EGU21-1742
https://doi.org/10.5194/egusphere-egu21-1742
EGU General Assembly 2021

Discordance Mapping of Argyre Basin: An Insight into the Fluvial and Subglacial Origin of Valley Networks in the Argyre Basin Region

Rickbir Bahia[1], Anna Galofre[2], Stephen Covey-Crump[3], Merren Jones[3], and Neil Mitchell[3]
[1]European Space Agency, European Space Research and Technology Centre, Noordwijk, Netherlands
(riccibahia@hotmail.com)
[2]Arizona State University, United States
[3]The University of Manchester, Manchester, United Kingdom of Great Britain – England, Scotland, Wales

Introduction: Martian valley networks are evidence for surface run-off and past water cycles on ancient Mars. Many of the networks resemble terrestrial precipitation-fed systems; however, recent analysis has found that the geometries and morphological characteristics of some valley networks are more comparable to subglacial valley formation. Subglacial valleys have morphological characteristics that make them distinct from fluvial valley systems (i.e., those formed via precipitation or sapping erosion). Unlike fluvial valley networks, which follow the surface slope of the underlying topography, sub-glacial networks are orientated in the direction of the surface slope of the overlying ice-sheet. Therefore, subglacial valleys may have orientations that are discordant with the underlying topography. Discordance analysis, a technique that compares the valley paleoslope direction and topographic slope direction, has been applied to Mars to determine areas that have undergone topographic modification since valley formation. This technique could also be a tool for identify valleys with potential sub-glacial origins.

In this study, we mapped and applied discordance analysis to valley networks in and around Argyre basin. Detailed analysis was performed on four valley networks on eastern Argyre, to determine whether their characteristics are indicative of a fluvial or sub-glacial origin.

Results: 2669 V-Shaped valleys (total length = 36155.5 km) and 45 U-Shaped valleys (total length = 2683.5 km) were identified. Most V-Shaped valleys dissect the eastern and northern rim of Argyre Basin, with fewer in the south and west. The densest northern valley networks have values up to 0.098 km^{-1}, compared to the densest in the south with values of only 0.040 km^{-1}. U-Shaped valleys are prominent along the south/south-west rim, but are lacking along the northern rim of Argyre.

Most valleys (47.8 %) are concordant (< 45° discordance) with present slope direction. Two dense groups of discordant valleys are present adjacent to Hale Crater and Nia Vallis. These areas display features associated with the presence of an ice-sheet/glacier – e.g., glacial moraines and eskers. Additionally, the morphology of these valley systems are consistent with a subglacial origin.

Fento Vallis and the Darwin Crater valley system are concordant with present topographic slope, and are in close proximity to one another; however, their morphologies differ greatly. Fento Vallis

consists of 25 valleys (total valley length of ~ 690 km) and drainage density of 0.019 km^{-1}. The Darwin Crater valley network consists of 49 valleys (total valley length of ~ 1351 km) and drainage density of 0.048 km^{-1}. Fento Vallis displays features (e.g., inner channel eskers) indicative of a subglacial origin. Alternatively, the Darwin Crater System has a planform associated with fluvial activity and originates from cirque like depressions. Although the Darwin Crater system appears to have a fluvial origin, less than 100 km to the east is Pallacopas Vallis, which displays inner eskers indicating that it has a subglacial origin.

Three of the networks analysed, which are > 1000 km apart from one another, are likely subglacial in origin. Their occurrence indicates that an ice-sheet or multiple ice-sheets were present along the eastern region of Argyre throughout its history.