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Tectono-magmatic interaction of mantle plumes with thin and warm Venus lithosphere: consequences for the origin of novae and coronae structures

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Recent global mapping of crustal and lithospheric thickness on Venus suggest that 47% of the planet has an estimated very low elastic thickness value of 0–20 km (Anderson and Smrekar, 2006), possibly indicating thin and warm lithosphere (Diament and Burov, 1992). These finding suggest that some of the prominent Venus surface structures such as coronae and novae may actually result from mantle plumes interaction with the thin and warm Venus lithosphere that may allow penetration of mantle upwellings to the bottom of the crust. Here we present new 3D high-resolution thermomechanical model of thermal mantle plume impingement into warm and thin lithosphere with Venus-like surface temperature. Numerical results suggests that nova-like and corona-like structures can result from magma-assisted convection of weak ductile crust, induced by decompression melting of the hot rising mantle plume. During the initial stage, nova forms by stellate fracturing of a topographic rise forming atop the growing crustal convection cell. Few million years later, nova can convert to coronae by inward dipping concentric fracturing of the nova rise margins and subsequent outward thrusting of partially molten crustal rocks over the surface. An outer annulus of concentric normal faults forms in the outer rise region of the downbending brittle upper crust. Whereas an inner annulus of concentric thrust faults forms in front of the outward thrusting crustal wedge. A trench-like depression forms between these two annuli. Resembling retreating subduction, the rudimentary concentric upper-crustal slab warms up rapidly and recycles into the convection cell. The convection cell remains active for up to 15 million years, fueled by heat and magma from the plume. Predicted surface topography and fracturing patterns agree with some small to moderate size novae and coronae on Venus.

References:

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