DETERMINING THE FILL OF THE GHOST CRATERS OF MARS' LOWLANDS. Y. Tewelde and M. T. Zuber, Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139 (yodit@mit.edu).

Introduction: One of the most noticeable features of the Martian surface is the dichotomy between the heavily cratered southern highlands and the relatively smooth northern lowlands which is thought to be caused by either a giant impact [1] or mantle convection/ overturn [2]. The northern lowlands appear smooth because of the relative low crater density in comparison to the southern highlands, as well as the fact that many of the craters in the north have been partially or completely buried under volcanic and sedimentary fill of unknown relative proportions. With the use of the Mars Orbiter Laser Altimeter (MOLA) topography data [3, 4], it is possible to map these Quasi-Circular Depressions (QCD) [5] or ghost craters and determine minimum fill volumes which can be extended to estimate a minimum volume for the northern plains as a whole.

Methods and Results: We use the MOLA topography map (Fig. 1) [3, 4] to identify the location and diameter of each QCD and correct for the latitudinal scaling factor of the equal area projection. Garvin [6] performed a study on the global scaling relationships for all non-degraded craters on Mars adequately resolved by MOLA and determined the following relations:

Simple: $d = 0.25D^{.65}$ $(D<7)$
Complex: $d = 0.33D^{0.53}$ $(7<D<70\ km)$
Giant: $d = 3.5D^{0.017}$ $(D>70km)$

where D is the rim crest diameter (km) and d is the fresh crater depth from rim crest to floor (km). Since our study excludes craters with a diameter under 20 km, only the equations for complex and giant craters were used to determine fresh crater depths.

The fresh crater volumes relationships were established in the study done by Garvin *et al.* [6, 7] for non-polar region craters. Numerical integration methods were used to establish the following empirical relationships:

$$V_C = 0.04D^{2.68}$$
$$V_M = (\pi\, n\, D^2\, d) / (8 + 4n)$$
$$n = 2.28D^{0.01}$$
$$V_{fill} = V_M - V_C$$

where V_C is current cavity volume (cubic kilometers), V_M is the modeled fresh cavity volume (cubic kilometers) and n is model cavity cross-section for non-polar craters (km). Applying these relationships provides a total crater fill volume of ~$3.26*10^5$ km^3 for the 249 craters included in the study (excluding Utopia Planitia and Isidis Planitia which require more extensive analysis due to their size) all 251 QCDs are shown in Fig. 1.

From the full set of crater depths we plan to generate an approximation for the total plains volume minimum by fitting the current surface topography and the crater floors surfaces to an equal area projection of the northern lowlands (Fig. 2). The first surface will be fitted by linear interpolation to the MOLA topography inside of the northern lowlands' contour [8] (excluding the north polar ice cap and correcting for flexural compensation), and the second surface will be fitted to the same dichotomy contour and the elevation points of the 251 fresh crater depths of the study in the same manner. Then the volume between the two surfaces will be generated by trapezoidal integration to provide the total plains minimum volume.

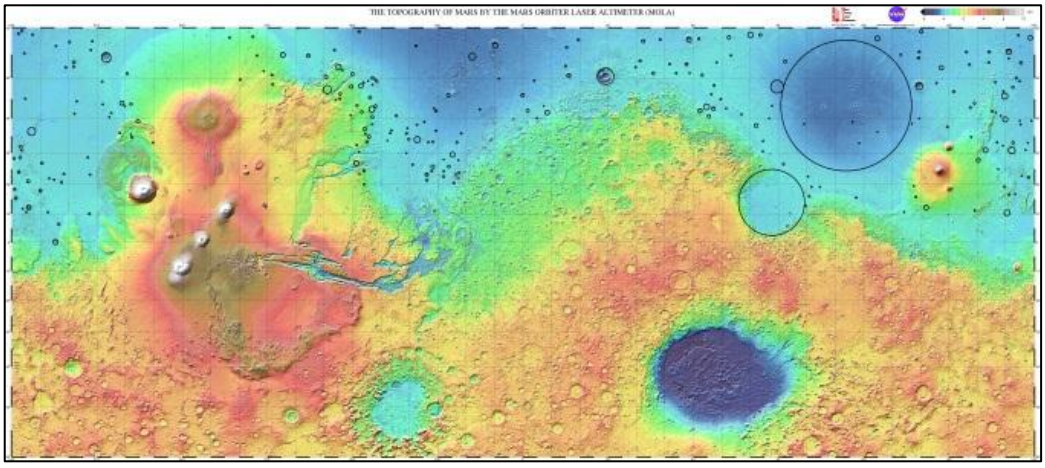

Figure 1. Map of the global topography of Mars from MOLA[3]. Craters included in study circled in black.

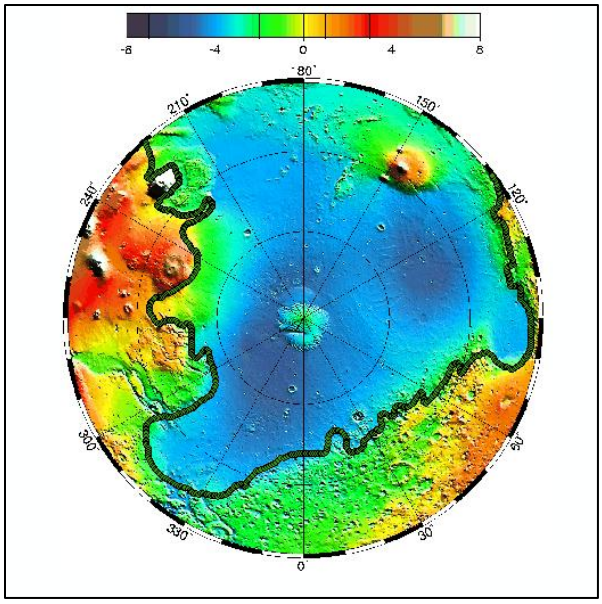

Figure 2. Polar projection of northern lowland plains of Mars relative to major bounding provinces. General location of lowland/upland boundary is indicated by a broad green line.

Discussion: Of interest is both the volume and composition of the northern plains fill. Future work will estimate gravitational attraction associated with this load from the Mars Reconnaissance Orbiter (MRO) gravity data [9]. The composition of the fill will be constrained from these density values and provide insight into the contributions of sediments verses volcanic material in shaping the geologic evolution of the northern hemisphere.

References:

[1] Andrews-Hanna J. C. and Zuber M. T. (2008) *Nature*, *453*, 1212-1215. [2] Zhong S. and Zuber M. T. (2001) *EPSL*, *189*, 75-84. [3] Smith D. E. and Zuber M. T. (1999) *Science*, *284*, 1495-1503. [4] Smith D. E. et al. (2001) *JGR*, *106*, 23689-23722. [5] Frey H. V. et al. (2002) *GRL*, *29*, 1384. [6] Garvin J. B. *Pers. Comm*. July 1, 2011. [7] Garvin J. B. et al (2000), *Icarus*, *144*, 329-352. [8] Parker T. J. et al. (1989), *Icarus*, *82*, 111-145. [9] Konopliv A. S. et al. (2011) "Mars Orbital Data Explorer." *PDS Geosciences Node Orbital Data Explorer*. Web.