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**A. T. DONABEDOV, V.
A. SIDOROV, K. V.
TIMAREV, and L. N.
TORKHOVSKAYA**

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Abstract

Full Text

GEOPHYSICS

A. T. DONABEDOV, V. A. SIDOROV, K. V. TIMAREV, and L. N. TORKHOVSKAYA

ON THE QUESTION OF RELATIONS BETWEEN THE RATES OF MODERN VERTICAL MOVEMENTS OF THE EARTH'S CRUST, GEOPHYSICAL FIELDS, AND GEOSTRUCTURAL ELEMENTS

(Presented by Academician I. P. Gerasimov on 28 X 1959)

Clarifying regular relations between geophysical fields and modern vertical movements of the earth's crust is possible in two principal directions.

One of the possible directions consists in studying changes over time in natural geophysical fields, with the simultaneous study of changes over time in modern vertical movements of the earth's crust, in order to detect **direct** correlative relations between these phenomena. These relations, by means of symbols, may be written in the form

$$GPhF(t) \Leftrightarrow H(t),$$

where $GPhF$ is the geophysical field; H is the magnitude of modern vertical displacements; t is time.

Another possible direction consists in studying not direct relations between natural geophysical fields and modern vertical movements of the earth's crust, but **indirect** relations, through definite types of structures of the earth's crust. The latter, as is known, find a regular reflection in all natural geophysical fields and, in particular, in the gravitational field. There is no doubt that modern vertical movements of the earth's crust also manifest themselves specifically within different types of geostructural elements.

Such a method of studying relations between spatial changes in natural geophysical fields and modern vertical movements may be written symbolically in the form

$$GPhF(x) \leftarrow GE \rightarrow V(x),$$

Fig. 3. Modern vertical movements of the Earth' s crust (1) and the Δg curve (2) along the Krasnodar–Stalingrad profile

Figure 1: Fig. 3. Modern vertical movements of the Earth' s crust (1) and the Δg curve (2) along the Krasnodar–Stalingrad profile

where $GPhF(x)$ is a geophysical field varying in space; GE is a geostructural element; $V(x)$ is the rate of modern vertical movements of the earth' s crust, varying in space.

This second direction was adopted in the geophysical laboratory of the Complex Southern Geological Expedition of the Academy of Sciences of the USSR, where, under the direction of A. T. Donabedov, since 1957 systematic investigations have been carried out to identify and analyze indirect relations between natural geophysical fields and modern vertical movements of the earth' s crust in connection with solving the problem of regularities in the geophysical characteristics of the principal geostructural elements of the earth' s crust.

Using the published results of repeated levelings ⁽¹⁾, which revealed modern vertical movements, as well as gravimetric data—

of the gravitational field for the territory of the Caspian Sea basin and its framing, we compiled a series of profiles, on the basis of the analysis of which several typical cases of relationships between Bouguer gravity anomalies and present-day vertical movements were established (Fig. 1).

Fig. 1. Main types of relationships between present-day vertical movements of the Earth' s crust and geophysical fields (gravitational field). **1**—curves of the velocities of present-day vertical movements of the Earth' s crust V ; **2**—curves of gravity anomalies Δg

Fig. 2. Present-day vertical movements of the Earth' s crust (**1**) and the Δg curve (**2**) along the Rostov–Salsk profile

Up to the present time three main types of relationships have been identified:

- a) the first type of relationship, termed **direct**, consists in the fact that the changes in the curves V and Δg have the same character, i.e., an increase or decrease in V corresponds to an increase or decrease in Δg (Fig. 1a);
- b) the second type of relationship, termed **inverse**, consists in the fact that that a relative decrease or increase in V corresponds to a relative increase or decrease in Δg (Fig. 1b);
- c) the third type of relationship, conventionally called **indeterminate**, consists in the fact that, with an intensive change over a certain distance in one of the curves V or Δg , the other undergoes no changes at all and retains its character beyond this segment (Figs. 1c and 1d).

Fig. 3. Modern vertical movements of the Earth' s crust (1) and the Δg curve (2) along the Krasnodar–Stalingrad profile.

Proceeding from the listed types of relationships and analyzing specific relationships between V and Δg together with schematic geological sections along the profiles Rostov–Salsk (Fig. 2); Stalingrad–Krasnodar (Fig. 3), taking into account data for other profiles, which are not presented here, the following conclusions may be outlined:

1. The decrease in V and Δg that occurs on the Rostov–Salsk profile corresponds, in general terms, to the subsidence from NW to SE of the Precambrian crystalline basement from 560 m in Rostov to more than 2 km in Salsk.
2. The gradientless character of V and Δg between the Proletarskaya and Tikhoretsk stations (Fig. 3) corresponds to an almost horizontal occurrence of the Paleozoic folded basement.
3. The Donets trough (its southeastern continuation), composed of metamorphosed Carboniferous deposits of great thickness within the deep subsidence of the Precambrian basement between the Proletarskaya and Kotelnikovo stations (Fig. 3), corresponds to inverse relationships between V and Δg .
4. The possible southeastern continuation of the Fore-Donets trough between the Kotelnikovo and Stalingrad stations (Fig. 3) also corresponds to inverse relationships, but here a relative maximum of V corresponds to a relative minimum of Δg .
5. For the western part of the Pre-Caucasian Alpine trough (the Krasnodar region, Fig. 3), a direct relationship is characteristic, when a decrease in V corresponds to a decrease in Δg .
6. Transitions between different types of relationships, usually sharp, are observed within comparatively narrow zones, which are characterized by comparatively high gradients of V and Δg , which was manifested especially clearly on the Stalingrad–Krasnodar profile (the Proletarskaya and Kotelnikovo region, Fig. 3). These comparatively narrow zones of transition from one

of one type of relationship between V and Δg to another type of relationship in a number of cases, and possibly in all cases, may reflect boundaries between differently structured sectors of the folded basement, which is of fundamental importance from the standpoint of more reliable identification and tracing of boundaries between possibly large blocks of the folded basement, and perhaps also deeper parts of the Earth' s crust (Figs. 2 and 3).

The immediate task of further research on the study of relationships between contemporary vertical movements of the Earth' s crust, the gravitational field, and other natural geophysical fields is to move from the relationships that have

been identified to the establishment of causal connections between these phenomena.

Institute of Geology and Development of Combustible Minerals
Academy of Sciences of the USSR

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1. Proceedings of the Central Scientific-Research Institute of Geodesy, Aerial Photography, and Cartography, vol. 123 (1958).

Note: Figure translations are in progress. See original paper for figures.

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