Geophysical Research Abstracts
Vol. 16, EGU2014-11380-1, 2014
EGU General Assembly 2014

Hydraulic modeling of an interior channel identified inside a Martian Valley

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Constraining the amount of water flowing on the surface of Mars during the ancient hydrological activity of the planet is one of the fundamental and crucial aspects to understand its paleohydrology. Within this work, a detailed hydraulic study of an interior channel is presented. The river reach is located in the Memnonia quadrangle between 166°0'0"w and 168°0'0"w longitude and between 8°0'0"s and 9°0'0"s latitude. The Mars Express high-resolution stereo camera digital elevation model, HRSC DEM, H31850000DA4, presents a spatial resolution of 75 m and it was used to characterize the geometry of the interior channel. Geomorphic evidences (i.e. flood terraces) were used to identify the probable bank-full level. In particular, we found out that the channel appears to be characterized by two different terracing levels. The river reach segment is 10 km long and averagely 1 km wide. The paleoriver bed presents a complex topography, characterized by significant changes in slope. We used a hydraulic model capable to perform one-dimensional water surface profile calculations for steady gradually varied flow in natural channels. At each cross section we computed the water level by solving the energy equation or, where this was not considered applicable, by using the momentum equation. The identified terracing levels were used to constrain the water discharge flowing on the surface and the roughness coefficient of the surface (the latter, as well as the energy and momentum equations, being adapted to the Martian gravity). By applying a Monte Carlo procedure, the relative frequency of the most probable discharge and roughness coefficient for both bankfull levels was derived. Hints on the grain size distribution are also presented. Regarding the lower bankfull levels, we obtained a median value of stream discharge and Manning roughness coefficient equal to 17400 $m^3 s^{-1}$ and 0.08 $m^{-1/3} s$. When considering the upper terracing levels our methodology indicated a median value of 140000 $m^3 s^{-1}$ and 0.16 $m^{-1/3} s$, for the discharge and the roughness coefficient, respectively.