OH WHERE, OH WHERE HAS THE CRATER RIM GONE? A QUANTITATIVE LOOK AT HELLAS BASIN RIM EROSION. N. K. Forsberg-Taylor and R. J. Phillips, Dept. of Earth and Planetary Sciences and McDonnell Center for Space Sciences, Washington University, St. Louis, MO 63130 USA (nft@levee.wustl.edu)

Introduction: Hellas Basin, with a diameter of approximately 2300 km and a present depth of almost 9 km, is one of the largest multi-ringed basins in the solar system. Formed during the heavy bombardment period of the Noachian, the crater remains rather well preserved, although volcanism and fluvial processes have irregularly modified this southern highlands region throughout the Hesperian and Amazonian periods [1,2,3]. While the northwestern rim of the basin remains relatively "pristine," with a narrow rim (~300 km) and steeply sloped crater walls, the remainder of the rim has been highly modified, characterized by wider rims and gently sloping walls [4]. Two morphologically distinct units are present on the basin floor – a smooth plains unit and a hummocky/knobby unit [5]. The origins and thicknesses of these deposits have been described in several recent studies [e.g., 4-8]. While most agree that the deposits resulted from early volcanism, mantled by later sedimentary deposits transported by either eolian or fluvial processes, there are numerous estimates of the thickness of these deposits, ranging from 0 km to >5 km.

Here we use the current Hellas Basin rim as well as models of the initial rim morphology to quantify the volume of material that was eroded from the inner rim of Hellas Basin since its formation, some or all of which was subsequently deposited onto the floor of the basin.

Methods: We quantify the volume of material eroded from the rim by modeling the morphology of the original basin rim at the time of formation and subtracting from it the morphology of the present rim. Using Mars Orbiter Laser Altimeter (MOLA) topography with a resolution of 128 pixels/degree, we limit our current study to the inner region of the basin rim. We define this area as beginning at the –5000 m elevation contour, the approximate boundary between the basin floor and the rim, and continuing radially outward a distance of approximately 900 km (Figure 1). This 900 km wide annular region is within the greater Hellas depression, as defined by Moore and Wilhelms [6], supporting the assumption that material eroded from this region would most likely flow down gradient and be deposited within the basin. Beyond this 900 km limit, the topographic profiles around the basin generally begin to level out.

To model the original rim of Hellas Basin, we assumed that the impact that formed Hellas was non-oblique and occurred into a surface that was relatively flat (i.e., did not have any significant elevation variation). This situation would produce a crater whose rim was invariant in height and width. The morphology of the northwestern "pristine" portion of the crater rim was then used as a model of the original morphology of the entire basin rim.

We utilized two different methods to quantify the volume eroded from the basin rim. The first method used involved taking numerous topographic profiles around the basin, similar to that done by Tanaka and Leonard [6]. The second method used subroutines within ArcMap, a commercially available geographic information system (GIS) program.

Profile Method Ninety-six evenly spaced topographic profiles were taken around Hellas Basin, starting at the –5000 m elevation contour and continuing radially outward a distance of approximately 900 km (Figure 2). Each profile was considered to represent a 3.75° wide wedge of the basin rim. The volume of each wedge was calculated by integrating the area under the profile over the width of the wedge. The volumes of the individual wedges were summed to determine the volume of the present day rim. The volume of the initial rim of Hellas Basin was estimated by averaging the profiles taken across the "pristine" portion of the rim. The area under this averaged curve was calculated and integrated around the entire basin. The volume removed from the basin rim from the time of formation to the present was calculated by subtracting the present day rim volume from the initial rim volume.

ArcMap Method With this method, we used the volume calculation subroutine available within the ArcMap program. This subroutine calculated the volume between a plane of –5000 m elevation and the present day MOLA topography of the rim. To calculate the volume of the original rim, the northwestern "pristine" portion of the rim was isolated and its volume was calculated. This value was then integrated around the rim. The volume eroded since formation was then calculated the same way as with the profile method.

Results and Interpretations: Both of the methods yielded similar results of the volume of material "missing" and presumably eroded from the inner rim of Hellas Basin since formation. Using the profile method, approximately 7.5×10^6 km^3 of material has been eroded from the 900 km wide portion of the rim studied. If this material was distributed evenly over the floor of Hellas (considered in this case to be the area contained within the –5000 m contour), it would produce a layer of sediment approximately 2.7 km thick. Using the ArcMap method, we calculated an eroded volume of 6.6×10^{6} km^{3} and an equivalent layer depth of 2.4 km.

It should be noted, however, that the values reported here may well be conservative. The present day basin rim represents a surface that has not only had destructive processes acting upon it, but also constructive processes. South of Hellas Basin lie two volcanic constructs, Amphitrites and Peneus Paterae, which rise above the surrounding topography a few hundred to 1500 meters [6]. These two constructs raise the elevation of the eroded rim. If we were to remove this region (Figure 2) from our study and replace it with an average of the surrounding regions that were not affected by the volcanism, an additional 0.7×10^{6} km^{3} of material would be added to the basin floor.

An additional study was completed using the ArcMap method to measure the volume of material present on the basin floor. Here we considered that the lowest point present on the floor represented the original floor elevation, once again, a very conservative assumption. We estimated approximately 5.2×10^{6} km^{3} of material on the basin floor, which would produce an equivalent layer 1.9 km thick. Thus, our reported results are reasonable.

Future Work: We initially focused our study on this inner rim region to yield conservative volumes of the material eroded. Within this region, virtually all of the material would have been transported down gradient and deposited onto the basin floor.

We will expand the study area further to include the entire Hellas drainage basin, as defined by Banerdt and Vidal [9]. This will better constrain the volume of surface materials eroded in the region that may have been subsequently deposited into Hellas Basin since it's formation. Quantifying the total amount of material deposited into the basin and the amount presently within the basin will allow an overall erosional and depositional history of the region to be developed.

Finally, we will investigate the geophysical implications of this magnitude of fill in the Hellas basin. Searls et al. [10] reported that a crustal thickness of ~90 km is required to match the geoid at Hellas for a 5-km elastic thickness and one km of basin fill. Increasing the amount of fill requires a combination of the crustal and elastic thicknesses to increase.

References: [1] Leonard G. L. and Tanaka K. L. (1993) *LPS XXIV,* Abstract #867. [2] Lahtela H. et al. (2003) *Microsymposium 38,* Abstract #MS057. [3] Raitala J. et al. (2004) *LPS XXXV,* Abstract #1134. [4] Tanaka K. L. et al (2002) *Geophys. Res. Let., 29,* 10.1029/2001GL013885. [5] Moore J. M. and Wilhelms D. E. (2001) *LPS XXXII*, Abstract #1446. [6] Tanaka K. L. and Leonard G. L. (1995) *JGR, 100,* 5407-5432. [7] Rogeiro I. M. et al. (2003) *Vernadsky-Brown MS XXXVIII*, Abstract #65. [8] Wichman R. W. and Schultz P. H. (1989) *JGR, 94,* 17333-17357. [9] Banerdt W. B. and Vidal A. (2001) *LPS XXXII*, Abstract #1488. [10] Searls M. L., Banerdt W. B. and Phillips R. J. (2006) *J. Geophys. Res.*, *111*, doi:10.1029/ 2005JE002666.

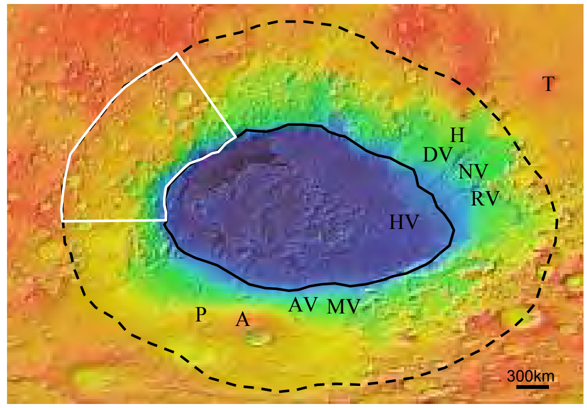

Figure 1. MOLA map showing the boundaries used in this study. The solid black line represents the –5000 m elevation contour, considered here to be the boundary between the basin wall and floor. The dashed black line represents the outer limit of this study, 900 km from the –5000 m contour. The white outlined region is considered "pristine", with a narrow rim and steeply sloped walls. Shown are some of the numerous volcanic and fluvial features that have eroded the basin rim: *patera-* P=Peneus, A=Amphitrites, T=Tyrrhena, H=Hadriaca; *valles-* AV=Axius, MV=Mad, DV=Dao, NV=Niger, HV=Harmakhis, RV=Ruell.

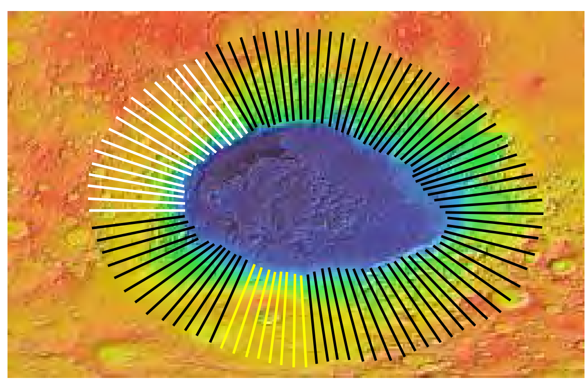

Figure 2. MOLA map showing the approximate locations of topographic profiles taken for the rim volume calculations. Profiles are approximately 900 km in length and begin at the –5000 m contour. White profile lines represent region considered to be "pristine." Yellow profile lines cut across the two paterae in Malea Planum.