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SEARCHING FOR PAST MARS CLIMATIC CONDITIONS VALIDATING SURFACE RUNOFF PALEORIVERBEDS INCISION IN THE CONTEXT OF THE EXOMARS MISSION

Abstract

The investigation of surficial aqueous processes and water bodies on early Mars is a major focus of Mars studies, because environmental conditions suitable for liquid water may have supported life or prebiotic chemistry on Mars (Ori et al., 2000). Much of the geologic record from the first billion years of Earth's history has been lost to erosion, metamorphism and subduction; on the contrary on Mars the ancient terrains recording the first billion years of history are detected on the southern highland plateau (Milton, 1973; Schultz et al., 1973; Pieri, 1976, 1980; Carr et al., 1981) where valley networks and paleolakes are found (Pieri, 1980; Parker et al., 1993; Carr, 1995). The most contentious issue regarding riverbed networks is their water source: during and after the Viking missions the hypothesis that was accepted is that groundwater sapping would have carved alone the observed valley networks (Carr, 1995). New high-resolution datasets revealed that densely branched valley netwoks carved by surface runoff favors formation by atmospheric precipitation (Masson et al., 2004, Mangold et al., 2004, Ansan et al., 2008), this modifying the above-mentioned hypothesis.

To infer considerations on the past Mars climatic conditions we created a detailed database consisting of several hundreds riverbeds, present in the Martian equatorial hemispheric dichotomy. Through MOLA Digital Elevation Model and HRSC high-resolution imagery, and thanks to the merging of literature and newly developed GIS techniques, we derived many hydrological parameters deeply related to past atmospheric conditions of Mars as the drainage density of the riverbed networks, derived by the ratio between the riverbed length and the drainage area, the Strahler order for each drainage network and its frequency, deriving the bifurcation ratio through Horton (1945) law of stream numbers. We also measured the mean length for each Strahler order deriving the stream length ratio (Horton 1945) and the Shreve magnitude. We focused on the measurement of the slope distribution for each drainage area and riverbed network.

Our riverbeds analysis is strongly interconneted with the search for Mars past life-sustaining conditions the ESA ExoMars will be looking for. It will provide new hints: on the surface runoff; on past long-lasting precipitation process needed to generate the water flows that carved the Martian crust; on the deltaic elevation distribution showing the possible presence of an ancient ocean coastline in front of the escarpment that separates the southern heavily cratered highlands from the northern smooth plains of Mars.