ANALYSIS OF DRAINAGE NETWORKS IN THE TRANSITION ARABIA TERRA/NOACHIS TERRA: IMPLICATIONS FOR THE HYDROLOGIC EVOLUTION OF MARS

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Abstract

The main objective of this study is the hydrological characterization of an area located in the transition between Arabia Terra and Noachis Terra, approximately centered at 22.5º S and 7.5º E. Mapping the hydrogeological features will allow to uncover the presence of large water masses and a potential coastline regression at southern latitudes on early Mars.

1. Introduction

Since the formation of the planet, early Mars environmental conditions were very different from the present [1]. The planet was characterized by an active hydrosphere with significant implications for both climate and life [2, 3].

For this reason, unveiling the geomorphological record of aqueous processes on Mars is paramount, and following the evolution of fluvial landforms provides the key evidence for climate change on a planetary scale.

In order to understand the hydrological evolution of Mars, our study is focused in the southern equatorial regions, in the transition between Arabia Terra and Noachis Terra and centered at approximately 22,5 S and 7,5 E, where we describe landforms related with the past presence of liquid water. We use orbital imagery to observe and model valley network systems and the remains of other indicators of aqueous erosion and deposition processes on Mars.

These evidences of fluvial activity include incisions on the surface that we interpret as valley networks, and impact craters with sediments that we think are paleolakes. All these features suggest that large bodies of water may have covered the surface of early Mars [4, 5], corroborating the existence of past aqueous activity on the region and making this study area on Mars an attractive place in terms of habitability.

2. Methods.

The drainage network map and stream ordering, shown in Fig.1, were calculated using the ArcMap Spatial Analyst 'ArcHydro' tools and the digital terrain model (DTM) from Mars Orbiter Laser Altimeter (MOLA; ~ 460 m/pixel, [6]) to determine the watershed area.

In support of our analyses, we used available Context Camera (CTX; ~ 6 m/pixel, [7]) High Resolution Imaging Science Experiment (HiRISE; ~ 25 cm/pixel [8]) images and High Resolution Stereo Camera (HRSC up to 10 m/pixel [9]) topographic data.

After defining the candidate basin at the site of interest, we mapped and described features that are consistent with aqueous activity using the ArcMap Software.

3. Preliminary results

The drainage network and stream ordering obtained by ArcMap reveal a significant aqueous activity in the study area during early Mars. That network indicates the best places to search morphologies related with past presence of liquid water.

The overlap between landforms formed through vastly different processes and times often requires a subjective interpretation. Likely some of the best morphologies to identify this type of features would be incisions or valley-like features for channels, and smooth and filled circular impacts for paleobasins where materials were deposited.

Topographic profiles of impact craters reveal flat floors, coherent with the impact processes melting the surface rock [10]. The craters form natural dams and help water accumulation inside the rim. This, coupled with that many times these type of morphologies are associated with hydrated mineral deposits such as phyllosilicates, and also with other aqueous morphologies like paleochannels, means they were filled with possible lake sediments and for that reason we interpret it as paleolakes.

All these features suggest that large bodies of water may have covered the surface of early Mars [4, 5], corroborating the existence of past aqueous activity on the region and making this study area on Mars an attractive place in terms of habitability.

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5. References

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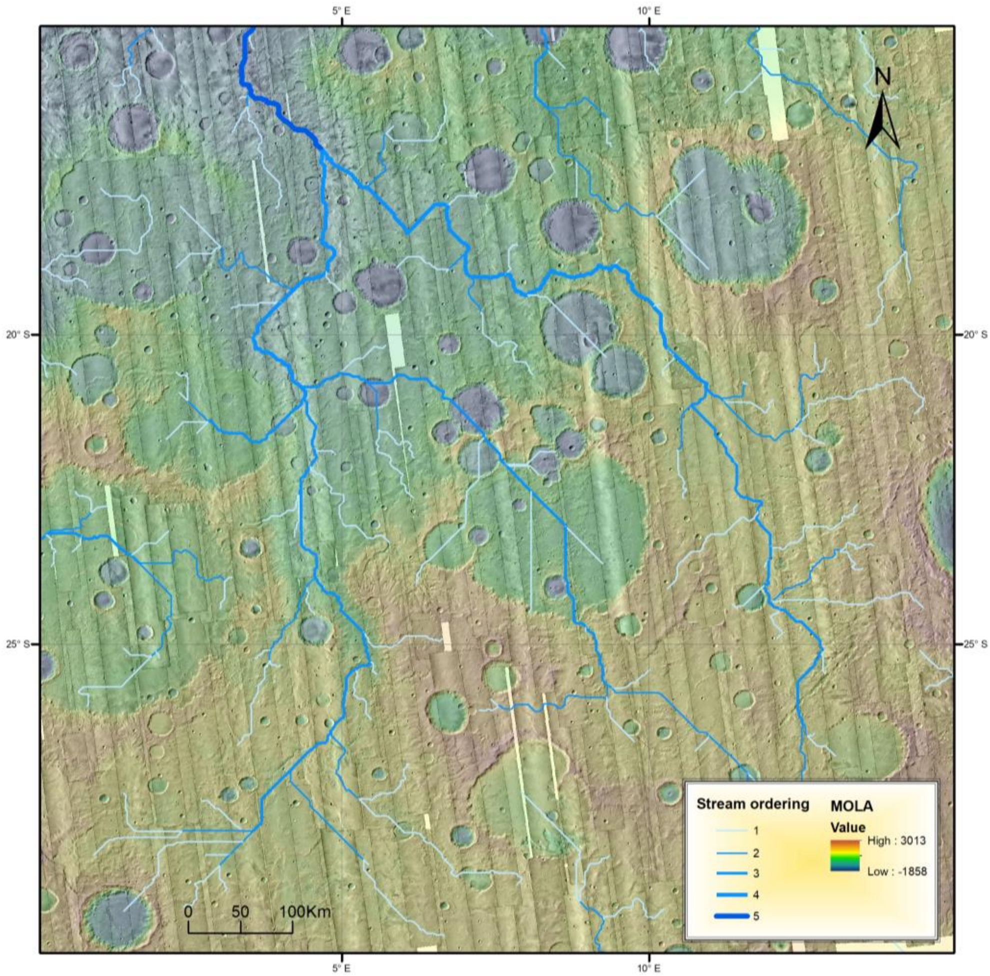

Figure 1. *Drainage network (obtained using ‘ArcHydro’ tools from ArcMap) over the CTX mosaic, superposed on a MOLA topographic map. The streams have been classified following the order of importance defined in* [11].