

Density and velocity model of metamorphic rock properties in the upper, middle and lower crust in the geospace of the Kola superdeep borehole (SG-3)

Felix F. Gorbatsevich, Mikhail V. Kovalevskiy, and Olga M. Trishina

Kola Science Center RAS, Geological Institute, Apatity, Murmansk Region, Russian Federation (gorich@geoksc.apatity.ru)

Using the experimental and calculated data as the base, a model for a depth dependence of density, compression and shear wave velocities along the Kola superdeep borehole (SG-3) section was developed down to a depth of ~40 km. In the section of the Kola SG-3 borehole, the density is 3.0 g/cm³ due to the high content of mafic rocks. According to our data, the average density in the middle crust is approximately constant at the same level as in the upper crust. In the lower crust, the average density increases to 3.15 g/cm³. The experimental and calculated variations of the upper crust in the velocity of P- and S-waves are 5.8–6.6 and 3.1–3.9 km/s, respectively. As noted above, by the conditions of rock formation ($P = 700-7900$, $T = 3.2-5.0$ kbar), the region to the west of Lake Chudzjavr can be related to the depth level of the middle crust. The variations in the calculated parameters (velocities of P- and S-waves) for these rocks are $V_P = 5.8-6.4$ km/s and $V_S = 3.4-3.6$ km/s. The physical properties of the lower crust rocks were estimated by granulite xenoliths from Elovoy Island. The limits of the variations in the calculated density and seismic velocities under the conditions ($P = 700-9300$, $T = 12-15$ kbar) corresponding to the lower crust are $V_P = 6.5-7.7$ km/s, and $V_S = 3.6-4.6$ km/s. The growth in the density and seismic velocities in the lower crust is caused by the increase in the content of pyroxene and garnet, which are high-velocity minerals. The experiments showed that the compression force leads to increasing and the temperature to decreasing velocities [Kern et al, 2001]. The relative reduction in the velocities of compression and shear waves with depth under the influence of increasing pressure and temperature in the range of 5-40 km is about 2%. The variations of the density, compression and shear wave velocities are mainly caused by the changes in the rock mineral composition. It should be noted that the velocity anisotropy of metamorphic rocks in the upper and middle crust is very significant [Structure..., 2015]. The work was performed within project № 16-05-00026- of the Russian Foundation for Basic Research.

References

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