TROUGHS AROUND VENUSIAN VOLCANOES: IMPLICATIONS FOR PROPERTIES OF THE LITHOSPHERE. D.L. Bindschadler, UCLA Dept. Earth and Space Sci., Los Angeles, CA 90024, and E.R. Stofan, JPL, Pasadena, CA 91109.

A number of large (160-475 km across) shield structures on Venus are surrounded by discontinuous annular troughs, including Tepev and Hathor Mons (Figure 1). Heights of volcanic structures possessing troughs range from about 1.0-5.0 km above the surrounding region, with most less than 2.5 km. Troughs around volcanoes are generally 50-75 km wide and less than 500 m deep. All of the major fresh-appearing shields (surrounded by distinct radar-dark and bright flow features) in the Venera 15/16 radar data and several shields in the southern hemisphere are partially surrounded by troughs. Exceptions to this include the prominent shields Theia, Rhea, Sif, and Gula Montes, all located in the Equatorial Highlands.

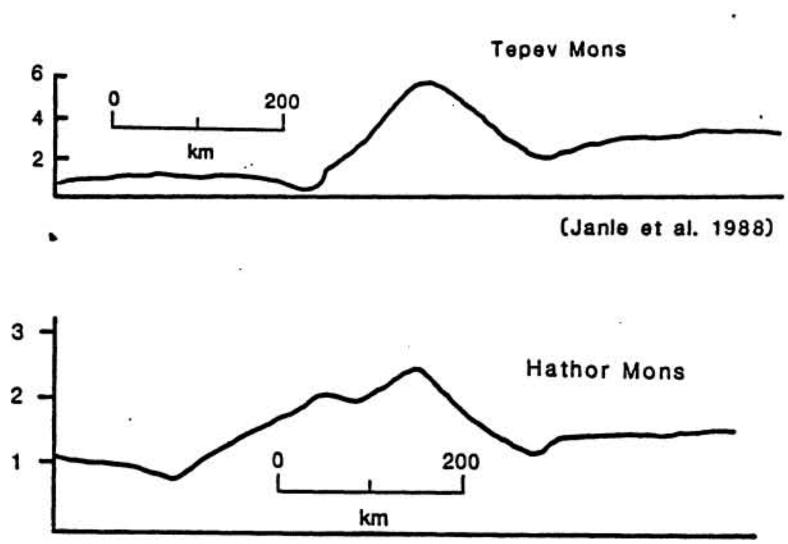
Mechanisms by which troughs might form around volcanic structures include loading and flexure of an elastic layer representing the elastic lithosphere and gravitational relaxation of a partly uncompensated load on the surface [1]. Both models potentially yield insight into the properties of the lithosphere of Venus. Janle et al. [2] used a flexural model to study the trough around Tepev Mons, predicting elastic lithospheric thicknesses of 30-100 km. The 30 km lower limit is in contrast to the thinner elastic lithospheric thicknesses found from models for the banded terrain (10 km; [3]) and consideration of the thermal gradient (also 10 km; [4]). Therefore, we examine a gravitational relaxation model for the production of troughs around shields.

The relaxation model treats the crust and mantle as a layered linear viscous halfspace. At the surface of the halfspace, shear stresses vanish and vertical normal stresses are those due to topography. Relief along the crust-mantle boundary is also treated as a vertical normal stress. At depth ($z \rightarrow \infty$) horizontal and vertical velocities vanish. Matching conditions at the interfaces between the various layers require continuity of velocity and shear and vertical normal stresses. The result is a linear system of equations whose solutions are the constants in the equations of flow. Values of viscosity are obtained from experimental flow laws for diabase ([5], crustal material) and olivine ([6], mantle material) by specifying a temperature distribution and a characteristic strain rate (10^{-15} sec^{-1}). We use a temperature distribution appropriate for a cooling halfspace, with surface and mantle temperatures of 700K and 1500K, respectively. The volcano is represented as a Gaussian shaped topographic high. With this model, relaxation is controlled by three parameters: the initial degree of compensation $\boldsymbol{c}$, crustal thickness $\boldsymbol{L}$, and the thermal gradient at the surface $\frac{dT_0}{dz}$.

Preliminary investigations [1] of the model shows that emplacement of a partially compensated volcano at the surface can result in the formation of a peripheral trough over a wide range of $\boldsymbol{c}$, $\boldsymbol{L}$, and $\frac{dT_0}{dz}$. As one example, we show three steps in the relaxation of a 4 km high volcano in Fig. 2, with $L = 10$ km, $c = 0.25$, and $\frac{dT_0}{dz} = 10$ K km-1. We assume that emplacement of the volcanic load occurs rapidly compared to the characteristic relaxation time (~2.5×10^5 yr for this case). The trough forms because longer wavelength components of the feature (e.g., the overall broad bulge of the volcano) relax more quickly than short wavelength components. By the time the volcano is ~25×10^6 yr old, the trough should be undetectable in PV data. We are currently attempting to set limits on crustal thickness and thermal gradient by measuring the troughs around Venus volcanoes and comparing them to model results.

Differentiation between a flexural model and a gravitational relaxation model for formation of the peripheral trough around volcanoes is critical to understanding the nature of the Venus interior. For example, the lack of troughs around several volcanoes in the Equatorial highlands could indicate (1) high thermal gradients and/or thick crusts, allowing relaxational troughs to disappear quickly, (2) elastic lithospheric thicknesses in these regions great enough to support the load of a shield with little or no bending, or (3) volcanic burial of troughs. The second possibility seems the least likely, given that the shields without troughs are located on topographic swells (Beta and Eisila Regiones) thought to represent mantle hotspots [7]. We are currently examining Venera images for evidence of burial of troughs.

[1] Stofan, E.R., D.L. Bindschadler, and J.W. Head, *EOS Trans. AGU, 69,* 1295, 1988. **[2]**Janle, P., D. Jannsen, and A.T. Basilevsky, *Earth Moon Planets, 41,* 127-139, 1988. **[3]** Solomon, S.C., and J.W. Head, *JGR, 89,* 6885-6897, 1984. **[4]** Grimm, R.E., and S.C. Solomon, *Lunar Planet. Sci. XIX,* 429–430, 1988. **[5]** Shelton, G., and J. Tullis, *EOS Trans. AGU, 62,* 396, 1981. **[6]** Goetze, C., *Phil. Trans. Roy. Soc. London, Ser. A, 288,* 99-119, 1978. **[7]** Esposito, P.B., W.L. Sjogren, N.A. Mottinger, B.G. Bills, and E. Abbot, *Icarus, 51,* 448–459, 1982; Campbell, D.B., J.W. Head, J.K. Harmon, and A.A. Hine, *Science, 226,* 167-170, 1984; Stofan, E.R., et al., *Geol. Soc. Am. Bull., 101,* 143-156, 1989; Senske, D.A., and J.W. Head, *Lunar Planet. Sci. XX,* 986-987, 1989.



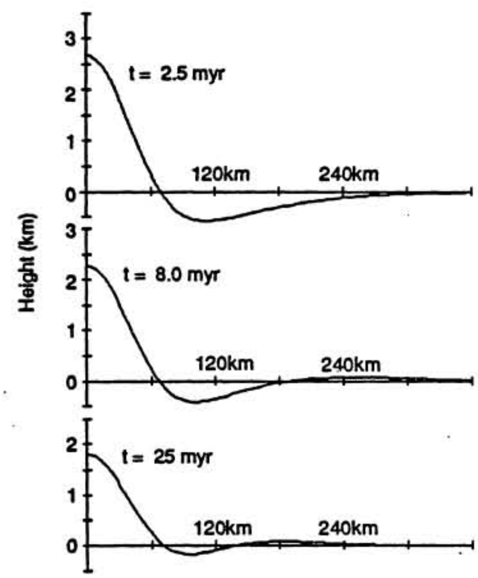


Fig. 1 (left): Venera 15/16 altimetry profile of Tepev Mons and PV altimetry profile of Hathor Mons.

Fig. 2 (right): Shape of relaxing volcano at three times after emplacement of volcanic load. Parameters are discussed in the text.