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3D density, thermal and compositional model of the Antarctic lithosphere

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In this study, we use an integrative approach combining gravity and tomography data with mineral physics constraints aiming to create a 3D density, temperature and composition model of the Antarctic lithosphere. In the first step, an initial model of the crust based on available seismic, receiver function and tomography data is created. Based on this model, the residual mantle gravity anomalies and residual topography are calculated. In addition, the effect of deep density heterogeneities, which is based on recent global models, is also removed from the residual anomalies. Next, S-wave velocities from two independent tomography models (SL2013sv and AN1-S) are converted to temperature and temperature induced density variations. These density variations are employed to correct the residual fields for the effect of temperature variations in the uppermost mantle. The resulting residual gravity and topography fields are then jointly inverted to obtain a 3D density model of the lithospheric mantle and compositional changes linked to the density changes in cratonic East Antarctica are estimated. On the basis of the new compositional model, a new temperature model is calculated and the scheme repeats until convergence is reached. Our results show a clear distinction between East and West Antarctica in both temperature and density up to a depth of about 200km. The strongest negative compositional density anomalies can be found at a depth of 200km, close to the pole and in the Wilkes Subglacial Basin, along the eastern flank of the Transantarctic Mountains (<-0.04g/cm^3) and in Dronning Maud Land (<-0.035g/cm^3) for the SL2013sv model. The AN1-S model generally yields similar results only with a shift of the density minima towards central East Antarctica. Apart from this general distinction, we also find evidence of smaller scale variations in density both caused by temperature and composition in central East Antarctica, as around the Gamburtsev Subglacial Mountains. Furthermore, the composition analysis yields changes in the Magnesium content of up to Mg# (100 x Mg/(Mg+Fe))>92 within cratonic East Antarctica. Compared to a vertically and horizontally uniform fertile composition with Mg#=89, this causes an increase in temperature of over 100°C.