Evidence for base level changes from fluvial deposits at Aeolis Dorsa, Mars

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1. Introduction

-Ridges at Aeolis Dorsa have been interpreted as inverted channel deposits [1,2] of late Hesperian/early Amazonian age [3] that accumulated over 1-20 Myr [4].

-We interpret a small set of these deposits (Fig. 1) as the fills of three distinct incised valleys that were cut by laterally migrating channels and later filled by sinuous channels displaying no evidence of significant lateral migration of river bends.

-On Earth, this style of valley incision and filling is commonly tied to base-level fall and rise connected to change in sea level. Inverted valley filling deposits at Aeolis Dorsa preserve a record of at least two cycles of base level fall and rise with amplitudes exceeding 40 m.

2. Identifying ancient incised valleys

-Stratigraphic criteria for identifying an incised valley [5]

- -Valley fill must have a regional extent (Fig. 1)
- -Valley must be bounded by a basal erosional surface (Fig. 2)
- -Internal deposits must onlap valley walls (Fig. 3)

-Pattern of incision, fill, and exhumation described in Fig. 4

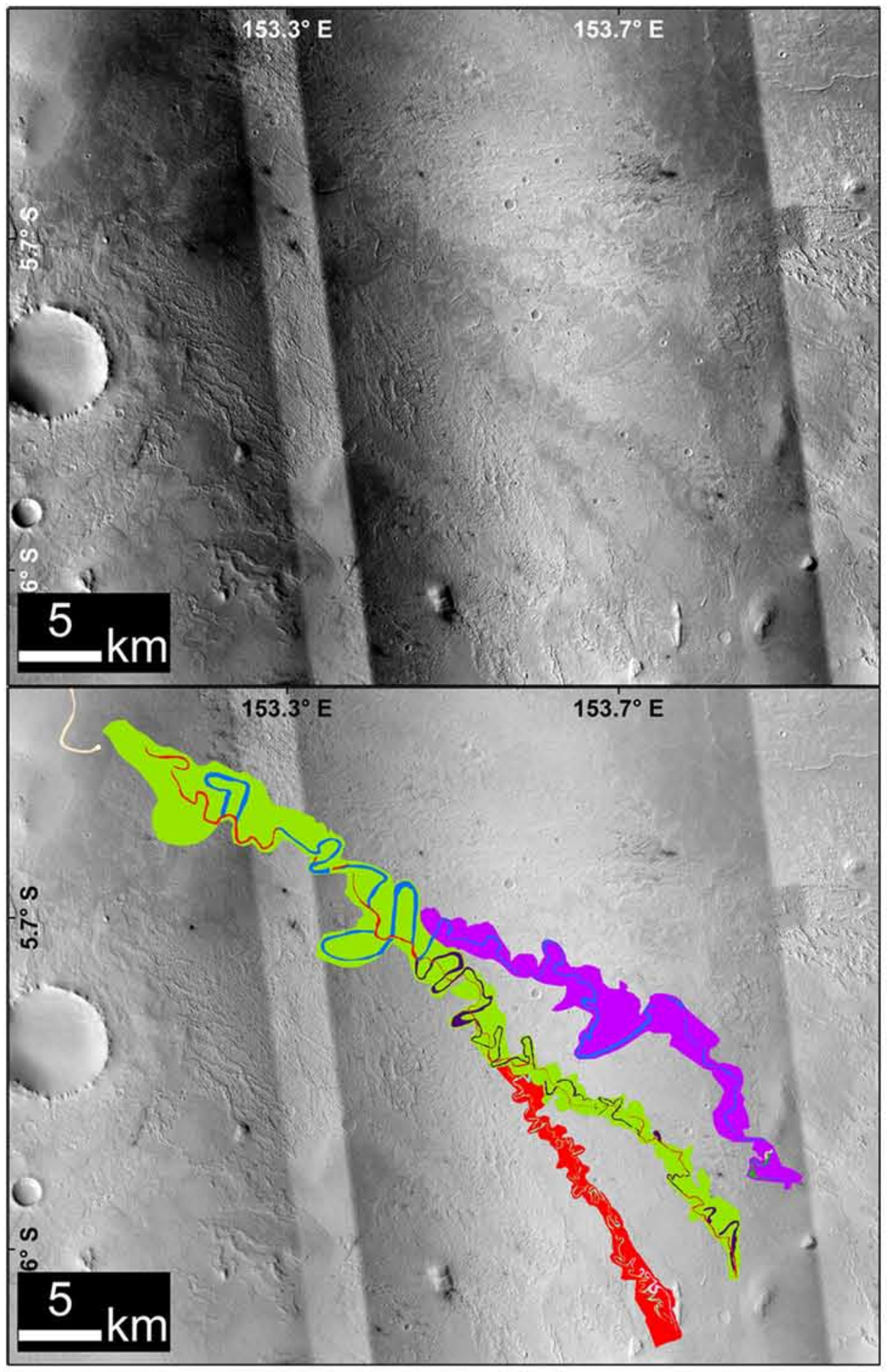

Fig. 1 - Study area at Aeolis Dorsa.
top: regional extent of valleys confirmed using deposit albedo.
bottom: Map of the three valleys and exhumed river channel deposits. Notice that these channelized deposits are confined within the valley walls.

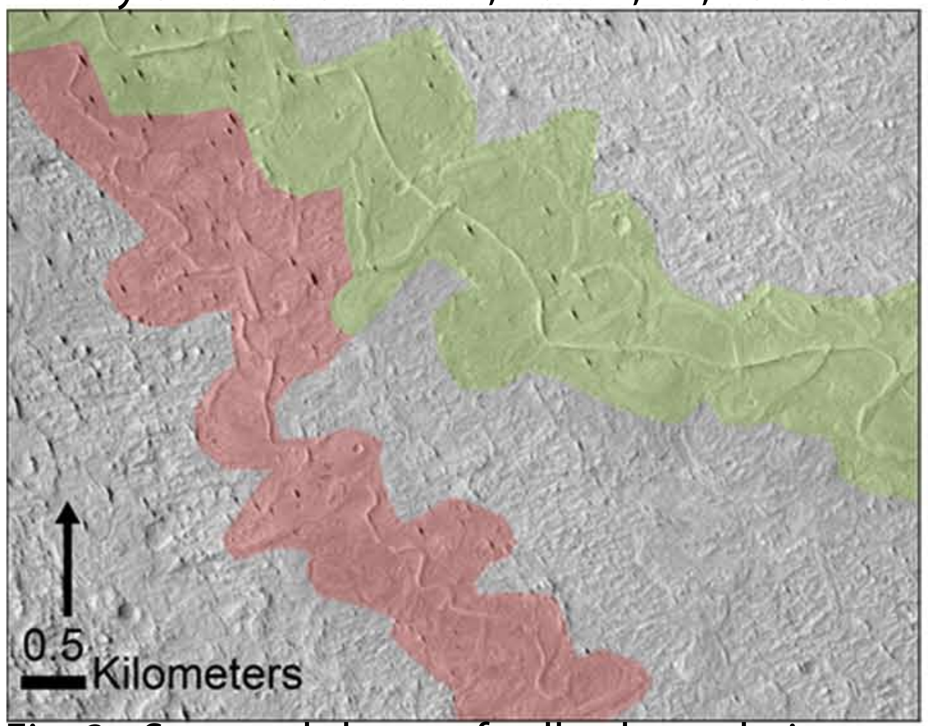

Fig. 2 - Scooped shape of valley boundaries preserve the form of outer banks of erosional, laterally migrating river bends.

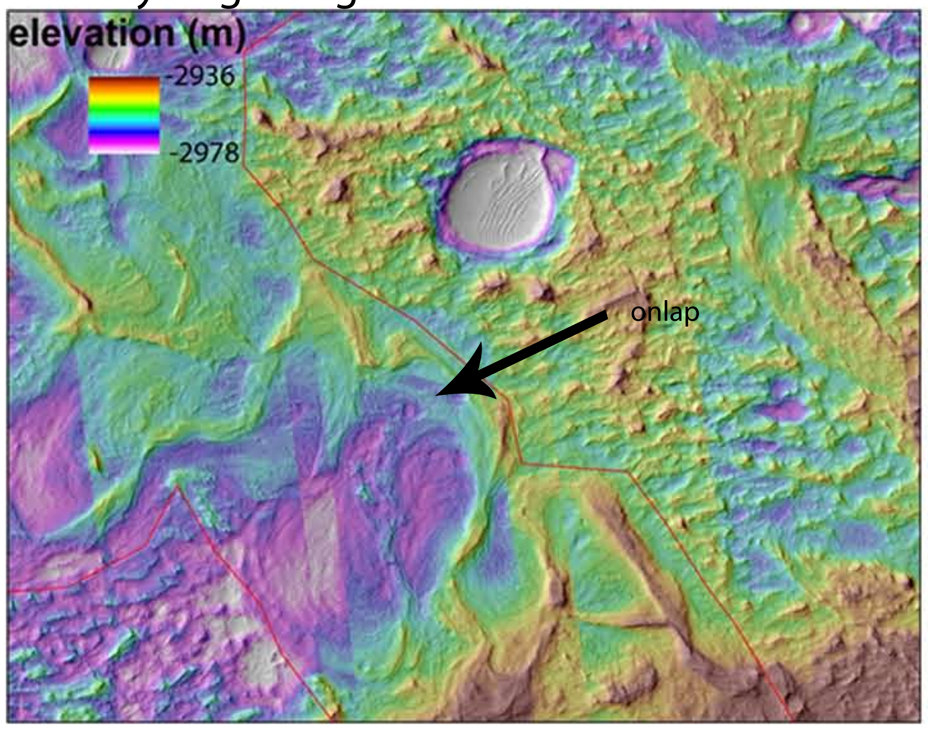

Fig. 3 - Three generations of exhumed channel-filling deposits within a 40-meter succession of strata. The approximate centerline of the youngest channel is mapped in red. The intermediate channel is mapped in blue. Point-bar deposits from the basal meandering channel are mapped in black.

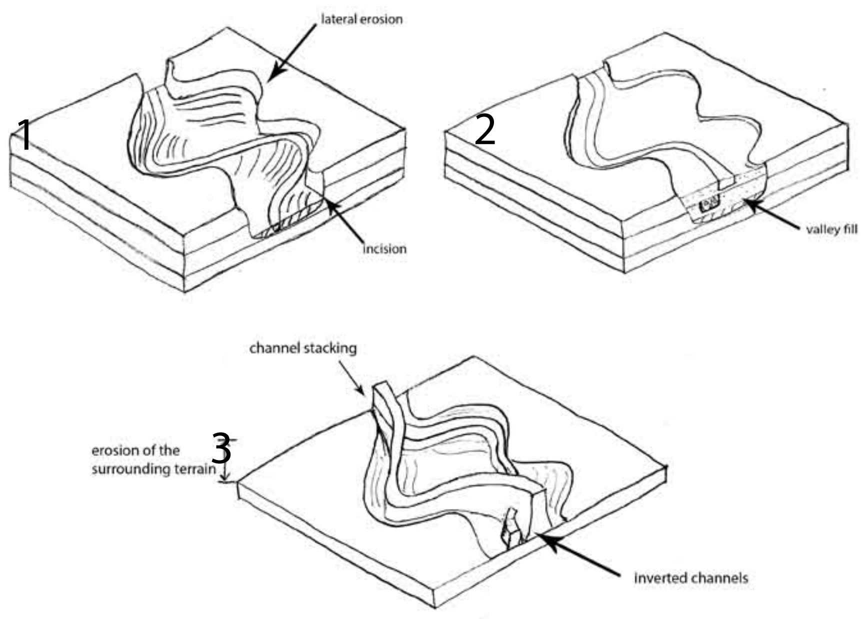

Fig. 4 - A series of block diagrams illustrating (1) valley incision during base level fall, (2) valley filling during base level rise, and (3) deposit exhumation and channel inversion over time.

3. Identifying valley fills

-several generations of channelized deposits within at least 40 m of strata (Fig. 3)

-decreasing occurence of channel reoccupation with the filling of topographic lows over time (e.g., the uppermost red channel in the green valley, Fig. 1, bottom)

4. Multiple episodes of base level change

-Deposits of green valley truncate channelized deposits within the red valley fill (Fig. 5)

-Implication: Red valley was cut and filled before its deposits were truncated by the green valley.

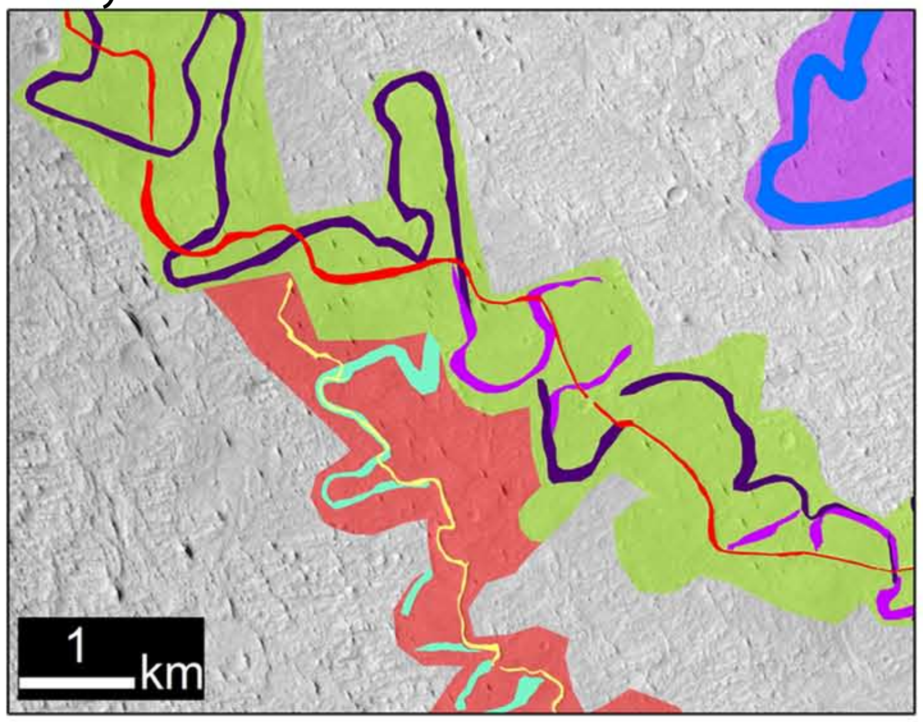

Fig. 5 - Green valley truncating deposits filling the earlier red valley

5. Conclusions

-Sequence of events: 1. Incision of red valley during base level fall. 2. Filling of red valley during base level rise. 3. Incision of green and purple valleys during base level fall. 4. Fill of green and purple valleys during a base level rise. 5. Final episode of filling preserved in the green valley (red channel, Fig. 1, bottom).

-Preserved evidence of base level fall and rise are consistent with changes in surface elevation of water body at Aeolis Dorsa proposed in previous studies [6].

-This body of standing water could have been a large lake or sea.

6. References

[1] Burr D.M. et al. (2009) Icarus 200, 52-76. [2] Lefort A. et al. (2012) JGR 117, E03007. [3] Jacobsen R.E. and Burr D.M. (2013) LPSC 2013 poster #2165. [4] Kite E.S. et al. (2013) Icarus 225, 850-855. [5] Boyd R. et al. (2006) SEPM Special Publication 84, 171-235. [6] DiBiase R.A. et al. (2013) JGR: Planets 118, 1285-1302.