SITES OF RESIDUAL AQUIFERS ON MARS THROUGH CHANNEL ANALYSIS.

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Through topological analysis of martian channel organization, it is deduced that the most probable origin of the networks is linked to the discharge of subsurface aquifers [1]. Seismicity was envisaged as one of the main cause of the water-table upset. Scarcity of channel distribution density could correspond to episodic marsquakes related to random meteorite falls, volcanic activity and/or crustal thermo-elasticity during the cooling period [2].

This mechanism implies the presence of a martian aquifer during the pre-Noachian period, the paroxismic episod of flow being estimated at 3.5 billion years ago during the Noachian/Hesperian transition and decreasing fastly then[2],[3],[4].

Aquifer formation and discharge. The aquifer formation can be related to 2 major origins :
1- Water on Mars came from the planetary accretion (water and iced bodies).
2- Water on Mars came both by accretion, vapor condensation and rainfall during the planet cooling. Surface runoffs partly evaporated and infiltrated. Their traces were obliterated by the meteoroid impact flux. This is deduced from the present visible physiography of networks which does not correspond to meteorological feeded basins.

The analysis of network physiography indicates that they originated by rupture of the water-table equilibrium and by regression of the springs from down to upstream. Martian networks are demonstrated to be binary systems of channels [2],[5],[6]. The drainage led to the organization by regression of divergences (bifurcations) opposite to the model of joined tributary systems. Order 1 channels at their upstream part are aligned in arches displaying amphitheatre distributions which correspond to an equipotential repartition [2],[5],[7]. The regressive erosion is effective as long as the water-table new stability equilibrium is not reached, which means that the complete discharge of the aquifer is not necessary to stop the flow emergence because the erosion may reach the potential crest.

Implications for future missions. This last observation is of particular interest for future missions towards Mars. If the aquifer did not completely discharge during the flow episode, the present upstream parts of network channels could indicate the localisation of potential zones of residual aquifers. Channel upstream depth indicates the level of the last emergence point and therefore gives an estimation of the past water-table upper level, considering the evaporation rate, and the evolution of temperatures through time and latitudes. Therefore, these sites appear as the most probable zone of present water location.

These water reservoirs should be iced in the upper part of the regolith and liquid at depth, depending of the evolution of thermal gradient and lithostatic pressure.

In addition, channel flows led to temporary ponds in low zones such as depressions, impact craters (essentially localized on the Cratered Uplands), or wide alluvial plains (Chryse Planitia flow deposits). On these zones, potential aquifers could have been constituted by infiltration of pond water.
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under hydrostatic pressure, with the lowest part preserved of evaporation. For the future exploration of Mars by automatic vehicles, these sites appear of high scientific interest. Channel walls provide unique natural transects into the upper part of the martian regolith over hundred or thousand meters [8]. Their upstream parts could be of help to determine the present level of residual water-reservoir on Mars, and the outlets will give information about sedimentary deposit rates, number of flows episodes, transported material, and therefore capacity of transport of martian channels under different gravity and atmospheric conditions. They are relevant sites for biology and life investigations [9].

Legende : Distribution of network upstreams (density for 360000 Km² : quadrangle of 10' x 10')

□ 1 to 5; □□ 6 to 10; □□□ 11 to 20; □□□□ 21 to 30; □□□□□ 31 to 40;
□□□□□□ 41 to 80; □□□□□□□ above 80

References: