Evaluating putative shorelines adjacent to the dichotomy boundary near Arabia Terra. Valerie E. Webb[1] and George E. McGill[1],[1]Department of Geosciences, University of Massachusetts Amherst, 01003. vwebb@geo.umass.edu.

Introduction: In 1989, Parker *et al*. [1] identified two geologic contacts, Contact #1 and Contact #2, which they believed demarcated two distinct highstands of a global ocean ponded within the northern lowlands. Since then, Clifford and Parker [2] presented new nomenclature for Contact #1 and Contact #2, now known as the Arabia and Deuteronilus trends, respectively. To date, a total of nine putative shorelines have been identified by Parker *et al*., [1, 2, 3], who categorized both global and regional scale trends. Our ~400,000 km^2 study area (Fig. 1) is just north of Arabia Terra, contiguous to the dichotomy boundary and centered on Cydonia Mensae. It is significant in further testing the shoreline hypothesis because it contains both the global scale trends Arabia and Deuteronilus, along with a regional trend known as Acidalia [2].

Further significance in our study arises from the fact that most previously published work [1,2,3,4] on the northern ocean's shorelines has been executed at much too low a resolution to provide quantitatively meaningful data. Our large-scale, relatively high-resolution study thus allows for a coherent dataset with which we can then use to test formation and post-formation shoreline models. Our analyses were aided by the interpretation of all available datasets, including Viking, MGS and Mars Odyssey datasets.

Recently, we rejected a shoreline interpretation for the Acidalia trend [5], due to the absence of evident erosion and the lack of its conformity to an equipotential surface. Our current results are in agreement with these earlier conclusions. Thus, this study will focus primarily on the Arabia and Acidalia trends.

Here, we provide new evidence supporting a shoreline interpretation for the Arabia and Deuteronilus trends. In the case of Arabia, we present a new site for the trend near the Bamberg crater area (Fig. 2). This newly adapted locality greatly strengthens the trend's approximation to an equipotential surface, with a mean elevation of –3700m and a mean deviation of ± 13m. We also conclude that the Deuteronilus trend appears to represent two distinct, regional shorelines, with mean elevations of –4200m and –4000m. Analysis of THEMIS imagery further strengthens the case for a shoreline interpretation of these trends (Fig. 3).

Methods: We began our analysis by first interpolating nine topographic grids of key areas within our study area (Figure 1). Each DEM was gridded at 231 m/pixel from a shapefile of MOLA Precision Experiment Data Record (PEDR) profiles downloaded from National Space Science Data Center's CD-ROM Catalog. The purpose of gridding our own data was two-fold: 1) we wanted to insure higher horizontal resolution and accuracy than is currently available from the Planetary Data System (PDS) imaging team's gridded 460 m/pixel model, and 2) we needed high-resolution DEM's to georeference (or align in spatial coordinates) Parker's unpublished MDIM's with the location of his shorelines. Higher horizontal resolution of the DEM corresponds to higher accuracy in the georeferencing of Viking and MGS datasets. Since the along-track shot spacing is ~300 m [6], and the across-track shot spacing within our area averaged ~200 m for the entire study area, but varied from less than 100 m to over 6 km, we feel that a pixel size of 231 m was a modest interpolation pixel size.

Next, we were able to georeference the two datasets together into the MGS coordinate system. Using Arc GIS 8.2 (a computing platform using both Arc Info and Arc View), we defined control points on both datasets and performed a polynomial transformation on the Viking MDIM's. The georeferenced dataset integrated the raw MOLA PEDR profiles, the gridded DEM, and Parker's Viking MDIM's (with the plotted shorelines) and projected them all into the same coordinate space.

The resultant dataset allowed us to determine where an individual MOLA profile crosses a plotted shoreline. We tabulated the elevations of each of these crossings based on the raw MOLA data. If a shoreline did not directly fall within a MOLA shotpoint, an inverse distance weighted relationship was used to calculate the elevation of each tabulated crossing. Thus, the vertical accuracy of the elevations used in this study are dependent on two factors: The resolution of the raw MOLA data, as explained above and in Smith, *et al.* [6]; and the weighted distance between the closest shot points and the measurement, which inherently varies from negligible to 150 m (half-way between two shot points).

More than 3000 observed crossings of the putative shorelines with MOLA profiles were used in this study to evaluate the topographic expressions of the shoreline trends.

Discussion and Results: From our analyses, we found that the Arabia trend is a close approximation to an equipotential surface. The only

substantial deviation from elevation constancy is near the Bamberg crater area (Fig. 1). If the crater impacted after the shoreline was in place, it would necessarily obliterate any evidence of its trend, and a shoreline could not be mapped in the area of its ejecta. If the crater formed before the shoreline, then the trend seen in Figure 1 is still most probably not a shoreline, due to the lack of its topographic expression.

However, our alternate hypothesis is that the shoreline continues north of the one originally mapped by Parker. Figure 2 shows our newly proposed location of the Arabia shoreline, trending north of Bamberg crater. This new portion of the trend follows an elevation contour consistent with the rest of the shoreline. We suggest that if this newly proposed trend is a shoreline then it is younger than the bolide event. However, it is important to note that high resolution Viking imagery within this area is rare, and evidence for coastal erosion along this newly proposed trend is still needed. We are currently awaiting new THEMIS imagery in order to shed new light on this issue.

If we shift the contact north, then the Arabia trend in its entirety conforms to an equipotential surface, with a mean elevation of –3707 m an a mean deviation of ± 13m. This contact is the oldest of all three originally mapped trends [2]. Its equivalence to an elevation contour within the entire study area suggests that little modification has occurred since the time of its formation.

Also, here we provide new evidence for the Arabia trend near Mawrth Vallis through the analysis of THEMIS imagery. Figure 3 yields a spatial correlation between an apparent geologic contact and the Arabia trend. In the THEMIS IR image, a brightness contrast exists between the material above and below the contact. This apparent contrast is separate from that of slope effect. Further, the material below the shoreline is clearly smoother than the material above it. The two portions of the visible THEMIS images within this area yield a potential coastal geomorphic contact that is concurrent with the location of the original Arabia trend. Since these observed contacts follow a single elevation contour, these observations are in agreement with a shoreline interpretation for the Arabia trend.

The Deuteronilus trend (see Figure 1) is the contact that Head *et al*., [4] found to be closest to an equipotential surface. Our results are in agreement with their conclusions except that we find the observed elevations of this trend appear to be bimodal, with two clusters of data at –4000m and –4200m. These two groups appear to represent two distinct regional shorelines, as the originally mapped shoreline is not a single equipotential surface. Since local deformation would necessarily disrupt the nearby, older Arabia trend along with the Deuteronilus trend, which runs just south of it, we have ruled out major post-formation modification as a responsible agent for the bimodality of the data. Topographic analysis further supports this conclusion, since there is no systematic variation in the along-trend profile, as would be present if tectonics disrupted a single, equipotential surface.

Conclusions: Shoreline recognition and evidence of coastal erosion provide valuable support for the past existence of a global ocean within the northern lowlands. Since 1989 [1], the validity of shorelines on Mars has been part of a highly controversial hypothesis regarding the hydrologic and geomorphic development of the northern plains [7, 8, 9, 10]. More high resolution, large scale studies must be executed in order to shed new light on this topic.

Here, we provide new data supporting a shoreline interpretation for the originally mapped Deuteronilus trend through the analysis of all available datasets. We also present an adapted locality for a small portion of the Arabia trend, strengthening its conformity to an equipotential surface. Further work is needed to determine if more than one flooding event occurred or if all of the presented regional shorelines represent multiple highstands of a single regressive body of water. Within our study area, our results support the first of these two scenarios, as age constraints and evidence of erosion upon the individual trends suggests, but either two settings are possible as potential resurfacing agents of the northern lowlands.

References: [1] Parker, T.J., *et al.* (1989) *Icarus*, 82, 111–145. [2] Clifford, S. M. and T.J Parker (2001) *Icarus*, 154, 40-79. [3] Parker, T.J., *et al.* (1993) *JGR*, 98, 11061- 11078. [4] Head, J. W., *et al.* (1999) *Science,* 286, 2,134-2,137. [5] Webb, V.E. and G.E. McGill, (2003) LPSC XXXIV Abst. #1132. [6]Smith, D.E., *et al* (2001) *JGR*, 106, 23,689-23,722. [7] Malin, M.C., and K.S. Edgett (1999) *GRL*, 26, 3049-3052. [8] Rice, J.W. (2000) LPSC XXX 2006-2007. #[8] Withers, P. and G.A. Neumann (2001) *Nature*, 410, 651. [9] Buczkowski, D.L. and G.E. McGill (2002) GRL, 29, 10.1029/2001GL014100.
[10] Carr, M.H. and J.W. Head (2002) AGU, 83(47), Fall Meet. Suppl. Abst. #P51B-0357.

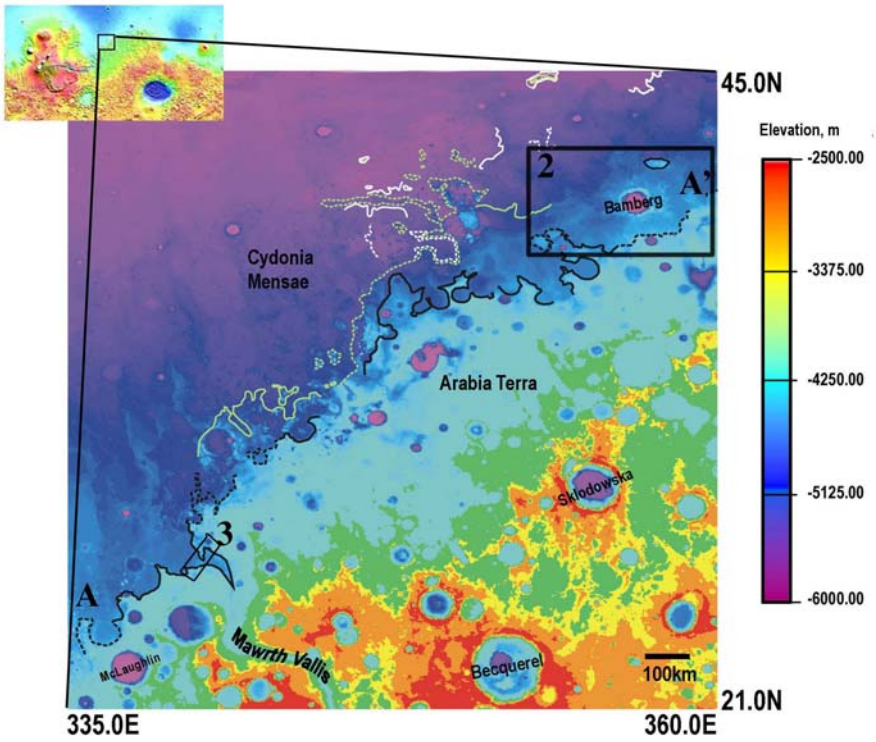

Figure 1: Location of Parker's putative shorelines plotted on 1/128deg per pixel gridded topography as provided by the PDS imaging team's MOLA Experiment Gridded Data Record (EGDR). Deuteronilus shown in green, Acidalia in white, and Arabia in black. Simple Cylindrical projection.

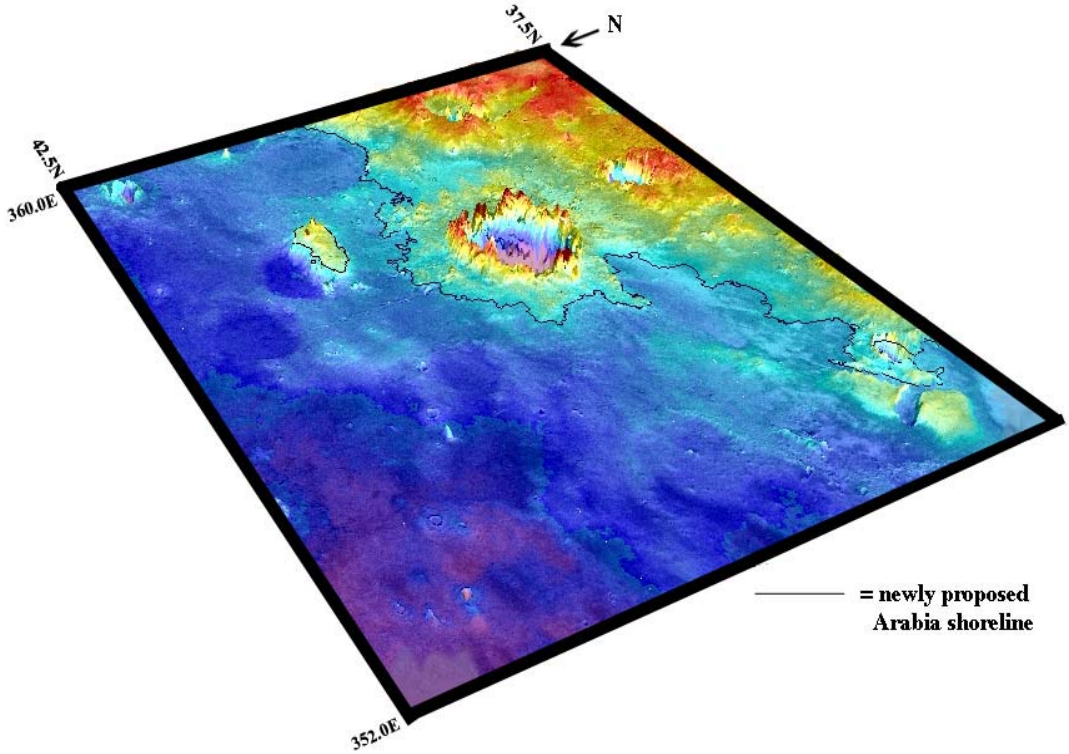

Figure 2: Newly proposed Arabia shoreline plotted on 3D perspective DEM looking southeast, gridded at 231 m/pixel. Vertical Exaggeration is ~ x20. The mean elevation of the profile shown is –3700m ± 2 m.

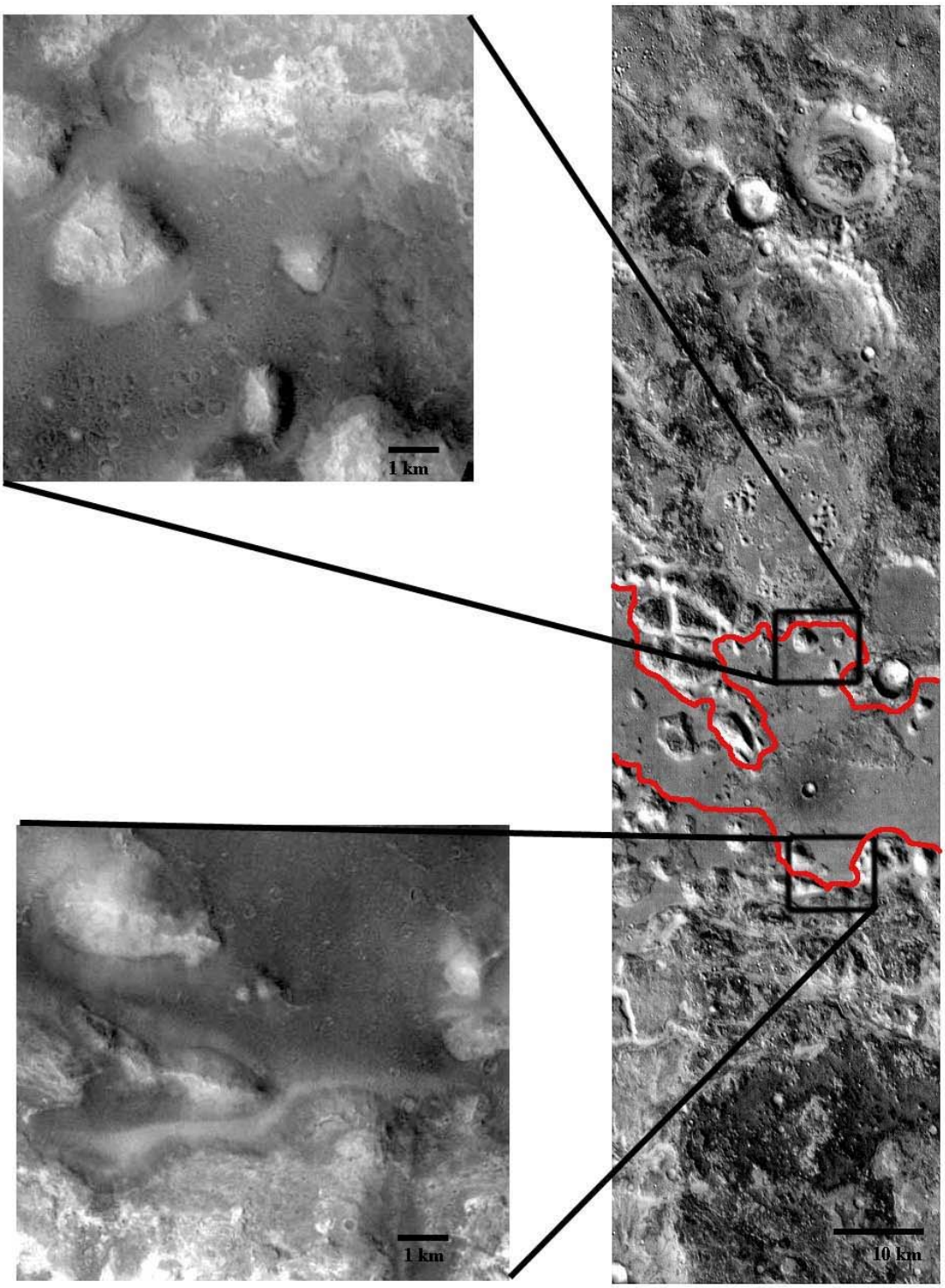

Figure 3: Evidence of coastal erosion near Mawrth Vallis. Daytime THEMIS IR image #I01561006 is on the right, with two insets from the visible THEMIS image #V01561007 on the left. The Arabia trend is shown in red. Center latitude/longitude of I01561006 is 24.955N and 340.326E, see Figure 1 for context.