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Origin of martian valleys : some highlights by geomorphic and hydraulic properties.

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The Mars valleys analysis is a crucial point for arguing the presence of liquid water on Early Mars ($\sim$ 3.5 Gy). Many studies indicate a strong analogy between earth and mars networks (dendritic organization, drainage density Strahler ordering).

Here, we study the downstream convergence of flows in rivers suggesting a stability of liquid water in the drainage network. This method lies on the relationship between the increase of width (W) versus the discharge of the river or the upstream drainage area (A) such as W= b$A^{0.5}$ (e.g Leopold and Maddock, 1953; Montgomery and Gran, 2001). On Mars, the extraction of the drainage area is problematic, so we have derived this relationship with the length of the river (L) in order to test a width-length relationship. With this approach, on Earth, by using the Hack relation L=c$A^{0.5-0.6}$, the previous relation becomes W=β L^{α} with α $\sim$1.

On Mars, we have plotted at the outlet of 150 valleys their lengths (between 10-1000 km) and widths (between 0.5-80 km) which indicates a global increase of the width-length ratio but with a very high dispersion of data. This dispersion is mainly correlated with the depth of the valleys and their topographic localization. The valleys are divided into two categories of depth (1) an uniform maximum depth of 250 m (2) varying depths but still above 300 m.

The first categories of valleys show no particular width-length relationship and represent flows that are established on roughly rectilinear slopes. Absence of enlargement with length suggests a process of non convergence of downstream flows. The global maximum depth of 250 m suggests either (1) a global paleo base-level that constrained this depth or (2) a threshold in erodible thickness due to particular erosive processes.

The second categories of valleys are in good agreement with the width-length relationship and represent flows that are established on non-rectilinear slopes with a clear escarpment near the outlet. Their width-length relationship such as W=β L^{α} with α $\sim$0.3 suggest a convergence of downstream flows (but with a lower exponent compared to Earth) combined with regressive erosion due to association of runoff and groundwater processes.

To conclude, we propose that shallow valleys correspond to non-permanent runoff processes while deep valleys correspond to more permanent groundwater processes.