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The thermal structure, the topographic and thegeoid anomalies of mantle plumes in three-dimensional models

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Thermal convection has been modeled in a 3-D model box, in order to study the thermal structure (temperature anomaly and diameter) of whole mantle plumes and their topographic and geoid anomalies. The aim of the study is the systematic analysis of the effects of the following parameters: the Rayleigh number, the depth-dependent viscosity, the internal heating and the temperature dependency of the viscosity. In the simplest models the viscosity is assumed simply exponential increasing with depth by a factor of 10 and 100. The interior of the convective cell had a lower temperature in the case of higher viscosity contrast. Therefore, the temperature anomaly of the plume became higher. In the topographic anomalies, there were no significant differences between the models of different viscosity contrast. The addition of low viscosity layer (asthenosphere) decreases the geoid and topographic anomalies. The lithosphere (high viscosity layer at the top) makes higher the temperature of the interior of the convective cell.The low viscosity layer at the CMB has no significant effect on the topography, but the interior of the convective cell will be warmer. Basal heating dominates in every model, but the effect of internal heating on the studied features suggests that it cannot be neglected. It decreases the topographic, geoid and temperature anomalies. The effect of the temperature dependent viscosity was studied by using a simple exponential viscosity law. The viscosity increases exponentially from the top to the bottom by a factor of 10 or 100, as in the previous models. The additional exponential temperature dependency has a factor of 2 - 1000. The temperature anomaly of the plume becomes lower by the addition of temperature dependency. The lower viscosity of the hot material can not support so high topography, that's why the topography radically decreases by applying stronger temperature dependence.