KNOB HEIGHTS WITHIN THE CIRCUM-CALORIS GEOLOGIC UNITS ON MERCURY: INTERPRETATIONS OF THE GEOLOGIC HISTORY OF THE REGION. S.E. Ackiss[1], D. L. Buczkowski[1], C. Ernst[1], J. McBeck[2], S. Edrich[1], and K.D. Seelos[1], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, [2]University of Massachusetts Amherst, Amherst, MA, 01003,

Introduction: Units located circumferentially around the Caloris basin are known as the Caloris Group and are composed of: the Caloris Montes, the Nervo Formation, the Odin Formation, and the Van Eyck Formation [1-3]. The Odin and Van Eyck units are consistent with Caloris ejecta morphology but the Odin materials have been shown to be younger than the basin interior and it has thus been suggested that they are likely volcanic in nature [4-7]. We will focus on the Odin and Van Eyck formations as well as the Smooth Plains Formation (a volcanic unit not associated with the Caloris basin), looking at the heights of knobs within the hummocky terrains of each region. Assuming the hummocky terrain knobs within the Odin and Van Eyck Formations are ejecta blocks [6, 8], we hypothesize that the knobs in those regions will be taller than those in the Smooth Plains Formation, as the unit's lava flows would have embayed any preexisting ejecta blocks in this region. Examples of this can be seen in lunar basins and ejecta as well [7, 9]. We also look for morphologic evidence of ejecta patterns around Caloris, which would suggest that the circum-Caloris units are related to the formation of the basin.

Methods: We used MDIS wide-angle camera (~200-300 m/pix) images to study 14 regions roughly 0.5 to 1 crater radius from the Caloris rim. Images were sorted by geographic location and high incidence angles (>60º) to aid in photoclinometry measurements. Knob heights were calculated by subtracting the incidence angle from 90°, converting to radians, and multiplying by the length of the knob's shadow. Images were processed through ISIS3 at the USGS in Flagstaff using Projection on the Web [10] and then imported into ArcMap, where the measurements were taken. Attempts to compare calculated knob heights versus actual knob heights were made using MLA [11] tracks, but due to the sparse nature of the tracks and the small size of the knobs, no direct comparisons could be made. We also calculated the density of the knobs and normalized the regions, following the methodology of [12].

Results: The height of the knobs within each study region ranged from ~0.1-0.5 km. The average heights of the study regions per formation show Van Eyck as the formation with the highest knobs, Smooth Plains as the formation with the lowest knobs, and the Odin Formation containing knobs of intermediate heights, all within error of each other (Table 1). Models of balistically emplaced ejecta [13] predict that the size and density of ejecta blocks decreases with increasing distance from the crater rim. We propose that our observations are consistent with the knobs in all three units representing ballistically emplaced ejecta blocks, with those in the areas mapped as Smooth Plains having been deeply embayed or completely covered by volcanic material, those in the Odin areas being embayed by relatively thin deposits of volcanic material, and those in the Van Eyck being not embayed at all.

It is important to note that the Van Eyck and Odin Formations have knob heights that are more similar to each other than the Smooth Plains Formation (Table 1). This is consistent with their location closer to the Caloris rim and our model of volcanic embayment subsequent to knob emplacement. However, if we look at specific study regions, there are two regions with anomalously high knobs that were inconsistent with other regions (Figure 1). While we are still exploring possible explainations for the differences within these regions, they were included in our statistics presented below.

The densities of knobs within each study region are also consistent with what we would expect to see in ejecta patterns [14-16]. Most of the knobs are concentrated in the Van Eyck and Odin formations while the lowest density of knobs is found in the Smooth Plains Formation. This is a very different result from the work of [12], who found that smooth plains materials had a higher knob density than the Odin Formation to the southeast of the Caloris basin. We suggest that the proposed presence of impact melt in the SE circum-Caloris region [12] is not present in the regions we have studied.

Conclusion: Overall, we see knob heights and densities that are consistent with ejecta blocks emplaced by ballistically derived methods and later embayed by a secondary geologic process. This could imply that the knobs in these three formations derived from the formation of the basin but the Odin and the Smooth Plains formations were embayed by what is most likely volcanic flows. If volcanism is not the process by which the embaying material is being emplaced, is it possible that impact melt emplacement from surrounding craters might be responsible for the resurfacing in this area; however, the differences between our knob densities and the results of [12] would suggest that there is no impact melt in our study region.

Key objectives for future work and extending our findings consist of an in-depth study of knobs at different crater radii from the basin within all three regions, separating the knobby Odin-type terrain and the smooth Odin-type plains to study how these knobs were emplaced and embayed.

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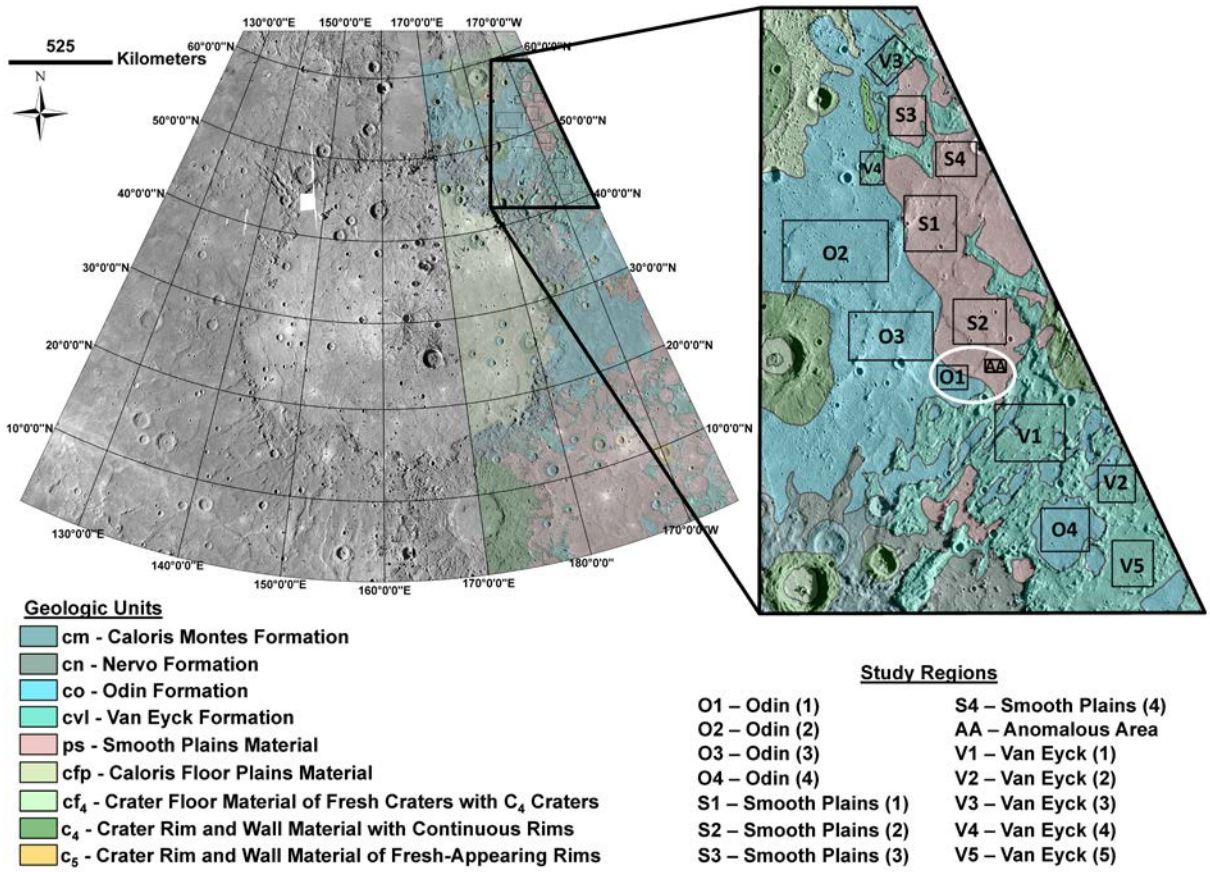

Figure 1. MESSENGER MDIS v9 mosiac centered on Caloris with [2-3] geologic maps at a 50% transparency. White circle shows the regions with anomalously high knobs.

Table 1. Average height and density of knobs per formation based on study region calculations in Table 1.

Formation	Average Knob Height (km)	Average Knob Height Error (± km)	Average Knob Density (knobs/km^2)
Van Eyck	0.287	0.058	0.0000081753
Odin	0.272	0.053	0.0000064438
Smooth Plains	0.239	0.041	0.0000024959