GEOMORPHIC INVESTIGATIONS OF CRATER PALEOLAKES ON MARS: RECONSTRUCTING THE AQUEOUS RECORD. D. C. Berman and R. M. E. Williams; Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; bermandc@psi.edu.

Introduction: The climatic history of Mars remains one of the principal fields of study in the planetary sciences. Constraining the relative timing and duration of surface aqueous periods based on the geologic record is of fundamental importance to an accurate characterization of past climate conditions on Mars, and by association, determining habitable periods at the planet's surface. Furthermore, study of the martian climate history is an important reference for climate studies on Earth and deepens our understanding of the characteristics of terrestrial climate change.

Although there is consensus that Mars has undergone climate change, questions remain regarding the nature of this transition [e.g., 1]. Water levels in large lakes fluctuate in response to major climatic cycles. Detailed temporal reconstructions of paleoclimate are based on correlations of lake-level chronologies. For example, paleolake-level variability across multiple enclosed basins in the western USA underpins our understanding of Pleistocene climate oscillations. Similarly, characterizing and comparing the detailed martian paleolake histories globally will improve our understanding of the relative timing and nature of martian climatic conditions.

On Mars, several impact craters and other topographic basins once hosted lakes. Prior studies have mapped the global distribution of crater lakes including classification as open and closed paleolakes [2-6]. Several martian paleolakes have been investigated in detail to establish the paleo-lacustrine history [e.g., 7-10]. Through geomorphic mapping, we are documenting lake metrics and characterizing the relative timing of lake levels in candidate craters. We have identified 74 potential former crater lake sites around the globe suitable for detailed analyses, 9 of which we have analyzed thus far (cf. Figures 1-4).

Background: One of the fundamental lines of geologic evidence used in reconstructing the climatic history on Mars is the distribution and preservation of valley networks [11]. The majority of Noachian-aged (>3.7 Ga) terrain is dissected by valley networks, indicating that climatic conditions were apparently conducive to the sustained presence of surface water during the planet's first half billion years (~4.1 to 3.7 Ga in the Noachian). Former paleolacustrine locations are identified by locations where valley networks terminate or breach topographic basins.

Although both valley networks [e.g., 11, 12] and candidate crater lakes [e.g., 13] were identified in

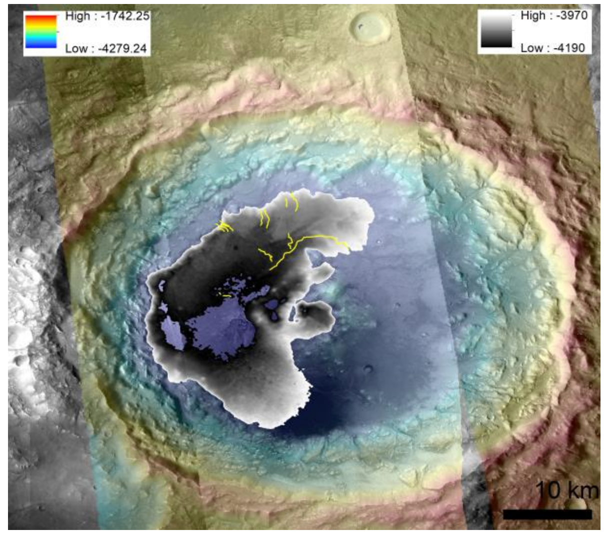

Figure 1. Unnamed 60-km diameter crater in Deuteronilus Mensae (centered at 35.6° N, 0.5° E) containing inlet valleys, alluvial fans, and ridges interpreted to be inverted channels (see Fig. 2). Extraction of DTM (grayscale) from range of ridge elevations (yellow lines) over full range of DTM elevations (color) and associated CTX orthoimages.

Viking images, our understanding of the aqueous history on Mars has greatly expanded in the last ~two decades with geomorphic investigations utilizing high resolution image and topographic data.

Data and Methods: In order to investigate the morphology, morphometry, and viability of potential crater lakes and their associated alluvial fans, inlet valleys, and inverted channels, we have utilized data from the Mars Reconnaissance Orbiter Context Imager (CTX) and High Resolution Imaging Science Experiment (HiRISE) instruments. We have used the Ames Stereo Pipeline (ASP [14]) to construct CTX and HiRISE DTMs at 20 and 1 m/pixel respectively. We are using ArcGIS 10.6 software to ingest image and topographic data, to identify craters of interest, and make measurements of features such as fans and ridges.

Survey: Assisted by previous global [2-6] and regional [15, 16] of related features, and utilizing the global seamless CTX mosaic [17], we have completed a new global survey of craters with features indicative of the presence of a lake, including alluvial fans, valleys, and ridges (inverted channels). Our survey identified 74 candidate craters. These candidates were chosen not only by the presence of the above-mentioned features, but on their viability for topographic analyses.

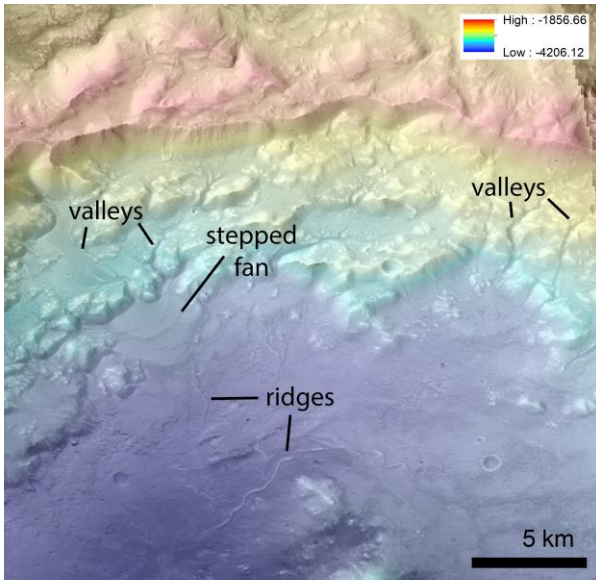

Figure 2. Northern floor of crater shown in Fig. 1 showing paleolake features in detail.

Topographic analyses: One or more CTX DTMs were constructed for 9 individual candidate craters thus far. All DTMs were registered to MOLA elevations and mosaicked together when adjacent. Associated orthophotos, hillshades, 50 m contours, and slope maps were constructed for each DTM mosaic. Ridges for each crater were mapped as polylines with ArcGIS Editor tools, and elevation ranges for the initiation and termination points of the highest and lowest ridges were recorded. DTMs were then clipped to those elevations to demonstrate potential lake fill levels. Topographic profiles were taken of ridge cross-sections.

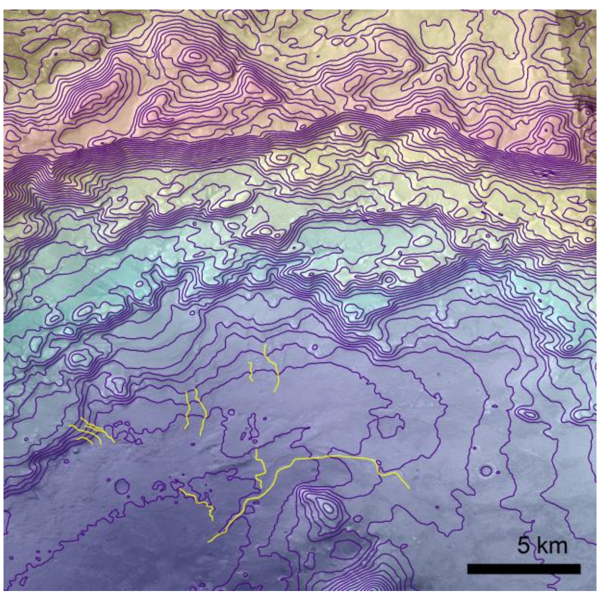

Figure 3. Northern rim of crater shown in Fig. 1 with 50 m contours (purple) and mapped ridges (yellow).

Results: Ridges typically emanate from beyond the margins of alluvial fans that extend from valleys incising into crater walls. In some cases, ridges superpose fan surfaces and show evidence of meanders. 212 ridges were mapped in 9 craters, ranging in length from 36 m to 1.2 km. Ridges are generally sinuous and narrow in planform (~ 150 m width). Ridge heights range from ~5 m to ~ 30 m. Elevation ranges of ridges show crater lake fill as deep as several hundred meters. Variability in elevations of ridge initiations and terminations indicate potential for variable lake levels; the timing and climatic implications of these are yet to be determined.

Future work: Additional CTX DTMs will be constructed over more candidate craters. Regional or global climatic trends will be assessed through comparison between the suite of study locations and existing paleolacustrine histories published in the literature. By adopting simple analytical techniques, following approaches used in study of terrestrial paleolakes to reconstruct paleoclimate, new insights into the regional and/or global martian climate oscillations will be probed.

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