MAPPING AND STATISTICAL ANALYSIS OF IMPACT CRATERS AROUND THE HEBRUS VALLES AND HEPHAESTUS FOSSAE, UTOPIA PLANITIA, MARS. R. Spurling and S. Nerozzi, University of Arizona Lunar and Planetary Laboratory (reedcspurling@email.arizona.edu).

Introduction: The Hebrus Valles (HV) and Hephaestus Fossae (HF), in Utopia Planitia, Mars, are outflow channel systems, carved by liquid water. Their formation ages have been constrained to ≲3 Ga by previous geologic mapping [1, 2], but remain uncertain. The origins of these features and of the waters that shaped them are also uncertain, though multiple candidate processes have been proposed, including (1) magma breaking through a layer of frozen ground—referred to as the cryosphere—thereby allowing liquid water from a pressurized aquifer beneath the cryosphere to flow onto the surface [4, 5], and (2) mud volcanism [5].

To better constrain the formation ages of the HV and HF, and by extension to improve our understanding of the origins and histories of the HV, HF, and similar features elsewhere on Mars, we are mapping and statistically analyzing impact craters in and around the HV and HF.

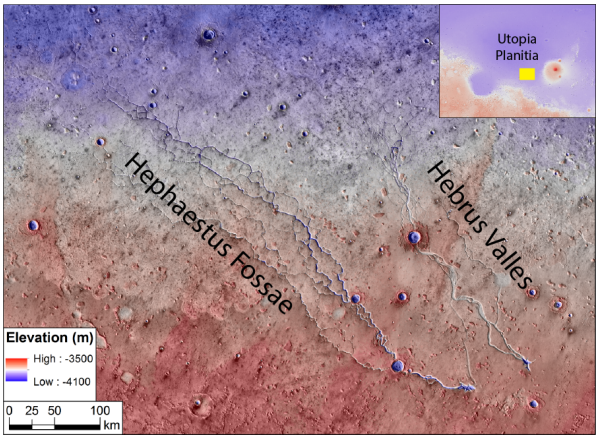

Figure 1: THEMIS IR day mosaic [15] of our study region in the broader context of Utopia Planitia. Elevation data from [17].

Methods: A CTX image mosaic [7] serves as the basemap for this project, covering our 309,000 km^2 study area shown in Figure (1). We mapped approximately 6600 craters in ArcMap 10.8 with the CraterTools plugin [14, 15]. These craters are shown in Figure (2). We used CraterStats [8, 9, 10, 11, 12] to conduct a preliminary statistical analysis of these mapped craters. The main results of this preliminary analysis are shown in Figure (3). Further statistical analysis of impact craters in our study region will follow the recommendations of Robbins et al. [16].

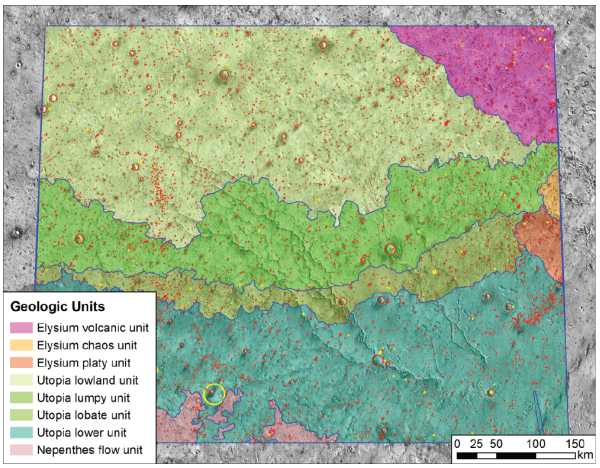

Figure 2: All impact craters mapped in this study, shown atop a THEMIS IR day mosaic [15]. Craters marked in red are used in the statistical analysis, while craters marked in yellow are excluded due to low confidence in their status as impact craters. One larger crater is excluded because it appears to belong to a ~Noachian-age population outside the current scope of this project.

Preliminary Results: Our preliminary statistical analysis focuses on the four geologic units cut by the HV and HF channels in our study area. Listed in descending order by average elevation, those units are: Utopia lower, Utopia lobate, Utopia lumpy, and Utopia lowland. We are also interested in geologic processes that occurred elsewhere in the region, so we have counted, though not yet analyzed, craters in units adjacent to the four channel-cut units. By examining all of these units individually and in comparison to each other, we can differentiate between obvious resurfacing events (e.g., extensive lava flows of limited depth) that altered crater size-frequency distributions across the entire study area, and possible resurfacing events that affected only individual units.

As shown in Figure (3), all four units crosscut by the channels appear to be younger than our previous best maximum age estimate of ~3 Ga. As can be seen in figures (2) and (3), we have not yet excluded clusters of craters from our statistics; this has likely affected our study area's model surface ages, and will be addressed soon. Our ongoing work will include digital terrain modeling and efforts to better communicate the limitations of crater-based surface dating in our figures and in our discussions of results.

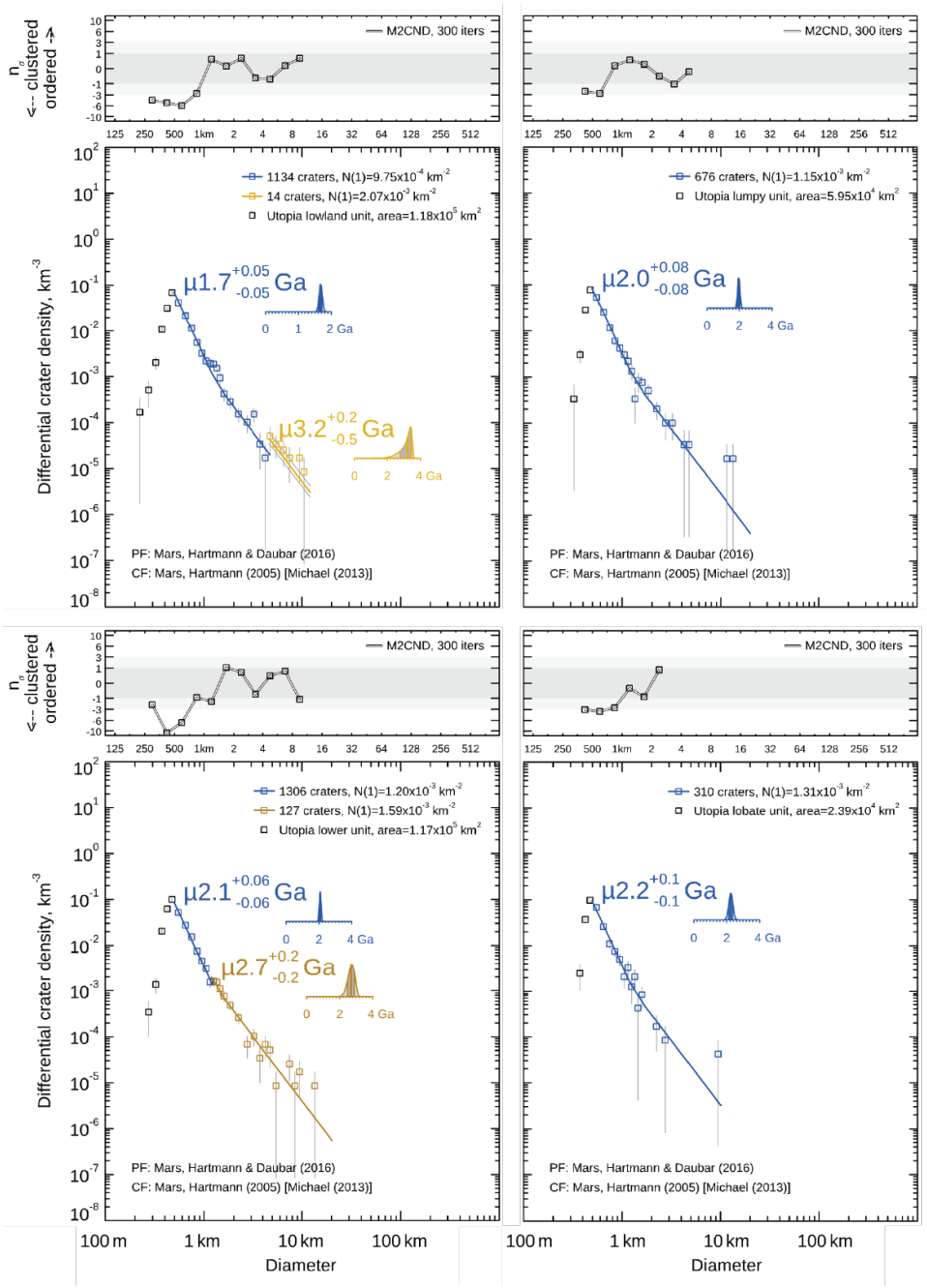

Figure 3: Differential Crater Size Frequency Distributions (CSFD) for the channel-cut geologic units in our study area, with model age fits and Poisson probability density function (PDF) plots of model age uncertainty. Note that the real-world uncertainties in these ages are much higher than shown on the plots, due to uncertainties in cratering rates, the effects of secondary impact craters, and variability in mapping methods, among other causes. Above each unit's CSFD is the result of a randomness analysis of craters in that unit; these analyses suggest that numerous clusters of secondary impact craters exist in our study area and may need to be accounted for in further work. The multiple model ages found here for the Utopia lowland and Utopia lower units indicate one or more resurfacing events.

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