LOCAL-SCALE STRATIGRAPHY OF INVERTED FLUVIAL FEATURES IN AEOLIS DORSA, WESTERN MEDUSAE FOSSAE FORMATION, MARS. R. E. Jacobsen[1] and D. M. Burr[1], [1]Earth and Planetary Sciences Department, University of Tennessee, Knoxville, TN (RJacobsen@utk.edu and dburr1@utk.edu).

Background: Sinuous ridges in Aeolis Dorsa (AD) – the region between the two westernmost lobes of the Medusae Fossae Formation (MFF) – are interpreted as inverted fluvial features formed by precipitation, run-off, induration, burial, and exhumation by aeolian erosion [1-4 and refs. therein]. The general stratigraphic position of inverted fluvial features indicates that formation processes occurred during the early emplacement of the MFF [1, 2], but their history has not been described in detail. This abstract presents local-scale analyses of stratal markers to derive a history of fluvial activity and associated climate. This work is assisted by mapping of northern plains volcanic material [5] and the MFF [6], which provide some numerical age constraints on fluvial activity. This local-scale work is part of a regional investigation of AD inverted fluvial features [4], which tests 3 hypotheses of fluvial history in AD.

Hypotheses: (1) Fluvial activity occurred once under unique climate and/or environmental conditions (e.g., obliquity, volcanism). Evidence supporting this hypothesis would be inverted fluvial features contained within a single MFF stratum. (2) Fluvial activity occurred episodically due to repeated conditions, which would be evidenced by inverted fluvial features found within multiple discrete strata. (3) Fluvial activity occurred continuously under varying conditions, as would be evidenced by inverted fluvial features found in all MFF strata.

Methods: Hypotheses testing involves use of visual images from the Context Camera (CTX, 6 m/px) and the High Resolution Imaging Science Experiment (HiRISE, 0.3 m/px), and topographic data from Mars Orbiter Laser Altimeter (MOLA, 80 m spot radii) and CTX digital elevation models. Hypotheses are tested at 3 locations (i-iii), with location identifiers from [1, Table 1]. (i) We study Area 43 (fig. 1) to understand fluvial stratigraphy near the highland/lowland boundary (HLB). Area 43 is a fan-shaped network of inverted fluvial features [e.g., 2]. Some fluvial features exhibit post-depositional topographic undulations possibly due to compaction or tectonic deformation [7]. (ii) We study Area 45 (fig. 2) to understand the fluvial stratigraphy of several fan-shaped inverted fluvial landforms, ~250 km north of the HLB. (iii) We study Aeolis Serpens (AS), a ~600-km-long inverted fluvial feature in central AD (fig. 3), because it contacts several mapped geologic units [5, 6]. These multiple contacts provide some numerical constraints on the timing of fluvial activity related to AS.

Observations of local geomorphological features and units are used to interpret MFF strata. Delineations of sinuous ridges [4] identify strata containing inverted fluvial features [1]. The orientations, sizes, and aspect ratios of elongate hills, interpreted as yardangs, distinguish multiple MFF strata and indicate paleo-wind direction [8]. Rootless cones [9] are used to identify locations where Cerberus lavas have embayed MFF strata. Stratigraphic relationships are derived using topographic data, 3-point solutions for strike/dip, and principles of superposition and embayment. These relationships are used to sequence stratigraphic columns at each location. Strata with inverted fluvial features are interpreted as periods of MFF deposition, fluvial activity, induration, and inversion by aeolian erosion [1]. Yardangs are interpreted as periods of MFF deposition and aeolian erosion [2, 8]. Rootless cones represent Cerberus lava flow events [5, 9].

Stratigraphic Observations: The described observations in each area begin with the topographically lowest feature/units and progress upward. (i) The fan-shaped plateau in Area 43 contains 3 observable features/units. Topographically low units in Area 43 have NE-SW elongate surface textures (yellow fig. 1; A & A′ fig. 1). The plateau surface stands ~80 meters above these topographic lows and is marked by a unit of N-S oriented yardangs. Some yardangs on-lap (arrows fig. 1) and cut inverted fluvial features (southern portions of Area 43), but many inverted fluvial features are ~20 m above the plateau surface (B fig. 1) and exhibit topographic undulations. (ii) Area 45 contains 5 features/units (a-e). Smooth-to-rippled surfaces are the lowest local unit (a, not shown in fig. 2), and 3-point solutions give a near horizontal

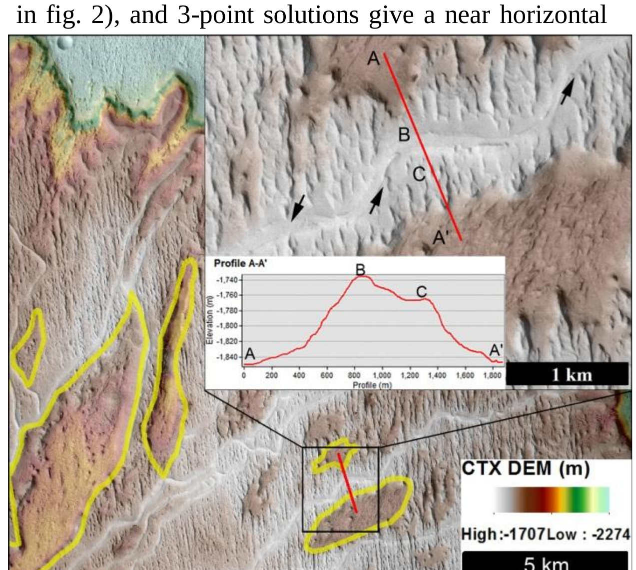

Figure 1: Area 43, near 6.2°S 151.6°E, showing 3 units (A-C).

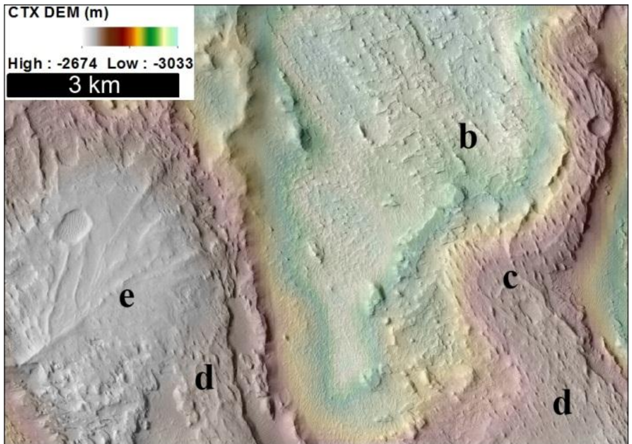

Figure 2: Area 45, near 2.8°S 149.5°E, showing 4 of the 5 geomorphic units (b-e).

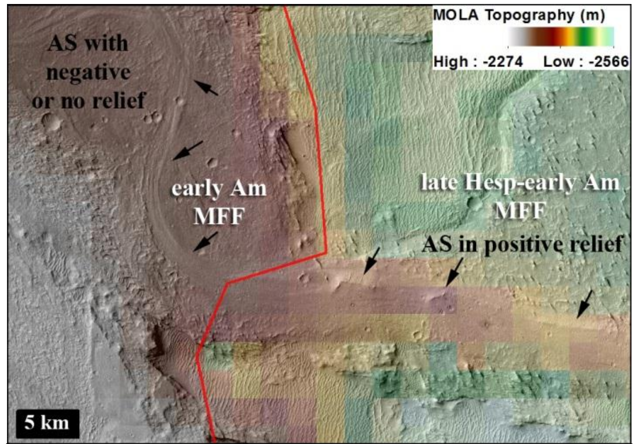

Figure 3: Aeolis Serpens (AS), near 1.8°S 150.6°E. Red line denotes unit boundary [from 6].

surface for this unit. A unit of irregular yardangs and rough MFF topography (b) are found above the smooth-to-rippled unit. Inverted fluvial features (c) are superposed on the irregular yardang unit, which in turn are superposed by a NW-SE orientated yardangs unit (d). The highest unit is distinguished by several fan-shaped inverted fluvial landforms (e). (iii) There are 3 units with respect to AS. AS has positive relief within a mapped unit of Amazonian-Hesperian, lower MFF [6]. However, AS has no relief, but retains fluvial morphologies, within a mapped unit of early Amazonian, lower MFF (fig. 3) [6]. In northern AD, moats around yardangs and a unit of rootless cones proximal to AS, identify middle to late Amazonian Cerberus lavas [5], which embay AS.

Stratigraphic Interpretations: (i) At least 3 strata of MFF material are interpreted in Area 43. Topographic lows (yellow fig. 1) are interpreted as “erosional windows”, revealing a subjacent MFF stratum, which was eroded by abrading NE-SW paleo-winds. Following this erosion, a second stratum of MFF, at least 80-100 m thick, was laid down. Fluvial features indicate fluvial activity and subsequent inversion processes in this second stratum. After aeolian erosion of the second stratum, a third stratum of MFF material was laid down and abraded by N-S paleo-winds. Afterwards, Area 43 was topographically deformed by compaction or tectonic processes, forming undulations [7]. (ii) At least 3 strata are interpreted in Area 45. The topographically low smooth-to-rippled unit is interpreted as eolian sedimentary fill and/or eolian erosion with exposure of underlying smooth topography (e.g., volcanic plains). One depositional episode of MFF material is required for the formation of the irregular yardangs (b) and the inverted fluvial features (c). A second stratum of MFF material is required to explain NW-SE yardangs (d) on inverted fluvial features (c). The unit of NW-SE yardangs (d) may have formed coeval with the exhumation of fan-shaped fluvial landforms (e), or as a separate subjacent stratum. (iii) Two MFF strata are interpreted with respect to AS. The fluvial activity of AS occurred within the early Amazonian MFF stratum, above the Amazonian-Hesperian stratum, because AS is visible in the superjacent stratum. AS embayment by the middle to late Amazonian Cerberus lavas indicates AS formed prior to the middle to late Amazonian.

Discussion: The 3 areas examined show different inverted fluvial feature stratigraphies. (i) Area 43 shows evidence of fluvial activity in one MFF stratum; this is consistent with hypothesis 1. Based on mapping by [6], fluvial activity in Area 43 occurred during the Hesperian-Amazonian transition. (ii) Area 45 presents a stratigraphy with at least two distinct strata with inverted fluvial features (i.e., inverted fluvial features and fan-shaped landforms), consistent with hypothesis 2. Based on mapping by [6], fluvial activity in Area 45 occurred either during the Amazonian-Hesperian transition or the early Amazonian period. (iii) AS formed within one stratum of early Amazonian MFF material, consistent with hypothesis 1. This work at local-scales shows that the history of fluvial activity in Aeolis Dorsa is spatially diverse and occurred over an extended time period, beginning as early as the Hesperian-Amazonian transition, with some activity also occurring in the early Amazonian.

References: [1] Burr, D.M. et al. (2009) *Icarus 200*, 52-76. [2] Zimbelman and Griffin (2010) *Icarus 205*, 198-210. [3] Burr, D.M. et al. (2010) *JGR 115*, E07011. [4] Jacobsen R. and Burr D. (2012) *LPS XCIII*, Abstract #2398. [5] Tanaka K. et al. (2008) *Icarus 196*, 318-358. [6] Zimbelman J. and Scheidt S. (2012) *Science 336*, 1683. [7] Lefort A. et al. (2012) *JGR 117*, E03007. [8] de Silva S. et al. (2010) *PSS 58*, 459-471. [9] Lanagan P. et al. (2001) *GRL 28*, 2365-2367.