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A Consistent Thermo-Compositional Model of the South American Cratonic Lithosphere from Integrated Inversion of Gravity and Seismic Data

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We present an integrated model of the cratonic lithosphere of South America. Gravity and seismic data were jointly analyzed using mineral physics constraints to assess state and evolution of the cratonic roots in South America in terms of temperature, density and composition. At the cratons, our model enables separation of two counteracting effects: the increased density due to cooling with age and decreased density due to depletion of iron. The depletion of iron can be described by the Mg# which gives the partition of Mg^{2+} among the double positive ions. A new crustal model (including depth to the Moho) based on existing seismic data was used to correct the gravity field for crustal effects and to uncover the gravity signal of the mantle. In addition, residual topography was calculated as a measure of the part of topography not balanced by the crustal density variations and depth to the Moho. Temperatures within the lithospheric mantle were estimated based on seismic velocities and mineral physics equations, initially assuming a juvenile mantle composition (Mg# of 89). The residual fields were corrected for the respective effects. In the following inversion of residual gravity and topography, we have determined additional density variations which can be interpreted as compositional ones. Furthermore, these results were employed to recompute the upper mantle temperatures taking into account possible compositional changes in the cratonic roots. In this iterative procedure, a consistent thermo-compositional model of the upper mantle has been obtained. Negative compositional density variations imply depletion of iron, leading to higher Mg#s. The highest depletion occurs in the Amazonas and São Francisco Cratons reaching values in the cratons' centers of up to 90 (Mg#). At the same time, their centers show very low temperatures, down to 600° C in the depth of 100 km. They stay below 1300° C even at a depth of 200 km, indicating deep lithospheric roots. Higher temperatures are found in the Andean forelands and along the Trans-Brasiliano-Lineament (TBL), dividing the Amazonas and São Francisco Cratons. Compositional density variations yield smaller to no amounts of depletion in the Amazonas Craton below a depth of 100 km. The São Francisco Craton still shows depletion in 200 km depth (Mg# up to 89.5). Slightly negative compositional density variations southwest of the São Francisco Craton also exist at depths up to 200 km,

indicating the Paranapanema cratonic fragment.