RELATIVE AGE DATING OF MARTIAN GEOLOGIC UNITS THROUGH A STUDY OF BURIED IMPACT STRUCTURES USING AN IMPROVED CRUSTAL THICKNESS MODEL. M.A. Wyant[1], H. V. Frey[2], and A. K. Davatzes[1], [1]Temple University, Earth and Environmental Science, 320 Beury Hall, 1901 N. 13th Street, Philadelphia, PA 19122, United States, michael.wyant@temple.edu, alix@temple.edu [2]Planetary Geodynamics Laboratory NASA/GSFC, Code 698 Greenbelt, MD 20771, United States, Herbert.V.Frey@nasa.gov

Introduction: Work done by Edgar and Frey [1] produced a global map of Quasi-Circular Depressions (QCDs) and Circular Thin Areas (CTAs) for Mars. This work showed that cumulative frequency curves (CFCs) of QCDs and CTAs for the highlands and lowlands were similar, suggesting that they were roughly the same age. This has critical implications for our understanding of the origin of the Martian dichotomy. In the previous study the QCDs were mapped using Mars Orbiter Laser Altimeter (MOLA) data and the CTAs were identified using a crustal thickness model (CTM) [2]. This global model was created using the gravity field data recorded by Mars Global Surveyor and the topography data from MOLA. In recent years, Mars Reconnaissance Orbiter (MRO) has provided higher resolution gravity data, which resulted in the production of an improved CTM [3]. The old model only had sufficient resolution for the identification of structures down to 300 km in diameter, therefore the regions analyzed had to be over 10 million km^2 in order to achieve a statistically sound sample set. The new CTM has an improved resolution and structures down to diameters of 200 km are observable, which allows for the analysis of areas down to roughly 5 million km^2.

Discussion: To date, a total of 8 regions on Mars have been studied. Initially, four areas covering approximately 14.5 million km^2 were chosen, two in the highlands (H1, H2) and two in the lowlands (L1, L2), to compare the cumulative frequency curves (CFC) produced from the old and new models. The CFCs produced using the new model had similar, but steeper slopes at smaller diameters compared to those produced by Edgar and Frey [1] (Fig. 1a,b, d, e). The test areas were then broken up into four quadrants, and it was found that there was high variability in the CFCs within each test area. This variability was attributed to regional differences associated with different lithologic units.

Therefore, two additional test areas, each representing approximately 7.5 million km^2, were then chosen based on geologic units to minimize regional variability. A test area in the lowlands, L3, is a section of Hesperian rolling planes material interpreted as lava flows. A test area in the highlands, H3, is a unit of Noachian hilly and cratered material interpreted as the oldest geologic unit on Mars. Using the previous CTM, there were not enough features in H3 and L3 to produce a working CFC. However, the improved resolution in the new CTM allowed for the production of CFCs within smaller areas. The CFCs from H3 and L3 when compared to the global totals followed the -2 power law slope (Fig. 1c, 1f). This result shows that with the improved resolution from the new CTM, smaller regions, down to roughly 5 million km^2, show enough features to produce a statistically valid CFC.

The Tharsis region was then considered due to its age as well as the known geologic boundary that exists between it and the underlying crust. In the previous study [1], the region defined as the Tharsis region (T1) is roughly 18.7 million km^2 (Fig. 2a). The CFCs produced using the structures found in the previous study followed the expected -2 power law slope, however there is a large degree of variability in the CFC produced using the data from the new CTM in the same region (Fig. 3). An area roughly half the size, 8.5 million km^2 (T2) (Fig. 2b) was chosen based on the geology of the Tharsis region, and represents the geologic unit of Tharsis volcanic plains material. The CFCs produced from this smaller region from the old data set do not show enough features, however in the new data set the CFC does follow the -2 power law slope (Fig. 3).

Conclusion: It was found, on average, that the new CTM revealed more CTAs in any given test area, and that the features seen in the original analysis need to be redefined due to better resolution of the new CTM. The original CTM allowed for the identification of features greater than 300 km in diameter, however, in the new model, CTAs less than 300 km in diameter were readily identified. In addition, the re-mapping of CTAs for this project indicated a distinction between the highlands and lowlands. Areas H3 , L3, T1, and T2 chosen based on geologic provinces produced CFCs that were closer to the overall CFC found from the total global data set produced by Edgar and Frey, 2008.

The new CTM provides better resolution data and allows for the identification of more CTAs at smaller diameters. There is also strong evidence that suggests regional differences across the planet. The investigators are currently looking at QCDs and CTAs in every geological province on Mars in order to discern the relationship between the provinces and the known geologic history of the planet. Edgar and Frey [1] showed that the CFC curves suggested similar ages for the highlands and the lowlands, which will either be confirmed or refuted.

References: [1] Edgar, L. A., and H. V. Frey (2008), Buried impact basin distribution on Mars: Contributions from crustal thickness data, *Geophys. Res. Lett.*, *35*, L02201, doi:10.1029/2007GL031466.
[2] Neumann, G. A. et al (2004), JGR (Planets), 109, E08002, doi :10.1029/2004JE002262. [3] Neumann, G. A., Lemoine, F.G., Smith, D.E., & Zuber, M.T.(2008), Marscrust3- A Crustal Thickness Inversion from Recent MRO Gravity Solutions, Lunar and Planetary Institute Conference Abstracts, 39, 2167

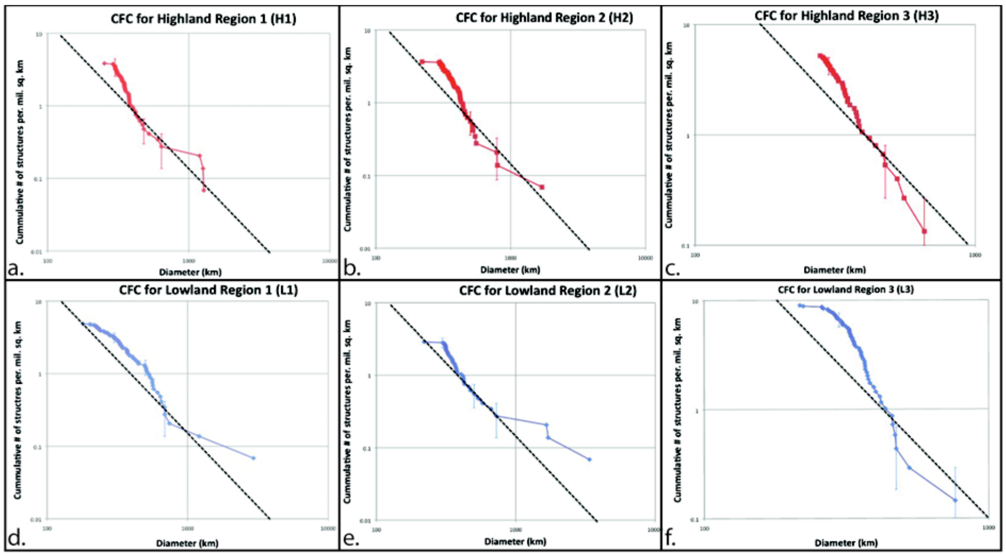

Figure 1a-f: Cumulative frequency curves for six of the study regions using features found in the new CTM. These plots are a combination of identified QCDs and CTAs. The dashed line shows the -2 slope. In all study regions at smaller diameters the curve steepens and derivates from -2 slope.

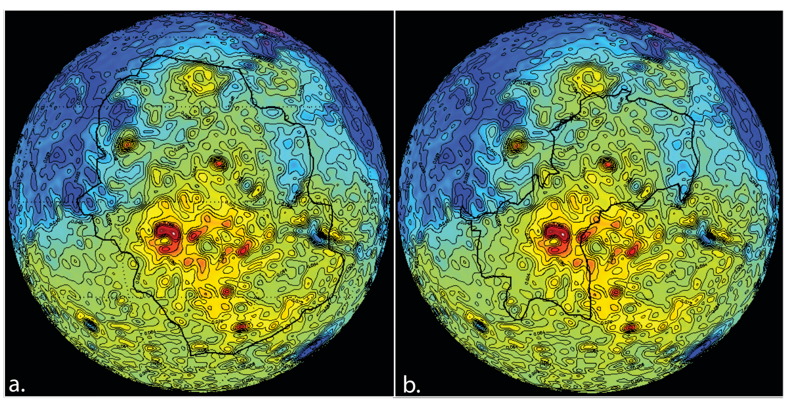

Figure 2a: Outlined in black is the first Tharsis study region (T1), which is roughly 18.7 million km^2, and (b) shows the second Tharsis study region (T2), which is roughly 8.5 million km^2.

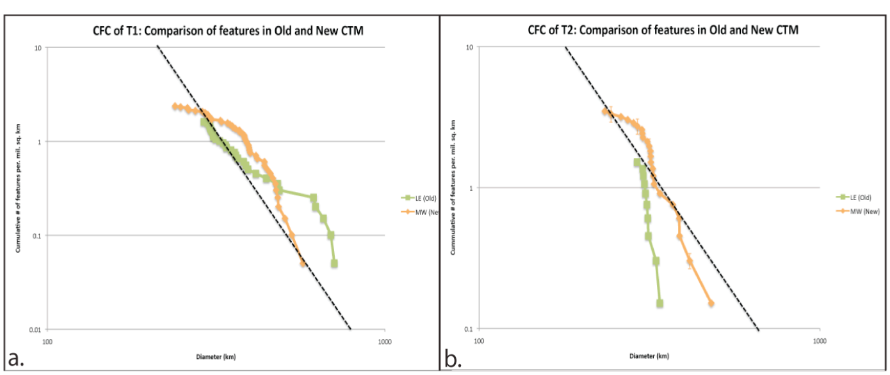

Figure 3a,b: Cumulative frequency curves from the Tharsis study regions (T1,T2). The green data is the features identified in the previous study, and the orange are those identified in the current study. The CFC produced from T2 follows the -2 slope better than features from T1.