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Confined channels and collapse features in Arsinoes and Pyrrhae Chaos (Mars): hints for a volcano-tectonic origin

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Arsinoes and Pyrrhae Chaos are Chaotic terrains (CTs) located in the equatorial zone of Mars, east to Valles Marineris. CTs are characterised by a disrupted morphology: polygonal deep fractures within the basaltic bedrock resulted in the present mesa and knob pattern. Units stratigraphically on top of the fractured bedrock are considered sedimentary by [1], who suggested a water-rich depositional environment, based on the occurrence of sulfates and hematite. The role played by water both in liquid and ice state, is supported by several evidences, e.g.: outflow channels, hydrated mineralogies. Water was proposed as main agent responsible for the formation of CTs in different scenarios: collapse due to the melting of buried ice lake [2], increase in pressure of the aquifer [3], and interaction between cryosphere and magma [4]. We investigate the possibility of a major role of the early magmatic activity in Arsinoes and Pyrrhae Chaos, followed by a late water-driven activity. The confined channels and pit chains observed in these two CTs do not resemble the fluvial channels, as more evident in other CTs; they lack braided or meandering patterns, they are mainly linear or slightly sinuous, with a blind end. They display bifurcations even perpendicular each other or with y-shaped conjunctions suggestive of inflation. Moreover in their proximity lava flows are visible in some areas. These hints seem to suggest a volcanic origin for the channels such as collapsed lava tubes and/or fissure vents.
In this volcanic scenario, also the CTs-forming collapses may assume a different nature: the chaotic disruption may be caused by the emptying of large magma chambers, resulting in collapsed calderas, as suggested by the concentric orientation of the structures around Arsinoes Chaos and the radial orientation in the nearby Margaritifer Chaos. Underlying or inherited impact basins might also share a similar pattern on the inner rim collapses. On Earth, several calderas were explained by noncoherent (or piecemeal or chaotic) collapses ([5], [6]), where the subsidence of the caldera floor was characterized by the activity of complex fault systems forming polygonal blocks. Also, structures in Arsinoes Chaos show two preferential orientations one of which sub-parallel to the strike of Valles Marineris (∼E-W). Further measurements will be performed, including the spatial distribution of the structures and the possible depth and volumes of the presumed magma chambers.

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