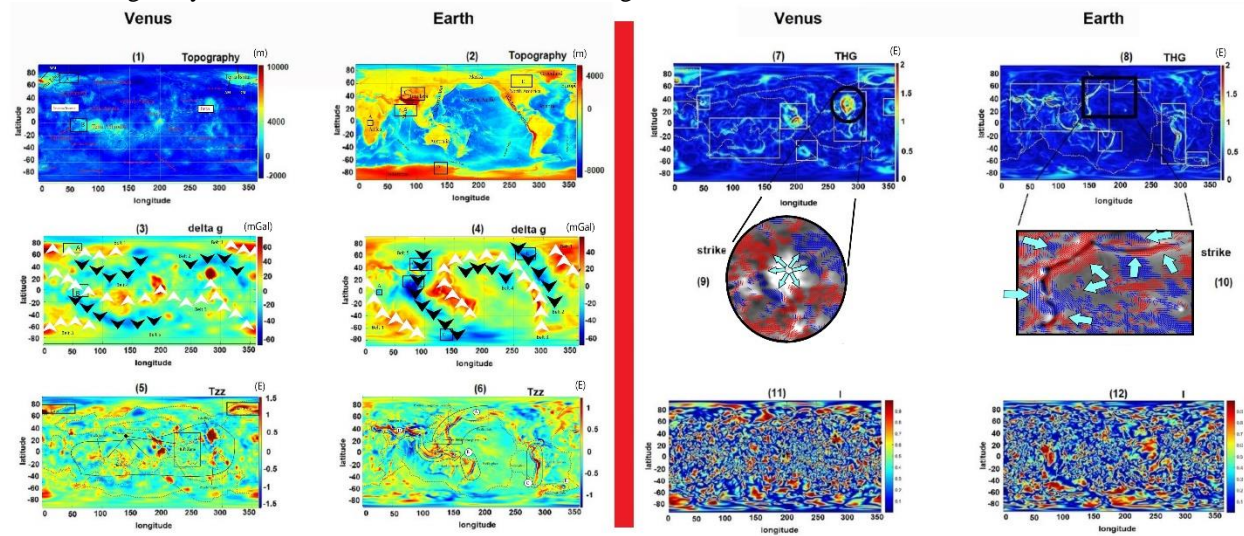


Clues of Earth like tectonics and mantle convections in Venus based on its gravity parametrs

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Introduction: In terms of gravitation, Venus is the most similar planet to Earth. Characteristics of the Venus geology can be deduced from a comparison of its gravity aspects to those of the Earth. The gravity aspects are gravity disturbance (δg), Murussi tensor components (T_{ij} 's) and its invariant (I), Total Horizontal Gradient (THG), and strike alignment. We detected Venus localities that are consistent with both upwelling and down-welling mantle patterns. Therefore, Venus may had operating plate tectonics in its past, now inactive. The structural weakness that may include faulting planes within the crusts are revealed from solution of strike angles, gravity aspect derived from Marussi tensor. The gravity models have been calculated at the height of $h=200\text{km}$.



Analysis: There are zones, like A, B, C, D and E on the Earth (Figures 2,4), and A and B on Venus (Figure 1,3), where the topography do not correlate with δg , implying that there is an ongoing geological activity resulting in rheological disequilibrium of the mantle in the respective districts. The average elevation of Ishtar Terra is larger than the average height of AB Regio ($\sim 2000\text{m}$ versus $\sim 1400\text{m}$). However, δg for Ishtar Terra is smaller ($\sim 30\text{ mgal}$ as opposed to $\sim 43\text{ mgal}$). This implies that either the AB Regio possess higher density or Ishtar Terra is closer to isostatic equilibrium. Similarly, the average height of Ovda Regio and Thetis Regio (OT Regio) is the same as AB Regio, but δg for this zone ($\sim 5\text{ mgal}$) is less than AB Regio ($\sim 43\text{ mgal}$). Since the origin of Ishtar Terra formation differs from OT and AB Regios, the likelihood for Ishtar Terra to be less dense than AB Regio, and the likelihood for OT Regio to be more isostatically compensated than AB Regio seem to be more. Both planets reveal several δg positive and negative wide belts (Figures 3,4), that may correspond with the down-welling and up-welling of the mantle, respectively. These are also visible in I maps (Figures 11,12). T_{zz} map of Earth (Figure 6) reveals elongated areas of maxima and minima that coincide with the plate boundaries. Mottled patterns with weak gradient field (T_{zz}), appear in south of Africa where at least two plate boundaries exist. The negative T_{zz} anomalous zones on Venus are associated with regional plains, lowlands with volcanics, and the outsides of the mountains and volcanoes. The mottled T_{zz} pattern on Venus may be indicative of the inactive tectonism. Most recent convection and tectonics has high amplitude T_{zz} . When older, the elasticity had time to erase the high amplitudes. This suggests that plate tectonics may have been active on Venus but is not active now. This is supported from modelling of the orbital and rotational motions [2], where there is an indication that the prograde rotational motion of Venus has slowed down due to atmospheric tidal friction. With this activity, the rotational axis has migrated towards equator and moved to the opposing side, while activating the retrograde motion of the Venus². This change from prograde to retrograde motion may have been the cause of Coriolis force change, slowing down the mantle convection, plate tectonic activity, that subsequently resulted in the mottled T_{zz} pattern shown in Figure 5. Comparing THG maps (Figures 7,8), it is evident that Venus possesses numerous circular and curved contacting zones, a feature that is not common on Earth. The strike solution (Figures 9 and 10) provides information about the stress anisotropy due to possible plate tectonics and volcanism. The solutions are perpendicular to the existing stress, and disclose the developed configurational weaknesses such as faulting. Unlike the Earth with elongated pattern, the combed¹ zones on Venus are circular. The greenish blue arrows in Figures 9 and 10 illustrate the linear and radial stress directions.

References: [1] Klokočník, J., et al (2014). *Earth Science Research*, 88-101. [2] Correia, A. C. M. & Laskar, J. *Nature* 411, 767-770.