LACUSTRINE HISTORY WITHIN SOUTHWESTERN MELAS BASIN, MARS. R. M. E. Williams[1] and C. M. Weitz[1], [1]Planetary Science Institute, 1700 East Fort Lowell, Suite 106, Tucson, AZ 85719-2395 (williams@psi.edu).

Introduction: A perched basin located in southwestern Melas Chasma has widely been recognized as the site of a postulated paleolake [1, 2]. Valley networks converge from the east and west into an enclosed 30 x 120 km basin and terminate in fan-shaped landforms. Fan deposits are interbedded with layered beds that are largely presumed to be lacustrine deposits [1, 2]. New details of the aqueous history in the Melas basin have been revealed from analysis of high-resolution image, topographic and spectral datasets. We examined high-resolution images (THEMIS, CTX, HiRISE), topographic data (HRSC), and complimentary CRISM spectral data of key regions to refine our understanding of the sequence of events within this basin. We conducted a comprehensive examination of the diversity of fan-shaped landforms within the basin to characterize their morphology based on meter-scale images, evaluate their origin, and synthesize a history for the basin based on fan superposition relationships,

Observations: Eleven fan-shaped landforms have been identified which reflect various depositional environments and some fans indicate lake level (Figures 1 and 2). Our results refine work on fan deposits by earlier studies [1, 2]. There are deep subaqueous fans (A and B identified in [2]), shallow subaqueous (e.g., fans E2, G, H, and J2), and subaerial deposits (fans D, E1, and J1). In this study, we noted composite fan structures, such as landslide deposits atop deltaic deposits (fans E and J).

There is a marked contrast in source region drainage patterns between the eastern and western catchments. Multi-stage fluvial incision is recorded in the western drainage basin tributaries with an earlier parallel drainage pattern that is buried and cross-cut by a later sinuous tributary channel system. This contrasts with the immature drainage system in the eastern catchment. Sediment was also sourced from the valley walls, as in the landslide deposits (fans J and K) and a late-stage debris flow (Fan D) that superposes the western fan complex (see Figure 1).

There are two noteworthy attributes of the layered beds identified in this study. Although most of the layered beds appear spectrally bland, a few isolated, bright outcrops display hydration features in CRISM data. Absorption features at 1.93 and 2.21 μm and a weak absorption at 1.41 μm are consistent with laboratory spectra of opal. These opal signatures occur across multiple beds and elevations. .

Also, a distinctive marker bed (Figure 3) with parallel megaripples (typical wavelength of 30-40 m) was identified in the layered beds. The morphology, scale and spacing of these megaripples is comparable to martian transverse aeolian ridges (TARs, [3]).

Discussion: Superposition relationships indicate discrete temporal windows for individual fan formation and enable reconstruction of various phases in the lacustrine history. The megaripple marker bed, interpreted as indurated aeolian bedfroms, is within the lower levels of the exposed stratigraphic record of presumed lacustrine deposits. This observation, taken together with the stratigraphic succession of fan-shaped deposits (Figure 2), indicates fluctuating lake levels with, at a minimum, early highstand (Fans A & B) and late-stage lake highstand (Fans G & H). Post-dating the last lake high-stand, there was episodic sedimentation from landslides and debris flows (e.g., Fans D, E1 & J1), as well as chemical precipitation or alteration of layered beds.

We conducted simple landscape evolution models to evaluate the minimum duration of aqueous activity constrained by the stratigraphic relationships among deposits within the basin. Landform scale was used to estimate paleovelocity and paleodischarge based on terrestrial analogs (see further details in [4, 5]). For the western drainage basin, we used inner channel width, meander wavelength and radius of curvature as inputs to derive estimates of average discharge (~30 m^3/s) and formative discharge (200-300 m^3/s). Lacustrine fill times for the 1.5 km^3 basin [1] associated with the average discharge, representative of persistent flow conditions, is several centuries. Assuming sedimentary deposition rates associated with large terrestrial deltas, the largest delta in the basin (Fan C) requires at least a century to form. In addition, to accumulate the ~25 m of layered deposits below fan A (Figure 2) assuming a range of plausible lacustrine sedimentation rates (0.01 - 1 cm/year) from terrestrial analogs results in a minimum formation period of $10^3 – 10^5$ years.

The synthesis of results from this study indicate the lacustrine period within Melas basin lasted at least centuries to millennia, and included at least two highstands with an intervening lowstand or hiatus. Climate conditions conducive to lake stability had to be maintained for a duration long enough to construct these fans.

References: [1] Quantin, C. et al. (2005) *JGR, 110*, doi:10.1029/2005JE002440. [2] Metz et al. (2009) *GRL 114*, E10002. doi:10.1029/2009JE003365. [3] Wilson, S.A. (2004) *JGR* 109, doi:10.1029/2004JE002247. [4] Williams, R.M.E. et al (2009) *Geomorphology 107*. [5] Williams, R.M.E., and C.M. Weitz (2013, *in review*) *Icarus.*

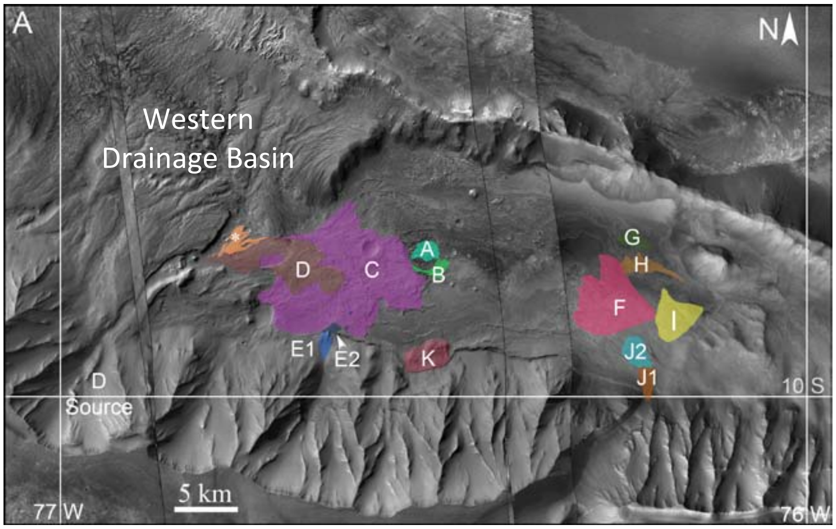

Figure 1: Study region and sketch map of eleven fans within the south-western Melas basin. Landslides (I1, J), debris flows (C1, D1), fan-deltas (C2, E, H), deltas (D2, F, G, I2), and deep sublacustrine (A, B) deposits are present within the basin. Orange region marked by * are deposits that may be associated with fan C1. Note that the source region for fan D (identified by [1]) differs from the bulk of the western fan complex (fans A-C) that derived from the western drainage basin.

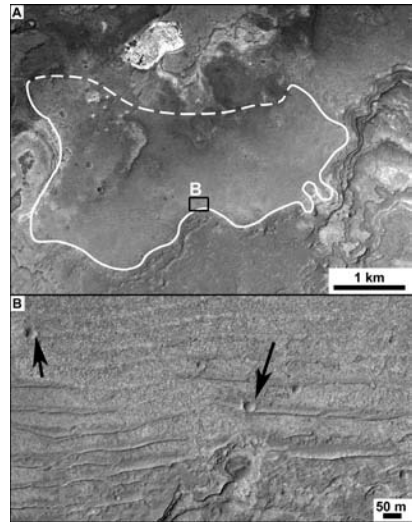

Figure 3: A) Outline of marker bed characterized by bedforms interpreted to be indurated TARs. B) Craters superpose bedforms (large black arrows), an indication of the bedform material strength.

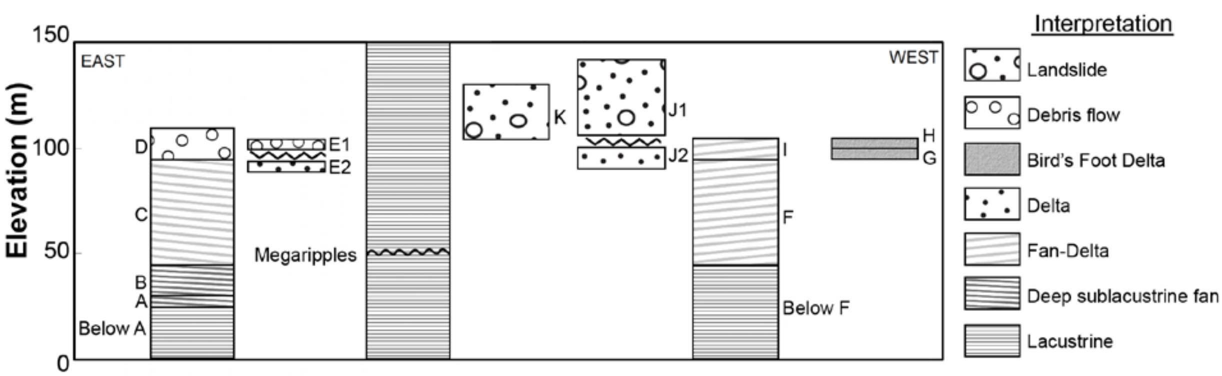

Figure 2: Stratigraphic columns for various places within the basin are presented with relative elevation offset to illustrate the approximate correlative depositional events. Estimates of fan deposit thickness were derived from measurements of vertical exposures of fan deposits in HiRISE and HRSC digital terrain models (DTMs). Note the consistency in thickness and relative stratigraphic position of fans C and F. These large fans are interpreted as fan-deltas that apparently formed coevally and indicate sustained fan development associated with a prolonged lacustrine period. Jagged line marks uncertain contact relationship between deposits in fans E and J.