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Plume tectonics and the uplift of Martian Tharsis

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The uplift of Tharsis is considered to be a significant event on the Martian history. The Tharsis Bulge started to elevate during Noachian Period (∼3.7 Ga) and continued until the late Amazonian Period (∼0.5 Ga). Such uplift was a long-term process which developed in association with volcanic eruptions early in the Martian history and continued with a late-stage extrusive and intrusive magmatism. Possible mechanisms suggested for the initiation of the Tharsis uplift are degree-1 mantle convection and mantle plume rising from core-mantle boundary. In this work, we explore the role of mantle plume(s) located beneath Tharsis to explain the uplift of the region, and the migration of the Tharsis volcanism and the extensional and compressional features by using 2D numerical geodynamic experiments. We designed coupled crust lithosphere and the asthenospheric mantle configuration in which a pulse of mantle upwelling is initiated at the bottom of the model configuration to start the mantle plume process (1000 km at depth). A series set of models with varying crustal and lithospheric thickness, viscosity and density variation of the plume and the imposed plate convergence velocity of the lithosphere are conducted. At the same time, a large datasets of surface geomorphological features (e.g spacing between the ridges), topographic cross sections are compiled to construct the structural characteristics of the South Tharsis ridge area. Model results show that the upwelling mantle may first result in the rapid elevation increase in the centre and the a slow subsidence subsequent to this. The uplift develops simultaneous with the extension and where crustal thickness has decreased > 20 kms in 20 Myr timescale.