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Effects of low-viscosity post-perovskite on thermo-chemical mantle convection in a 3-D spherical shell

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Recent ab initio density function theory calculations by Ammann et al. (2010, Nature) reinforce the idea that post-perovskite has a significantly lower viscosity than perovskite at the (p,T) conditions of the base of the mantle, although due to different activation enthalpies this viscosity difference depends on temperature. We perform numerical simulations of thermo-chemical, multi-phase mantle convection in a 3-D spherical shell in order to determine how a low post-perovskite viscosity affects dynamics and structures in the deep mantle arising from thermo-chemical convection. Low-viscosity post-perovskite weakens the deepest part of slabs, allowing them to more easily spread over the core-mantle boundary (CMB). This increases the size of 'piles' of dense material, the horizontal lengthscale of regions of pooled slab material, and the steepness of piles' edges (in composition and phase), consistent with the existence of sharp-sided edges found in seismic analyses. This may also strongly affect the core. CMB heat flux is strongly enhanced in regions of low-viscosity post-perovskite (consistent with a theoretical prediction) and both CMB and surface heat flux are increased on average by a low viscosity of post-perovskite, which could have important implications for the evolution of Earth's core and mantle.