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Investigating the characteristics of a potential West Antarctic mantle plume with geodynamic models

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Located far away from the margins of either Large Low Shear Velocity Province, West Antarctica is no typical region to expect a hotspot fed by a deeply rooted mantle plume. Also, neither a large-scale flood basalt province nor a clearly age-progressive hotspot track have been identified - both common surface signatures of a plume. However, recent studies provided evidence that the ice cover in Marie Byrd Land conceals one of the largest volcanically active provinces in the world, as well as a distinctively elevated surface heat flux. In addition, volcanic rock samples show a geochemical signature similar to that of ocean island basalts, glacial isostatic adjustment models indicate low viscosities in the upper mantle and seismic tomography reveals distinct zones of slow seismic velocities extending at least down to the transition zone. Altogether, these findings have kept a debate on the existence of a plume alive over the past 30 years. Our study addresses this long-standing hypothesis using geodynamic models as a novel approach in this discussion. We have developed an instantaneous model setup with the mantle convection code ASPECT: as an initial state, we utilize a three-dimensional lithosphere scale model of the Antarctic continent that combines satellite gravity gradients and seismological data. Then we insert a thermal anomaly beneath the lithosphere, simulating ponding plume material. This setup enables the testing of various plume parameters and positions, in order to investigate if a plume can consistently explain the elevated heat flux and low upper mantle viscosities. Thus, our study aims at an evaluation of the likelihood as well as the characteristics of a West Antarctic mantle plume from a geodynamic point of view.