MORPHOMETRY OF CIRCUM-CHRYSE OUTFLOW CHANNELS: PRELIMINARY RESULTS AND IMPLICATIONS. R. M. Williams[1] and R. J. Phillips[2], [1,2]Department of Earth and Planetary Science, Washington University, St. Louis, MO 63130, [1]becky @wurtzite.wustl.edu [2]phillips@wustite.wustl.edu.

Introduction: High-resolution Mars Orbiter Laser Altimeter (MOLA) elevation data affords an opportunity to study the morphometry of the circum-Chryse outflow channels. Channel depth and gradient can be quantitatively determined with this topographic data set. Bedform channel morphologies, such as teardrop-shaped islands, rounded knobs and longitudinal grooves, indicate the channels terminated in Chryse Planitia. The shape of the channel and bedforms may help distinguish between competing hypotheses for channel formation mechanism (glacial vs. catastrophic flooding vs. debris flows) [1-3].

Channel Morphometry: MOLA acquires measurements of topography that have a maximum vertical resolution of ~30 cm and along-track spatial resolution of ~300 m [4]. With the available MOLA data available to date (i.e. prior to HGA anomaly in mapping phase on 4/15/99), minimum channel bottom elevation was plotted as a function of distance downstream for the circum-Chryse outflow channels (figure 1). Those outflow channels that cut Hesperian-aged Lunae Planum (Kasei, Southern Kasei, and Maja, which forms the eastern boundary of the plateau) and Shalbatana (which incised Xanthe Terra) all have negative downstream gradients (average slope –0.8, -0.6, -2.8, -2.9 m/km, respectively). However, most of the outflow channels, which incised older Noachian Xanthe Terra (Simud, Tiu and Ares Valles), have atypical postive downstream gradients (average slope 0.5, 1,2, 0.05 m/km, respectively), suggesting a different origin or modification history than the Xanthe Terra outflow channels. These shallow and reverse slopes were also observed in groundbased radar observations[5].

Digital elevation models (DEM) of these channels were constructed and stretched to highlight the channel bottom (figures 2, 3). The DEM of Ares Vallis shows that much of the channel floor has an undulatory character. This can be explained in part by the presence of etched channel deposits [6]. Further, figure 3 illustrates cross-cutting relationships between channels are evident. An abandoned tributary to Ares Vallis is now a hanging valley. Tiu Vallis clearly cross-cuts Ares Vallis, confirming inferences made from Viking images [7,8]. As we receive more complete MOLA coverage of these regions, a detailed sequence of channel-forming events will be produced and can be used to evaluate published outflow channel histories [6-8].

Regional depressions are evident in the DEM of Simud and Tiu Valles, that may be isolated scour zones or the result of discontinuous MOLA coverage over these north-south trending channels. Particularly striking is an abrupt slope change (18 m/km) at ~15° N, a trend observed in a dozen topographic profiles (figure 4).

Discussion: Several potential explanations for the shallow and uphill gradients are being evaluated. Regional tectonism [5,9] is a plausible explanation, but would likely be the result of local tectonic warping since channels to the west have normal gradients. The differing ages of incised terrains may have played a role. The Noachian terrain of Xanthe Terra probably developed a thicker megaregolith and therefore, may have been more easily eroded relative to the younger Hesperian Lunae Planum, leading to a larger suspended bed-material load. Flows (water or ice) of sufficient depth could traverse shallow or reverse gradients. If the channels formed as the result of deep flows, the uphill trends may represent channel deposition. Post-formation fill may result from aeolian processes, mass wasting or a lava flow, though evidence for the last is lacking. Evidence for channel fill is found in Viking image 366S04 in the northern portion of Simud Vallis at the approximate location of the abrupt slope discussed above (figure 4). We interpret this to be a region of defaltion and that the knobby terrain (possibly buried chaotic terrain) is being exhumed. A detailed analysis of regional high resolution MOC and Viking images combined with MOLA data, as it becomes available, is underway. This preliminary study inidicates the original channel shape may be overprinted or only regionally preserved for Ares, Tiu and Simud Valles; thus, hydrological calculations based on channel morphometry need to be reexamined.

References: [1] Carr, M. H. (1996) Water on Mars. [2] Lucchita, B. K. (1982) *JGR, 87*, 9951-9973. [3] Tanaka, K. L. (1999) *JGR, 104*, 8637-8652. [4] Smith, D. E. et al. (1998) *Science*, *279*, 1686-1691. [5] Lucchitta, B. K. and H. M. Ferguson (1983) *JGR, 88*, A553-A568. [6] Nelson, D. M. and R. Greeley (1999) *JGR, 104*, 8653-8669. [7] Tanaka, K. (1997) *JGR, 102*, 4131-4149. [8] Rotto, S. and K. L. Tanaka (1995) *USGS Misc. Inv. Serv. Map I-2441*. [9] Roth, L. E. et al. (1980) *Icarus*, *42*, 287-316.

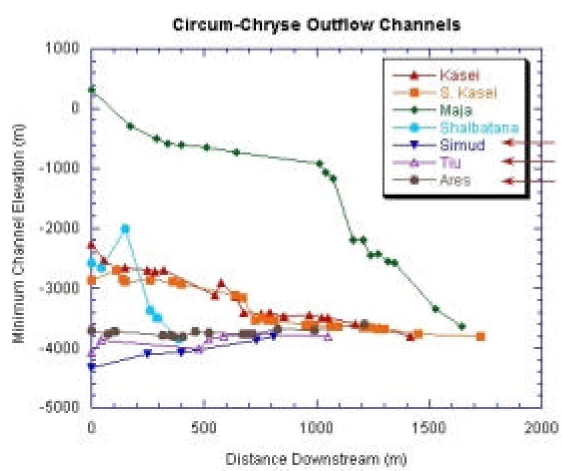

Figure 1: Longitudinal profils of circum-Chryse channels. Kasei, Southern Kasei, Maja and Shalbatana Valles all have slopes consistent with inferred downstream direction implied by bedform morphologies. In contrast, Simud, Tiu and Ares all have contrary slopes.

Figure 2: DEM superimposed on Viking mosaic of Ares Vallis. Resoltuion of DEM is 0.1° per pixel. Regions without color are greater than –2.34 km, with the exception of some crater floors. Yellow box highlights section of channel with undulatory character (purple to blue to purple to blue). Also, note the high elevation of the tributary channel and the deeply incised path of Tiu Vallis (purple swath at upper right).

Figure 3: (below left) DEM superimposed on Viking mosaic of Simud Vallis (western channel) and Tiu Vallis (eastern channel). Resoltuion of DEM is 0.1° per pixel. Regions without color are greater than –3.60 km, with the exception of some crater floors. Regional depressions in the channel are evident as dark blue or purple. Simud Vallis undergoes a gradational uphill slope at ~15° N (transition from green to yellow in DEM).

Figure 4: (below right) MOLA topographic profile of orbit 1594 illustrating elevation transition from knobby terrain to smooth terrain. Data gap between 15.06 and 15.78° N latitute. Inset is Viking mosaic (from PDS Mapmaker website http://www-pdsimage.wr.usgs.gov/PDS/public/explorer/html/marslvls.htm) with orbit path shown in yellow. Vertical exaggeration is 160X.