Idea362

Title: Modelling of the Antarctic and Arctic Polar Regions' Deep Structure and Geodynamic Features Using the Gravimetric Tomography Technique

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Rationale

Most of tectonic topics are restrained by insufficiency of the deep Earth's interior data. This problem relates especially for the difficult-accessible polar regions. An informative source of such data is the seismic tomography technology [1] with the earthquakes and explosions signals. We developed and applied [2] another the "gravimetric tomography" technique to reconstruct the interior structure.

Scientific Background

The method is based on using of the geoid model spherical harmonics and altimeter data.
The Gravimetric Tomography includes a decision of the following tasks:
1. Calculation of a relationship between a harmonic degree of the geoid topography and depth of a disturbing layer of the Earth.
2. Determination of a density of anomalous disturbing masses.
3. Creation of tomographic images of dense inhomogeneous for studied regions.

To evaluate a depth *r* of disturbing layer we used an inversion solution of the well known harmonic function *1/r* in the geoid theory *(*where *r* is the distance from the sphere surface down to the disturbing mass). As a result, the relationship between harmonic degrees and depth of disturbing layer was obtained as a bilogarithmic diagram. It is coordinated with estimations of layers' depths responsible for disturbance of some spherical harmonics which are cited in the works [3, 4].
To transform geopotential anomalies to density anomalies is used a solving of the inverse gravity problem by H. Moritz [5].

Some results

The three-dimensional images of a deep structure from surface to the core for any cross section are built. Polar stereographic maps show also a distribution of density inhomogeneities because of geodynamic processes in different depths. Values of the gravity potential in units of heights of the geoid and values of density harmonic anomalies in g/cm3 are computed by the EGM96 geoid model with an interval 15'.
In accompanying Figures are shown examples of maps of a differential geoid for the Antarctic (Fig. 1) and Arctic (Fig. 3) with the surrounding areas. These residual topographies are calculated by a range of spherical harmonics 50-360 degrees which are disturbed by layers a thickness of 20 km from the geological surface of the land and sea-bottom. Many of these undulations have a good accordance with known topography of the relief. Structure and dynamics of lower horizons (asthenosphere, mantle and topography of the outer core) are distinguished considerably. More bright tint is more dense structure.
Distribution of density inhomogeneities is displayed along the Scotia Sea's central 58S latitudinal vertical cross-section between 70-20W (Fig. 2). The area of increased density is noted in depth 100 km. It is a root part of the really Scotia body. The roots of the South

Sandwich Island ridge (1) are sloped to the Scotia Sea side and are immersed into depths 25-30 km. The South Sandwich Trench (2) is traced up to depth 20 km.
In Fig. 4 is shown a deep distribution of structures which are known on surface along longitudes 146W-34E: 1- Canadian Basin, 2 – Alpha Ridge, 3 – Makarov Basin, 4 – Arctic Mid Ocean Ridge, 5 – Nansen Basin, 6 – elevation in the Barents Sea. Boundary of the asthenosphere is on depth 60 km. Exaggeration is different for layer up to 15 km and for layer 15-100 km.

Activities

Our main activities within this idea should be: identification of tectonic structures and geodynamic features on the whole range of depths of the crust, lithosphere and mantle for the Scotia Sea region, for different Antarctic Peninsula's blocks (Trinity, Graham, Transfer Zone, Palmer, Elsworth) and for the continental margin westward of the Antarctic Peninsula using the gravimetric tomography method.
These researches will be accompanied by calculation of the detailed altimetric geoid for the regions, by processing and analysis of interferometric ERS images and fieldworks in the ukrainian antarctic expeditions with bathymetric, geological sampling and marine geophysical surveys.
Moreover, we propose an international collaboration to carry out modelling of the tectonosphere in different regions of Antarctic and Arctic on the basis of the gravimetric tomography technique.
The suggested activity will make a contribution to the SCAR/ANTEC Program (IPY project no. 335).

Interrelations with other IPY proposals

Imaging of the internal structure with the gravimetric tomography is close to purpose of the IPY project no. 32.
Data of the gravimetric tomography can be informative for the projects no. 75, 182, 204, 223, 314, 342 (19, 20) and 353 (1).
We invite others researchers to contact us in case they want to obtain more detailed preliminary data on a deep structure of their areas.

1. Bijwaard et al. JGR 1998.
2. Greku R.Kh., Usenko V.P., Bondar K.M., Greku T.R. Geodynamic Features and Density Structure of the Earth's Interior within the Scotia Arc with the Geoid and Altimetric Data, ISAES-IX Proceedings Volume, Antarctic Contributions to Global Earth Sciences, Sept. 8-12, 2003, Potsdam, Germany, submitted to D.K. FÜTTERER et al. (editors, in press).
3. Allan R.R. 1975. Depth of sources of gravity anomalies. "Nature. Phys. Sci." , 236, #63, 22-23.
4. Gainanov A.G. 1981.Geology and Geophysics of the Eastern Indian Ocean Floor (by the 54 and 58 cruises data of the RV Vityaz). - Moscow, Nauka, -256 p. (in Russian).
5. Moritz H. 1990. The Figure of the Earth. Theoretical Geodesy and the Earth's Interior. Wichmann, Karlsruhe.