Earth's Crust Model of the South-Okhotsk Back-arc Basin by Multiwave Seismic Data

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Deep seismic studies with ocean bottom seismometers (OBS) and 3-component wave field registration along the near north-south line in the Sea of Okhotsk (Fig. 1) were a framework for the depth models reflecting the position and geometry of the main interfaces in the crust and upper mantle, as well as distribution of P-wave velocity values (Vp), velocity ratio (Vp/Vs), and density (σ) (Fig. 2).

Geophysical data reflect the geology of the southern area of the Sea of Okhotsk region, including structures of the South Okhotsk Borderland, the South Okhotsk Back-arc Basin, and the Kuril Island Arc. All geostructures have individual arrangement of structural and physical parameters, enabling to identify the sedimentary cover, upper, middle, lower crust, and upper mantle (Kashubin et al., 2017).

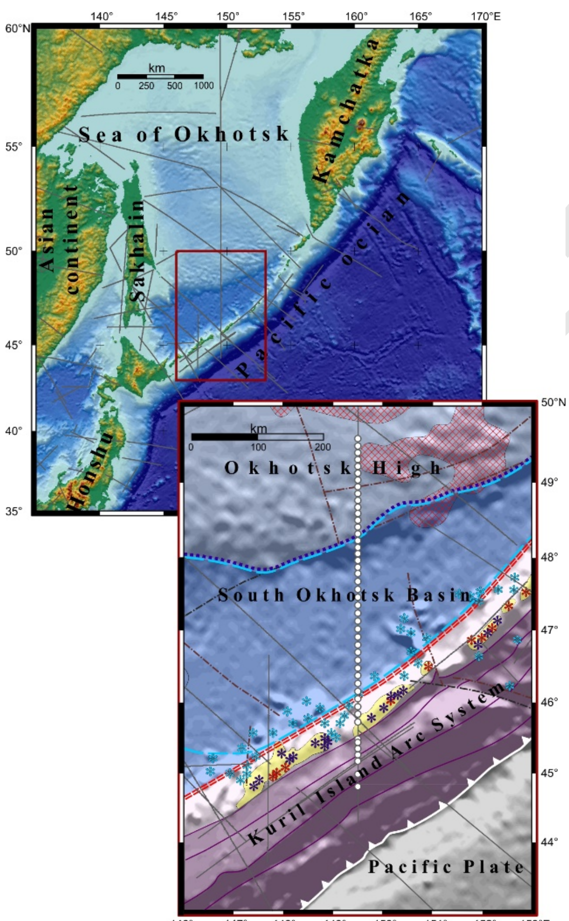

Figure 1. (Top left) Topographic and bathymetric location map of wide-angle reflection and refraction profiles (gray lines) in the Sea of Okhotsk. (Bottom right) Tectonic zoning of the study area on the topographic and bathymetric background. Unfilled circles show OBS positions at the segment of the 2-DV-M Profile presented in this study; white line with triangles – the boundary between the Pacific and the Okhotsk Plates, asterisks – volcanoes: modern active (red), extinct (purple), submarine (blue)

South Okhotsk Borderland and the Kuril Island Arc have the most complete set of crustal layers. Sections of these domains include three layers in the consolidated crust (upper, middle, and lower crust) and two in the sedimentary cover. Crustal thickness in these structures is 22÷26 km, with an insignificant proportion of the sedimentary cover. Crustal thickness in the South Okhotsk Basin, which separates the borderland and the island arc, is much smaller (14-16 km). Thickness of the sedimentary layer is increased here, thickness of the upper crust is significantly reduced. Velocity and density parameters corresponding to a typical lower crust were not detected. Common features of the deep structure have certain symmetry with respect to the axe of the mantle dome, whose arch is located below the South Okhotsk Basin, as shown in Fig. However, this symmetry is not complete. That is observed in some reduction of the total crustal thickness of the Kuril Island Arc and is accompanied by an increase in the proportion of mafic varieties and by growth of lateral heterogeneity of that part of the section. Thickness of the velocity and density anomalous layer in the uppermost mantle is also asymmetric.

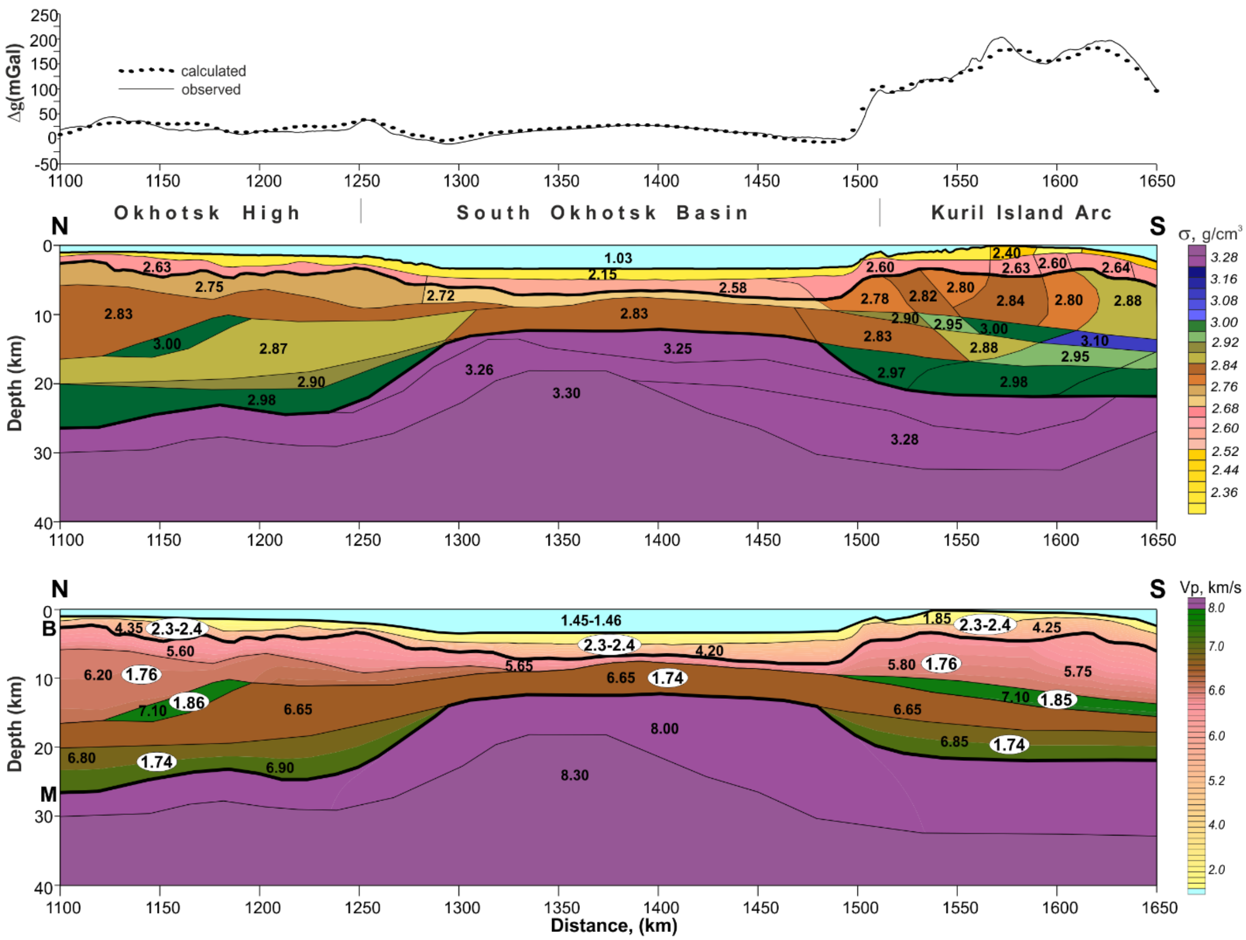

Figure 2. (Top) Observed and calculated gravity profiles along the seismic line. Velocity (bottom) and density (middle) models of the Earth's crust and upper mantle of the South Okhotsk Back-Arc Basin. Densities in the section are given in g/cm3, P-wave velocities in km/s. Numbers in ellipses present Vp/Vs ratio. B – basement, top of the crystalline crust, M – Moho.

Architecture of the Earth's crust and upper mantle, shown in megacomplex structure, enables to typify crust in the distinguished large geological structures. Crust of the South Okhotsk Borderland is characterized as a "typical" three-layered consolidated crust and developed sedimentary layer despite the reduced crustal thickness (about 25 km). Entire set of features can confidently attribute the South Okhotsk Borderland crust to be of a continental type. Crust of the Kuril Island Arc is symmetrically arranged on the other side of mantle dome and is close to that of the borderland in macroparameters. The difference of the island-arc crust from the borderland crust is only in more complex lateral zoning related to volcanic processes. Since, the decisive argument for attributing of the continental crust is not its thickness but the presence of a "granite layer" in crustal structure, this criterion enables to attribute the strongly stretched crust of the South Okhotsk Back-arc Basin to the continental type, where the upper "felsic" part is preserved.

References

Kashubin, S.N., Petrov, O.V., Rybalka, A.V., Milshtein, E.D., Shokalsky, S.P., Verba, M.L., Petrov, E.O., 2017, Earth's crust model of the South-Okhotsk Basin by wide-angle OBS data, Tectonophysics, 710-711, 37–55.