3D SPHERICAL CONVECTIVE MODELS OF VENUS.

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The strong correlation between the gravity field and the topography observed on Venus, at the difference of the Earth, might be due to the absence of well developed plate tectonics on this planet, so that these data fields might directly reflect the convective structure of its mantle. In such a case, the mantle viscosity profile plays a determinant part in the relationship between gravity and topography. In order to investigate the possible viscosity stratification of the Venus mantle, we performed some basic numerical experiments of mantle convection in a fully 3D spherical geometry. We stayed in the Boussinesq approximation, with no internal heating, only considering the viscosity stratification as a free parameter.

With a constant viscosity, the circulation is driven by hot ascending plumes. The resulting topography (Fig1-case1) shows a low elevation curvilinear network associated with mantle downwellings and surrounding isolated or connected cylindrical shaped areas with high topography corresponding to mantle upwellings. This kind of pattern presents strong similar features with the one obtained from the analysis of the global topographic distribution of Venus (1,2). The spectral admittance is always positive but higher than the observed one.

In case of a lower mantle 10 times more viscous than the upper one, the convective pattern remains roughly similar with strengthened hot plumes. However, the admittance becomes negative for spherical harmonic intermediate degrees, ranging from 6 to 15. This feature is reduced by introduction of a 100 km thick lid with a viscosity equal to the lower mantle one, but does not disappear.

Case 2 and 3, shown in figure 1, are performed with an isoviscous mantle underlying a lid respectively 10 and 100 times more viscous. The viscosity decrease with depth yields to a positive admittance but strongly changes the convective pattern. For a small viscosity contrast (case 2), the hot plumes are linearly connected and for a stronger contrast (case 3) the circulation is driven by a single proeminent cold plume.

On this basis, it seems that a viscosity increase with depth is unable to account for the observed admittance on Venus. On the other side, a strong viscosity decrease produces an unexpected topographic pattern (fig.1, case3).

Figure 2 displays the hypsometric curves associated to the dynamic topography of the corresponding three cases. It is worth to point out that the hypsometric curve is very sensitive to the viscosity profile. Indeed, in case 3, the linear trend of the curve is associated to the nearly global surface area while in case 1, it is associated to a much lower surface area (cf. figure 2). A simple comparison with the global venusian curve shows that case 1 clearly departs from the venusian case while a much better agreement is obtained with case 2. The best agreement would probably be obtained with a factor of increasing viscosity, between the mantle and the lithosphere, ranging between 10 and 100.

This basic modelling approach reveals nevertheless that it is fruitful to combine apparently independent types of analyses in an attempt to constrain the mantle convective structure at Venus.

REFERENCES: (1) Pinet P.C. et al. (1993), *DPS Abstract, BAAS, 25,* 1085. (2) Pinet P.C. et al. (1994), *Acte du colloque national de planétologie de l' I.N.S.U.,* S14-1.

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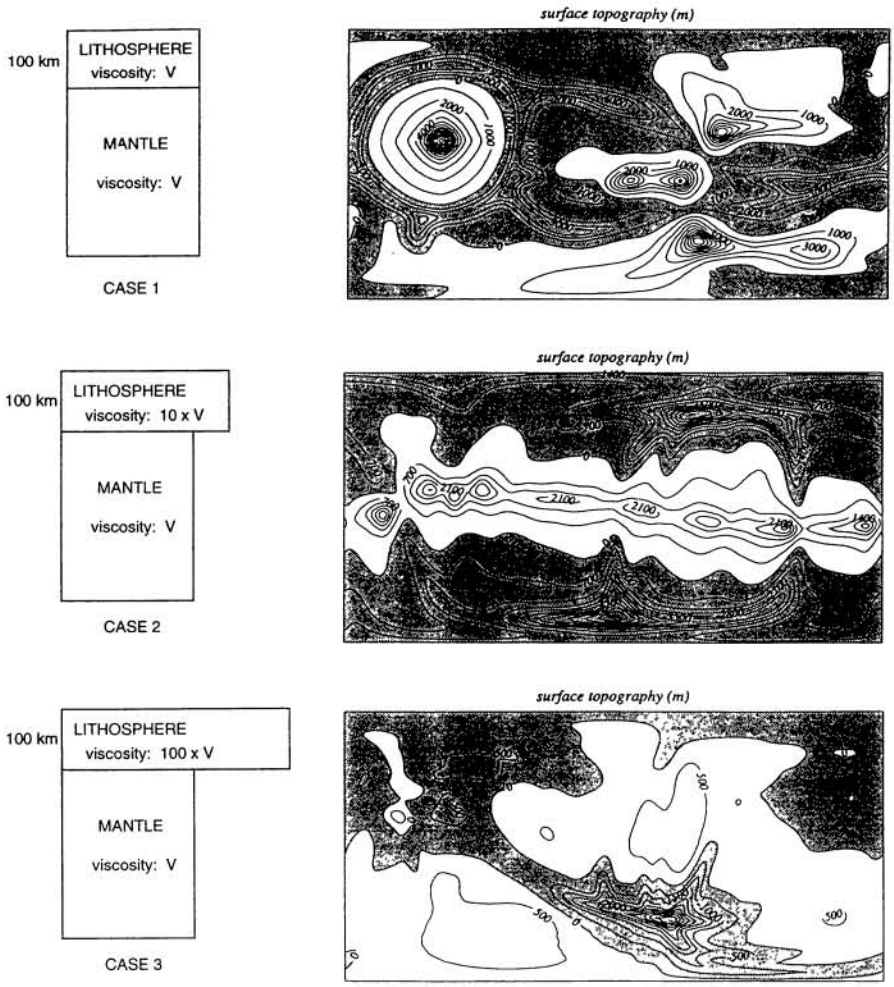

Figure 1: Dynamic topography resulting from a fully 3D spherical geometry experiments of mantle convection with three diferent viscosity profiles.

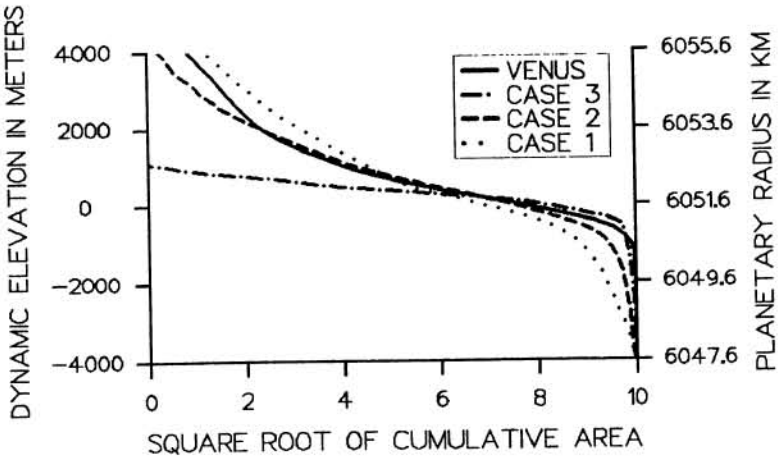

Figure 2: Comparison of hypsometric curves between the venusian topography and the dynamic topography of the three cases displayed in the figure 1. A good agreement is obtained with the case 2.