PALEODISCHARGE ESTIMATION FROM MORPHOMETRY FOR ANCIENT CHANNELS.

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Introduction: The mass/volume of water was present at or near to the surface of Mars during the planetary evolution is an important question. The runoff valleys are thought to have formed by sapping [1,2,3], the outflow channels by water or cryoclast flows [4,5,6]. The exact style of the flows, the sediment load, the discharge and many other factors are not fully understood [7,8,9]. In this work we outline a possible easy morphology based paleodischarge estimation method for martian channel, which is not able to give exact values, only row estimations, but could be easily used because of its simplicity in many cases as a secondary method together with other ones.

Bases of the method: It is known based on examlpes from the Earth that with the meandering rivers the dimensions of the meanders are determined by the maximal descharge [10]. The method could be used for ancient riverbeds in the paleodischarge estimation. Because on Mars we have only ancient channels (beside the newly discovered small gullies at certain slopes) the method could be useful in the paleodischarge estimation. We had showed in a previous work that there are connections between the dimensions of the meanders (amplitude, radius, wavelength) and the channel width (the later probably proportional to the paleodischarge) (Fig. 1.). We analysed meanders of 120 channels for amplitude, wavelength and radius determination.This suggest that there is similar discharge/morphometric relation on Mars like on Earth. The currelations for all channels are: R=0.954 (amplitude/width), T=0.736 (radius/width), R=0.935 (half wavelength/width); for only runoff channels are 0.875, 0.672, 0.648 respectively. In the following we would like to connect absolute discharge parameters to the morphometric data. We measured the horizontal dimensions based on images of the Viking orbiters [12], channel cross section and slope measurement by MOLA results.

Uncertanties and errors: During the process of the measurement the following factors caused uncertanties and errors: 1. The resolution of the MOLA data was high enough but we used only some representative values for certain channels not integration and average from “all values”. 2. We modelled the shape of the channels’ cross sections with triangles or trapezoids instead of the real cross section. 3. The hydraulic behaviour of the water flows under the surface gravity of Mars differs from that we know on the Earth where the Manning equarion is used for deisharghe estimation. 4. The solid matter content is unknown too which can cause differences in the viscosity and flow velocity. 5. The greatest errors coulr arise from the unknown water depth and later sedimentary infill. This could be greatest at the case of the oldest runoff channels because their channel width are probably equal to the width of the valley.

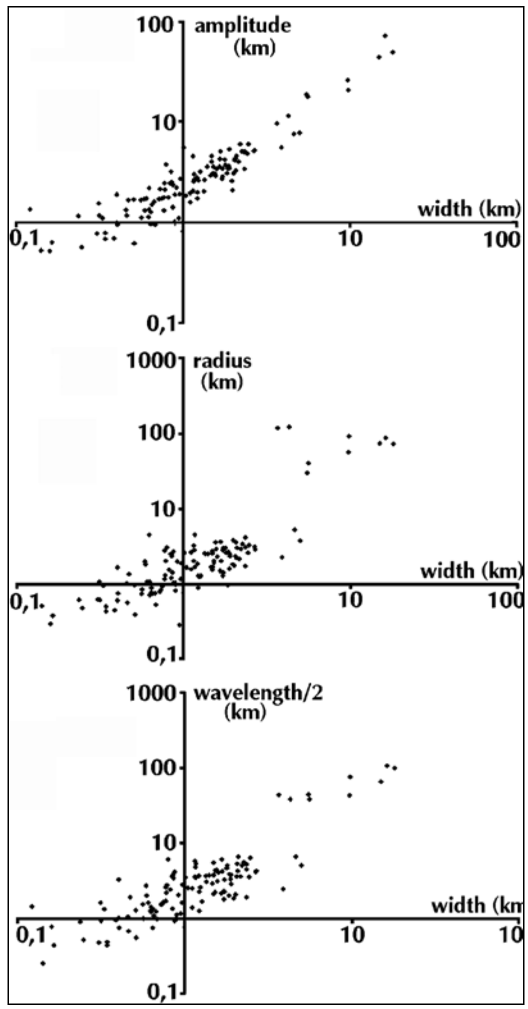

Fig. 1.
Meander/channel width correlations

Meandering and the origin of channels: Several styles of formation was supposed for the runoff and outflow channels. Mo matter what was the original solid matter content of the flows (“clean” water, high mud concentration, submarine turbidity flows, CO_2 driven cryosclastis flows etc. the hidraulic behaviour can result such morphology which is in connection with the discharge of the fluid (or fluid like matter). It is known from the Earth that meandering can be observed at not only rivers but turbidity flows or atmospheric currents.

Results*:* We have estimated the paleodischarge values based on the Manning equation modified to accound Mars lower gravity [13] with n=0.075 for runoff and outflow channels. Fretted channels were excluded except that cases where originally the channel was formed by meandering fluvial erosion obviously based on the sinous appearance. Some ourflow channels was excluded too beacuse their unusual slope direction does not coincide with the supposed flow direction based on morphology [14]. The correlation between the discharge values and the meanders’ parameters is lower than that ones between the channel width and the meanders’ parameters. The discharge values computed from Manning equation versus the meanders’ radius are visible in Fig. 2. (*A*: for all analysed channels, *B*: only runoff channels, *C*: circum-Chryse and circum-Hellas are emphasized, *D*: correlation for runoff and outflow channels without circum-Hellas ones) The weaker correlation can be caused by the uncertanties of the depth of water had flowed in the channel. There are special cases for the channels around Hellas. Their discharge values are too lagre comparing to the sizes of meanders which could be the result of differences in the sedimentation on the bottoms’ of the channels and/or in the hydraulic behaviour of the fluid.

Conclusions: 1. The strong correlation between the width and meandering parameters suggest correlation between the paleodischarge and morphometry. 2. The correlation between the estimated paleodischarge (based on Manning equation) and meandering parameters is weaker possibly because of the uncertanty in the estimation of the original water depth. The correlation excluding the circum Hellas channels is R=0.933 and including circum Hellas channels is R=0.487. This suggest great differences between the circum Hellas and circum Chryse channels in the hydraulics and/or in the sedimentation. For the runoff channels the estimated discharges are highly variable at the same meandering parameters. The meandering method can be usefutl in the cases when no topographic data is available. In the case of buried outflow channels was discovered around Chryse Planitia based on their

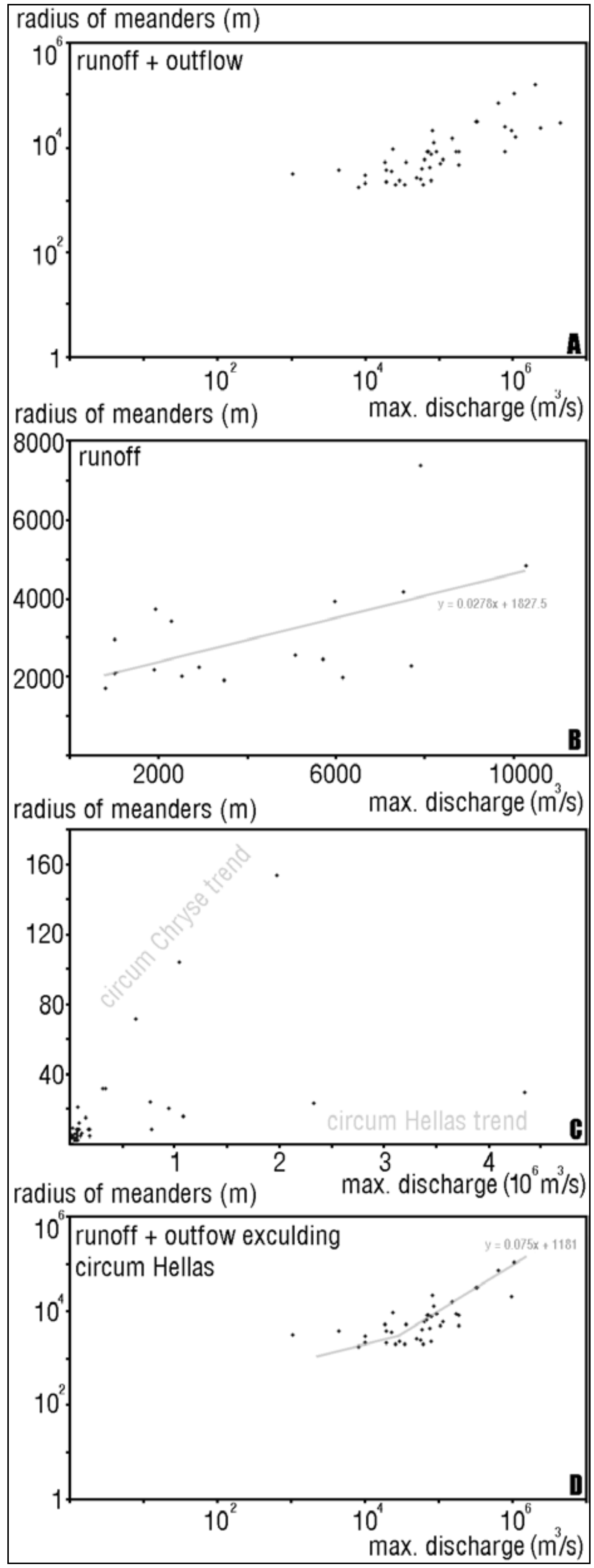

Fig. 2. Meander/paleodischarge correlation

gravity anomaly. No obvious meanders are visible but done detailed future data may reveal meander like phenomena and would be able to estimate paleodischarge fot buried channels too. The method can be used for the discharge changes at the same channel, see Fig. 3. for an example (top: morphology, different meander generations marked with numbers, bottom: morphometric connection).

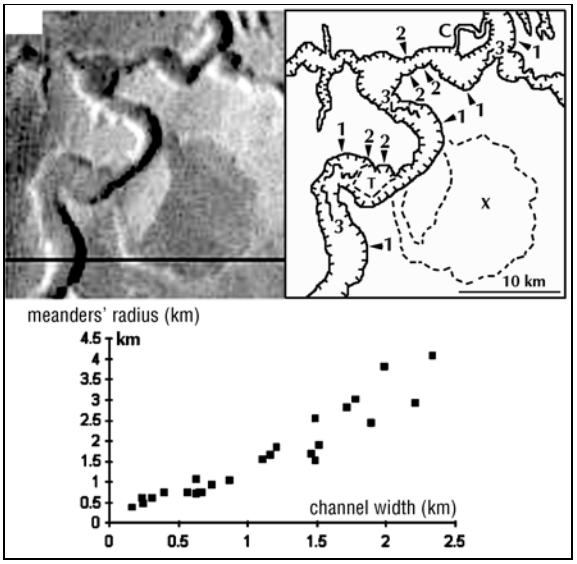

Fig. 3. Meander generations

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