PERPLEXING EROSION OF MARTIAN RADIAL EJECTA. M. R. Kirchoff¹, S. J. Robbins¹, R. E. Grimm³, and J. D. Riggs². ¹Southwest Research Institute, 1050 Walnut St., Suite 300, Boulder, CO 80302. ²Dept. of Applied Statistics and Research Methods, University of Northern Colorado. Email: kirchoff@boulder.swri.edu.

Introduction: In an effort to understand the spatial and temporal evolution of martian subsurface equatorial ice, which is one key to constraining Mars’ climate and geology, we have initiated a study to determine the formation ages of adjacent layered and radial (lunar-like ballistic) ejecta craters. Layered ejecta craters are suggested to tap buried ice [e.g., 1], while radial ejecta craters do not apparently encounter substantial buried ice [e.g., 2]. In a previous study [3], we noted that layered and radial ejecta craters in a representative equatorial area (classified by Robbins and Hynek [4]) were spatially intimately mixed (Fig. 1). The median intercrater distance considering both classes is only 24 km and the correlation length (range of a spherical variogram fitted to binary class data; [5]) is just 7 km. This implies that finding another crater of the same class has a higher probability than randomly sampling the overall distribution only within 7-km and that the spatial distribution of subsurface ice could be quite heterogeneous. Boyce and Mouginis-Mark [6] previously found the different classes of layered ejecta craters (single, double, and multi), which plausibly require different concentrations of subsurface/surface volatiles to form [e.g., 7], also were intimately mixed.

Temporal information is missing in these studies. Both analyses implicitly assumed that the subsurface ice distribution does not change with time. Yet, in our previous study [3], we found that layered ejecta can remain in an observable state for up to ~3 Ga. Thus, the cratering response to temporal variations in buried ice could manifest as spatial heterogeneity. The availability of near-global ~6-m/pixel imaging allows us to estimate the formation model ages of individual craters from smaller craters superposed on their ejecta blankets [3]. The goal of our new study is to obtain the crater retention model formation ages of layered (any subclass) and radial ejecta craters ≥ 3 km in diameter in close spatial proximity in a representative Noachian area around Mars’ equator (Fig. 2). This would allow us to more robustly incorporate timing into the spatial statistical analysis. However, erosion and classification of radial ejecta has introduced unexpected complications. In this preliminary presentation, therefore, we describe these complications and their mitigation for further work.

Methods: We sought to identify groupings of radial and layered ejecta craters in proximity to each other spread over the study area (Fig. 2). We started by closely examining the classifications in the Robbins and Hynek [4] database using the higher resolution (~6 m/pixel) and visible light (database was developed from infrared THEMIS imaging) Mars Reconnaissance

Figure 1. Locations of layered ejecta craters (blue; all subclasses) and radial (lunar-like ballistic) ejecta craters (red) as classified by Robbins and Hynek [4] with diameters 6 to 52 km in a 30°x30° area centered at 15°S, 15°E. Background is THEMIS daytime mosaic.

Figure 2. Locations of selected layered ejecta craters (blue; all subclasses) and radial ejecta craters (red) with adjusted classifications. Diameters cover 3 to 70 km in a 30°x30° area centered at 15°S, 355°E.
Orbiter Context (CTX) camera images. We adjusted classifications dependent on our observations. Then, we created groups of adjacent radial and layered ejecta craters to study based upon these adjusted classifications (Fig. 2).

Results and Discussion: We found that 24% (266 of 1132) of the initial Robbins and Hynek [4] classifications changed based upon our observations, and that 81% (215) of these changes are for the radial ejecta craters. For 85% (227) of the changes, the ejecta observed in THEMIS appeared to be another feature at higher resolution (e.g., wind streaks, underlying topography; e.g., Fig. 3), or, rarely, had no corresponding observation in CTX. In the latter case, it could be that the thermal signature of the ejecta remain, while the visual signature has been eroded away. For 15% (39) of the changes, the CTX observations indicated a different ejecta classification than THEMIS (e.g., Fig. 4; over ¾ went from radial to, usually eroded, layered). For <10% (25) of the changes, the ejecta switched between having a layered or radial ejecta classification in THEMIS to seemingly having both ejecta together in CTX (i.e., here called “hybrid” ejecta; also described by [8]) or being able to be clearly defined in CTX (as layered for all cases) although given a hybrid classification in THEMIS (e.g., Fig. 5, the noted fine features appear ballistic in THEMIS, but are revealed as flowing features in CTX). The cause(s) of such hybrid craters is not clear.

Finally, and most perplexing, while we started with an ~60/40 split between radial and layered ejecta, we are left with an ~50/50 split after our observations in CTX. All of these results would seem to imply that radial ejecta is harder to observe in CTX than THEMIS. As suggested earlier, this could be result of erosion removing all traces in the visual imaging while leaving a thermal signature. However, some of the classification changes would indicate that there are just fewer craters with radial ejecta than initially classified in THEMIS imaging. Our preliminary inferences are: 1) the ratio of radial to layered ejecta formation is lower than initially suggested, 2) radial ejecta is eroded more quickly than layered, and/or 3) better imaging than CTX is required to properly observe radial ejecta. Our goal is to present some of these observations and discuss the possible causes and implications for subsurface volatile distribution.

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