Gravity and geomagnetic data for studying geological structures and geodynamical processes in the Black Sea region

Гравиметрични и геомагнитни данни за изучаване на геоложки структури и геодинамични процеси в Черноморския регион

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Introduction

Geological and geophysical studies of the Black Sea region help to clarify the various aspects of the often conflicting scientific views on evolution, geological, tectonic processes and crustal structures in depth. We have the capability to extract more useful information for discovering the geological structural heterogeneity and to expand the scientific exploration in this region using advanced geophysical methods and satellite technologies for obtaining, processing and presentation of variety types of data.

Available gravity and geomagnetic data for the Black Sea region

A gravity map of the Black Sea area (free-air anomalies at sea and Bouguer anomalies on land) is presented in Fig. 1. It’s marine part is based on a 1:1 000 000 Scale map compiled from about 35 000 in situ observations made in the period around over 40 years. These data were collected by various industrial and academic organizations from the former Soviet Union (Starostenko et al., 2004). Different instruments and navigation systems were used although all data have been reprocessed

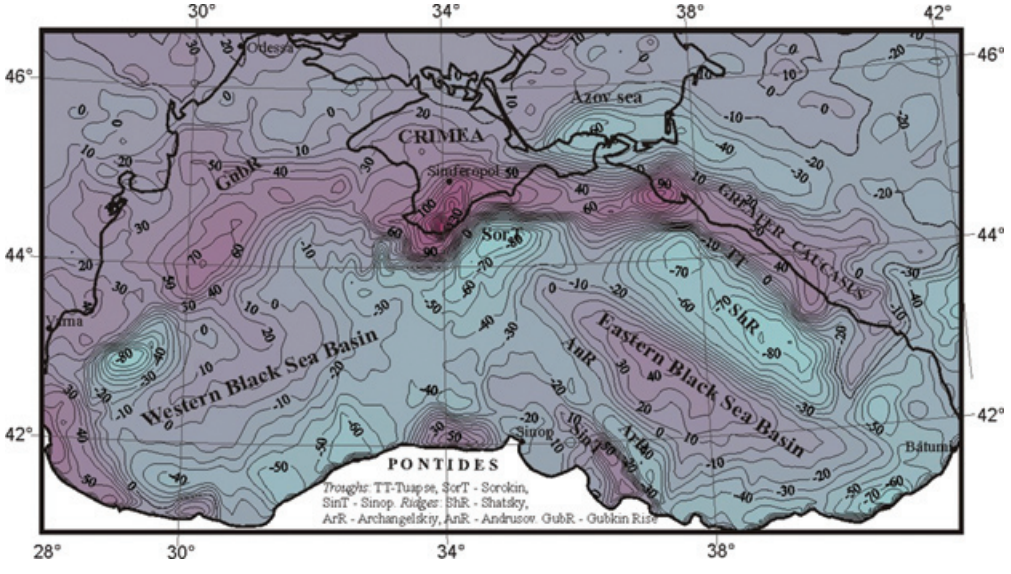

Fig. 1. Simplified anomaly gravity map of the Black Sea region: free-air anomalies (at sea) and Bouguer anomalies (on land). Contour interval is 10 mGal.

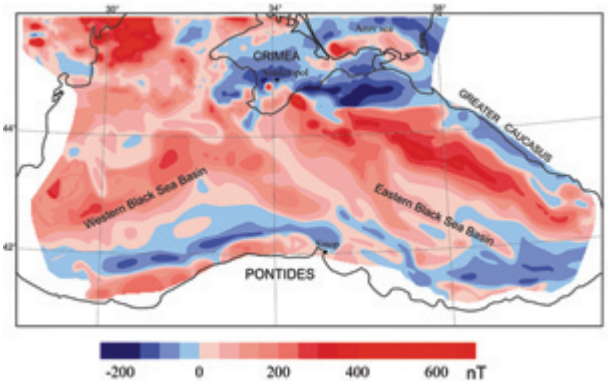

Fig. 2. The anomalous magnetic field ΔT of the Black Sea

to a common standard and are referenced to IGSN71. The free-air anomaly error from all processed data is estimated to be ±1.6 mGal.

Despite the significant thickness of young, roughly flat-lying sediments in the Black Sea and their more or less constant thickness within the basin, there exist local positive and negative gravity anomalies (near the Bulgarian shelf, the Sorokin Trough, the Greater Caucasus coast, etc.) with magnitudes up to several tens of mGal. The gravity field in the adjacent continental areas correlates with deep structures of the individual geological features. Further, isolated gravity anomalies with large amplitude are observed in or near to the margins of the Black Sea Basin (NW shelf), which extend into the land areas. Their marine termination nearly always coincides with the 200 m isobath. In the western sub-basin, two positive anomalies of 60–70 mGal are occurring and they comprised the area from the western boundary of the Burgas zone to the West Pontides. On the boundary between the Black Sea Basin and the Gulf of Odessa, the Gubkinsky gravity maximum (over Gubkin Rise) is of about 80 mGal. On the northern margin, there is a gravity maximum which extreme value of over 180 mGal is associated with the Crimean Mountains. The large West Caucasus anomaly (with magnitude more than 100 mGal) is located on the northeast margin of the Black Sea. In the easternmost Black Sea, the positive anomaly is with magnitude of more than 40 mGal. The southern margin is characterized by two positive gravity anomalies each with values above 70 mGal. The first is situated southeast of Sinop and the second is to the west.

The results of the general survey in 446 settlements (1958–1960), in which D, I, H, Z, T-components of the Earth's magnetic field have been measured are the basis of geomagnetic researches in Bulgaria. Based on these studies the normal field for all geomagnetic components was constructed and their anomalous values were calculated (Kostov, Nozharov, 1974).

The data for the Earth magnetic field for the Black Sea region are published (Malovitskiy et al., 1972; Simonenko, Pashkevich, 1990). Marine data are available in the National Geophysical Data Center (OCN) Boulder, Colorado from 2003. The data are for profiles (trk68996 MAGNETICS) in the digital format for the storage of XYZ geospatial potential field data (www.ngdc.noaa.gov/mgg/geodas/trackline.html). Digital magnetic anomaly maps of the Black Sea and adjacent areas are given in Kravchenko et al. (2004) and Purucker (2007). On Fig. 2 a map of the anomalous magnetic field ΔT for the studied area is presented.

NASA launched the magnetic field satellite MAGSAT to examine specifically large- and medium scale lithospheric anomalies. The MAGSAT data indicates that negative magnetization values are over the east Black Sea due to a thick pile of the sedimentary rocks and semi-oceanic crust. CHAMP satellite data are used for preparation of the World Magnetic Anomaly Map (Maus et al., 2007). The magnetic anomaly field model MF5 shown on this map is derived by upward continuation of the geomagnetic field data to the satellite altitude.

Conclusions

The recent progress in gravity and magnetic methods and the qualities of surface, marine, airborne, and satellite measurements expand the possibilities to study the Black Sea region. Up-to-date gravity and magnetic surveys are a valuable source of data for engineering, petroleum, mineral, environmental, geological and archeological exploration of the lithosphere as well as for improvement of potential-field interpretation, modeling of geological structures and geodynamic processes. New satellite-derived gravity and geomagnetic data allow an optimal combination with in situ observations, which enable to perform researches everywhere in the sea.

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