Morphometric analysis of Alaldari valley western Deccan traps: Implications for the Martian analogue studies.

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Introduction

The geological history of an area, including information of the structures and surficial conditions, can be deciphered from the study of drainage patterns [1]. In the present study, basic morphometric analysis for the Terrestrial basin and the Martian basin has been performed to understand the terrain modulation and probable causes of the differential geomorphic features. The valley observed on the Deccan plateau has similarities with the valleys carved within the Echus plateau (Fig. 1) on the Martian surface. The rock types are similar at both places, i.e., basalt [2].

Data and Methodology

The Survey of India (SOI) toposheets are used to delineate drainages, contour maps, and other linear features in the analog valleys. Further, the drainages are drawn on high-resolution satellite images by using the flow continuity model on the ArcGIS (10.4.1) platform. To understand 3D aspects of valleys and streams, SRTM worldwide elevation data (3 arc-seconds resolution) were utilized for the terrestrial geomorphic features. The Martian Valley data used for carrying out detailed studies consists of Context Camera (CTX) images having ~6 m/pixel resolution and width ~30 km [3], in the form of pyramidized TIFF files. Thorough studies of the morphology and geometry of valleys and detailed mapping of the geomorphic features have been performed using images available on the Mars Image Explorer website of the Arizona State University (http://viewer.mars.asu.edu/ viewer/ctx#T=0). These TIFF files were used to create a mosaic of study areas to map the geomorphic features on the GIS platform (ArcGIS (10.4.1)). The MOLA-HRSC DEM/DTM data used in making the elevation profile of significant valleys and cross-section profiles are extracted by using ArcGIS (10.4.1). Further, the morphometric analysis was performed on the GIS platform.

Results and discussion

The basic morphometric parameters are calculated based on the dataset discussed above, for the terrestrial and Martian valleys. These parameters include qualitative analysis such as stream ordering (Strahler method for ordering drainages), bifurcation ratios, drainage densities, total stream length for main streams, river sinuosity, basin asymmetry factor, valley floor width to height ratios, rose diagram for the first, second and third-order stream. The analysis was done based on the ratios and magnitude-dependent parameters calculated for both the valleys on Earth and Mars to understand the detailed morphological characterization of an area. The ground-truthing of the geomorphic features was done by extensive fieldwork in the analogue valley. On a broader scale, both the basins have experienced tectonism and catastrophic flooding through time. This leads us to believe that variation in climate, subsequent volcanic activity, and tectonics, which have played a significant role in shaping the present-day scenarios on Earth, can aid in assessing Martian geomorphology.

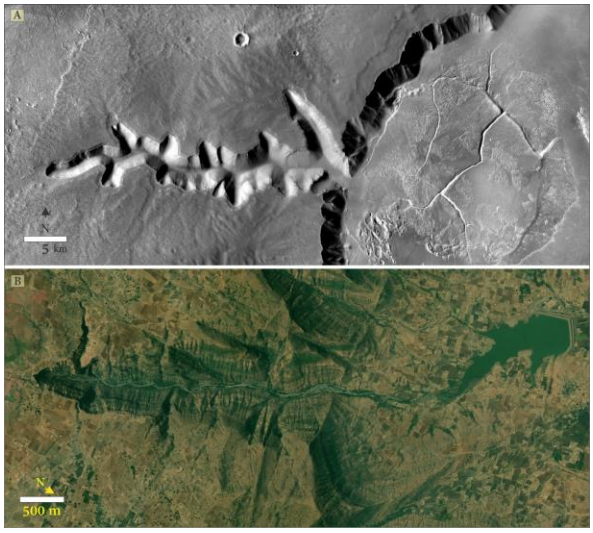

Figure.1 High-resolution images of basin A) CTX image mosaic derived from the context camera images Echus plateau valley 2) B) Satellite image of Alaldari valley analogue basin Deccan trap.

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