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Tectonics, Deep-Seated Structure and Recent Geodynamics of the Caucasus

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The tectonics and deep-seated structure of the Caucasus are determined by its position between the still converging Eurasian and Africa-Arabian plates, within a wide zone of continental collision. The region in the Late Proterozoic - Early Cenozoic belonged to the Tethys Ocean and its Eurasian and Africa-Arabian margins. During Oligocene–Middle Miocene and Late Miocene–Quaternary time as a result of collision back-arc basins were inverted to form fold-thrust mountain belts and the Transcaucasian intermontane lowlands.

The Caucasus is divided into platform and fold-thrust units, and forelands superimposed mainly on the rigid platform zones. The youngest structural units composed of Neogene–Quaternary continental volcanic formations of the Armenian and Javakheti highlands and extinct volcanoes of the Great Caucasus.

As a result of detailed geophysical study of the gravity, magnetic, seismic, and thermal fields, the main features of the deep crustal structure of the Caucasus have been determined. Knowledge on the deep lithospheric structure of the Caucasus region is based on surface geology and deep and super deep drilling data combined with gravity, seismic, heat flow, and magnetic investigations.

Close correlation between the geology and its deep-seated structures appears in the peculiarities of spatial distribution of gravitational, thermal and magnetic fields, particularly generally expressed in orientation of regional anomalies that is in good agreement with general tectonic structures.

In this study we present two tomographic models derived for the region based on two different tomographic approaches. In the first case, we use the travel time data on regional seismicity recorded by networks located in Caucasus. The tomographic inversion is based on the LOTOS code which enables simultaneous determination of P and S velocity distributions and source locations. The obtained model covers the crustal and uppermost mantle depths. The second model, which is constructed for the upper mantle down to 700 km depth, is based on the data from the global ISC catalogue. We use travel times corresponding to rays which travel, at least partly, through the study volume. These data include rays from events in the study area recorded by worldwide stations, as well as teleseismic data recorded at regional stations.

The computed seismic models reveal some deep traces of recent tectonic processes in the Caucasus:
• For the 5, 15, 25 and 60-km-depth, there appears a clear coincidence between anomalous low velocities of P and S-waves with the fold-thrust mountainous belts of the Great and Lesser Caucasus, and also connection of high-velocity anomalies with the Trasncaucasian forelands.
• Lowest-velocity anomalies are characteristic of the areas of Neogene-Quaternary volcanism of the Great and Lesser Caucasus. Areas with the lowest velocities of P- and S-waves coincide with the mountainous-folded belts, whereas the areas of high-velocity predominantly coincide with the platformal structures and forelands, as well as with basins of the Black and Caspian Seas.
• Clear spatial correlation of the areas of lowest values of P- and S-velocities with the areas of Neogene-Quaternary volcanism occurs up to the depth of 150-200km that evidences location of magma sources within the crust – upper mantle - asthenosphere.
• Tomographic data unambiguously confirm spatial unity of the main structures of the Caucasus and its basement, the location of the structures in situ in Late Cenozoic and connection of the volcanic constructions with their roots - magma chambers.