GENETIC HYPOTESIS FOR THE FORMATION OF THE WESTERN ARABIA TERRA SURFACE: ASTROBIOLOGICAL IMPLICATIONS

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Abstract

Western Arabia Terra (WAT) is a transitional region, being on the border of many global processes that took place during the early history of Mars. It comprises the northernmost portion of the Martian highlands, the gradual transition between both sides of the Mars' dichotomy and one of the oldest terrains on the planet. It is one of the few areas on Mars where groundwater is predicted to have reached the surface [1], and besides being affected by the process that formed the dichotomy, it was influenced by the Arabia bulge raise to the east, and the possible Borealis oceans to the west [e.g., 2].
The WAT region shows a heavily degraded landscape with many high-standing mesas compared to the smooth, lightly cratered, and topographically lower adjacent lowlands. Its low valley network density is complemented by extensive networks of inverted fluvial channels [3], displaying a landscape consistent with a massive glacial, fluvial, aeolian, or atmospheric deposition followed by a subsequent period of considerable erosion. Most of the observations favor a pyroclastic origin for the mantling deposit, which can cover a large area evenly [4]. The absence of a nearby clear source may suggest that these deposits could be originated from hypothesized supervolcanoes found in the area [5].

The transitional position of WAT stressed the surface tectonically, in compensation to the crustal thickness differences and the changes in the water load after ocean level fluctuations, which ultimately favored the volcanic activity. Volcanic edifices found in the area, similar to large crater basins, together with collapse features with low topographic relief and their association with plains-style lavas and friable layered deposits matches well with the plains-style caldera complexes [5, 6]. Volcanic materials may have covered this area, but the topographic slope (produced early in its history), always favored the transport over the deposition, washing those materials to the next and depressed Northern lowlands [7], shaping WAT to its current characteristic denuded surface.

Phyllosilicates are abundant in the WAT region, and Mawrth Vallis is the most extensive exposure of aqueous kind of mineralogy on Mars. The local stratigraphy implies conditions for deposition with enough water availability to produce leaching [8, 9]. Although hydrochemical or climatic changes are also a possible explanation for the observed stratigraphy [10].

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Here we show that a similar sedimentation sequence can be found in Coogoon Valles, which points to a possible genetic relationship [11]. Since Coogoon Valles has characteristics of both outflow channels and valley networks, we hypothesize that it was formed in different phases [12]: initially by a series of outflow events, later by surface runoff, and subsequently by headward extending sapping, which reactivated the valleys. Therefore, the primordial Coogoon Valles channel may follow a similar evolution as the Mawrth Vallis outflow channel [13]. Here, we provide a more in-depth discussion on the possible past conditions of the WAT region, focusing on the implications for habitability and biosignatures preservation.

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