

MODELING SUBDUCTED LITHOSPHERE FRAGMENTS INTERACTING WITH MANTLE PLUMES ON VENUS. M.C. Kerr¹ and D.R. Stegman^{2, 1,2} Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California San Diego (¹mkerr@ucsd.edu, ²dstegman@ucsd.edu).

Despite the Earth and Venus sharing approximate size, composition, and distance from the Sun, the two terrestrial planets have distinctly different surface and atmospheric features. These differences are likely due to different modes of thermal evolution and heat transfer out of the planetary system. While Venus does not have a fragmented lithosphere like Earth's tectonic plates, which expel interior heat efficiently, topographic data show trench features on the surface of Venus, some along the arcing edges of circular volcanic upwellings called coronae¹. This indicates the possibility of subduction of Venus's lithosphere in areas of surface weakening^{2,3}.

The goal of this research is to explore how a descending fragment of the brittle Venusian lithosphere might interact with mantle convection if there was a modest temperature gradient across the core-mantle boundary (CMB) of Venus producing mantle plumes⁴.

An analog two-dimensional Venus mantle is created in a half-annulus geometry using geodynamic code StagYY. The mantle material can be modeled as a temperature-dependent, viscous fluid (10^{18} - 10^{24} Pa·s), and fluid dynamics equations of conservation of mass, momentum and energy (Stokes equations) are solved. A series of reference mantle models ran without a subducting fragment for potential temperatures of 1600 K, 1700 K, and 1800 K, each with temperature jumps of 100 K- 400 K across the CMB for the lower boundary condition. All models have free-slip boundaries, and a low-viscosity "sticky-air" layer is present at the upper boundary ($T=700$ K). The viscosity of the mantle increases linearly with depth, simulating pressure-dependence of viscosity.

These reference models are compared to models in which a cold, tilted slab of uniform cold temperature (1000 K) is placed at a depth of one-third of the mantle thickness and allowed to descend as a thermal boundary layer forms on the CMB. The thickness of the slab was varied between 150 and 300 km in intervals of 50 km and the maximum viscosity of the mantle is varied (10^{23} Pa·s, 10^{24} Pa·s, and 10^{25} Pa·s) to allow for different deformability of the slab.

In the reference models, 4-7 plumes form with rise-times ranging from 10-100 Ma and lifetimes upwards of 200 Ma. However, we show that in the presence of a subducting fragment of lithosphere, plume formation is suppressed, and the size and longevity of the mantle plume eventually forming underneath it is affected. These effects are different depending on the thickness

and deformability of the slab, as well as how long the thermal boundary layer (TBL) at the CMB has evolved.

Future research will constrain the magnitudes of these plume changes, as well as improve the timing of the falling lithosphere and TBL evolution to reflect a more realistic planetary interior.

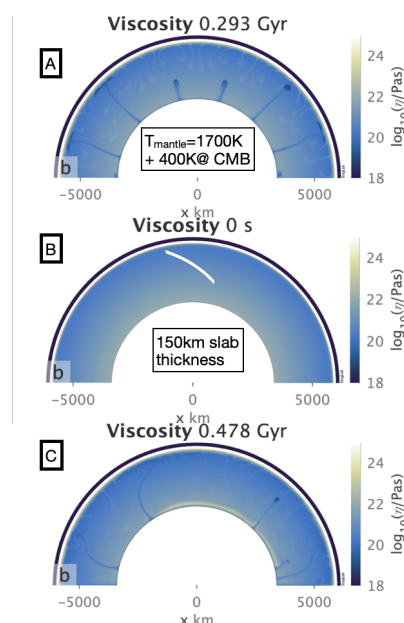


Figure 1. A) The reference model with no slab, a mantle potential temperature of 1700K, and a CMB temperature of 2100K. B) The initial condition with a cold slab covering 13% of the CMB with the same mantle and CMB temperatures. C) 478 Ma following the above initial condition, local suppression of the plumes.

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