TOPOGRAPHIC POST-FORMATION MODIFICATIONS OF INVERTED FLUVIAL FEATURES IN THE WESTERN MEDUSA FOSSAE FORMATION, MARS. A. Lefort[1], D. M. Burr[1], R. A. Beyer[2,3], A. D. Howard[4], [1] University of Tennessee Knoxville, Knoxville, TN (alefort@utk.edu), [2] Sagan Center at the SETI Institute, Mountain View, CA, United States, [3] Space Science and Astrobiology Division, NASA Ames Research Center, Mountain View, CA, United States, [4] Department of Environmental Sciences, University of Virginia, Charlottesville, VA, United States.

Introduction: One common assumption in investigating the Martian surface is that current topography reflects original conditions. For example, in flood/fluvial modeling studies, topographic slopes are assumed to have remained unchanged since the time of fluid flow [e.g. 1, 2 3]. Topographic analyses of sinuous ridges (SRs, [4]), interpreted as inverted fluvial features [4, 5] in the region of Aeolis-Zephyria Plana (AZP), suggest that, contrary to this assumption, the current slopes for these inverted channels and floodplains have changed significantly since the time of formation. We combine several datasets to investigate the topography of a distributed sample of inverted fluvial features in the AZP and to determine the amplitude and origin of the ridge undulations.

MFF: The AZP region, located at the martian equator and centered at 1.5°S, 152°E includes the western Medusa Fossae Formation (MFF [6,7,8]), one of several light-toned layered deposits that ring the Martian equator [e.g. 9]. The MFF is dated to the Hesperian/Amazonian epochs [e.g. 4] and inferred as a primary volcaniclastic deposit [8, 10], deposited from the atmosphere along the dichotomy boundary.

Sinuous ridges: The SRs of the AZP are mostly interpreted as inverted fluvial features [4, 5], either inverted paleochannels or inverted floodplains, formed by precipitation, indurated, buried by subsequent deposition and finally exhumed following the lowering by aoelian abrasion of the surrounding landscape [4, 5]. Induration is attributed largely to chemical cementation of the fluvial sediments, although some SRs may have been indurated through lava capping. The location of these sinuous ridges, mostly within the MFF, implies that they are also the youngest such population yet discovered on Mars. A previous study [4] documented about 150 sinuous ridges in AZP and identified 5 main morphological types.

Data and Methodology*:* Three different and independent types of topographic data were used in these investigations: 1) individual MOLA data points (~150-m-footprint and ~300-m-along-track spacing), 2) digital terrain models (DTMs) created from Context Camera (CTX) [11] stereo pair images (6 m/pixel), and 3) DTMs created from High Resolution Imaging Science Experiment (HiRISE) [12] stereo pair images. HiRISE and CTX images were radiometrically corrected and projected using the Integrated Software for Imagers and Spectrometers (ISIS; [13, 14, 15]). For method 1) Inverted channel profiles were derived from MOLA data by using digitizing points along the channel centerline and using the 75th percentile elevation of all MOLA shot points within a 1 km radius to estimate the ridge summit elevation. For method 2) HiRISE and CTX DTMs were produced using SocetSet and the Ames Stereo Pipeline [16] and imported into ArcGIS, where data were collected to create longitudinal and cross-section profiles. The SR profiles were then analyzed comparatively with the morphology of the SRs as shown by the CTX and HiRISE images.

Results: The derived SR profiles surprisingly show gradients locally reversing direction of slope along the presumed flow direction and adjacent, converging SRs occasionally slope in opposing directions. The resultant SR profiles exhibit undulations with amplitudes from 10 m up to 100 m. Eigen-decomposition **[**17] processing of CTX and HiRISE DTM slope profiles allow isolating two main types of undulations [fig.1]. Shorter wavelength undulations (λ ~100 m) have amplitudes of a few tens of meters, and low points along the profiles correspond to degraded SR reaches. Longer wavelength undulations (λ~2000 m) have amplitudes greater than 50 meters (i.e., greater than SR relief) and are not associated with degraded SR reaches. Although these long-wavelength undulatory slopes could indicate subglacial flow, the densely networked pattern and SR morphologies are very dissimilar to the patterns and morphologies of terrestrial eskers. SRs at different locations over the study area show different amplitudes in the long-wavelength undulations [fig.2], suggesting spatial variations in the amount of differential settling.

Hypotheses: We hypothesize two mechanisms for slope undulations.

Differential erosion consitutes the localized removal of the capping layer along shorter sinuous ridge segments that exposes the underlying material, causing erosional stripping of the underlying, less resistant substrate. These sites of erosion are often closely spaced [see 1, Fig. 10], so this mechanism is consistent with short wavelengths undulations (~5-100 m). However, the mechanism would be confined to those undulations that are lower in amplitude than the relief of the sinuous ridges, as any further erosion would entirely efface the sinuous ridge from the land surface. Therefore, differential erosion is hypothesized for locations where the sinuous ridge appears less distinct (reduction of the sinuous ridge width and/or height), and where the decrease in elevation is limited to the height of the sinuous ridge.

Differential settling results from the compaction of porous MFF material under a (now eroded) overlaying mass, or from removal of material at depth. Thus, differential settling is hypothesized for locations where the upper surface of the sinuous ridge is still distinct (preserved surficial sinuous ridge morphology). This process could produce undulations that are greater in amplitude that the relief of the sinuous ridges, since the drop in elevation is produced in the subsurface.

Implications: The long, large amplitude profile undulations are consistent with differential settling of the western MFF in some locations occurring subsequently to creation of the SRs. The inference of settling is consistent with findings from MARSIS that the unit is either 1) very low density, which allows for compaction during settling, or 2) has a significant content of water, whose removal through processes such as melting of subsurface ice, or reduction of pore volume though ground water withdrawal, or possibly sublimation, would allow for compaction [18, 19]. The spatial variability in the long-wavelength undulation amplitudes suggests that this hypothesized settling has not been uniform within the MFF. Determining the amount and locations of differential settling may help in estimating the degree and distribution of porosity in the MFF and provide information on the original composition of the MFF, which constitute a significant and enigmatic subset of Martian lithostratigraphy.

These results therefore suggest that slopes in the MFF cannot be assumed to be original and consequently cannot reliably be used as input into fluvial models. Neither can they be used to discriminate with certainty features such as eskers (which can cross local elevations) from inverted fluvial channels. This finding may also apply to other light-toned martian deposits similar to the MFF.

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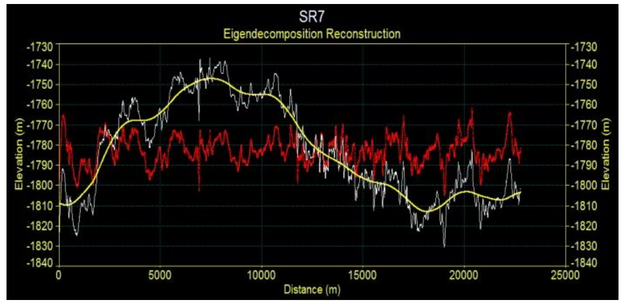

Fig 1. Topographic profile of a SR. White: CTX topographic profile, yellow: long-wavelength ridge undulation with amplitude > 50 m (first eigenmode), interpreted as the result of differential settling; red: short-wavelength ridge undulation with amplitude < 50 m (other eigenmodes), interpreted as the result of differential erosion.

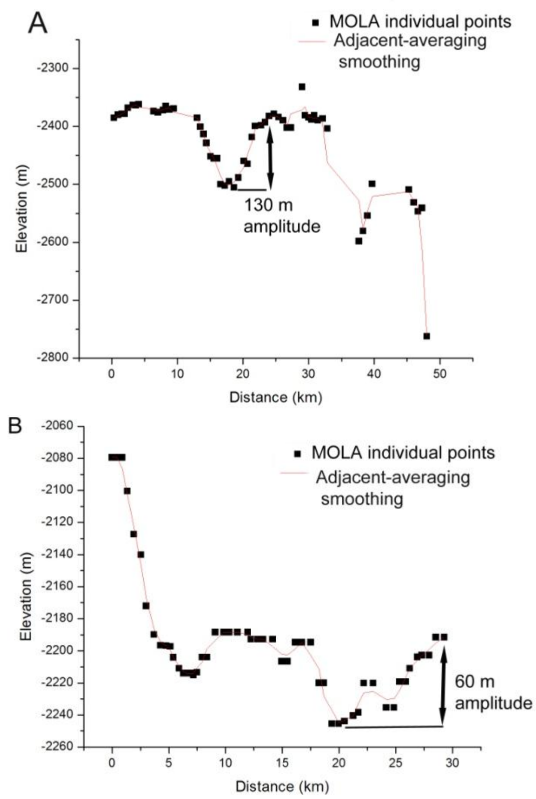

Fig 2. MOLA profiles of a SR in the NW of our study area (A) and a SR in the SE of our study area (B). Both show ridge undulations > 50 m in amplitude, although amplitude of the undulations is greater in A (130 m) than in B (60 m).