# REGIONAL FEATURES OF THE STRUCTURE OF THE EARTH' S CRUST OF THE RUSSIAN PLATFORM FROM DATA ON AVERAGED GRADIENTS OF THE GEOMAGNETIC FIELD

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## Abstract

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# REGIONAL FEATURES OF THE STRUCTURE OF THE EARTH' S CRUST OF THE RUSSIAN PLATFORM FROM DATA ON AVERAGED GRADIENTS OF THE GEOMAGNETIC FIELD

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To reveal regional features of the Earth' s crust of the Russian Platform, a method is proposed for converting (transforming) the geomagnetic field $\Delta T$ into a field of averaged horizontal gradients $\Delta T$. The use of magnetic-field gradients has proved useful in the interpretation of local anomalies (in questions of determining the depth of occurrence of an important group of disturbing bodies ([1,2])). In a somewhat different modification, the gradient method is successfully used in electrical prospecting.

In passing from the study of local geomagnetic fields to the investigation of regional features of the geomagnetic field, a number of fundamental difficulties arise, of which the most complex is the transition from large-scale geophysical maps to small-scale ones. The method of direct pantographic reduction leads to averaging of the values of the anomalous magnetic field, which entails a great loss of geological information contained in a large-scale map (since individual local anomalies merge in this process, so that, for example, a series of intense meridional anomalies may turn into one less intense anomaly of latitudinal direction).

To reveal the regional features of the deep geological structure of the territory under consideration, it proved expedient to present the results of magnetic surveys in the form of axes of horizontal gradients of the magnetic-field intensity (Fig. 1). Maps of $\Delta T$ in isolines were compiled by M. S. Zakashanskii, E. E. Fotiadi, A. N. Korneva, and others. Earlier an attempt had been made to present the results of magnetic surveys in the form of axes of anomalies (Fig. 2).

We have proposed a new method for transforming the anomalous magnetic field $\Delta T$ by calculating the modulus of the averaged horizontal gradients of $\Delta T$. The $\Delta T$ maps (presented as isolines) were divided into equal squares, and in each of them, over a unit segment equal to the side of the square, the greatest rate

of change of $\Delta T$ was calculated, i.e., the gradient vector of $\Delta T$. Through the point with the maximum value of the gradient (at the place where the isolines are condensed), a segment was drawn perpendicular to the latter (the vector) and called the axis of the gradient of $\Delta T$ (in the square under consideration), to which the magnitude of the vector was assigned.

It was found that the highest values of the gradients (more than 500 gammas/km) lie east of the Riga meridian within a zone that we have called the Baltic-Ukrainian. The eastern boundary of this zone passes along the line Narva –Pskov–Minsk and farther east of the city of Pinsk. Within this zone, the gradient axes are the most persistent linear trends, the principal ones of which are close to meridional (the areas: Viljandi, Võhma, Cēsis, Pļaviņas, Vilnius, Baranovichi, Krynki). The noted trends reflect the character of the most ancient Precambrian folding, tectonic disturbances, and deep faults. This zone is characterized by an uplifted part of the relief of the surface of the Precambrian basement and, apparently, by a deeper level of erosional truncation. Local uplifts of the basement correspond here to intense positive $\Delta T$ anomalies, caused –

[Map diagram]

**Fig. 1.** Diagram of combined results of integrated investigations. **I.** Values of the horizontal gradients of the magnetic field (in $\gamma$/km): $a$ –> 1000, $b$ – 500-1000, $v$ –200-500, $g$ –100-200, $d$ –50-100, $e$ –20-50. **II.** Rate of contemporary tectonic movements (mm/year): uplifts –1 –7-10; 2 –5-7, 3 –2-5, 4 –0-2; subsidences –5 –0-2, 6 –> 2. **III.** Isobaths of the surface of the crystalline basement. **IV.** Boreholes drilled to the basement. **V.** Areas with local structures: 1 –Gusevskaya, 2 –Vyborgskaya, 3 –Taurskaya, 4 –Salduskaya, 5 –Prussian, 6 –Kaunasskaya, 7 –Panevezhskaya, 8 –Bauskaya, 9 –Elgavskaya, 10 –Rechitsa, 11 –Luzhskaya, 12 –Gatchinskaya, 13 –Ozerskaya.

···are caused by the heterogeneity of the material composition and magnetic properties of the basement rocks, which, in turn, determine the structural features of these uplifts–for example, steep slopes and ledges in the area of the Loknov uplift. In terms of area, local magnetic anomalies usually have···

have smaller dimensions than the gravitational ones, and are located on the periphery of the latter (in areas of large gravity gradients). In the eastern part of the zone, high gradients of $\Delta T$ take the form of arcs with maximum convexity to the east at the latitude of Daugavpils. In Estonia, arcs of NW trend stand out sharply (Türi–Võhma–Tartu), and in Belorussia, arcs of SW trend (Drissa –Minsk–Baranovichi). A continuation of the trends of the described arcs, but with smaller gradient values, is also present beyond the Baltic-Ukrainian zone of high gradients (as far as the meridian of Luga). East of the Luga meridian, the direction of the gradient axes becomes a mirror reflection of the indicated arcs, simultaneously corresponding to the western margin of the Central Russian syneclise. It should be noted that the direction of the arcs reflects fold systems close in age.

Fig. 2. Diagram of magnetic-field anomalies of the Baltic region (after Faitelson)

Figure 1: Fig. 2. Diagram of magnetic-field anomalies of the Baltic region (after Faitelson)

**Fig. 2. Diagram of magnetic-field anomalies of the Baltic region (after Faitelson)**

High gradient values within the uplifted part of the basement surface are associated with the distribution in the basement of basic-magmatic rocks possessing increased density—2.8-3.0 g/cm$^3$—and magnetic susceptibility—up to 500-1000 $\cdot 10^{-6}$ CGS.

In the areas of Jõhvi, Võhma, Lokno, Stanitskaya, Krasnoe, Belitsy, Zubkovichi, Morino, and Mikashevichi, boreholes penetrated basic rocks of the basement (pyroxenes, amphibolites, magnetite quartzites, and schists).

A coincidence is observed between the Baltic-Ukrainian zone of high gradients and the zone of intense upward neotectonic movements.

For selecting promising directions for prospecting work, structural elements of the basement of ancient origin and long-term development are of substantial importance. Zones of intersection of two different directions of gradient axes reflect the most mobile sectors. They correspond to ore occurrences, intersections of regional faults, and lines of placement of local structures, including those prospective for oil and gas (in zones of the downwarped part of the basement). The position of these zones should be taken into account when selecting promising directions for prospecting work.

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## CITED LITERATURE

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