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Integrated geophysical modeling of the lower crustal - upper mantle structure in the area of the Yenisei-Khatanga trough

Alena I. Filippova[1] **,** Elena Y. Sokolova[2,3] , Sergey V. Filippov[1] , Egor M. Bolshakov[2]

[1] Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of the Russian Academy of Sciences
[2] All-Russian Research Geological Oil Institute, Russia
[3] O.Yu. Schmidt Institute of Physics of the Earth, Russian Academy of Sciences

aleirk@mail.ru

The Yenisei-Khatanga trough is intensively investigated by various geological and geophysical methods due to its oil and gas potential. In our study, we consider the crust and upper mantle structure under the trough based on geomagnetic, gravity, and seismological data and infer some geodynamical insights from all the obtained results.

Firstly, we performed a spectral analysis of the lithospheric geomagnetic field, presented with the EMAG2v3 model, using the centroid method for the Yenisei-Khatanga trough and adjacent areas of the Siberian platform and Taimyr Peninsula. Secondly, a 3D density distribution was calculated for the crust and uppermost mantle under the trough. Restrictions from independent geophysical and geological information, including deep seismic sounding (DSS), 2D seismic profiling, borehole, and magnetotelluric data, were applied during the inversion of the observed gravity field. Finally, 2D S-wave velocity patters along the existing DSS profiles, crossing the considered area, were estimated from local Rayleigh wave group velocities within the periods of 10–250 s, which had been determined by us previously for the whole Arctic.

It has been shown that the deepest bottom depth of the lithospheric magnetic sources (about 50 km) is observed along the whole Yenisei-Khatanga trough. Assuming that this depth to some extent can be regarded as the Curie point depth (CPD) and the main magnetic mineral in the lithosphere is magnetite with the CPD of 578°C, our results contradict available data on lithospheric temperatures inferred both from surface heat flow measurements and inversion of different seismic tomography models. At the same time, an area with high densities (3.1–3.2 g/cm^3) is traced at the depth of 30–45 km under the trough axis according to our 3D density model. Along with the deep CPD, this fact allows us to propose an existence of a basification area in the lower crust and uppermost mantle there with partly serpentenized rocks, for which the CPD reaches 620–1100°C. Therefore, our results support a hypothesis of the riftogenic nature of the Yenisei-Khatanga trough. According to this hypothesis, rifting was developed there in the Permian-Triassic due to the mantle upwelling at its early stage. Remnants of the upwelling are, probably, seen as a low S-wave velocity area at the depths 120–180 km, revealed under the western part of the trough from surface wave data. Remarkably, that for the whole trough the deepest CPD is observed there. Under other parts of the trough, decreased S-wave velocities at the same depths are also traced, but velocity variations are smoothed.