Magnetic properties and magnetic model of trap formation of Volyn

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ABSTRACT

The research of trap magnetism constantly involves attention of geoscientists of the world and is determined, on the one hand, by connection of a number of important minerals (copper-nickel, iron and other ores), with trap formations, and on the other hand - has large importance for the decision of general and urgent theoretical problems of sciences on Earth. A special place is occupied by research methods of magnetic field and construction of magnetic models of traps. In the essay the magnetic properties and magnetic model of trap formation of Volyn are considered.

INTRODUCTION

Traps of Volyn represent one of most ancient in the world areas of basic platform volcanism and are studied already more than 200 years. The works of last decades (Orlyuk, 1996; Glevasskaya, 1999; Yusypiv, 2003) have shown, that the research of magnetic properties (I_n, χ, Q_n, D, *J*) of the traps allows obtain valuable information on the age of magmatism, geological structure of territory and features of an abnormal magnetic field of territory. The values I_n, χ, Q_n depend on structure, amount, size and time of formation of ferromagnetic components - titanomagnetites, which are ore Fe-Ti oxides of canks. Effusive flows stiffen in a geological time scale practically instantly, each of them fixes the direction of a geomagnetic field in a short interval of time, therefore it is possible to use D and *J* for allocation of synchronous formations outside of dependence on their structure, which can be dated for the different volcanic centers. It is very important for study of the geological structure of territory (fig.1).

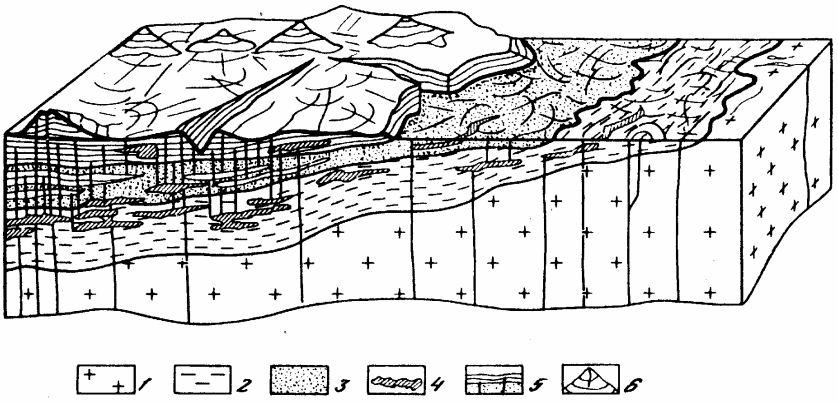

FIG.1. Model of trap formation of Volyn on platform:
1 - base; 2 – sedimentary series; 3 - tuffs; traps: 4 – intrusives and dikes; 5 - lava and dikes, 6 – volcanoes of central type.

MAGNETIC PROPERTIES OF THE TRAPS

The natural magnetic properties of vulcanites are characterized by the module and vector of natural magnetization I_n, magnetic susceptibility χ, factor Q_n, inclination *J* and declination D.

The size of the magnetic susceptibility χ as a whole expresses concentration of ferromagnetic minerals of basalts. Less magnetic are the tuffs, in them χ does not exceed 10^{-5} SI units.

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zation of basalts is determined by presence of titanomagnetites and products of their transformation – titanomaghemites, magnetites (Glevasskaya, 1993). The average value χ of basalts is higher than $2000 \cdot 10^{-5}$ SI units, and for separate flows achieves $7000\text{-}11000 \cdot 10^{-5}$ SI units. The variations of χ inside the flows do not exceed 30 %.

The size of natural magnetization is much higher for basalts, and low for tuffs, lava breccias and other rocks. For separate basalt flows I_n achieves $5000 \cdot 10^{-3}$ A/m.

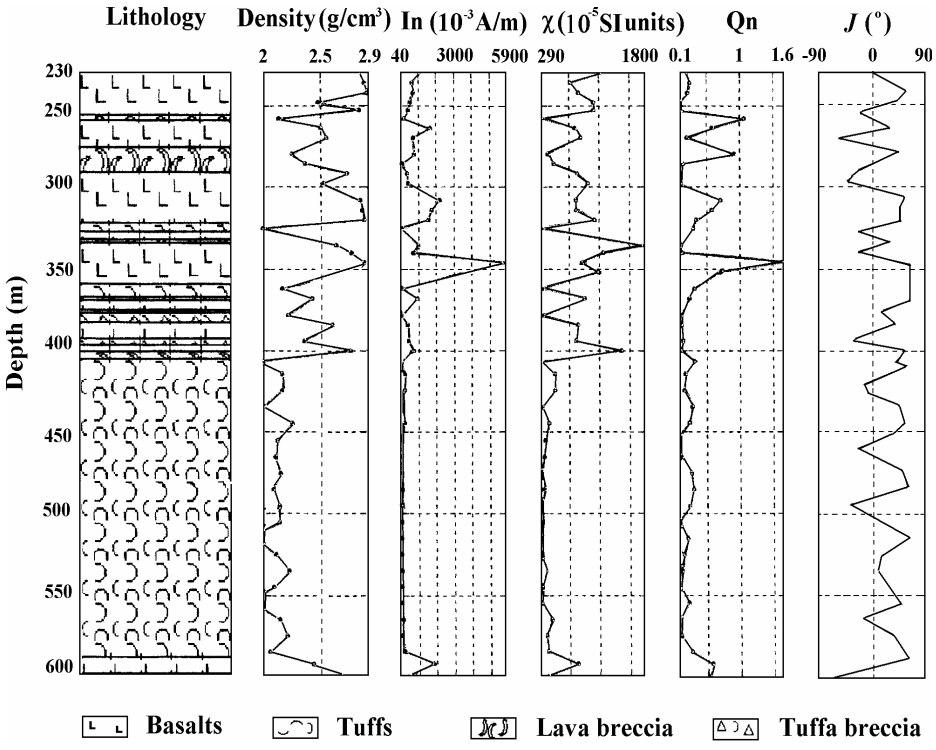


FIG. 2. Magnetostratigraphic record of a typical well drilled in the territory of trap formation of Volyn.

Thus average value of the factor of Kenigsberg Q_n almost for all rocks makes about 1, $Q_n = I_n/0.5\chi$. The factor Q_n does not depend on concentration of magnetic minerals, but the same as I_n is sensitive to the size and structure of ferromagnetic grains, so it is closely connected to conditions of crystallization of rocks. According to this attribute it is possible to make conclusions about essential distinctions of separate bodies of vulcanites. The magnetostratigraphic record is presented of a typical well drilled in the area of researches of traps. Core samples were measured in the laboratory of geomagnetism, thus the values I_n, χ, Q_n, D, *J* were taken. In the figure 2 the lithologic record is shown to the left, to the right - data of measurement of core values I_n, χ, Q_n, *J*. Thus it is visible how the basalt flows in the well are precisely fixed.

MAGNETIC MODEL OF THE TRAP FORMATION OF VOLYN

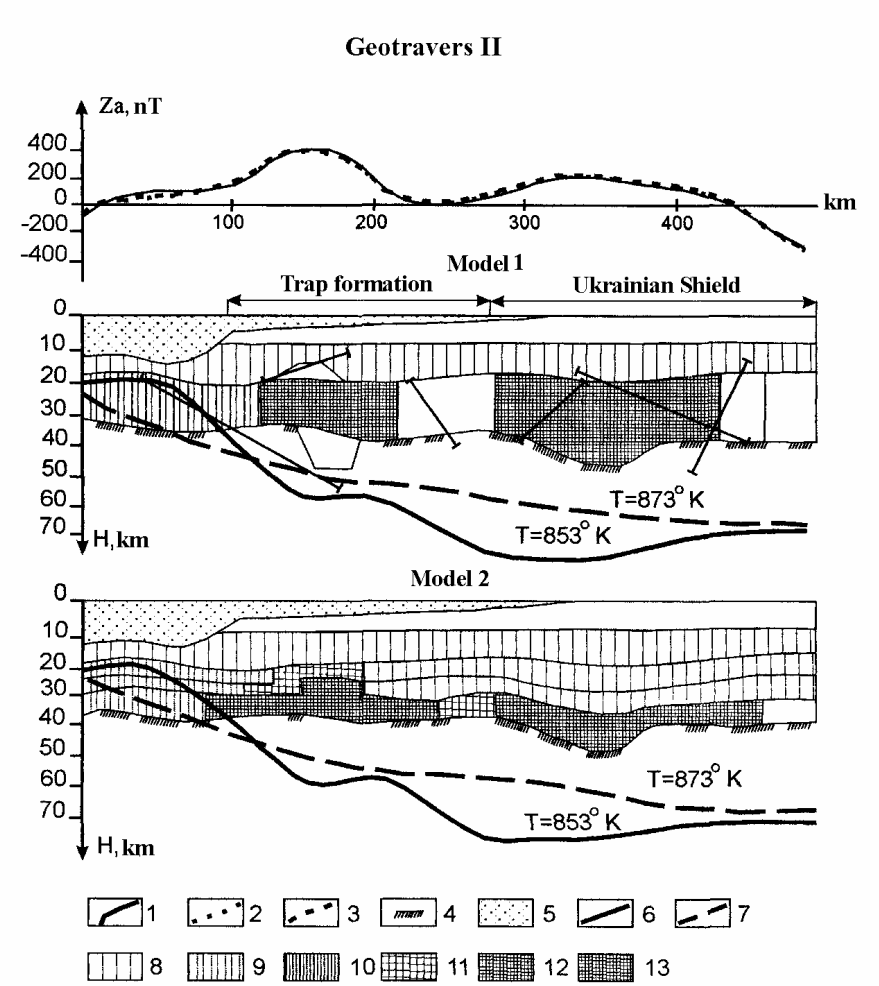
There are some possible approaches to construction of magnetic model:

1. Interpretation of an abnormal magnetic field by one of methods of the solution of an inverse problem of magnetic prospecting and further coordination with the data of other methods.
2. Selection of values of magnetization of the crust, using the data of previous interpretation of petrologic materials and data of other methods about the top and bottom limits of magnetically active mantle.
3. Application of the close to linear dependence on the basis of study and generalization of an actual material allows pass from seismic gravity model to the magnetic one (Orlyuk, 1996).

At creation of magnetic model more often the first and second approaches are used, the third one carries out the function of the control.

Using the computer program for magnetic modeling of Zavoisky by international geotraverse II, which passes through trap formation of Volyn, the influence of the top part of terrestrial crust to depth of 10 km is estimated and excluded. The selection of magnetization of crust's bottom part

was carried out, the field from which satisfies regional component, obtained by the formula: Zreg. = Zocf. - Z10, where Zocf is an observed component of the field; Z10 - effect of the top 10 km of the crust section.



Model 1. The magnetization of the basalt layer changes on lateral from 1,0 up to 5,5 A/m. The field selected in this way differs from the initial on 30-40 nT, that it is possible to consider sufficient at modeling a regional field (fig. 3).

Model 2. The magnetization of the basalt layer changes on lateral from 1,0 up to 4,5 A/m. In case of magnetization of the top part of terrestrial crust in the area of Rovno magnetic anomaly, which achieves 1,5 A/m, the magnetization of the bottom crust changes within limits of 1,0-3,5 A/m.

FIG 3. The 2D magnetic model of terrestrial crust by geotraverse II, which passes the trap formation of Volyn: 1 – regional component of the magnetic field; 2 – calculated field of the models 1 and 2; 3 – calculated field of the models 3 and 4; 4 – reflecting sites of the border of the border of Mokhorovichich; 5 – sedimentary mantle; 6 – Curie isotherm of magnetite by V.V.Gordienko; 7 – isotherm T = 600 ^{0}C by R.I. Kutas; 8 – 13 - values of magnetization: 8 - 0,25-0,5 A/m; 9 - 1,0-1,5 A/m; 10 - 2,0 A/m; 11 - 2,0-3,0 A/m; 12 - 3,5-4,0 A/m; 13 - 5,0 A/m and more.

CONCLUSIONS

1. The analysis of magnetic parameters of rocks of trap formation has shown, that practically every effusive version are represented by strongly magnetic rocks, whereas pyroclastic deposits, in particular small-sized tuffs are much weaker, both by magnetic susceptibility, and by natural magnetization. In this connection the different layers of trap formations as a whole should be displayed unequally in the magnetic field. One thing is clear - though it is considered, that basically magnetic field is connected with material structure of rocks of the crystal base, the deposit of effusive and subvulcanic phases of traps into the general magnetic field should be essential.

2. Basically each basalt flow differs by an original magnetic direction (it can be connected to age variations) but majority are inversely magnetized rocks, as it is characteristic for vend as a whole.

3. The technique of construction of magnetic model has shown a real opportunity of use of the magnetic field not only for traditional study of superficial, but also of deeper zones of terrestrial crust in conditions of platforms areas, zones of wide trap formations. The rocks of trap formation are represented as alternate mosaic field on the background of larger anomalies caused by heterogeneity of the crystal base.

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http://www.uoregon.edu/~nsheldon/PPP2003.pdf

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