

Upper mantle density in Europe and the North Atlantic region

Alexey Shulgin¹, Irina Artemieva²

¹CEED, University of Oslo, Norway, alexey.shulgin@geo.uio.no

²IGN, University of Copenhagen, Denmark, irina@ign.ku.dk

We present a new model, EUNArho, for the density structure of the lithosphere mantle (LM) in the region that extends from the Atlantic coast of North America to the Ural mountains and from northern Africa and Arabia to the Arctic shelf. Gravity modeling, using tesseroids, is constrained by a regional seismic crustal model EUNaseis, a global continental thermal model TC1 and the half-space cooling model for oceans.

On continents, the cratonic LM has a highly heterogeneous density structure and shows no clear distinction from the Phanerozoic LM of western Europe. However, the craton edge along the Trans-European suture zone is marked by a sharp high-density (+1.0+1.5%) LM density anomaly. A low density mantle (3.32 g/cm³) beneath the Archean-early Proterozoic shields of Baltica and Greenland corresponds to the known kimberlite provinces and we find a strong correlation between mantle density and the occurrence of diamondiferous kimberlites. Deep platform basins have a very dense mantle (3.40-3.45 g/cm³), which indicates that eclogitization may have played an important role in their formation. Similar high-density LM is typical of the East Barents shelf, while the West Barents basin has density similar to Proterozoic cratons (ca. 3.35 g/cm³). Platform basins have positive density anomalies of a much smaller amplitude than the cratonic basins, except for the North German basin with +2% density anomaly (>3.41 g/cm³). The Cenozoic collisional orogens of Europe are underlain by a slightly dense (+0.5%) LM associated with subducting slabs. The Gondwana massifs of western Europe have a low-density LM, similar to the cratons.

In ocean south of the Charlie Gibbs fracture zone (CGFZ), we observe only small lateral variations in mantle density, indicating that it is controlled mostly by temperatures that follow the half-space cooling model. Strong low-density LM anomalies (<-3%) are beneath the Azores and the MOR north of CGFZ, including Iceland, and are well correlated with geochemical data, suggesting the presence of continental fragments in oceanic mantle and different degrees of mantle melting. A comparison of mantle residual gravity anomalies in the North Atlantic ocean with normal oceans (that follow the square-root-of-age pattern) shows that south of the CGFZ major anomalies are associated with hotspots and volcanic provinces of the Azores, the Canaries, and the New England volcanic province, while all ocean north of the CGFZ is anomalous. However, the amplitude of the anomalies in the region around Iceland is small and at the edge of resolution by seismic methods.