ISOSTASY MODELS AND CORRELATIONS OF GEOID AND TOPOGRAPHY DATA FOR CHARACTERISTIC HIGHLANDS ON VENUS;

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We have used the newest solution for the Venus geopotential, incorporating tracking data from the circularized orbit (cycle 5) of Magellan, along with global Venus topography data to study correlations of geoid and topography variations (N and h) in several regions characteristic of the principal classes of highlands found on Venus. For each region, mean value.s of N and h data were compared to theoretical correlations for Pratt, Airy, and thermal isostasy. We find strong coherence in the regional correlations of this data and the topography is substantially compensated. Although there are large variations in model parameters for the regional fits, h and N data correlations in the chosen sample. areas can be explained by isostatic compensation models involving variations in crustal (Airy) and/or lithospheric (thermal) thicknesses provided a thick zero-elevation thermal lithosphere, is assumed for Venus.

Following the success of the aerobraking experiment, the orbit of the Magellan spacecraft has been quasi circularized. From the preliminary cycle 51 Doppler tracking, data, a new 60x60 degree and order Venus geopotential spherical harmonic solution has been produced (1) which features lower uncertainties than previous cycle 4 models and higher resolution gravity data at high latitudes for part of the planet (eg Western Ishtar Terra). We used this new geopotential mode.] along with a global 12.() x 120 spherical harmonic model for Venus topography (2,3) to obtain 5* x 5° mean values of observed geoid and topography anomalies for six 300 x 300 regions most representative of the three principal classes of highlands (4) found on Venus. Our chosen samples include an area in Western Ishtar Terra, in the Northern latitudes, namely the high plateau of Lakshmi Planum surrounded by mountain ranges on all sides (5). Also included are five samples in the equatorial zone, namely: the topographic swells of Beta and Atla Regiones, the plateau-shaped areas of Ovda and Thetis Regimes and one sample region in the central part of Aphrodite Terra, in the so-called Chasmata area, The latter is in a class of its own, presenting a series of elongated ridges and linear to arcuate throughs (4).

For each of the 300 x 30" areas considered in this study we performed a least-squares fit of the observed geoid anomaly versus elevation data values to Pratt, Airy, and thermal theoretical correlations of N and h. For these models, isostatic compensation and support of high topography is achieved by horizontal variations in density, low density crustal roots, and thinning of the thermal lithosphere (thermal boundary layer) by basal heating, respectively. Geoid anomalies are non-zero in isostatically compensated regions and are thus preferred over gravity anomalies to determine the dependency of density with depth and study the mechanism of compensation in the lithosphere. Indeed, for a shallow source (density distribution) and in the long-wavelength approximation, the isostatic geoid anomaly is directly proportional to the dipole moment of the density-ckpth distribution (6,7). This so-called 110'1" formula was used to obtain the theoretical h, N relationships for the isostasy models considered in this work.

For a given region, fitting of the models to the data yields the following model parameter values: the geoid to topography ratio ((i'l'l<), or the slope of the best fitting correlation line, and the. corresponding depth of compensation W for the Pratt mechanism; for the Airy correlation the zero-elevation crustal thickness I] and, for a given regional elevation h, the total crustal thickness T(h) =] 1 -ı b(h) with b(h) the corresponding root; finally, for the thermal thinning model the thickness of the unperturbed (ie corresponding to zero elevation) thermal lithosphere $Y_{1,0}$ and, for a given thermal elevation of h, the, thickness of the thinned lithosphere $Y_{1,}(h)$. For each of our sample regions we also define a degree of compensation C (8) as the slope of the regression line fitted to the regional S^0 x 5° data values of $\Delta g^u - \Delta g$ plotted against Δg^u, with Δg^u the Bougher gravity anomaly for an uncompensated topography and Δg the observed gravity anomaly.

From the results of the fits listed in Table 1 we first note that the degree of compensation is high for all samples and that the correlation of the h, N data presents strong coherence. For all three models considered there are large variations in model parameters between the regional fits. Also, for the Pratt and Airy model correlations there is a grouping into classes depending on model parameter values. These are relatively small for Ovda and Lakshmi and large for the Beta, Atla, and Chasmata area samples. The Thetis sample has somewhat intermediate values. These observations hint towards the application of different compensation mechanisms for the various areas considered. This seems particularly true for Aphrodite Terra which shows an increase in GTR, W and H from West to East thus confirming with the Magellan data a tendency previously noted by other authors (9, 10, 11) in studies using lower resolution PVO data. In the case of the thermal correlations, however, it must be noted that the theoretical model barely manages to reproduce the Thetis data (ie the highest elevations) and completely fails for Ovda Regio and Lakshmi Planum. For the other regions a thermal thinning model can account for the observed regional topography and geoid though it is reasonable to assume that the thermal component may vary in strength depending on the sample considered.

Thus it appears that isostatic compensation models can explain the geoid-topography correlations observed in the highland areas considered in this work. However, a thick unperturbed thermal lithosphere is required, with Y_{Lo} ~300 km. One way to obtain such a thick lithosphere would be conductive cooling during the past -500 My, as suggested by Turcotte (12). Based on these premises, compensation mechanisms could be distributed among our sample regions as follows: mainly Airy isostasy for Ovda Regio and Lakshmi Planum. For Thetis Regio: Airy with perhaps a thermal component. And a very strong thermal component for Atla, Beta, and the Chasmata area since the large, values of H obtained for these regions are unrealistic even with a 300" km lithosphere.

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TABLE 1. Parameters for Regional Model Fits

Region	Cx100	h	GTR	W	σ_{Pratt}	H	T(h)	σ_{Airy}	Y_{Lo}	Y_L	σ_{th}
	%	km	m/km	km		km	km		km	km	
Lakshmi	89.0	4.7	10.4	134	9.3	62.0	96.0	9.7	NA	NA	NA
Beta	67.8	2..8	33.3	426	3.8	?35	255	13.7	357	102	16.8
Ovda	92.8	4.0	9.1	117	6.4	53.8	82.8	6.5	NA	NA	NA
Thetis	85.5	3.2	19.4	248	0.6	129	153	11.0	292	0.2	8.6
Chasmata	80.2	1.2	21.9	280	5.5	157	166	5.4	209	99.2	5.7
Atla	64.4	4.0	23.7	304	13.0	158	187	13.3	369	4.3	13.0