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Formation of Coronae Structures on Venus by Thermochemical Diapirs

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One of the most prominent features on the surface of Venus are the coronae. They are large scale volcano-tectonic structures, which are approximately circular with a mean diameter of 200 – 300 km [Dombard et al., 2007], with extrema ranging from 60 km to about 2000 km diameter. A total of 515 coronae were found on Venus in the Magellan data [Stofan et al., 2001]. The intruiging point about corona is that there is no counterpart on the other terrestrial planets for these structures. Nine different groups of coronae have been observed on Venus [Smrekar and Stofan, 1997]. Smrekar and Stofan [1997] suggested that these different groups can stand for different steps in the time evolution of coronae. Several mechanisms have been proposed to explain their formation: Dombard et al. [2007] suggested that coronae form in response to magmatic loading of the crust over zones of partial melting above thermally buoyant heads of transient mantle plumes that impinge on the base of the thermal lithosphere. On the other side, the potential importance of crust delamination induced by mantle upwellings as formation mechanisms for coronae was pointed out by Smrekar and Stofan [1997]. Here, we present results on coronae formation using the recently developed 2D finite element code MILAMIN_VEP, which employs MILAMIN technology [Dabrowski et al., 2008]. We apply a temperature and stress-dependent visco-elasto-plastic rheology in a rectangular box, which includes a rising thermochemical diapir beneath the Venusian crust and lithosphere. The rheological parameters are taken from results inferred for Venusian materials [Mackwell et al., 1998]. A free surface is used in our calculations, which allows for the self-consistent computation of topography induced by the buoyant diapir. A hybrid particle-in-cell approach allows remeshing of strongly deformed grid cells. A systematic investigation of the physical conditions under which coronae can form is being performed in 2D. Initial results confirm the delamination hypothesis due to the impinging thermo-chemical diapir. The flattening of the diapir allows for the formation of coronae with radii several times larger than the initial diapir radii. Our calculations strengthen the hypothesis that coronae pass several stages of topographical appearance. They however also indicate that the formation of coronae might happen on much shorter timescales than suggested by previous studies.