EVIDENCE FROM FLUVIAL DEPOSITS FOR CHANGES IN WATER SURFACE LEVELS OF A SEA OR LARGE LAKE AT AEOLIS DORSA, MARS.

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Introduction: Sinuous ridges at Aeolis Dorsa have been interpreted by several researchers as inverted sedimentary deposits filling paleochannels [1]. Using imagery and stereo pair DEMs from HiRISE and CTX, we have mapped a downstream reach of the inverted paleochannels known as Aeolis Serpens, which meander asymmetry [2] preserved in the ancient channel deposits indicates a southeasterly paleo-flow direction. In the study area, we have found evidence that several generations of stacked paleochannels were confined within the fills of ancient incised valleys. The study area has two discrete and cross-cutting valley fills, and a similar stratigraphic succession of fluvial deposits is seen within each valley. Similar fluvial stratigraphy can be observed in terrestrial incised valleys as a result of eustatic sea level changes [3]. Taken together, the valley and channel stratigraphy are interpreted to preserve a record of variations in base level of a sea or large lake that includes at least two episodes of fall and rise of greater than 40 meters.

Mapping: In the study area, Aeolis Serpens branches into three corridors which we have interpreted as the remnants of incised and filled valleys on the basis of the following criteria: the corridors are of regional extent, show signs of downcutting and lateral erosion greater than the extent of a single channel, and fluvial sedimentation was confined within the boundaries of the corridors. Textural differences in the visible imagery and thermal inertia differences in TIR imagery between the valley fills and the surrounding terrain were used to map the valley boundaries (Fig. 1). The topographic expression of a valley and walley walls has not been preserved here, so the extent of the valley fill serves as a proxy for valley extent. The paleochannels within each valley were mapped with an emphasis on identifying continuous individual channels.

High resolution DEMs helped to confirm the stacking pattern of paleochannels. Cross cutting relationships were used to establish the relative timing of valley formation and filling.

Stratigraphy: An abundance of amalgamated point bar deposits in the lowermost paleochannels of each valley records evidence for considerable meandering of the oldest channels (Fig. 2). The scooped shape of the corridor boundaries (Fig. 3) indicates that lateral valley cutting was the result of outer bank erosion during meander migration. Preserved scroll bars are absent from the subsequent generations of paleochannels, which instead take on a sinuous ridge morphology (Fig. 2). The sinuosity of these inverted paleochannels is primarily inherited, due to the reoccupation of the underfilled channels left by the previously meandering system. The tendency of younger channels

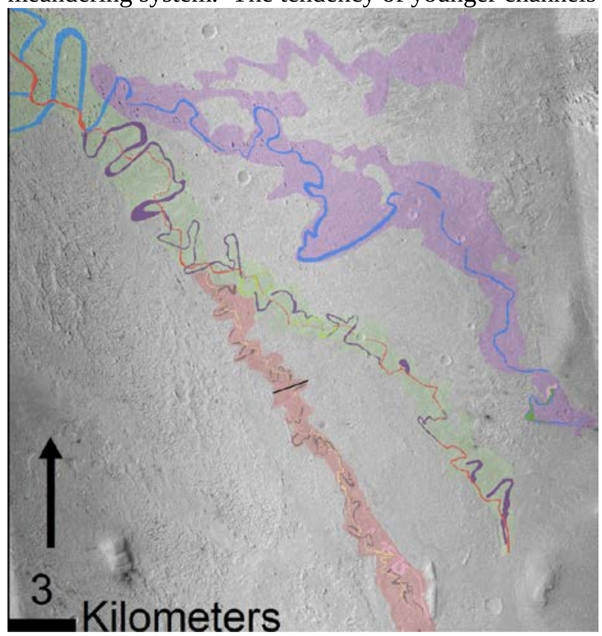

Figure 1 - Study area with incised valleys mapped in red, green, and purple. Features mapped in each valley are topographically inverted paleochannel deposits.

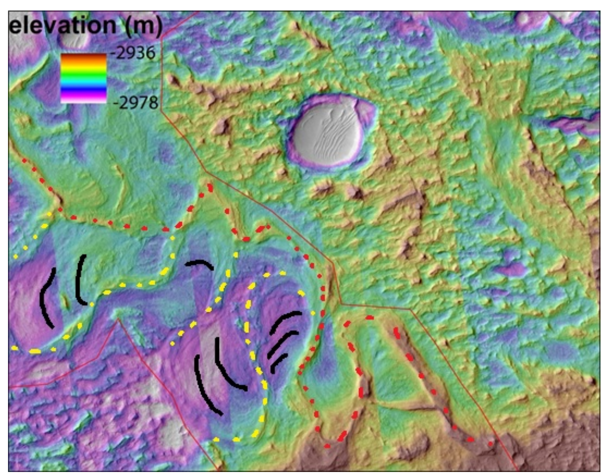

Figure 2 – HiRISE DEM displaying about 40 meters of fluvial stratigraphy. The upper fluvial deposit is mapped with red dots, the middle deposit with yellow dots, and the amalgamated point bars of the basal deposit are mapped in black. Valley boundaries are shown as solid red lines. Notice the channel mapped in red dots seems to have been redirected along the valley wall.

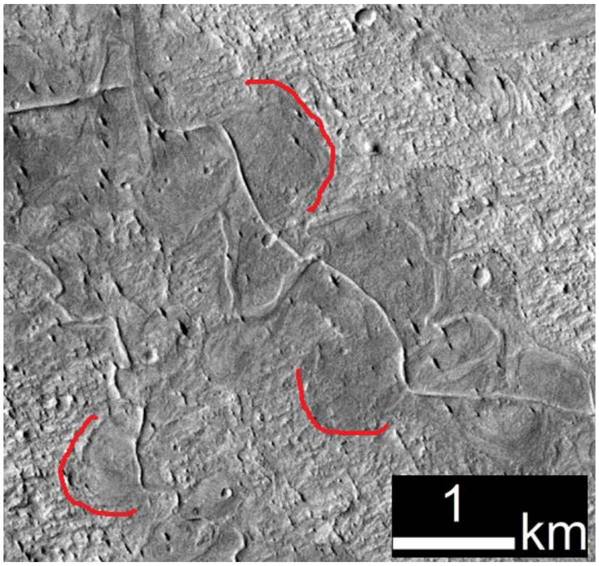

Figure 3 - HiRISE image displaying the scooped shape of the valley boundaries, indicating valley erosion was tied to channel migration. A few examples are mapped in red.

to reoccupy the positions of older channels decreases with each generation of channel, indicating that over time enough sediment accumulated within a valley to remove any topographic expression of the olderchannel forms. As a result, the youngest paleochannels are least sinuous and often occupy the center of each valley (Fig. 1, red channel). However, none of the inverted paleochannels exist beyond the boundaries created by the earliest, erosional meandering channels, supporting the hypothesis that these channels remained confined to a valley incised by either its basal meandering channel or older, unpreserved channels. The inverted paleochannels do occasionally seem to have interact with the valley boundaries (Fig. 2), supporting the hypothesis that the channels were confined.

Estimates for thickness of valley deposits was measured as the difference between the minimum and maximum elevations within the valley at cross-sections with exposures of the basal meandering channel. The thickest deposit measured 40 meters.

Relative Timing: Cross-cutting relationships have been used to identify the relative timing of valley incision and subsequent filling by channelized flows. In Figure 1, the channels confined by the red valley are cut out by the green valley, suggesting that upstream deposits of the red valley have been reworked by activity in the younger green valley. The green and purple valleys are interpreted as coeval branches of the same larger valley; the blue channel mapped in the purple valley is continuous upstream into the green valley. Red channel deposits define the latest stage of sedimentation within the valley complex. These observations can be explained by the following sequence of events:

1. Incision of the red valley, which once extended upstream into the position of the green valley.
2. Fluvial deposition within the red valley.
3. Coeval incision of the green and purple valleys and erosion of the upstream portion of the red valley deposits.
4. Channelized deposition in the green and purple valleys, ending with deposition in the green valley only.

Fluvial Response to Baselevel Changes: Changes in elevation of the water surface for a large standing body of water are used to explain common similar successions of valley-filling fluvial deposits on Earth [3,4]. Valley incision is due to a relative base level drop tied to a low water-surface elevation. These intervals are represented by deposits of net-erosional meandering channels and valley formation at Aeolis Dorsa. Rising baselevel and water-surface elevation drive fluvial sedimentation within the valleys. These intervals are connected with sedimentation by sinuous, but not meandering rivers fully contained within the incised valleys. The cross-cutting nature of the red and green+purple valleys implies two complete episodes of baselevel fall and rise.

At locations where the positive relief of the valley wall is still preserved, a minimum value for base level drop can be estimated as the change in elevation from the top of the highest fluvial deposit to the surface of the basal meandering deposits. We have measured this value to a maximum of 40 meters (Fig. 3). This measurement also functions as a minimum estimate of water level change.

Implications: Aeolis Dorsa sits on the crustal dichotomy and is at least presently, open to the northern lowlands where ancient oceans have been hypothesized to have existed [5]. The observations presented here and by others [6] suggest that Aeolis Dorsa channels were deposited near the shoreline of an ancient body of water, although the aerial extent of this body of water remains unknown. This study provides evidence that these channelized systems underwent multiple episodes of cutting and aggradation driven by base-level changes; changes that were most likely the product of change in the water-surface elevation of an ancient lake or sea.

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