ARE THE EQUATORIAL HIGHLANDS ON VENUS PRODUCED BY MANTLE DIAPIRS?;
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Several different explanations have been proposed for the Equatorial Highlands on Venus, including spreading centers, analogous to mid-ocean ridges on Earth (1), and plume-uplifted regions, analogous to hotspots on Earth (2). The spreading center hypothesis has recently been shown to be incompatible with the observed topography and geoid variations over the highlands (3). It is also unlikely that the highlands result from steady-state plume activity. There is more than one order of magnitude variation in admittance values (geoid/topography ratios) among the highland regions, which strongly suggests that the regions reflect different stages in a time-dependent uplift process. A plausible dynamical explanation is that the equatorial highlands are transient structures produced by interaction of the lithosphere with massive thermal diapirs, rising from deep in the mantle (4). In this model, the Beta Regio uplift is supported by a thermal diapir that has just reached the lithosphere, whereas Thetis Regio and Ovda Regio in the western Aphrodite Terra are supported by diapirs which have collapsed and spread out beneath the lithosphere, and therefore represent later stages of highland evolution. I have analyzed the diapir hypothesis using numerical calculations of the evolution of rising thermals in a viscous fluid, with a rigid surface layer (lid) representing the crust and lithosphere. The calculations include a simplified representation of partial melting by decompression. There are three stages in evolution of the diapir, marked by distinct episodes of magmatism and surface tectonics. In the first stage, when the diapir is rising through the mantle, there is broad-scale surface uplift and some magmatism ahead of the diapir. During this stage, the admittance is proportional to the depth of the diapir. In the second stage, the diapir collapses beneath the lithosphere, producing flank uplift and magmatism primarily within the diapir. At this stage, the admittance depends primarily on the lid thickness. The final stage is characterized by slow conductive cooling of the diapir, slow subsidence and little melt production. This model appears capable of explaining many aspects of the Equatorial Highlands. However, it requires the existence of very large mantle diapirs, with radii of 300 km or more.

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