

Migration of Tharsis volcanism on Mars caused by differential rotation of the lithosphere

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The Tharsis Rise and crustal dichotomy are the two most important surface features on Mars. The crustal dichotomy is characterized by ~5 km elevation difference between the southern highlands and northern lowlands, and is the oldest geological feature on Mars. The Tharsis Rise is a vast volcanic construct in the equatorial region near the dichotomy boundary. Tharsis volcanism was initiated in the southern highlands and the main volcanic center had subsequently migrated to its current location, suggesting a relative motion between the lithosphere and the underlying mantle. However, Mars, an one-plate planet, cannot have large-scale horizontal motion of lithosphere, in the standard theory of stagnant-lid convection for one-plate planets. Here I demonstrate that a unique mode of horizontal motion of lithosphere, differential rotation of lithosphere, is readily excited for Mars with an one-plume convection and lithospheric thickness variations. This mechanism explains the temporal and spatial patterns of Tharsis volcanisms and offers a path to a unified model for the Tharsis Rise and crustal dichotomy. This mechanism has implications for volcanisms, tectonics, and true polar wander (TPW) for one-plate planetary bodies. *CitcomS* is used for this project.

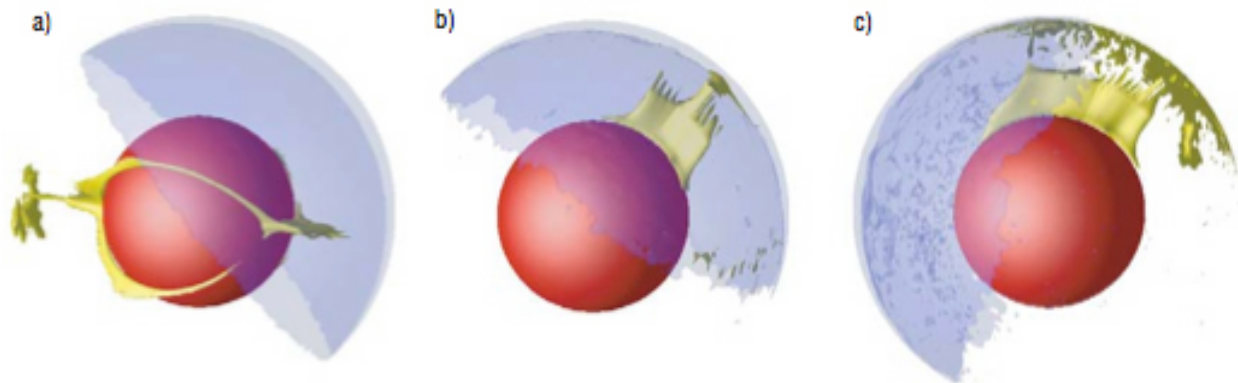


Figure: (a) Convection at an early stage before degree-1 convection is formed (the light blue isosurface represents a high viscosity melt residue cap), (b) one-plume structure forms under the cap, and (c) the lithospheric shell rotates above the one-plume structure such that the plume is finally stabilized near the cap boundary.

References

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