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Geodynamic Features and the Earth's Interior Structure of the Europe-Mediterranean Region using the Gravimetric Tomography Method

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Introduction

Most of tectonic researches are constrained by the shortage of the deep Earth's interior data. An informative source of such data is the seismic tomography technology [1] with the earthquakes and explosions signals. We developed and applied another "gravimetric tomography" technique to reconstruct the interior structure of the Earth.

Deep dense structure and geodynamic features of the Tethys region are presented as a result of the gravimetric tomography method using the EGM96 geopotential geoid model data. A distribution of density inhomogeneities in depths is considered along 3, 7 and 8 geological/geophysical geotransects (TRANSMED Project) and on lateral layers in different depths on maps within the region of 25º-50ºN and 14ºW-42ºE.

Method

This method is based on using the geoid global geopotential model and includes the following tasks:

1. Calculation of the relationship between a spherical harmonic degree of the geoid topography and depth of the disturbing layer.

2. Determination of density of anomalous disturbing masses.

3. Creation of tomographic images of dense inhomogeneities for studied regions.

The well known geoid theory harmonic function $1/r$ is used to evaluate the depth r of a disturbing layer. The solving of the inverse gravity problem by Professor Helmut

Moritz [2] is used to transform geopotential anomalies to density anomalies.

Values of the gravity potential as heights of the geoid and values of density harmonic anomalies in g/cm3 are computed using the EGM96 geoid model data with an interval of 15'.

Results

The reconstruction of the Earth's geological structure shows a detailed distribution of masses in the upper layers of the lithosphere, geometry and sizes of density inhomogeneities, their displacement in depth on impact of geodynamic processes, and correlation of subsurface bodies with the visible topography also.

Internal structures along geotransects 3, 7 and 8 for all depths from the surface up to 5300 km are shown as an intensity of a disturbing gravity potential calculated by the all of 360 harmonics of the geoid model. Only large-scale structures are visible at the 3d plain images in this case. A dense layer in depths of 3200-2000 km at the boundary between the outer core and lower mantel is observed at all sections. The lower mantle in depth of 750 km under the Mediterranean Sea is complicated by the intrusion of the less dense body. Apparently it is a heated matter (plum), which is uplifted from the hot spot located in coordinates of 25ºN and 12ºE in depth of 2800 km. This matter get up on the surface in the Gulf of Lions, Adriatic Sea and near the Crete Island. The boundary between lower and upper mantle are visible very clearly in depth of 300 km approximately. Roots of the mountain massifs of the Anatolia, Aegean Sea and Rodope have a total body in depth of 60 km. The body is moved along the 7th section northward for the space of 400 km under the Dobrogea. This displacement is not more than 200 km on the 8th section due to the Black Sea's fault.

The characteristic feature at the 3rd geotransect (Massif Central-Gulf of Lions-Sardinia-Tyrrhenian basin-S. Apennines-S. Adriatic-Albanides-Balkanides-Moesian platform) is the displacement of the Apennines root westward for the space of 500 km under the Sardinia up to depth of 40 km. Structure images up to depths of 100 km and 10 km are shown for detailed analysis of the mutual distribution and geodynamic features in the region.

The typical rift construction with a narrow channel for the abruption of heated matter and flanking ridges which are dived with an inclination is visible along the 7^{th} geotransect (Dobrogea-Moesian platform-Rhodope massif-Aegean Sea-Crete-Sea of Libya-Cyrenaica) in area of the Crete Island. We observed the like constructions in others regions of the World Ocean.

The 8^{th} geotransect (Ukraine-Black Sea-Cyprus-Sahara) have an extension of 2337 km. The lower mantle in depths of 2800-800 km is characterized by two blocks: the negative density is in the south part and positive is in the north. The vertical boundary between them are projected to the southern edge of the Anatolia.

The layer of 800-500 km is the transitive zone from the lower to upper mantle. Three large anomalies are allocated in the basis in depth 300 km.

The central dense body is more than 1300 km for an extension along the geotransect. There are characteristic ledges at its foot (depths of 330 and 250 km) connected with spill of the body's material on the more dense substratum of the lower mantle. A narrowing of this body up to 500 km is observed in depths 70-35 km. The epicentre of density of the anomaly with maximum 0.21 g/cm3 is in depth of 14 km. Total density range for different anomalous bodies along the transect is changed from -0.1 g/cm3 (lower mantle) up to 0.21 g/cm3 (mountain ridge).

A differentiation of geological masses is increased in smaller depths. Only six positive and negative bodies are allocated in the layer of 20 km along the transect. And 20 anomalies are observed in depths of 2.5 -3.0 km.

Significant spatial geodynamic displacements (up to 300 km) of the bodies' root parts relatively their location on the surface are identified in depths less than 10 km.

Regional spatial distribution of dense inhomogeneities are shown in different depths on maps. Structure of the lower layers are presented without an influence of the upper layers. Mutual distribution of the upper masses only are shown on the other maps.

Conclusion

The Gravimetric Tomography method displays a mutual disposition of anomalous heterogeneous on density mass and their geometry within an interior of the Earth. It make possible to identify geodynamic tendencies in different scales from large global structures like the convective cells, which are responsible for the plate tectonics, to surface structures of the crust like the continents and more smaller bodies which are dived in the lithosphere.

The tomographic method allows to obtain a new information on the structure and tectonics, to improve an understanding of geodynamic processes and possible their evolution, discover relationship between geospheres in the core-mantle-crust system.

References

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