Idenfication of Paleo-Lakes in Floor-Type Central Pits, Mars: an Update. S. E. Peel[1] and D. M. Burr[1], [1]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville (speel1@vols.utk.edu).

Introduction: Central pit craters (CPCs) are impact craters that contain a centrally located, approximately circular depression formed during crater emplacement [e.g., 1-3]. Previously, 96 floor-type CPCs on Mars were found to contain valleys leading into the central pit (Fig. 1; [4]). Results of [4] suggested that, under certain conditions, 5 of the 96 CPCs could have hosted lakes in their central pits. Their methodology included the identification of these outlet channels suggesting lake overflow, the identification of sedimentary fans at the termini of valleys interpreted as deltaic in origin, and model channel discharge calculations. Following this initial, exporatory work, a more expansive study is underway [7] that increases the number of craters inspected (all of the 96 craters for which the necessary data are available) and the breadth of criteria utilized. We report on our methods and results to date.

Methods: We test the hypothesis that there were lakes within these 96 floor-type central pits utilizing morphomologic and morphometric tests (Fig. 2).

Outlet channels – Channels formed by overflow of past standing water from a central pit are strong evidence of a paleo-lake. To identify such outlet channels, we inspected the floors of the CPCs with valleys using available Context Camera (CTX) images in ArcGIS. CTX Digital Elevation Models (DEMs) were overlain atop of the CTX images and inspected to identify the channel slope direction. Channels that breached a pit rim and for which slope data were available showed a paleo-flow direction away from the pit, were identified as outlet channels.

Lake Sedimentary Structures – Desiccation cracks can be indicative of a paleolake and can occur at a scale resolvable with High Resolution Imaging Science Experiment (HiRISE) images [7-9]. Therefore, the available HiRISE images were used to identify any potential desiccation cracks in the CPCs.

Fan Grain Size Distribution and Observation – Alluvial fans and deltas also have different spatial distributions of sediment sizes, which can be used to distinguish them [10-11]. For the sedimentary fans within floor pits, Thermal Emission Imaging System (THEMIS) thermal inertia data (TI) were used to identify if the fans had coarser grains on the steepest slope bounded by finer grain deposits (deltaic fan) or coarser grains towards the apex and fine grains concentrated at the toes (alluvial fan). Where HiRISE images were available, direct observation of boulder-sized grains on the sedimentary fans was also completed.

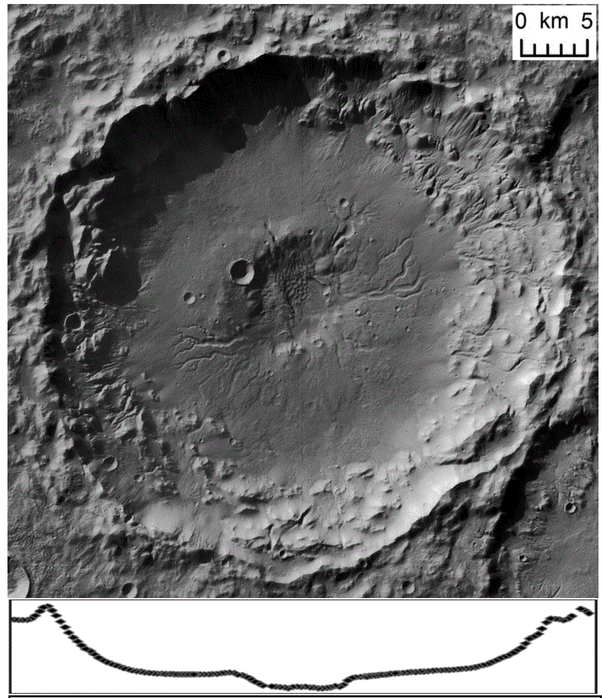

Fig. 1: (Top) Floor-type central pit crater (~40 km diam) with interior valley networks draining into the central pit (~500 m deep); in CTX [5]). (Bottom) MOLA PEDR [6] profile across the crater above. Vertical exaggeration of ~2.5.

Sedimentary Fan Convexity – For well-preserved sedimentary fan deposits, fan surface convexity can provide evidence to distinguish between alluvial and deltaic deposits: convex deposits are more consistent with deltaic origins [e.g., 10, 12]. CTX DEMs, High Resolution Stereo Camera (HRSC) DEMs and Mars Orbiter Laser Altimeter (MOLA) Precision Experiment Data Records (PEDR) coverage were collected for fans identified on the floors of the central pits in CTX images. Topographic profiles, providing a representative statistical sample, were then taken across each fan.

Sedimentary Fan Slope –The slopes of delta topset and foreset beds can also be used as evidence to distinguish them from alluvial fan deposits [10-11]. Each sedimentary fan profile was investigated to determine its slope value. These values were then statistically compared to the slope values expected for horizontal delta plains (topset) and inclined delta front (foreset) regions to determine if the measured slope values matched the values expected from the terrestrial literature [10]. The one-directional single-sample t-test was used for the delta plane slope measurements. The single-sample chi-square test for a population variance was used for the delta slope region slope measurements. The data used were CTX DEMs, HRSC DEMs, HiRISE DEMs and MOLA PEDR points.

Results to date: Three floor pits are found to have outlet channels, supporting the hypothesis that they hosted paleo-lakes. One floor pit contains a polygonal ground pattern consistent with desiccation cracks. In two central pits, six sedimentary fans are found to exhibit a convex morphology, consistent with deltas and therefore paleolakes. Three sedimentary fans are found to have slope values that match those expected for deltas. Only one fan is found to exhibit TI patterns consistent with a deltaic origin (although data coverage and mantling materials may be responsible for these limited results). Four central pits had fans with resolvable grain sizes constituent with a deltaic origin.

Ongoing Work: *Spectral Signatures* – For central pits that had at least one line of evidence in support of a paleo-lake, Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) data are being used to test these results by identifying minerals that would be expected in paleo-lake deposits (e.g., carbonates, phyllosilicates and sulfates [13, and citations therein]). To give evidence of a central pit lake, these minerals have to have formed in the lake and not simply have been transported there from the watershed. Therefore, two Targeted CRISM observations are required to identify these minerals. Browse products for six CPCs, that have at least one line of evidence in support of a paleo-lake and have the necessary two-part CRISM overage, support the probable presence of phyllosilicate, sulfate and/or carbonates in those central pits. We are currently using the ENVI-based CRISM Toolkit to investigate these potential signals of past paleo-lakes.

Timing of the Paleo-Lakes – The presence of paleo-lake features for craters has been documented repeatedly [e.g., 14-17]. In order to place the identified central pit paleo-lake features within the context of the greater aqueous history of Mars (e.g., Fig. 5), we have identified the craters' ages using [18]. We are conducting crater counts in ArcMap using the CraterTools application on the ejecta of craters with more than 2 lines of evidence for paleolakes. Age dating results to date have placed most of the craters with possible CPC paleolakes in the Hesperian and Amazonian periods.

Conclusion: Our findings provide at least one line of evidence for paleolakes in seven CPCs. The results of this global study will contribute to understanding of the location, amount, and timing of water on Mars.

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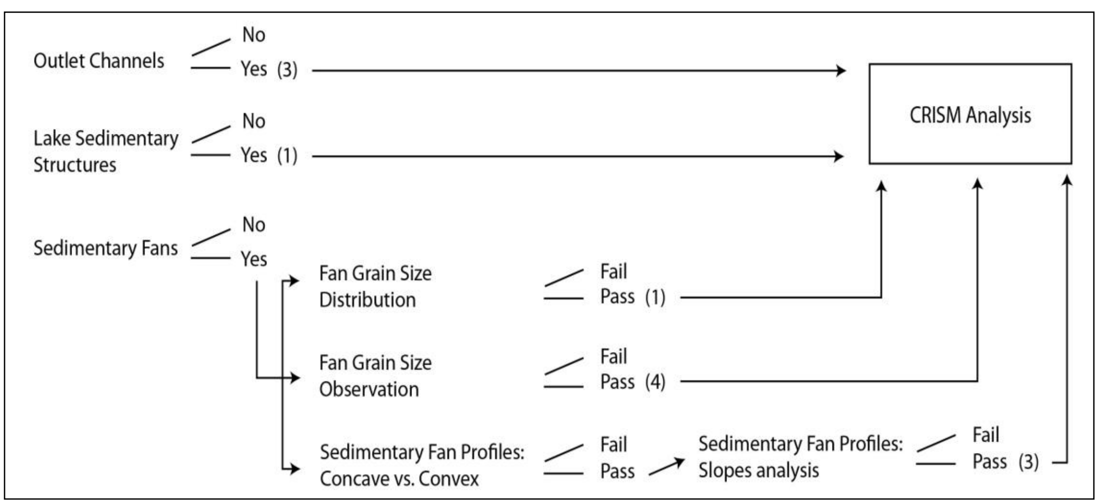

Fig. 2: Flow chart for this investigation showing the different analyses conducted for the 96 CPCs. Box indicates the test that is part of ongoing work. (n) are the number of CPCs that pass. The total number of passing results (evidence for a paleolake) leading into the CRISM Analysis test is greater than seven because some CPCs have more than one passing result.