Acta Geologica Sinica (English Edition), 2021, 95(supp.1): 9–10

Upper Mantle Density Heterogeneity in the European-Anatolian Tethys Belt

Alexey SHULGIN[1] and Irina M. ARTEMIEVA[2, 3, 4, *]

[1] *CEED, University of Oslo, Norway*
[2] *School of Earth Sciences, China University of Geosciences, Wuhan, China*
[3] *Marine Geodynamics, GEOMAR Helmholtz Center for Ocean Research, Kiel, Germany*
[4] *Department of Geophysics, Stanford University, CA, USA*

Citation: Shulgin and Artemieva, 2021. Upper Mantle Density Heterogeneity in the European-Anatolian Tethys Belt. Acta Geologica Sinica (English Edition), 95(supp. 1): 9–10.

We present a new model for the density structure of the lithosphere mantle (LM) in the region that extends from the Atlantic coast of Eurasia to the Ural mountains and from northern Africa and Arabia to the Arctic shelf (Artemieva and Shulgin, 2019; Shulgin and Artemieva, 2019).

For the European continent, the North Atlantic region, and the Arctic shelf, we perform gravity modeling, using 3D tesseroids. The input parameters are constrained by a regional seismic crustal model EUNAseis (Artemieva and Thybo, 2013) and a global continental thermal model TC1 (Artemieva, 2006, 2019). The results show a highly heterogeneous density structure of the cratonic LM of the Baltic Shield and the East European craton (Fig. 1). A low density mantle (3.32 g/cm^3) 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. The craton edge along the Trans-European suture zone is marked by a sharp high-density (+1.0+1.5%) LM density anomaly.

Surprisingly, we do not observe a clear distinction between the cratonic LM and the Phanerozoic LM of western Europe (Shulgin and Artemieva, 2019). For example, the Gondwana massifs of western Europe have a low-density LM, similar to the cratons. The Paleozoic sutures associated with the closure of the Tethyan oceans are marked by changes in the density structure of the lithosphere mantle.

Deep platform basins have a very dense mantle (3.40–3.45 g/cm^3), 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/cm^3). 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/cm^3). The Cenozoic collisional orogens of Europe are underlain by a slightly dense (+0.5%) LM associated with subducting slabs.

We also present the first thermal model for the lithosphere in Turkey (Artemieva and Shulgin, 2019), which shows a highly heterogeneous pattern associated with mosaics of the Tethyan and modern subduction systems (Fig. 2). Lithosphere thinning to 50–75 km in most of western Anatolia may have developed in response to the Hellenic slab rollback, while the Neoproterozoic block in the Menderes Massif preserves a 150 km deep lithosphere root. In central Anatolia, the lithosphere

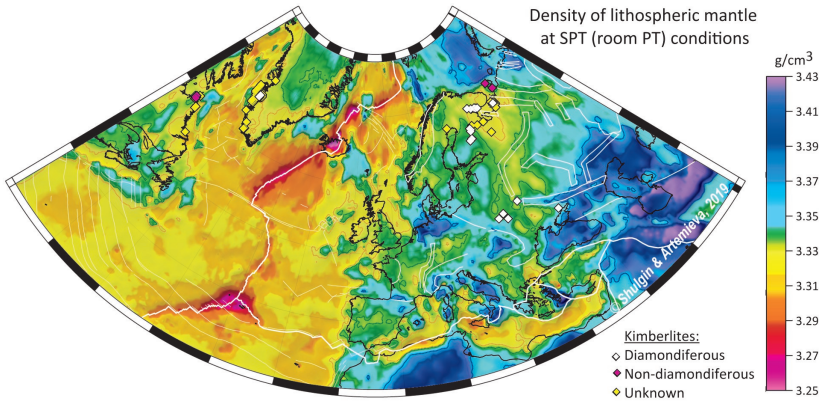

Fig. 1. Compositional heterogeneity of the lithospheric mantle in the North Atlantic region and Europe (from Shulgin and Artemieva, 2019).
The map shows variations in density of the lithospheric mantle at SPT conditions (P = 1 atm, T = 20°C), which allows for their comparison with laboratory measurements.

* Corresponding author. E-mail: iartemieva@geomar.de, iartemieva@gmail.com

http://www.geojournals.cn/dzxbcn/ch/index.aspx
https://onlinelibrary.wiley.com/journal/17556724

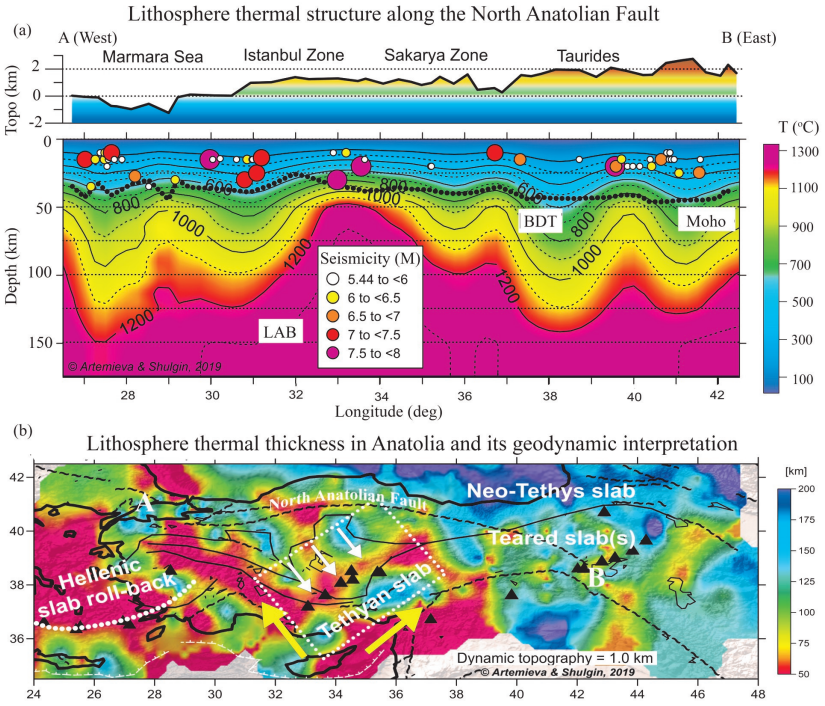

Fig. 2. Lithosphere thickness in Anatolia and geodynamic interpretation of the anomalies (from Artemieva and Shulgin, 2019).

thickness decreases southward from 100–150 to 50–60 km along a linear belt of young basaltic volcanism, followed by a belt of a 150 km thick lithosphere. We interpret this characteristic pattern by a SE dipping paleoslab beneath the western Taurides, which may cause the Cyprus subduction melting zone to deviate toward NW and NE. The Eastern Pontides-Lesser Caucasus have 150–200 km thick lithosphere roots caused by collisional tectonics. The East Anatolian Plateau is underlain by a 80–140 km thick lithosphere, which suggests the presence of significant continental fragments; the patchy pattern of its thermal heterogeneity may be explained by teared and fragmented Tethyan slabs.

In the Tethyan Belt of Anatolia, a poor correlation between the lithosphere thermal structure, heat flux, the Neogene volcanic regions, and mantle seismic velocities implies that seismic anomalies are essentially controlled by heterogeneous mantle hydration by subduction systems of different ages and cannot be explained by temperature variations alone (Artemieva and Shulgin, 2019).

References

Artemieva, I.M., and Shulgin, A., 2019. Geodynamics of Anatolia: Lithosphere thermal structure and thickness. Tectonics, 38: 4465–4487.

Artemieva, I.M., 2019. Lithosphere structure in Europe from thermal isostasy. Earth-Science Reviews, 188: 454–468.

Artemieva, I.M., 2006. Global 1° × 1° thermal model TC1 for the continental lithosphere: Implications for lithosphere secular evolution. Tectonophysics, 416: 245–277.

Artemieva, I.M., 2011. The Lithosphere: An Interdisciplinary Approach. Cambridge University Press, 1–794.

Artemieva, I.M., and Thybo, H., 2013. EUNAseis: A seismic model for Moho and crustal structure in Europe, Greenland, and the North Atlantic region. Tectonophysics, 609: 97–153.

Shulgin, A., and Artemieva, I.M., 2019. Thermochemical heterogeneity and density of continental and oceanic upper mantle in the European-North Atlantic region. Journal of Geophysical Research: Solid Earth, 124: 9280–9312.

About the first author

Alexey SHULGIN, M.Sc. from Lomonosov Moscow State University (Physics) and University of California at Berkeley (Geophysics), Ph.D. from GEOMAR Helmholtz Center in Germany, Research Scientist at CEED Center of Excellence, Oslo University, Norway. Expert in marine seismics with more than 1 year in scientific marine cruises (also as Chief-Scientist of marine expeditions) in the Atlantic and Indian Oceans, and the Mediterranean, Barents, Black, and the Azov Seas. Expert in seismic tomography, scientific code development, and gravity inversion. E-mail: alexey.shulgin@geo.uio.no.

About the corresponding author

Irina M. ARTEMIEVA, Professor, GEOMAR Helmholtz Center, Kiel (Germany), visiting professor at Stanford University (USA), distinguished professor at School of Earth Sciences, CUG, Wuhan. Editor-in-Chief of Journal of Geodynamics, Associate Editor in Nature Scientific Reports, Tectonophysics. Academician of the European Academy of Sciences (Academia Europaea), of the International Eurasian Academy of Sciences, of the Royal Danish Academy of Sciences and Letters. Fellow of the Royal Astronomical Society London. Fellow of the Geological Society of America. Scientific Leader and Executive Board Member of the past EUROPROBE programme of the European Science Foundation. Past President of Geodynamics of the European Geosciences Union. Recipient of the Augustus Love Medal of the European Geosciences Union. Major interest: thermal modeling, integrated geophysical-geodynamic modeling of lithosphere structure and evolution. E-mail: iartemieva@gmail.com.