DYNAMIC MODELS FOR RIDGE BELT FORMATION ON VENUS;

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Introduction. Deformation in a number of lowland plains regions on Venus is concentrated into distinct linear zones or belts [1, 2]. High-resolution images and altimetry of such deformation belts have recently been obtained by the Magellan spacecraft for Lavinia Planitia, a broad quasi-cirular lowland in the southern hemisphere. These data reveal that the belts are 50-200 km wide, several hundred kilometers long, spaced several hundred kilometers apart, and are generally elevated by several hundred meters above the surrounding plains (see accompanying figure). They are characterized morphologically by sets of closely spaced ridges and grooves that tend to parallel the trend of the belt and to be concentrated in the most elevated terrain [3, 4, 5]. The belts are interpreted as products of lithospheric shortening and crustal thickening. The lithospheric shortening expressed by the ridge belts has been postulated to be the result of convective downwelling beneath the lowland planitia [6, 7]. In this paper we test this hypothesis quantitatively; specifically, we develop dynamical models for the interaction of mantle convection with the crust and we compare the models to the characteristics of the ridge belts in Lavinia Planitita.

On Earth, large scale surface-deformation is confined to the plate boundaries. This behaviour is ascribable to the presence of a relatively strong plate overlying a low viscosity asthenosphere. However, on Venus, the elevated surface temperature leads to a weak lithosphere. Furthermore, the high correlation of long wavelength topography and gravity, as well as the large apparent depths of compensation, indicate that Venus does not have an asthenosphere [7 - 10]. Thus, models of tectonic deformation on Venus must account for convectively induced stresses. Because of the very low erosion rates on Venus [12], any large-scale tectonic expression of underlying convection may be preserved for considerably longer times than on Earth. Indeed, different tectonic areas of Venus may each be an expression of distinct stages in the evolution of convective upwellings and downwellings [e.g., 6, 12].

Approach. On the basis of analytical models of convection-induced crustal flow [e.g., 13, 14,], the crust may be regarded as having has two responses to convective downwelling. The first is a "flexural" response, during which the surface and crust-mantle boundary can be thought of as deforming "in phase." Following this, the crust responds by thickening, which continues until isostatic and dynamic equilbrium is established, at which point the surface boundary and the crust mantle boundary are anticorrelated. In our models, we examine the transition from the relatively instantaneous initial "flexural" response to the beginning of crustal thickening. The models use a marker chain/marker particle version of the 2-D Cartesian finite element program ConMan [15], a procedure which allows us to follow the deformation of both crust and mantle.

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Unlike analytical models, we can employ both material- and temperature-dependent viscosities. In addition to the crust-mantle boundary and surface deformation, we also calculate the thermal gradient and the stress field in the lithosphere.

Models. A series of models have been developed to address several objectives. The most important of these are the relationship of mantle downwelling to the formation of zones of concentrated crustal thickening and the factors controlling the spacing and dimensions of deformation belts (e.g., vertical structure, initial lateral heterogeneity). The sensitivity of the crustal deformation pattern to regional thermal gradient and mean crustal thickness is also being investigated.
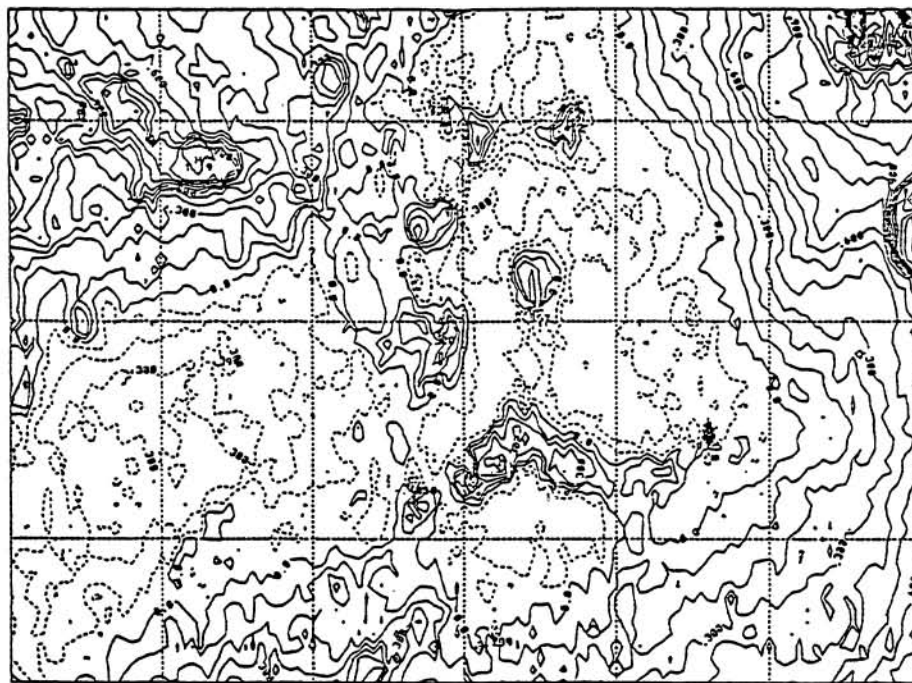
Magellan topographic contour map of the ridge belts of Lavinia Planitia. The datum is a planetary radius of 6050.8 km. Postive contours are solid; negative contours are dashed; 100 m contour interval. The figure is centered at 45˚S, 350˚ E; latitude and longitude lines at 5˚ intervals.

References: [1] Barsukov et al., *JGR*, 91, D378, 1986; [2] D.B. Campbell et al., *Science*, in press, 1991; [3] S. C. Solomon et al., *Science*, in press, 1991; [4] S. W. Squyres et al., this volume; [5] S. L. Frank et al., this volume; [6] M. T. Zuber, *GRL*, 17, 1369, 1990; [7] R. J. Phillips et al., *Science*, in press, 1991; [8] W. L. Sjogren et al., *JGR*, 88, 1119, 1983; [9] B. G. Bills et al., *JGR*, 92, 10335, 1987; [10] S. E. Smrekar and R. J. Phillips, *EPSL*, in press, 1991; [11] R. E. Arvidson et al., *GRL*, 17, 1385, 1990; [12] R. J. Phillips, *JGR*, 95, 1301, 1990; [13] D. L. Bindschadler and E. M. Parmentier, *JGR*, 95, 21329, 1990; [14] H. Schmeling and G. Marquart, *GRL*, 17, 2417, 1990; [15] S. D. King et al., *PEPI*, 59, 195, 1990.