More Thoughts on Tharsis Rise Mars and Small-Scale Convection

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Using *CitcomS,* a series of 3D spherical incompressible convection calculations with strong temperature-dependent rheology and a step increase in viscosity in the lithosphere over one hemisphere are used to understand convection on a planet with a hemisphere step in the lithosphere structure, which may represent the hemispheric dichotomy on Mars. The calculations start from a uniform hot mantle and the flow is followed for one billion years. There is a significant difference in the convective plan form of the two hemispheres. The thick hemisphere has a simple upwelling plume structure while the thinner hemisphere has time-dependent, short-wavelength structure below the lithosphere.

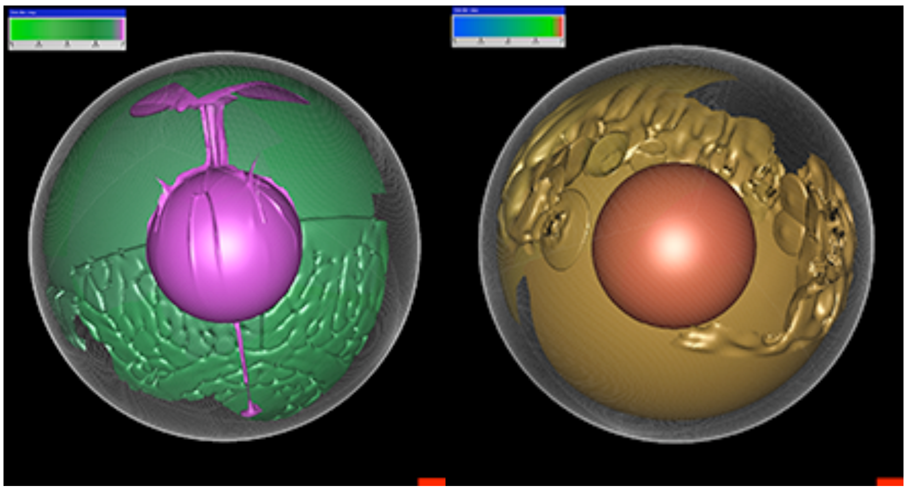

Figure 1: (left) Spherical temperature-dependent convection with a hemispherical near-surface lithosphere thickness variation of 250 km. The green surface is a temperature (0.90) isosurface just below the lithosphere. The smooth hemisphere is the thick lithosphere hemisphere and the rougher surface is the thinner lithosphere hemisphere. Two stable plumes have developed, one large plume beneath the thick hemisphere and a weak plume beneath the thin hemisphere. (right) Same as the calculation on the left with the inclusion of a low viscosity channel beneath the lithosphere. The calculation is approximately 100 m.y. after the initial uniform hot interior. The gold surface is a temperature isosurface just below the lithosphere. No plumes have developed and small-scale convection occurs at the lithospheric step boundary.

In contrast to the stable plume model (left), with a low-viscosity channel below the lithosphere small-scale convection develops along the lithospheric step within the first 100 million years (right). I am in the process of mapping out the parameters necessary for this mode of small-scale convection, addressing the time scale and whether it can generate enough melt to produce the Tharsis volcanic province.

There are several possible explanations for why only part of the dichotomy boundary had extensive volcanism. The mantle may have had an anomalously hot region beneath the area that becomes the Tharsis swell. Alternatively, the geometry of the dichotomy may have favored that region over others. Finally, there may have been anomalous lithospheric structure that favored edge driven convection beneath Tharsis. These ideas will be explored with further computational experiments.

King, S.D., Mars Mantle Structure: Results from Calculations with an Imposed Hemispheric Lithosphere Step, *LPSC XL*, 2009.