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Cratons: topography, lithospheric structure, and mantle processes

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High topography of cratons is commonly attributed to depleted, low-density composition of the cratonic lithospheric mantle. However, most of the early Proterozoic East European Platform (EEP), and especially its southern part, is covered by an unusually thick (ca. 3 km) cover of sediments. The study discusses a possibility of a compositional subsidence of the EEP in Paleozoic as a response to Devonian rifting at its southern margins. Phanerozoic rifting could cause a density increase of the depleted cratonic lithospheric mantle due to an intrusion of Fe-rich basaltic melts and thus can be responsible not only for subsidence due to thermal relaxation, but also for compositional subsidence. To support this hypothesis, lithospheric density variations of non-thermal origin are calculated from free-board constraints. The results indicate a dramatic north-south change in temperature-corrected density of the lithospheric mantle of the EEP which correlates with the amplitude of the post-Devonian subsidence: density deficit in lithospheric mantle decreases from ca. 1.4% in the Kola-Karelian province of the Baltic shield to 0.6-0.8% in central EEP to zero density anomaly in the southern parts affected by Devonian rifting (Artemieva, EPSL, 2003). The latter could result in a compositional modification and/or detachment of the entire lithospheric column and the consequent, on-going, subsidence of the southern EEP. The conclusions are strongly supported by the results of gravity modeling (Kaban et al., EPSL, 2003): residual mantle gravity anomalies, which represent compositional density anomalies in continental lithospheric mantle after the effect of thermal expansion being excluded, show significant increase in mantle density from the Baltic Shield to the southern parts of the EEP.