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The deep lithospheric structure of the Namibian volcanic margin

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A model of the thermal, compositional, density, and seismological structure of the lithospheric and sublithospheric mantle along a 500-km transect across the Namibian volcanic passive margin is presented. This margin juxtaposes old oceanic lithosphere and a Precambrian continental domain. The model combines within an internally consistent framework data from petrology, mineral physics, and geophysical observables. The calculated mantle temperature and density distributions down to a depth of 400 km are consistent with available xenolith-derived data, and fit simultaneously the observed free-air anomaly, geoid height, surface heat flow, and elevation. The model also explains the anomalously thick oceanic crust and the depletion of the lithospheric mantle in the ocean-continent transition and in the Proterozoic continental domain. Seismic velocities predicted by the present model are in good agreement with values obtained from wide angle reflection/refraction and tomography experiments. The thermal lithospheric thickness is $\sim$100 km in the oceanic domain, increasing gradually to $\sim$125 km across the ocean-continent transition and then more sharply to $\sim$175 km in the continental domain. The density distribution in the mantle differs significantly from current purely thermal approaches where density is assumed to be only temperature-dependent. Non-negligible compositional density differences are encountered between the oceanic, transitional, and continental domains. Results show that non-thermal effects such as composition and phase changes cannot be neglected in models of the upper mantle.