REGIONAL MODELS OF TOPOGRAPHIC SUPPORT ON VENUS FROM ADMITTANCE ANALYSIS OF TOPOGRAPHY AND CALCULATED VERTICAL GRAVITY; *David R. Williams, Department of Geology, Arizona State University, Tempe, AZ, 85287.*

A generally noted feature of Venus is that despite the similarities with the Earth in terms of bulk properties, such as mass and volume, the surface expression of venusian tectonics is quite different from that of the Earth (1,2). In an attempt to determine both the extent of these differences and their causes, the line-of-sight (LOS) gravity (3) and the topography (4) of Venus as measured by the Pioneer Venus orbiter have been analyzed. Using a minimum variance technique (5,6), with the topography as an a priori constraint on the smoothness of the solution, a vertical gravity field at 200 km altitude has been calculated for a number of regions of Venus. This is a static inversion of the LOS gravity, as opposed to a dynamic inversion which would take into account the fact that the spacecraft position is also a function of the gravity anomalies, introducing non-linear terms into the calculation. Although this effect is most significant at the longest wavelengths, it may also be non-negligible at the regional-scale wavelengths examined here. Use of the ORBSIM program (7) will help quantify the magnitude of this effect, and show if a dynamic inversion is necessary.

The results of the inversion are shown for western Aphrodite Terra, Niobe Planitia, and Beta Regio in figures 1, 2, and 3, respectively. These show the vertical gravity anomaly at 200 km altitude in mgals. The vertical gravity for all three regions show very close correspondence with the topography, although the case for Niobe, due to the low amplitude of both the gravity and topography, is not as clear. A two-dimensional Fourier admittance analysis of the vertical gravity and the topography for each region reveals that simple models of Airy isostasy, or combinations of isostasy and flexure, cannot match the observations. A calculation of the coherence between gravity and topography for the regions leads to the conclusion that the lithosphere is thin (~25 km or less) for the highland regions, while Niobe may have a lithosphere as thick as 75 km. Uncertainties in the data, as well as the general uncertainties involved in calculating lithospheric strength from coherence, allow for uncertainties in the lithospheric thicknesses of up to 50 km, so this result is not unequivocal.

Although simple load models cannot match these results, a model combining loading within the mantle and correlated surface or near-surface loading can explain the data. This model is consistent with upwelling convective limbs within the mantle supporting highland topography, heating the base of the lithosphere, and causing enhanced surface volcanism. The lowlands are associated with downwelling limbs of the convective cells. These cooler downwelling limbs may explain the thicker lithosphere postulated for Niobe from the results of the coherence analysis. Interpretation of the admittance data in terms of this model reveals a general trend of increasing effect of surface or near-surface loading with decreasing wavelength. For shorter wavelengths, the effect on the admittance due to density perturbations in the mantle becomes less prominent, and the volcanic loading begins to dominate both the gravity and topography signals. These results seem to point to a hot-spot type model, in agreement with other workers (8,9), with convective upwellings heating and thinning the overlying lithosphere and causing enhanced magmatism, while downwelling plumes cool and thicken the lithosphere. The main support for the highland regions is dynamic, provided by thermal heterogeneities in the mantle. This is in marked contrast to the Earth, where high topography is generally compensated near the surface, and is usually related to the interaction between moving lithospheric plates.

References: (1) Masursky et al., J.G.R., 85, 8232, 1980. (2) Phillips et al., Science, 212, 879, 1981. (3) Sjogren et al., J.G.R., 85, 8295, 1980. (4) Pettengill et al., J.G.R., 85, 8261, 1980. (5) Kaula, Theory of Satellite Geodesy, 1966. (6) Jackson, Geophys. J.R.A.S., 57, 137, 1979. (7) Phillips et al., J.G.R., 83, 5455, 1978. (8) Morgan and Phillips, J.G.R., 88, 8305, 1983. (9) Kiefer et al., Geophys. Res. Lett., 13, 14, 1986.

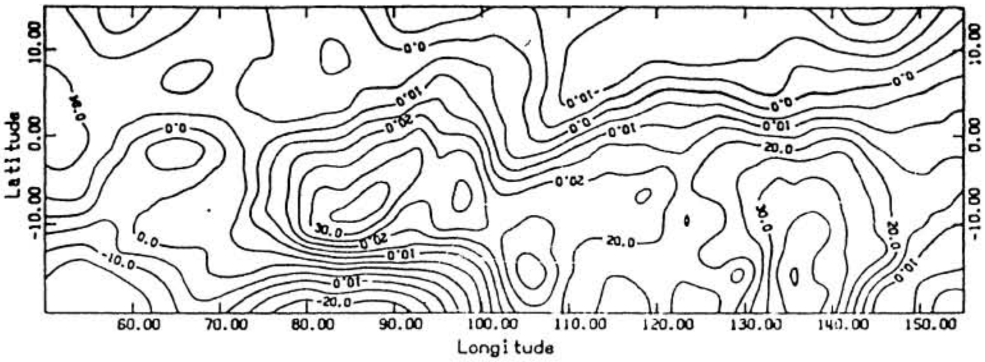

Figure 1: Vertical gravity anomaly calculated at 200 km altitude, in mgals, for western Aphrodite Terra. Contour interval is 5 mgals.

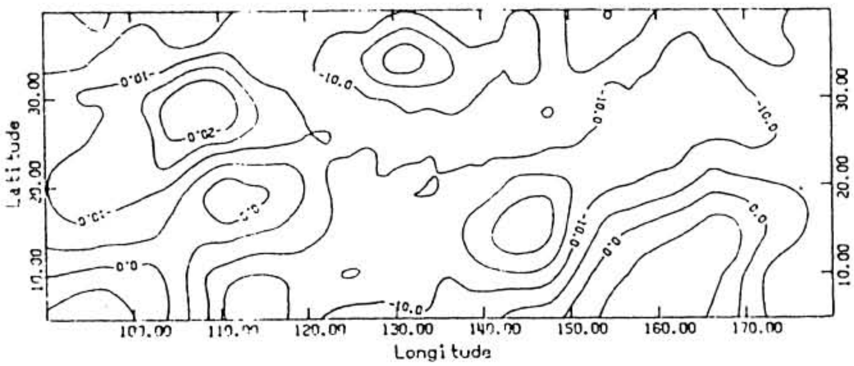

Figure 2: Vertical gravity anomaly calculated at 200 km altitude, in mgals, for Niobe Planitia. Contour interval is 5 mgals.

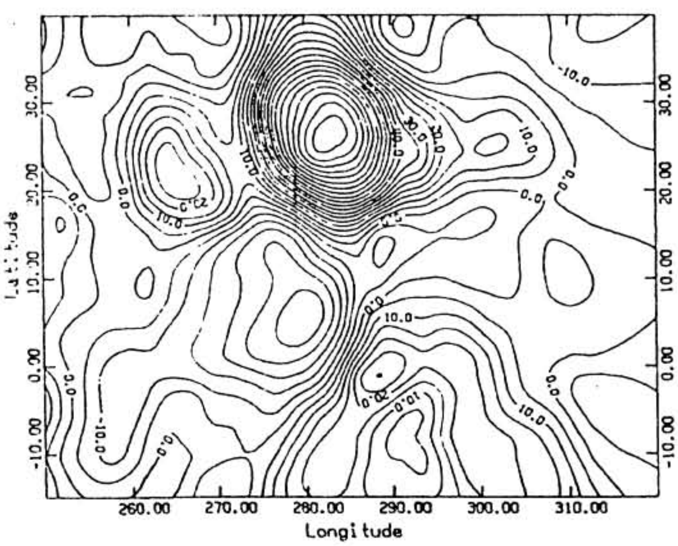

Figure 3: Vertical gravity anomaly calculated at 200 km altitude, in mgals, for Beta Regio. Contour interval is 5 mgals.