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Are xenoliths representative of the "intact" cratonic mantle? A geophysical perspective

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I use two independent approaches to argue that xenolith data on densities and seismic velocities in the Archean-Paleoproterozoic lithospheric mantle maybe non-representative of the "intact" cratonic mantle.

The first example (doi:10.1016/j.gloplacha.2007.02.013) is based on buoyancy modeling for the East European Craton (EEC), that lacks surface relief but has huge amplitudes of topography at the top of the basement (20+ km), at the crustal base (ca. 30 km), and at the lithosphere-asthenosphere boundary (200+ km). I examine the relative contributions of the crust, the subcrustal lithosphere, and the dynamic support of the continental sublithospheric mantle (CSLM) to maintain surface topography, using regional seismic data on the structure of the crystalline crust and the sedimentary cover, and thermal and large-scale P- and S-wave seismic tomography data on the structure of the lithospheric mantle. The results of buoyancy modeling indicate either a smaller density deficit (ca. 0.9 per cent) in the CSLM of the Archean-Paleoproterozoic parts of the EEC than predicted by global data on mantle xenoliths (ca. 1.5 per cent) or the presence of a strong convective downwelling in the mantle beneath the craton interior.

The second example (doi:10.1016/j.lithos.2008.09.015) is based on geophysical constraints on global-scale compositional variations in the CSLM. I calculate seismic velocity variations of a non-thermal origin in the CSLM using global Vs surface-wave and body-wave seismic tomography data (S. Grand, N. Shapiro and M.Ritzwoller)and lithospheric temperatures. In agreement with xenolith data, the results show strong positive velocity anomalies of non-thermal origin (attributed to mantle depletion) for all of the cratons; their amplitude, however, varies laterally and decreases with depth, reflecting either a peripheral growth of the cratons in Proterozoic or their peripheral reworking. CSLM of the cratonic regions where kimberlite magmas erupted shows only weakly positive compositional velocity anomalies as compared to the adjacent "intact" cratonic mantle. A reduction in the amplitude of compositional velocity anomalies in kimberlite provinces is interpreted to result from metasomatic enrichment (prior or during kimberlite emplacement) of the cratonic mantle, implying that xenolith data maybe non-representative of the "intact" cratonic mantle.