ESTABLISHING THE CONTROL OF PRE-EXISTING TECTONIC STRUCTURES ON THE CHANNEL COURSES BY ORIENTATION ANALYSES: A CASE STUDY FROM NOACHIS TERRA AND MARGARITIFER TERRA, MARS.

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Introduction: Courses of channels on Mars are often guided by local or regional structures [1-6]. In between the boundary region of Margaritifer Terra and the north-western part of Noachis Terra quite a number of channels are present (Figure 1). These channels have several sharp bends and long straight segments that are frequently observed in the structurally controlled channels. The presence of narrow grabens (fossae) and the Polygonal Impact Craters (PICs) in the area supports such possibility of tectonic control over the channel courses as they stipulate the existence of pre-existing faults or subdued fractures in the region. This invoked us to do further investigations on the courses of the channels of the area in order to understand the control of tectonic structures on the channel courses.

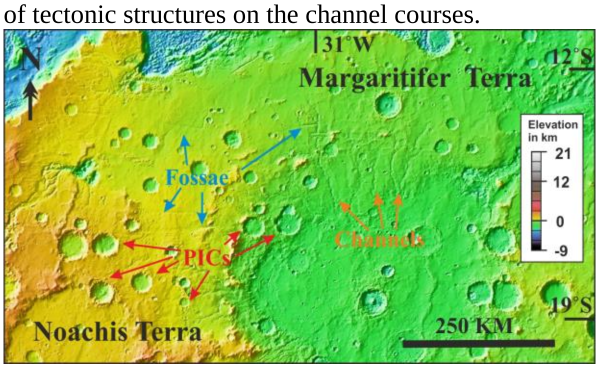

Figure 1. MOLA colorized elevation map of Mars showing the area of study. Some of the channels, fossae roughly, and PICs are shown by orange, blue and red arrows, respectively.

Polygonal Impact Craters and Fossae: In an area with subdued basement fractures or faults, impact craters postdating the fractures or faults often partially or wholly resemble like a polygon. These craters, known as PICs [6-11], serve as good indicators of pre-existing hidden (subdued) fractures in the basement. Orientations of pre-existing target structures, usually found at a depth of ~100 to ~1000 m, can be assessed from the orientations of crater rims as they form parallel to the strikes of the target structures [11]. PICs are more common in the older geologic units of Mars [11]; they are abundant in the study area (Figure 1) covered with rocks of early and middle Noachian highland units [12].

Fossae, a term used for narrow grabens, are linear to curvilinear depressions bounded in both sides by two parallel normal faults, dipping towards each other. In the area of the study, there are several roughly E-W trending fossae present (Figure 1).

These structural planes of weakness were studied in detail to understand the reason behind the shape of such channel courses.

Dataset and Methodology: To assess the role of tectonic structures on the courses of channels, orientation analyses such as frequency rose plots of the straight segments of channels, PIC rims and fossae have been performed. The topography of the region and morphology of the structures were understood using Mars Orbiter Laser Altimeter (MOLA) colorized elevation map (resolution: 463 m/pixel) [13] and MOLA-High-Resolution Stereo Camera (HRSC) blended Digital Elevation Model (resolution: 200 m/pixel) [14]. Primary identification of the channels, fossae, and PICs was done using Thermal Emission Imaging System (THEMIS)-InfraRed (IR) Day Global Mosaic (100 m/pixel) [15, 16]. HRSC (resolution: 12.5 m/pixel) [17, 18] and Context Camera (CTX) (resolution: 6 m/pixel) [19] images were used for detailed observation. Mapping of the channels and structures was done using CTX images in ArcGIS; THEMIS-IR Day Global Mosaic was used to fill the gap between CTX stamps wherever applicable. Channels (and their tributaries) of the region with long straight segments were mapped

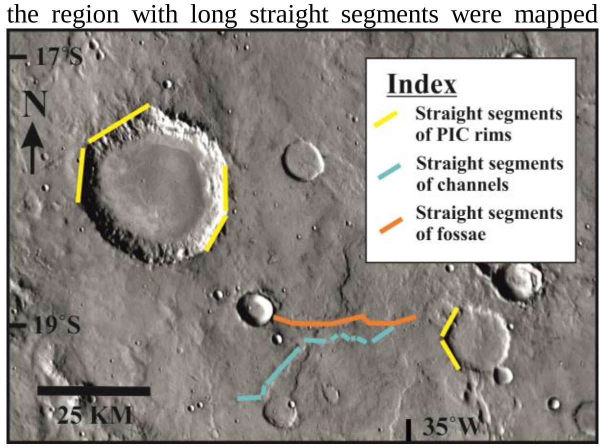

Figure 2. THEMIS-IR Day Global Mosaic showing examples of mapped straight segments of the channel, fossa, and PICs.

(Figure 2) at first. Thereafter, straight segments of the channels were identified and mapped (Figure 2). Azimuths of the straight segments were measured in ArcGIS and were plotted in a frequency rose diagram (Figure 3.A) using GEOrient. Craters with at least two adjacent straight segments and a clearly discernible angle between them qualify as PICs [20] and such craters were identified from the region to map their straight segments (Figure 2). Strikes of each straight segment of individual fossa were then mapped (Figure 2). Azimuths of the straight segments of the PIC rims and fossae were measured individually and plotted separately in two different frequency rose plots (Figure 3.B and C) similar to those of channel straight segments.

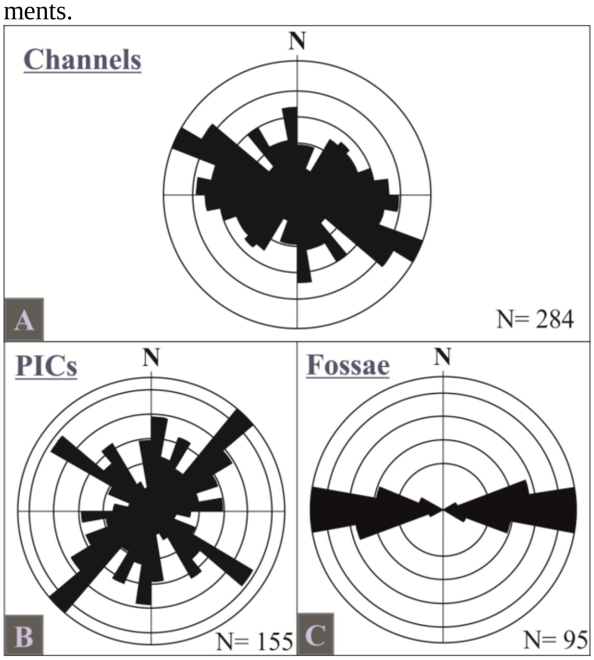

Figure 3. Frequency rose diagram plot of mapped straight segments of **(A)** Channels **(B)** PIC rims and **(C)** Fossae with a sector interval of 10˚.

Results: From the frequency rose plot of 31 channels (and their branches) with 284 long straight segments a major clustering along WNW-ESE (290˚-310˚; Figure 3.A) is found. Two more major clusters are found in E-W (270˚ -280˚; Figure 3.A) and N-S orientation (350˚-360˚; Figure 3.A). Frequency rose plot of 43 PICs with 155 straight segments reveal three major peaks at NE-SW (40˚-50˚; Figure 3.B) followed by WNW-ESE (300˚-310˚; Figure 3.B) and N-S (0˚-10˚; Figure 3.B) orientations. Orientation analyses of 95 straight segments of faults bounding 17 fossae found in the region indicate that the gross orientation is E-W (260˚ -280˚; Figure 3.C).

Discussion: In the area of study orientations of structural planes are reflected by those of straight rims of PICs and fossae. A comparison between the frequency rose plots of straight channel segments, fossae, and straight rims of PIC marks that:

(a) E-W peaks observed in the rose plots of both fossae (most frequent) and the PIC rims (subordinate) are also found in the frequency rose plot of channels (Figure 3).

(b) Both PIC rims and the channels have peaks in along WNW-ESE orientation (Figures 3. A and B).

(c) A less prominent concordance is found along N-S orientations between PIC rims and channels (Figures 3.A and B).

(d) It is also observed that the most frequent trend of PIC straight rims along NE-SW is not followed by the channel straight segment (Figures 3.A and B).

Therefore, it is suggested that orientations of structural planes reflected by the PICs and fossae trends are partially followed by the channels or in other words, pre-existing weak planes partially controlled the channel courses. Moreover, PICs are found to serve as an important tool to examine the orientations of pre-existing fractures in an area.

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