EPSC Abstracts
Vol. 10, EPSC2015-296, 2015
European Planetary Science Congress 2015

Fluvial channels in the north-western part of Noachis Terra, Mars: Implications for tectonic controls

K. De (1), N. Dasgupta (2), A. Kundu (1) and P. Chauhan (3)
(1) Asutosh College, Kolkata, India (2) Presidency University, Kolkata, India, (3) Space Application Centre (ISRO), Ahmedabad, India (de.keyur@gmail.com)

Abstract

Palaeochannels in the western part of Noachis Terra are mapped to understand their origin and also the control on their courses. Relation to impact craters, trends and cross-correlations between their paths indicates to impact-related origin and tectonic lineament controlled courses for the rivers.

1. Introduction

Fluvial channels are reported from Martian surface long ago, yet their origin and evolution are still not very clear [1]. In general the source of Martian valley networks are ascribed to groundwater sapping process, though hypotheses suggesting subsurface ice melting and rainwater are also proposed [1]. Presently available high resolution images like MOC, HiRISE, HRSC, CTX help to identify many paleochannels with complex drainage history. Terrestrial analogs of these channels help scientists to understand the origin of Martian valley networks and the processes responsible for their evolution. Martian streams indicate considerable degree of surface incision though it is lesser than that on Earth. Martian low-order river valleys often have relatively flat longitudinal profile when compared to terrestrial valleys [1]. There are evidences that the erosive action of these fluvial channels were promoted by rainfall. Our study aim to find the source of river water and the control over their courses in the north-western part of Noachis Terra, a region that is still geologically less explained compared to the other regions of the red planet [2, 3, 4].

2. Channel configuration and correlation

In the north-western part of Noachis Terra, within an area [29˚W, 26˚S to 19˚W, 32˚S] (Figure 1) of 164500sqkm, palaeochannels display a specific pattern or orientation. A detailed study of the topographic features and the channels reveal that the channel courses were possibly controlled by tectonic lineaments. The area displays sinuous river channels with prominent trend of N-S to NNE-SSW. In the area of study, there are a series of grabens with consistent E-W trend [5]. All N-S trending fluvial channels terminate at these grabens almost at right angles (Figure 1). Consistent orientation of these channels for considerably (30-50km) long stretches invites to think over the control on such a straight

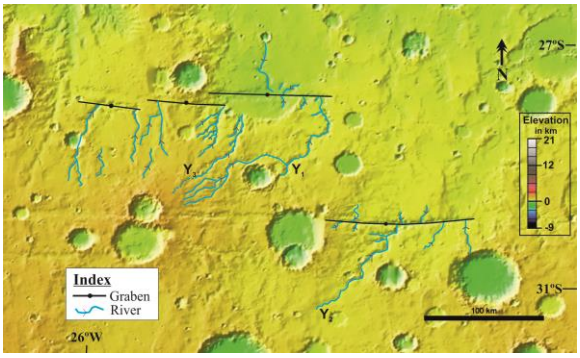

Figure 1: MOLA [6] colourised elevation map of the area of study in the north-western part of Noachis Terra. Note that the rivers emerge from impact crater rim or periphery of impact crater ejecta blanket.

course. MOLA [6] based profiles along different E-W sections across the palaeochannels show that the levels of exposed ground on eastern and western banks are almost at same altitude. Therefore, the linear depressions which were followed by these channels possibly are extensional fractures, without any relative vertical displacement across them, rather than normal faults leading to crustal extension. Moreover most of the N-S trending channels emerge from the impact-crater rims or from the periphery of ejecta blankets (Figure 1). This fact leads to a proposition that the source of water that created the channels was sub-surface ice that melted due to the

impacts of bolides. Segments of the N-S palaeochannels and also the tributaries follow E-W trend at parts, possibly controlled by the set of fractures similar in trend to that of grabens. Therefore, altogether the N-S trending palaeochannels and E-W trending tributary channels reflect a rectangular drainage pattern commonly found in regions with perpendicular joint set [7]. A statistical analysis on the palaeochannels has been done to examine the structural control behind the river courses. Correlated paths of three rivers (Y_1=120km, Y_2=90km, Y_3=140km, Figure 1), show high cross-correlation coefficients [8] (ranging from 0.5 to 0.98) (Figure 2,3)

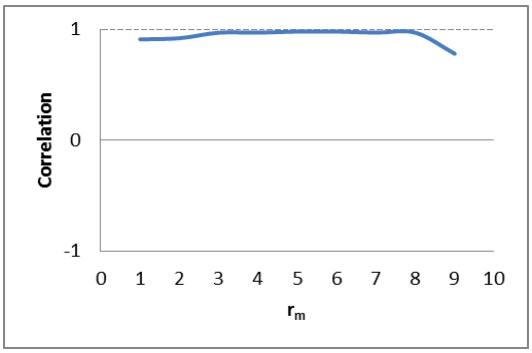

Figure 2: Correlation graph between River Y_1 and Y_2 of Figure 1.

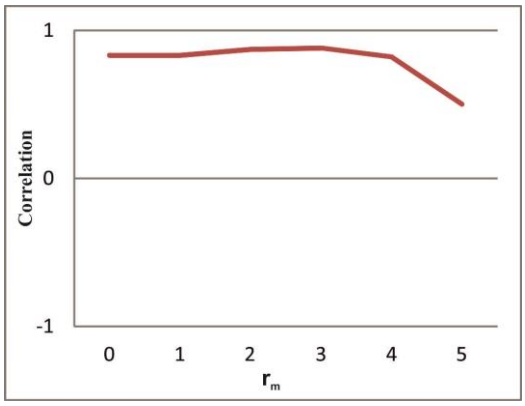

Figure 3: Correlation graph between River Y_1 and Y_3 of Figure 1.

implying a striking similarity between the river courses, few tens of kilometers apart from each other, within the area. We propose that such systematic similarities in their courses are due to tectonic controls, which here possibly were N-S trending and E-W trending fracture systems. The river channels are guided by these fracture systems that have developed in the area and not merely by the topography of the area.

3. Conclusions

Palaeochannels in the western part of Noachis Terra exhibiting a general N-S trend emerge either from the rims of impact craters or from the margins of ejecta blankets revealing their origin from subsurface ice that melted by the bolide impacts. The N-S trending palaeochannels along with their E-W trending segments and palaeotributaries indicate to a tectonic control on their courses. High values of cross-correlation coefficients indicate similarities between the channel courses which is only possible if the channels followed tectonic lineaments.

Acknowledgement

The authors acknowledge a project grant from the Space Applications Centre (ISRO), Ahmedabad, India.

References

[1] The Geology of Mars: Evidence from Earth-Based Analogs, Edited by M. G. Chapman, Cambridge University Press, 2007.

[2] Aittola, M., Korteniemi, J., Öhman, T., Törmänen, T. and Raitala, J.: Geology of Central Noachis Terra, Mars Proceeding Lunar and Planetary Science Conference, 38, 1654, 2006.

[3] Korteniemi, J., Aittola, M., Öhman, T., Törmänen, T. and Raitala, J.: Water and ice in central Noachis Terra, Mars?, 42nd Vernadsky-Brown Microsymposium on Comparative Planetology , Moscow, Russia, 2005.

[4] Raitala, J., Aittola, M., Korteniemi, J., Öhman, T. and Törmänen, T.: A Pingo Group on Noachis Terra, Mars, 50th Vernadsky-Brown Microsymposium on Comparative Planetology, Moscow, Russia, 2009.

[5] De, K., Kundu, A., Chauhan, P. and Dasgupta, N.: An example of consistent palaeostress regime resulting in morphometric irregularity in the north-western part of Noachis Terra, Mars, (accepted), Current Science.

[6] Smith, D., Neumann, G., Arvidson, R. E., Guinness, E. A. and Slavney, S., Mars Global Surveyor Laser Altimeter Mission Experiment Gridded Data Record. NASA Planetary Data System, MGS-M-MOLA-5-MEGDR-L3-V1.0, 2003.

[7] Monroe, J. and Wicander, R.: The Changing Earth: Exploring Geology and Evolution, 7th Edition, Cengage Learning, 2014.

[8] Davis, J., C.: Statistics and Data Analysis in Geology, 3rd Edition, John Wiley & Sons, 2002.