WET-TO-DRY HYDROLOGICAL TRANSITION ENCAPSULATED IN FLUVIAL STRATIGRAPHY OF AEOLIS DORSA, MARS. R. E. Jacobsen[1] and D. M. Burr[1], [1]University of Tennessee, Knoxville, TN USA 37996 (RJacobse@vols.utk.edu and dburr1@utk.edu).

Background: The geomorphology of precipitation-fed fluvial activity suggests a transition from wetter conditions to drier conditions in martian history [1 & refs. therein]. The Aeolis Dorsa (AD) region, located between Aeolis and Zephyria Plana and south of the Cerberus lavas [2], contains numerous sinuous ridges and fans interpreted to be inverted fluvial deposits [e.g., 3-8]. These deposits, when arranged stratigraphically, are a microcosm of martian fluvial history [cf. 7]. In addition to a rich fluvial history, the region has experienced burial by volcanic ash and/or aeolian deposits of the Medusae Fossae Formation (MFF), exhumation through aeolian abrasion, forming yardangs [9 & refs. therein], and topographic modification by collapse or tectonic processes [5].

The most common inverted fluvial features are flat-topped sinuous ridges and ridge networks [3]. Some ridges have semi-concentric lineations similar to terrestrial meander deposits, which on Earth, generally require more steady hydrologic conditions [10]. These deposits have been interpreted as scroll-bars [3] or laterally aggrading channel beds of meandering rivers [8]. Inverted fluvial features imply some inurdation [4 & refs. therein], likely by geochemical cementation, followed by erosion of host MFF [4]. Thin sinuous ridges, some of which appear stacked above flat-topped inverted fluvial features, have been interpreted as inverted paleochannels from a second episode of fluvial activity [3,4,6]. The fan-shaped features connect to inverted paleochannels or paleochannel networks, and have been interpreted as alluvial fans [3,7], which on Earth have intermittent flows and "flashy" discharges [11].

Hypothesis: Previous analyses [e.g., 3-8] suggest the following sequence of events for the formation of AD. **(a)** Long-duration, meandering rivers deposited sediments within valleys at least a few kilometers wide. **(b)** MFF deposits infilled these river valleys. **(c)** Sinuous but narrower rivers exploited some of the same river valleys, depositing sediment within these (stratigraphically higher) channels. **(d)** Fluvial sediments from both (a) and (c) were indurated. **(e)** River valley walls (MFF) were eroded, resulting in topographic inversion of (a) and (c). **(f)** Relief developed along the interior margins of Aeolis and Zephyria Plana. **(g)** Alluvial fans formed along interior margins. **(h)** Fans became indurated. **(i)** MFF deposits covered the region. **(j)** Exhumation and erosion inverted the (indurated) fans and revealed the (previously inverted) fluvial features of (a) and (c). **(k)** Local to sub-regional deformation (e.g., by collapse or tectonism) occurred. The transition from wetter to drier conditions are inferred from the deposits of events **(a)**, **(c)**, and **(g)**.

Methods: To test the geographical extent of this hypothesis, stratigraphies were made and compared among geospatially distributed locations, Area 45N and Area 40 (Figure 1). Hypothesis testing required images from the Context Camera (CTX) [12], High Resolution Imaging Science Experiment (HiRISE) [13], and topography from CTX digital terrian models, derived from Ames Stereo Pipeline [14]. Boundaries for geomorphological units were delinated in ArcMap software. Interpretations of inverted fluvial features, lava units, and yardangs were based on previous interpretations described in the background [2-9].

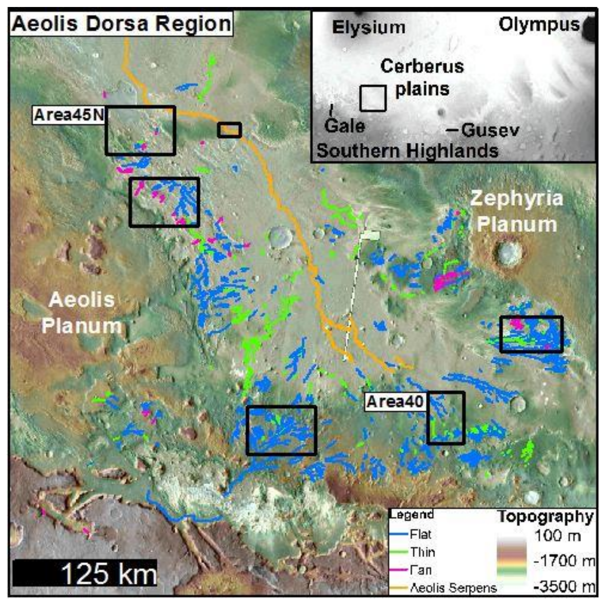

Figure 1: Black boxes mark locations for geomorphological and stratal observations presented here, and previously [6].

Results: *Area 45N:* Flat-topped ridges, consistent with broad deposits of inverted fluvial channels or fluvial valleys [3,4], are hosted within the lowest unit (fd) (Figure 2). A superposed thin ridge, interpreted as an inverted fluvial channel, points to later deposition of a subsequent fluvial unit (fct). This stacked assemblage indicates two episodes of fluvial activity. NW-SE-oriented yardangs cross-cut thin inverted channels (unit fct), cover inverted fluvial deposits (unit fd) and intra-ridge areas, indicating that units fct and fd were inverted, covered by MFF, and later eroded by aeolian abrasion. An alluvial fan grades into NW-SE yardangs that superpose unit fd, indicating that the fan formed in a unit (af) deposited with or after deposition of MFF.

Area 40: Flat ridges with interior, semi-concentric curved ridges, consistent with inverted fluvial meander deposits [3,4,8], are hosted within unit fm (Figure 3). Narrower flat ridges, consistent with flat-topped inverted fluvial channels [3,4], are hosted within unit fcf. Unit fm cross-cuts unit fcf, indicating that unit fcf is older than unit fm. A unit of thin inverted fluvial channels (fct) superposes unit fm, indicating a third period of fluvial activity and subsequent inversion. A mound-forming unit (mu) has many small craters, and troughs that terminate at a unit of fans (af), indicating a fourth period of fluvial activity.

Discussion: The formation of Area 45N is similar to the hypothesis. Deviations from the hypothesis occur in events (a), because evidence for meandering (i.e., semi-concentric lineations) is lacking, and event (k), since no evidence of deformation is observed [5].

The stratigraphic history in Area 40 differs from the hypothesis. Older paleochannels of unit fcf indicate that, depending on location, event (a) may consist of one or more stratal units (i.e., members). Troughs in unit mu that lead to fans (af) also differ from the hypothesis. In Area 40, relief was created along unit mu, followed by precipitation, run-off, sediment transport, and deposition. In many other areas of AD, including Area 45N, the host unit for the fans (unit mu) has been eroded, leaving inverted paleochannels and fans.

Conclusions: The transition from wetter to drier hydrological conditions is preserved in the stratigraphy of Aeolis Dorsa, beginning with fluvial deposits of greater hydrologic stability (e.g., meander deposits in Area 40 and integrated fluvial channels or valleys in 45N) and ending with hydrologically intermittent alluvial fans in both areas.

Measurements of paleochannel morphology by area and stratal unit will be coupled with scaled form-discharge relationships [4,7,15 & refs. therein] to estimate paleodischarge through time.

References: [1] Carr (2012) *Phil. Trans. Royal Soc. 370*(1966). [2] Tanaka et al. (2005) *USGS Map*, SI-2888. [3] Burr et al. (2009) *Icarus 200*. [4] Burr et al. (2010) *JGR: Planets 115*(E7). [5] Lefort et al. (2012) *JGR: Planets 117*(E3). [6] Jacobsen & Burr (2013) *Plant. Geo. Map. Meeting*. [7] Kite et al. (2014) *LPS XLV*, #2638. [8] Matsubara et al. (2014) *Geomorphology, in press*. [9] Mandt et al. (2008) *JGR: Planets 113*(E12). [10] Howard (2009) *PNAS 106*(41). [11] Blair & McPherson (1994) *JSR 64*(3). [12] Malin et al. (2007) *JGR 112*. [13] McEwen et al. (2007) *JGR: Planets 112*(E5). [14] Moratto et al. (2010) *LPS XLI*, #2364. [15] Jacobsen & Burr (2015) *this conference*.

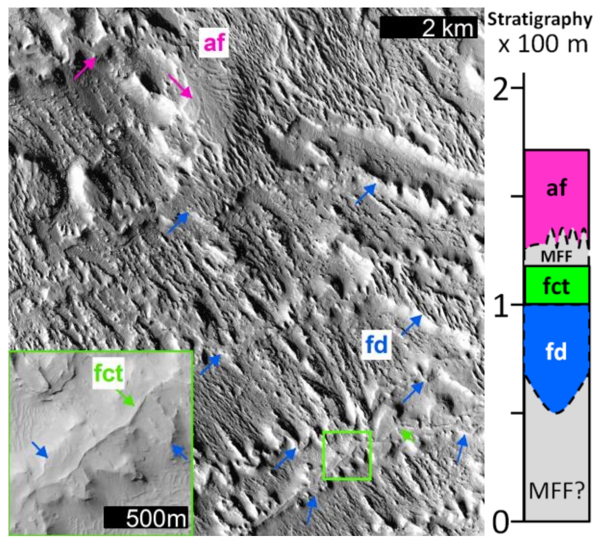

Figure 2: CTX image of part of Area 45N shows morphological units (see text for descriptions). Inset is HiRISE image, showing unit fct above unit fd.

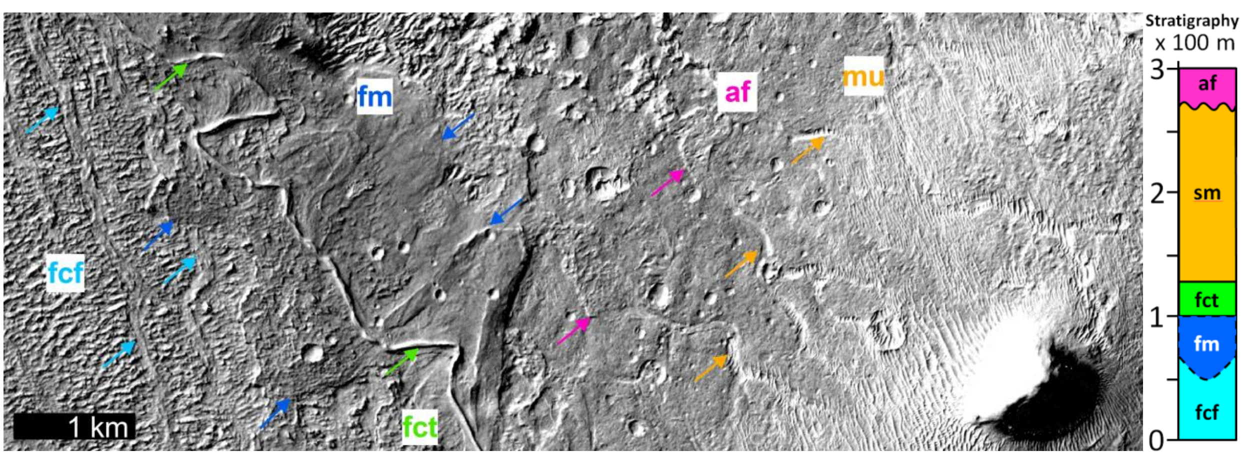

Figure 3: CTX image of part of Area 40 shows multiple morphological unit (see text for descriptions). The left part of the image shows the contact between fm and fcf, where the deposit of fm cross-cuts a paleochannel of fcf.