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Small brooks never make great rivers : The Mars example.

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Abstract

The global geometrical properties of Early martian networks (width-depth-length evolution) indicates a non convergence of fluid (water) supply at the outlet of each valley networks. The geometrical (erosional) properties of the valley were controlled at first order by (1) martian global slope and (2) the presence of local escarpment (crater rims, dichotomy..) rather than erosion due to fluid (water) accumulation along the watershed. On Earth the water flux convergence at the outlet of the rivers are associated with widespread rain upon all the watershed, we can considered that on Mars, such a mechanism was minor and we must envisage other multiple, abundant but discrete sources of fluid probably associated with meteoritic bombardments and/or volcanism (permafrost melting).

Analysis of geometrical properties of martian valley networks.

We have analyzed the evolution of the width, the length and the depth of 120 valley networks characteristics of Early Mars i.e. between the most terrestrial dendritic geometries to the long isolated valleys (Fig 1 and 2).

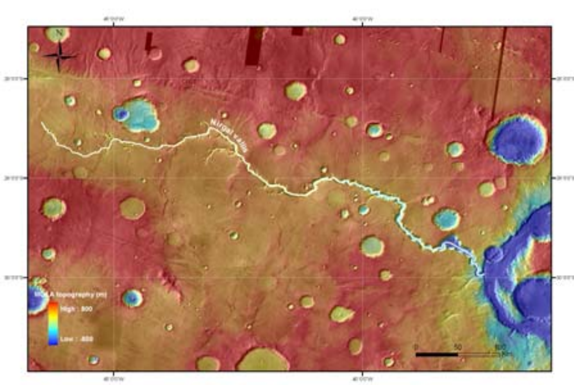

Fig 1 : Example of isolated valley with roughly linear geometry

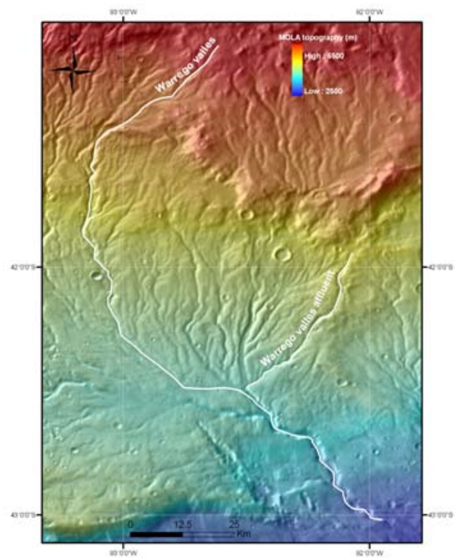

Fig. 2: Example of a valley network with dendritic geometry..

Whatever the en-plan geometry of the valley network, (dendritic to linear), the width of the main valley inside each system is not correlated with the length of the valley i.e. with the size of the watersheds and so with the volume of fluid (water) collected upon this area (Fig. 3).

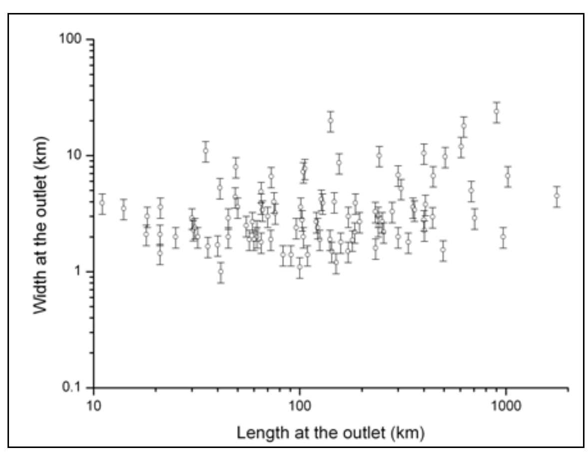

Fig. 3 : Evolution of the width of 120 valleys as function of the length of the outlet.

Par cons, there is a better correlation with the depth of the valleys, the valleys are becoming larger with increasing depth. (Fig. 4).

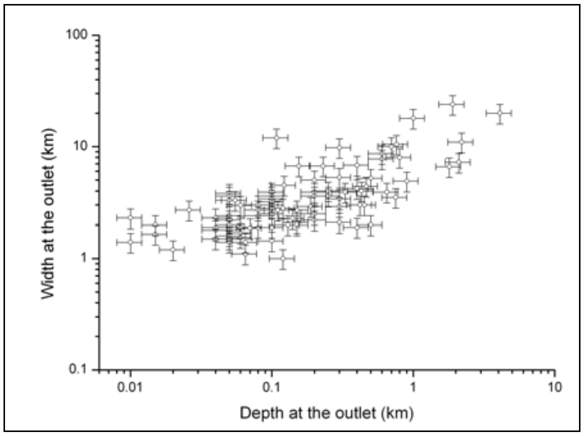

Fig. 4 : Evolution of the width of 120 valleys as a function of the depth at their outlet.

2. Conclusion

Our observations indicate that the size of the watersheds and therefore the passing flow of liquid through the outlet was not the dominant factor controlling the morphology of the networks. The existence of an escarpment along the valley and/or at its outlet i.e. a strong local slope variation, inevitably conducts to an important widening of the valley.

Thus, we can resume that the incision mechanism was rather controlled by the slope than the watershed area.

We therefore conclude that, unlike Earth, the Early Mars valley networks have never known a confluence of the fluid flow at their outlet and therefore have never known a synchronous activation of the entire watershed as a result of widespread precipitation.

All valley networks behaves as if they were activated only with a repetition of intense discrete sources of liquid supply (intense volcanism and meteorite bombardment).

The activity of the valley follows the progressive decreasing of those source of activation. Only some volcanic and/or meteoritic events can newly reactive a sufficient production of liquid at the Mars surface to create new watersheds.

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