PRECISION TOPOGRAPHY OF PLUVIAL FEATURES IN WESTERN NEVADA AS ANALOGS FOR POSSIBLE PLUVIAL LANDFORMS ON MARS. J. R. Zimbelman[1], W. B. Garry[1], and R. P. Irwin III[1], [1]CEPS/NASM MRC 315, Smithsonian Institution, Washington, D.C., 20013-7012; zimbelmanj@si.edu.

Introduction: The possible presence of confined bodies of standing water on early Mars has been postulated for many years, both as large oceans [e.g., 1-5] and as lakes associated with impact crater or intercrater basins [e.g., 6-10]. The northern ocean hypothesis was tested using Mars Orbiter Laser Altimeter (MOLA) elevations along two suggested shorelines, resulting in a fairly poor geopotential fit to the shoreline of the largest water body, but a more reasonable fit to the lowest shoreline [11]. A suite of littoral landforms is expected to be associated with standing water bodies on Mars [1, 3, 12], but thus far the conclusive identification of Martian coastal landforms remains elusive [13-15]. A previous Mars Fundamental Research Program (MFRP) grant involved the collection of precision topography across pluvial shorelines in Nevada [16-18], but these shoreline features tended to be smaller than what could be detected with MOLA data [15, 18]. A new MFRP grant (NNX07AQ71G) proposed to investigate both depositional and erosional shoreline features to provide ground truth for evaluating possible pluvial features within crater basins on Mars, and here we present the results from the first field project supported by the new MFRP grant.

Surprise Valley, Nevada: The study site was the southern end of Surprise Valley, along the Nevada-California border (Fig. 1). A well-preserved series of beach ridge shorelines is present along both sides of Surprise Valley, best expressed around the southern end of the valley. In April of 2008, we collected ten precision topographic profiles across these pluvial features using a Trimble R8 Differential Global Positioning System (DGPS), all tied to a common point that corresponded to a USGS-surveyed elevation. Individual DGPS points have a horizontal precision of 1-2 cm and a vertical precision of 2- 4 cm [19]. Multiple base station locations were required to tie all the surveys together, leading to a cumulative uncertainty across the valley of 20 cm horizontal and 40 cm vertical, which was sufficient to correlate features on both sides of the valley. Figure 2 shows one DGPS profile (Transect A) in detail.

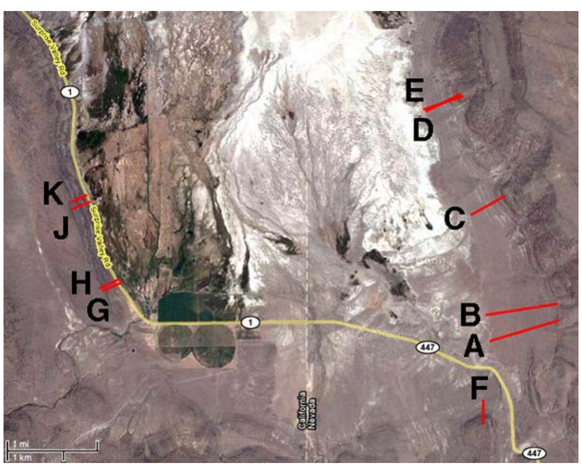

Figure 1. Location of ten profiles surveyed at the southern end of Surprise Valley (41.1°N, 120.0°W). Image: Google, DigitalGlobe, GeoEye, NAVTEQ.

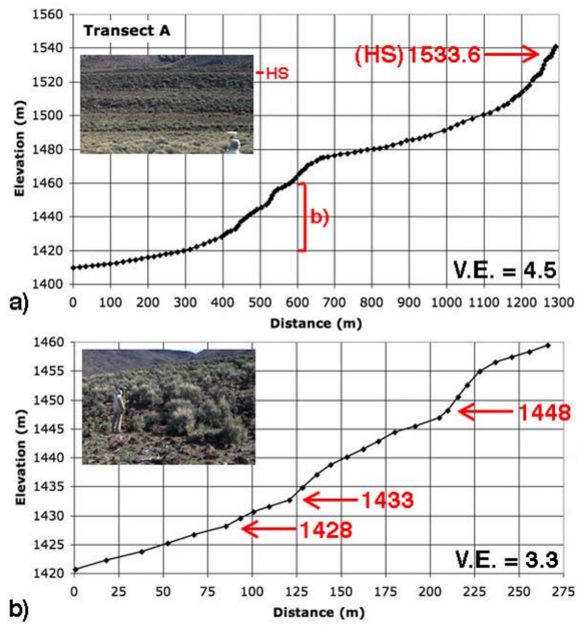

Figure 2. DGPS Transect A (see Fig. 1). a) Entire A transect, with vertical exaggeration of 4.5. Inset shows oblique view of prominent beach ridges (see b). High stand shoreline (HS) is at 1533.6 m elevation. b) Enlarged view of most prominent beach ridges, labeled by elevation at base of each ridge. Inset shows field view at the base of the 1433 m ridge.

Results: The ten DGPS transects consisted of >900 individual points, with field notes and photos keyed to the survey points. The highstand (HS) shoreline was identifiable in eight of the ten transects, indicating an elevation for this lake level of 1533.4 m ± 0.4 m (representing the maximum cumulative error present between transects K and D-E). HS shorelines likely have the greatest potential for definitive correlation using remote sensing data for Mars, where the lack of shorelines upslope of the HS provides a compelling argument that observations correspond to the same paleolake level. For shoreline features below the HS, our data suggest that an overall vertical precision of at least 50 cm should be required in order to have confidence that equivalent lake levels are being compared between multiple transects separated by as much as 9 km horizontally. The variability was remarkable for both the detectable topographic signature across a shoreline ridge and its surface expression in the field (in Surprise Valley, this was usually a concentration of rounded to subrounded cobbles and boulders on the beach ridge); shorelines prominent along one transect may be indistinguishable in an adjacent transect only ~100 m away, but reappear in another transect well-removed from the first one (Fig. 3). We interpret such

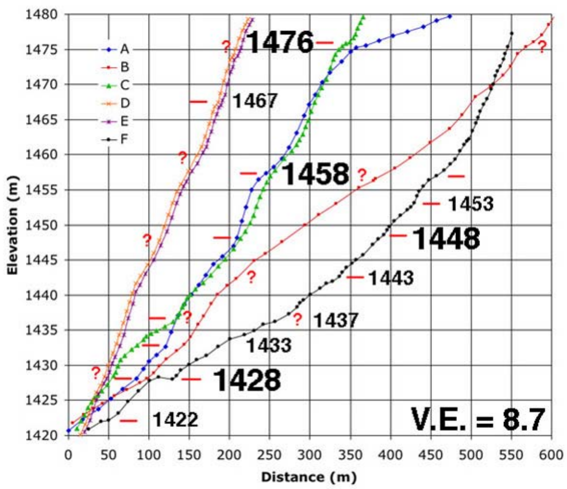

Figure 3. Comparison of beach ridge elevations from six DGPS profiles obtained along the eastern side of Surprise Valley (see Fig. 1). Plots are offset by 5 m along the distance scale, for clarity. Red lines indicate base of beach ridges for various profiles; '?' means a ridge may be present, but was inconclusive. Numbers show elevation for the base of ridge levels; large numbers indicate strong ridge signatures are present in two or more profiles, while small numbers indicate a ridge is clearly evident in only one profile.

a high degree of variability to be related perhaps to lateral variations in bedrock competency around the valley, or maybe to variations in the incidence direction of storm waves when they broke against the valley wall (both factors should be considered when attempting to follow a possible shoreline feature on Mars). The four transects on the western side of the valley displayed far less obvious shoreline features, both in the DGPS profiles and while climbing the talus slopes, except for the HS; this was at least in part due to the presence of large talus slopes along this section of the valley wall (and abundant talus slopes developed on crater walls will similarly complicate shoreline identification inside impact craters on Mars). Two of the shoreline ridge levels below the HS were strongly lithified by accumulations of tufa on and around the boulders and cobbles, strengthening the confidence of cross-valley correlations for these levels; if lake chemistry on Mars was supportive of tufa deposition, such shoreline levels might be detectable by spectroscopic measurements if not thoroughly masked by dust deposition.

Future work: We plan to conduct the next field effort for this MFRP grant in May of 2009, when we will collect DGPS surveys for both depositional (beach ridge) and erosional (wave-cut scarp) pluvial features in Long Valley, located in eastern Nevada.

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