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DISSERTATION TITLE: *Density variations and metastability of lower crustal rocks: implications for geodynamic processes*

Knowledge of the composition and physical properties of the Earth's lower crust is crucial to understand the structure of the lithosphere, crust formation and implications for geodynamic processes such as continent collision, basin formation or delamination. Due to the inaccessibility of major parts of the lower crust we have to study rocks presumably derived from lower crustal levels (e.g. granulite terranes, xenoliths, crustal cross-sections) or use indirect methods such as geophysical surveys. Another approach is applied in this thesis and involves the computation of phase equilibria from real or hypothetical whole rock compositions and the extraction of physical rock properties such as densities and seismic velocities.
These thermodynamic models enable us to predict rock behaviour as a function of pressure, temperature and composition and can therefore be combined with geodynamic models for lower crustal processes. The computations show that mafic rocks are not always the densest rock type nor do they always provide the largest increase in density. The metamorphism of hydrous metapelitic Al- and Mg-rich rocks due to pressurization and heating causes a significant densification of thickened crust and consequently subsidence, while heating of dry, basaltic crust leads to a decrease in density. In addition to compositional uncertainties, some lower crustal rocks do not seem to be equilibrated to lower crustal conditions. For instance, the pressure-temperature estimates for cratonic lower crustal xenoliths deviate significantly from cratonic geotherms and are ~200-300 °C higher than what is expected at the base of the lower crust.

The reasons and consequences for geodynamic models such as delamination are further explored in the PhD thesis. Moreover, compositional differences in lower crustal rocks are potentially large and exist on the scales of centimetres up to kilometres resulting in non-unique seismic and gravity data. While larger heterogeneities can be detected as reflections on seismic profiles, irregular small-scale compositional variations are not likely to be discovered, but will influence the averaged seismic velocities and densities of an area. This may have consequences for the interpretation of rock types from seismic data and may lead to the overestimation of the proportion of certain rock types in the lower crust.