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Tidal constraints on the interior of Venus

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As a prospective study for a future exploration of Venus, we compute the tidal response of Venus' interior assuming various mantle compositions and temperature profiles representative of different scenarios of Venus' formation and evolution. The mantle density and seismic velocities are modeled from thermodynamical equilibria of mantle minerals and used to predict the moment of inertia, Love numbers and tidal lag characterizing the signature of the internal structure in the gravity field. The viscoelasticity of the mantle is parameterized using an Andrade rheology. From the models considered here, the moment of inertia lies in the range of 0.327 to 0.342, corresponding to a core radius of 2900 to 3450 km. The potential Love number, k_2, varies from 0.25 to 0.36. Viscoelasticity of the mantle strongly increases the Love number relative to previous elastic models : depending on mantle viscosity, k_2 is increased by up to 25% using a liquid core. Moreover, once a viscoelastic rheology is assumed for the core, our calculations show that the estimation of k_2 from tracking of Magellan and Pioneer Venus Orbiter does not rule out the possibility of a completely solid core. Except if the solid core has a high viscosity ($\geq 10^{18}$ Pa.s), solutions with both liquid and solid cores are consistent with the present-day estimation of k_2. More accurate estimation of the Love number together with estimation of tidal lag by future exploration mission are required to determine the state of Venus' core and to constrain the thermo-compositional evolution of the mantle.