinct sub-units: a dark sub-unit and a (relatively) bright sub-unit. The dark sub-unit has a higher concentration of knobs, knobs that are both bright and dark and craters that are both embayed and superposed. Meanwhile, the bright sub-unit has a lower concentration of knobs, knobs that are predominantly bright and craters that are fresh and/or superposed. Outcrops of the bright material can be associated with crater ejecta blankets, but are not always.

There is an inherent difficulty in determining if there is an age difference between the dark and bright sub-units. Crater counts on sub-units may be affected by the relatively small size of craters (< 20 km). Recent work by [7] indicates that secondary craters on Mercury can be as large as 25 km. More of the Caloris intra-ejecta dark plains need to be mapped, to provide a large enough area and crater population for viable counting. However, the observation that dark sub-unit craters encompass all crater classifications while bright sub-unit craters are almost uniformly fresh and superposed does imply that the bright sub-unit is younger.

Ongoing work: We continue to identify all craters within the dark annulus surrounding the basin in the MESSENGER MDIS data. Each primary crater is assigned a classification, as discussed earlier. Secondary craters, which usually have morphologies distinct from primary craters and they tend to occur in either clusters or chains, are mapped separately.

Craters identified while mapping are compared to the resultant geomorphic units. The diameters of craters superposed on each individual surface unit are measured and counted, and the area covered by each geomorphic unit is determined. Crater counts will be normalized to a common area of one million square kilometers in order to generate a crater size-frequency distribution (SFD) for each geomorphic unit. The SFDs are plotted on a log-log graph with crater diameter against the normalized cumulative crater count. Younger surfaces have SFDs that plot to the left and below older surfaces and so the relative ages of multiple units can be determined. Statistical uncertainties and plotting techniques will follow the form outlined by the Crater Analysis Techniques Working Group [8].

References: [1] Schaber and McCauley (1980) USGS Map I-1199. [2] Guest and Greeley (1983) USGS Map I-1408. [3] Murchie et al. (2008) *Science 321*, 73-76. [4] Strom et al. (2008) *Science 321*, 79-81. [5] Fasset et al. (2009) *Earth Planet. Sci Lett 285*, 297-308. [6] McCauley et al. (1981) *Icarus 47*, 184-202. [7] Strom et al. (2011) LPSC abs 1079. [8] Crater Analysis Techniques Working Group (1979) *Icarus 37*, 467-474.

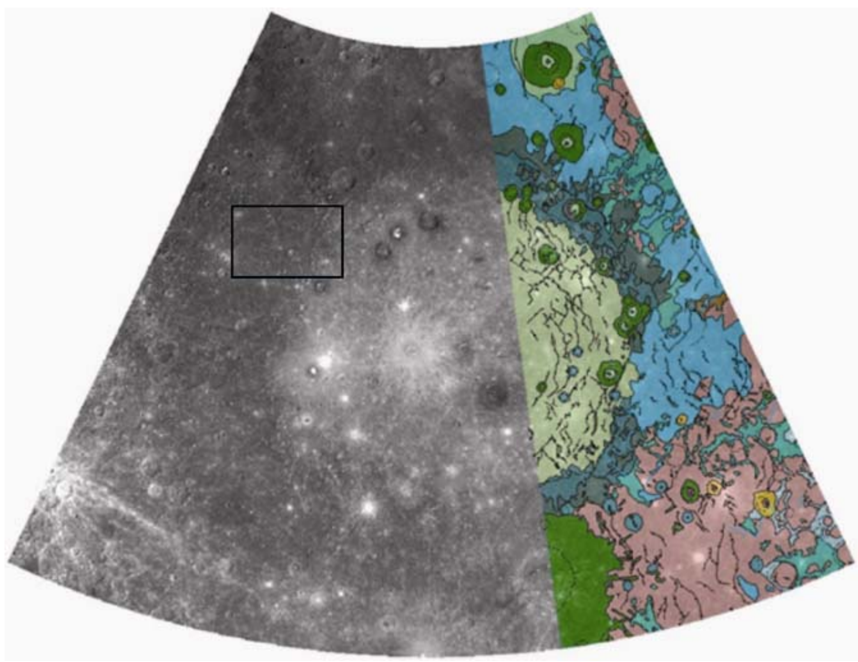

Figure 1. MESSENGER mosaic of the Caloris basin overlain by portions of the H-8 Tolstoj [1] and H-3 Shakespeare [2] quadrangles. Odin Formation is light blue; Smooth Plains are pink. Black box indicates location of Figure 2.

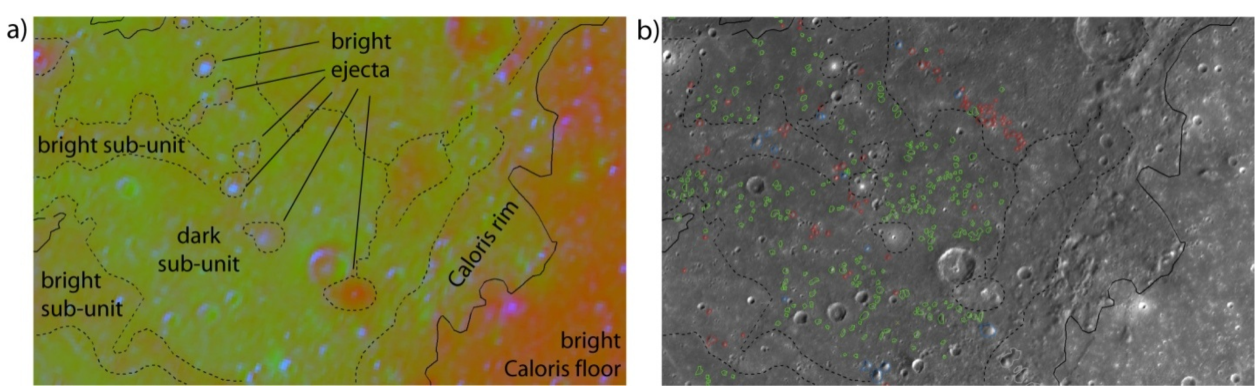

Figure 2. Part of Caloris dark annulus used as Odin Formation example in [5]. a) Principle component map, to demonstrate how bright and dark sub-units were mapped. Sub-units are labeled. b) Odin Formation knobs, shown with sub-unit contacts (dashed lines). Green knobs are dark in the MDIS principle component map; red are light. Note that the majority of knobs are identified in the dark sub-unit.