**THE MARS OCEAN HYPOTHESIS: OBJECTIVES AND PRELIMINARY RESULTS.** T. J. Parker and B. G. Bills, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, tjparker@jpl.nasa.gov.

**Introduction and Objectives:** We are evaluating our updated global map of proposed paleo-shorelines, to assess their departures from horizontality, and infer what that says about the spatial accuracy of the mapping and the appropriateness of the global datasets used. To first approximation, the mapped shorelines do appear to define nearly-planar surfaces averaged globally, but the local details show scatter of tens to hundreds of meters over distances of kilometers to tens of kilometers.

The long-wavelength variations could indicate important tectonic and isostatic deformations of once-horizontal surfaces. The shorter wavelength scatter could suggest a number of possible causes: 1) placement of the shoreline shapefiles needs improvement; 2) the resolution of the DEM is insufficient at large scales to provide accurate elevations for the shapefiles at these scales; and 3) there have been real, short wavelength changes to the topography that have affected the elevation of the shapefile vertices (e.g., fault scarps, wrinkle ridges). To address these factors, the evaluation of the mapped shorelines will include local assessments at large GIS map scales if the shapefile appears too generalized with respect to available high spatial resolution image and topography data.

The analysis of the global shoreline shapefiles will include these steps: 1) measure the volume contained within the surfaces defined by the proposed shorelines to provide comparisons with model estimates of Mars' water inventory over time (i.e., did Mars accrete and outgas a sufficient volume of water, or was some of it introduced during Late Heavy Bombardment); 2) use published ages from global geologic maps of surrounding surfaces to determine approximate ages for each shoreline; 3) address whether long-wavelength departures from horizontal point to global tectonism, polar wander, or isostatic adjustments post-ocean.

**Preliminary Results:** We present the current status of our global shoreline map, which consists of GIS shapefiles representing proposed shorelines (Fig. 1). This map uses the global digital elevation model (DEM) of MGS Mars Orbiter Laser Altimeter (MOLA) data, merged with DEMS from from the Mars Express Camera (HRSC) and gridded at 200 m/pixel [1]. For global imagery, the 6 m/pixel image mosaic of Context Imager (CTX) data on MRO was used [2].

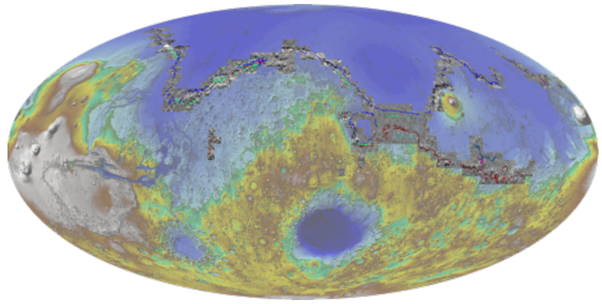

Fig 1: Molleweide projection of Mars showing major proposed shorelines highlighed in Table 1, below. Topography from [1]. CTX imagery from [2]

Due to the precision at which the global CTX mosaic was assembled, and the lower resolution of the global DEM, this study is currently limited to regional and global map scales. Very high resolution DEMs of select terrestrial analogs in SW Utah illustrate the need for high-resolution data to evaluate these features at large scales.

**Potential pitfalls** in determining horizontality of features in CTX 6m/pixel imagery using 200m gridded DEM: 1) global DEM is 2 orders of magnitude lower in resolution than CTX imagery; 2) CTX global mosaic may have lateral uncertainties as much as several tens of meters. 3) Mapped shoreline shapefiles may not have been accurately placed with respect to the DEM, resulting in incorrect elevation determinations.

We have begun to extend identification of the higher, less well-preserved proposed shorelines using the CTX global mosaic and HRSC/MOLA global DEM. We have also begun measuring global trends in elevation of the proposed shorelines and inferred water volumes in cubic kilometers and global equivalent layer (GEL) values so that these measurements can be compared with published model predictions of volatile inventory relative to planetary accretion, outgassing, and Late Heavy Bombardment.

**Table 1: Criteria used and approximate elevations of major proposed shorelines.**

| Level Name | Type Locality | Geomorphic Expression | Elevation | Volume (1E6km3) | Area (1E6km2) | Area (% of total surface) | Average Depth (meters) | GEL (meters) |
|---|---|---|---|---|---|---|---|---|
| Acidalia | East Acidalia | Sharp Contact, Lobate Flow Fronts | -4050 m | 12.7 | 19.2 | 13 | 661 | 88 |
| Deuteronilus (Contact 2) | East Acidalia | Lobate Flow Fronts, Terrace | -3900 m | 15.9 | 23.6 | 16 | 674 | 110 |
| Mamers Vallis 2 | East Acidalia | Terrace | -3820 m | | | | | |
| Mamers Vallis 3 | East Acidalia | Terrace | -3800 m | | | | | |
| Ismenius | East Acidalia | Terrace, Tsunami swash Rills (e.g., Rodriguez, J. A. P., et al. 2016) | -3785 m | 18.8 | 27.0 | 19 | 700 | 130 |
| Mamers Vallis 5 | East Acidalia | Faint contact | -3670 m | | | | | |
| Arabia (Contact 1) | East Acidalia | Terraces, Sediment Drapes, Albedo Contact | -3600 m | 24.2 | 31.0 | 22 | 781 | 167 |
| Elysium | Southern Elysium Planitia, ~3°S, 163°E | Platy Flow Margin, Adjacent Terrace | -2880 m | 50.2 | 40.8 | 28 | 1230 | 346 |
| Mamers Vallis 7 | East Acidalia | Faint Terrace, Sediment Drape? | -2800 m | | | | | |
| Aeolis | Southern Elysium | Sediment Drapes, Deltas (e.g., di Achille & Hynek) | -2500 m | 66.7 | 45.7 | 32 | 1460 | 460 |
| Ma'adim Vallis | Gusev Crater Highland Slope S of Elysium | Ma'adim Vallis Delta, Sharp Contact | -1600 m | 112.6 | 56.6 | 39 | 1990 | 777 |
| Terra-Sirenum 1 | Sloping Highland E of Gusev | Degraded Erosional Terrace | -1000 m | 148.5 | 63.0 | 44 | 2357 | 1024 |
| Amenthis | Highland Slope west of Gale | Degraded Erosional Terrace | -150 | 206.2 | 72.5 | 50 | 2844 | 1422 |
| Terra-Sirenum 3 | Sloping Highland E of Gusev | Degraded Erosional Terrace | 0 m | 217.2 | 74.3 | 52 | 2923 | 1498 |
| Aeolis Mons Summit | Gale, Gordii & Eumenides Dorsa, Amazonis Mensae | Summit Elevation of MFF and Gale Crater Mounds | +500 m | 255.9 | 81.2 | 56 | 3151 | 1765 |
| Hellas-Isidis Spillway | Trough Bet Hellas & Isidis ~9°S, 78°E | Possible Spillway | +1200 m | 318.0 | 97.4 | 67 | 3265 | 2193 |

Table 1: Criteria used and approximate elevations and volumes contained within major proposed shorelines.

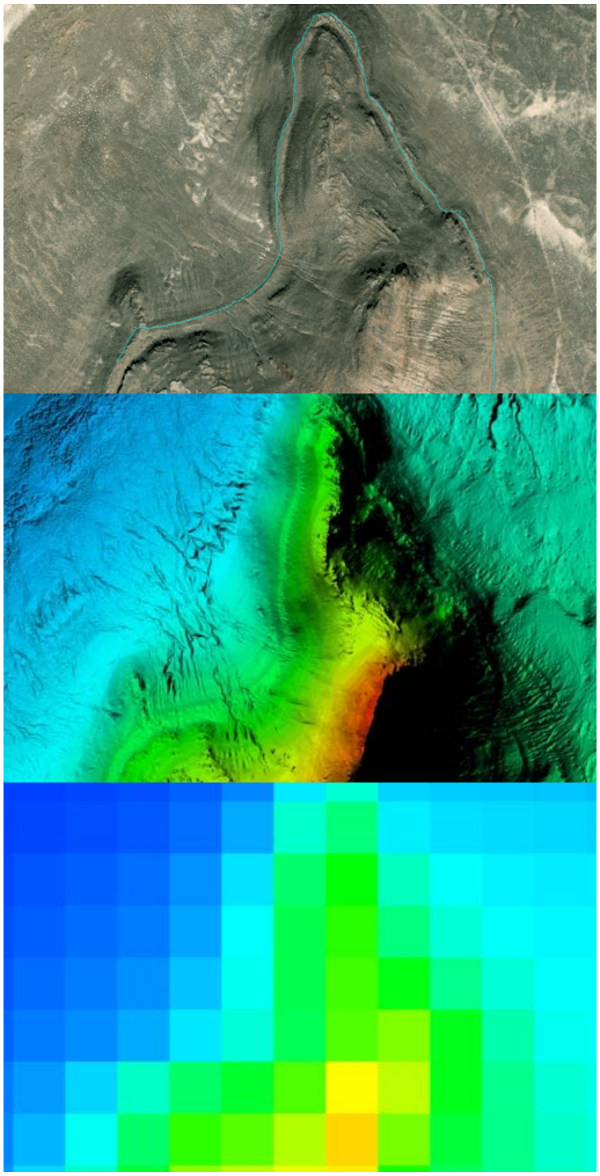

Figure 2: a) Provo shoreline (blue line), Cricket mountains, SW Utah. Digital Globe, 25cm/pixel imagery. b) USGS 3DEP DEM, 1.8m posting, hillshade applied. c) USGS 3DEP DEM, resampled at 200m posting.

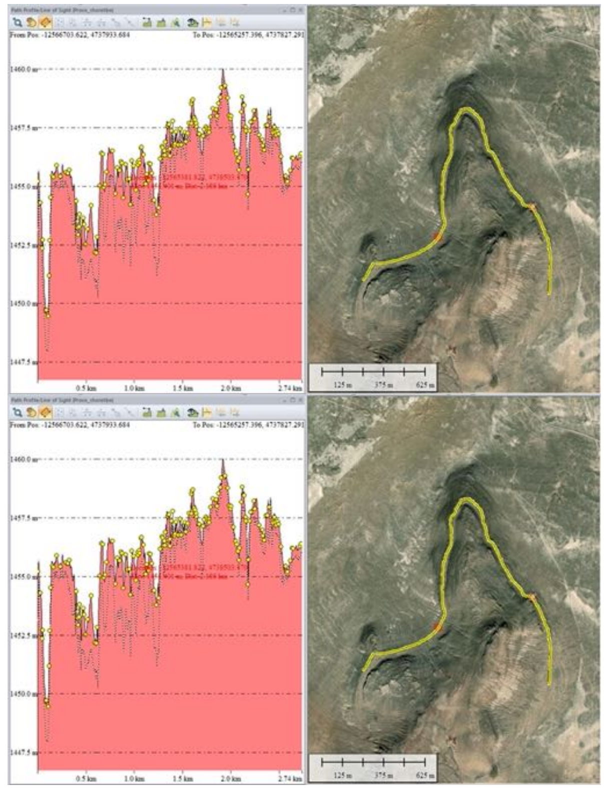

Figure 3: a) Profile along Provo shoreline using 1.8 meter posting DEM. Vertical scatter less than 10 meters. b) Profile along Provo shoreline using DEM resampled at 200m/posting, comparable to [1]. Vertical scatter ~90 meters.

**Plans Going Forward:** We will incorporate relative age determinations of the proposed shorelines based on superposition relationships with other geologic surfaces for which ages have been assigned by other researchers based on crater counts. Finally, we will develop and apply geophysical models of surface response to large sediment and water loads. Hypotheses will be developed to explain deviations from equipotential surfaces delineated by the proposed shorelines, that might indicate their isostatic and tectonic deleveling over geologic time.

**References:** Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

[1] R. L. Fergason et al. (2018) Astrogeo. PDS Annex, USGS, http://bit.ly/HRSC_MOLA_Blend_v0. [2] J. L. Dickson et al. 2018, Lunar and Planet. Sci. 48, LPI Contrib. No. 2083.