Formation of Venusian Crustal Plateaus over Mantle Downwellings; J.G. Kidder, R.J. Phillips, Dept. of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130.

Introduction. It has been proposed that formation of Venusian crustal plateaus such as Ovda, Thetis, and Tellus Regiones is due to the presence of mantle downwellings ("coldspots"), which lead to large amounts of crustal flow, and ultimately to crustal thickening [1, 2, 3]. We have performed a finite element analysis of crustal thickening over a mantle downwelling using the finite element code TECTON [4], a Lagrangian finite element formulation capable of solving problems of visco-elastic deformation for materials with Newtonian or power law rheologies, and temperature dependent viscosities. A finite element solution of this problem may be more realistic than an analytical solution in that conservation of mass is assured without any assumption of layers of infinite horizontal dimensions. In this abstract we conclude that under a variety of conditions the topographic uplift produced over a mantle downwelling never exceeds one kilometer in one billion years of simulation.

Models. We have carried out a series of model runs with different boundary conditions, geometries, and flow laws to test the feasibility of formation of large crustal plateaus over mantle downwellings in a geologically reasonable period of time. Our reference model consisted of a 20-km-thick diabase crust overlying a 30-km-thick dunite mantle (50 km being chosen as the thickness of the Venusian mechanical lithosphere). Power law rheologies were used with the diabase flow law of Caristan [5] and the dunite flow law of Chopra and Patterson [6]. The model is 6000 km wide and the boundary conditions are as follows: the left side is fixed in the x-dimension (a symmetry boundary condition), but free to move in the y-dimension, the right side and top are free boundaries, and the base is a free boundary, with a downwelling force imposed by a gaussian-shaped load (σ = 700 km and maximum magnitude such that the initial isostatic depression is 1 km at the surface) applied over the first 2000 km. The temperature distribution was calculated using the error function equation of Zuber and Parmentier [7], with the surface temperature 740 K, the asymptotic temperature 1510 K, and the temperature gradient at the surface 15 K/km. This gave a temperature at the base of our reference model of 1331 K. We ran the model through approximately 1 billion years, and achieved only 863 m of positive topography at the surface (see Figure 1A).

We have tested the effect of (i) varying the width of the model, (ii) a fixed vs. free side boundary condition, and (iii) using the diabase flow law of Mackwell et al. [8] to model the crust. Using the new flow law dramatically reduced the amount of crustal thickening in the model: after 1 billion years, the surface was still depressed 996 m (see Figure 1B).

Conclusions. None of the model runs produced the high topography associated with large Venusian crustal plateaus such as Ovda Regio. Bindschadler and Parmentier [1] show a non-dimensional uplift ratio of four or greater, but for our models this quantity is never greater than unity after a billion years of simulation. The amount of topography generated is greatly affected by using realistic horizontal dimensions of material and by the use of the diabase flow law of Mackwell et al. [8]. Our ongoing investigations are examining the effects of changing the crustal thickness, the temperature gradient, the mantle flow law [9], and the depth of the perturbing source. We are also studying the effect of an axisymmetric vs. a plane strain

VENUSIAN CRUSTAL PLATEAUS: Kidder, J.G., and Phillips, R.J.

geometry, and are applying a velocity boundary condition at the base of the crust to better simulate the shear forces caused by a convecting mantle. We will also take into account the effects of the thickening crust on mantle convection itself.

References. [1] Bindschadler D.L. and Parmentier M. (1990) *JGR, 95*, 21329; [2] Lenardic A. et al. (1991) *GRL, 18,* 2209; [3] Bindschadler D.L. et al. (1992) *JGR, 97,* 13495; [4] Melosh H.J. and Raefsky A. (1980) *Geophysical Journal of the Royal Astronomical Society, 60,* 333; [5] Caristan Y. (1982) *JGR, 87,* 6781; [6] Chopra P.N. and Paterson M.S. (1984) *JGR, 89,* 7861; [7] Zuber M.T. and Parmentier E.M. (1990) *Icarus, 85,* 290; [8] Mackwell S.J. et. al. (1993) *EOS, 74,* 378; [9] Karato S. and Wu P. (1993) *Science, 260*, 771.

FIGURE 1A

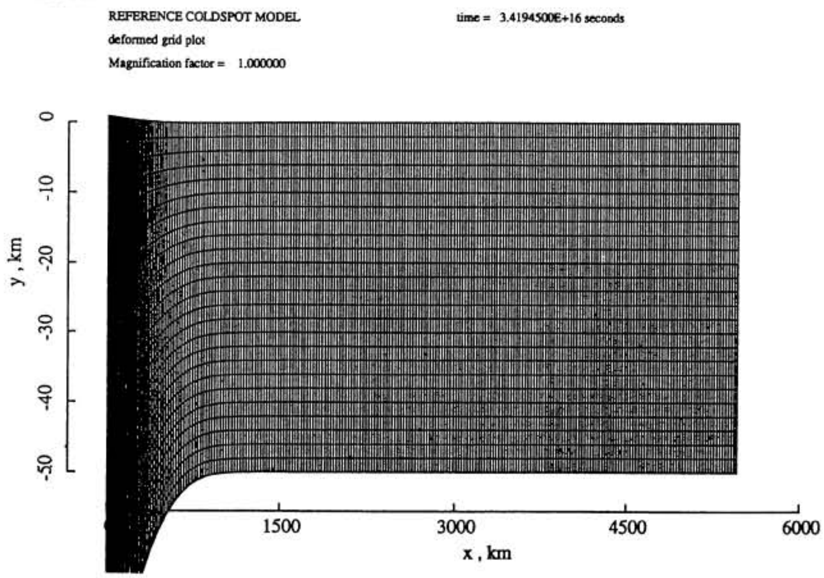

FIGURE 1B