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Late Tharsis Formation and New Perspesctives for Early Mars

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The Tharsis bulge is the largest volcanic complex on Mars and the associated excess of Mars has likely driven a True Polar Wander which has moved the province close to the present equator [1,2]. It has been suggested that the Tharsis load on the lithosphere influenced the orientation of the Noachian/Early Hesperian (>3.5 Ga) valley networks and therefore that most of its topography was completed before their incision during the Noachian era (> 3.7 Ga) [3]. We calculated the rotational figure of Mars and its surface topography before Tharsis, when the spin-axis of the planet was controlled by the hemispheric dichotomy. We show that the observed directions of valley networks are consistent with topographic gradients in this configuration and thus do not require the presence of the Tharsis load. Furthermore, their distribution along a small circle tilted with respect to the equator is found to correspond to a regular south tropical band in the pre-TPW geographic frame. Preferential accumulation of ice or water in a south tropical band is predicted by Early Mars climate model simulations applied to the pre-TPW topography [2,4]. This study implies a major overhaul of the relative chronology of the main events affecting the Mars geological and climatic history during the Noachian and Hesperian periods. A late rise of Tharsis, contemporaneous with fluvial activity, argues for a causal link between volcanic outgassing and the stability of superficial liquid water. The revised chronology, the topography and planet's configuration before Tharsis offers new perspectives to examine the surface conditions with respect to Early Mars habitability.

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