

PRACTICE OF MAGNETIC SURVEYS OVER HYDROCARBON FIELDS IN CARPATHIAN FOREDEEP, UKRAINE

The results of magnetic studies over hydrocarbons fields in the Outer zone of Carpathian Foredeep were studied. It was stated that upon oil and gas deposits are observed static and dynamic local anomalies connected with supervising tectonic displacements. The conclusion about genetic correlation between local anomalies and oil-and-gas content in the investigated deposits was done.

Key words: magnetometry; anomalous magnetic field; local anomalies; hydrocarbons.

Introduction

Possibilities of magnetic survey in oil and gas geological structures on regional and local levels were not been studied satisfactorily yet. But last years this method is more popular in the complex of geophysical techniques during searching of perspective oil and gas structures in Ukraine and in the world [Omelchenko et al., 2011, Gadirov and Eppelbaum, 2012, Schumacher, 2010].

Existence of local magnetic anomalies with a few nT amplitudes upon oil and gas deposits proportionate with structure contours was approved in practice by magnetic measurements in different hydrocarbon structures and can be one of the searching criteria for hydrocarbon traps [Kuderavets, 2009, Gadirov and Eppelbaum, 2012, Schumacher, 2010].

The studying of long-term variations of the anomalous geomagnetic field is also used for investigations, mapping of active tectonic fault zones, of seismic-tectonic processes and solving other problems concerning geology and geodynamics [Maksymchuk et al., 2001]. Dynamic variations of ΔF can be calculated by means of repeatable magnetic survey during definite time intervals on the fixed point's network.

The genetic relationships of discovered static and dynamic anomalies with hydrocarbons are problematic and require detailed study.

Geological description, methods of investigations

The ground magnetic survey was fulfilled on few oil and gas fields (Makuniv, Rudky, Nyklovychi, Orhovychi, Dobriany, Vigomlja, Swydnytsia, Retychyn, Kochanivka) located in the NW part of Bilche-Volytsa zone in the Carpathian Foredeep (fig. 1). Investigated structures are located in the Upper Miocene deposits and are adjusting with the Krakovets, Sudova Vyshnia and Gorodok regional fault system. Their oil-and-gas content is connected with two complexes of sediments: under-gypsum (oil-bearing) and over-gypsum (gas-bearing). To obtain real experimental data about thin AMF structure high-precision ground magnetic survey was done upon selected objects. Measurements of total magnetic field module F were done every 50 meters by means of proton magnetometer with 1.0 nT sensitivity.

Classical methods of tectonomagnetic investigations consist of synchronous measuring of the magnitude of total geomagnetic field vectors on a

fixed network of points (Fp) and a reference (basic) point (Fb) through definite time intervals. Such a scheme generally allows elimination of the influence of external magnetic field variations in differences $\Delta F = F_p - F_b$. Objective values of tectonomagnetic measurements are variations of ΔF between pairs consecutive observation cycles ($\Delta \Delta F = \Delta F_2 - \Delta F_1$). The registration of the total field F at the basic point and at the all other points was fulfilled with proton magnetovariational station MV-01 (sensitivity 0.1 nT). The mean-square error was 1 nT.

In the frame of investigations of temporal variations peculiarities for geomagnetic field ΔF and definition of their relations with tectonic structure, geodynamics and oil-and-gas content in the Carpathian Foredeep were founded three profiles. One of them - Malniv-Ugniv - in the NW part of Bilche-Volytsia zone and SE margin of East European Platform near 70 km long, 43 points of measurements during 3 cycles: June, 2011, July, 2012 and June, 2013. Distance between points 1.5 – 2 km.

Discussion of results

Though significant distortion of a magnetic field (due to electric-magnetic noise, caused by railroads, gas pipelines, drilling, power transmitting lines, industrial objects, settlements, etc.), on the low-gradient ΔF regional component the local magnetic anomalies ΔF_a can be observed (fig. 2).

Analysis of local anomalous magnetic field morphological peculiarities upon the geological structures grounds definition of few types ΔF_a anomalies. One of them is positiv, near 3 km wide and up to 10 nT intensity (fig.2, a). Another is negativ with 4 – 8 nT amplitude, 4 – 5 km wide (fig.2, b). The next one – variable high-frequency anomaly in marginal parts of structures, with 15 – 20 nT amplitudes and 2 km wide (fig.2, c). And the last one – the negativ in central part (up to 3 km, 3-5 nT amplitude) with two positiv short-frequency anomalies on the margins (fig.2, d).

Comparison of defined ΔF_a anomalies with structure of seismic GA (gypsum-anhydrite, up to Upper Badenian surface) horizon allows to make a conclusion that positive ΔT_a anomalies have relations with Krakovets deep fault and negative anomalies spatially co-relate with some oil and gas fields in the NE direction from Krakovets fault.

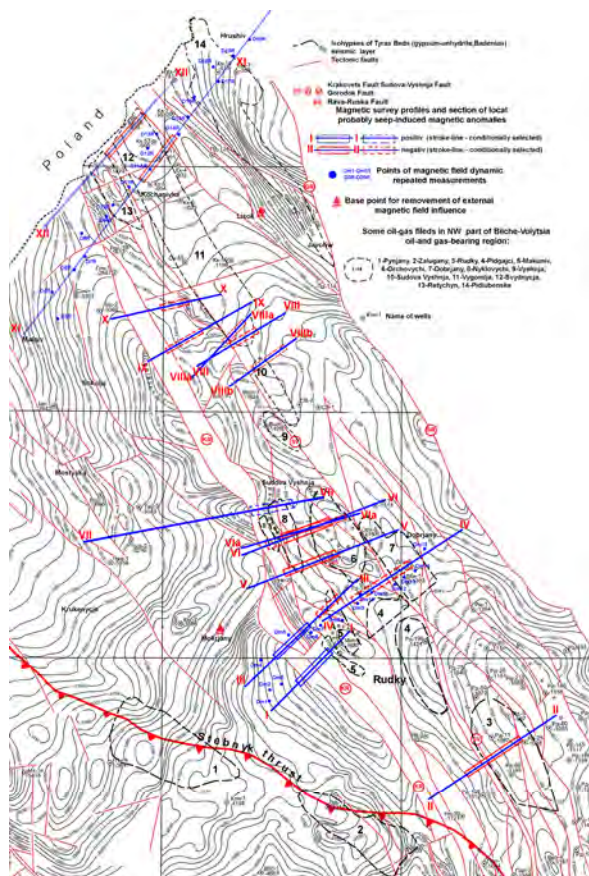


Fig. 1. Structural map (GA-seismic layer, Tyras Beds) and the section of probable seepage-induced local magnetic anomalies ΔF_a associated with oil-gas fields, the points of magnetic field dynamic repeated measurements in NW part of Bilche-Volytsia zone of Carpathian Foredeep (the seismic data from “Ukrgeofizyka” West Ukrainian Geophysical Prospecting Expedition, 2008).

Anomalous magnetic field ΔF along the profile Malniv-Ugniv is shown on the fig.3. The interesting peculiarity of this profile is its location in the contact zone between Carpathian Foredeep and SW margin of Eastern-European Platform. This zone often associates Teisseyre-Tornquist Zone (TTZ). ΔF field in the NE part of profile sharply increases, what is connected with an influence of regional Lviv magnetic anomaly.

Investigations of ΔF variations diagrams during June, 2011 – July, 2012 and June, 2011 – June, 2013 show complex structure of this variations and repeatability from cycle to cycle. The intensity of $\Delta\Delta F$ anomalies on this profile varies in the range of -1.1 - +2.7 nT. The most intensive variations of magnetic field were defined within the range of Bilche-Volytsia zone and Lviv Paleozoic Depression.

Also was defined alternating $\Delta\Delta F$ anomaly (-1.1 (D13R) - +1.8 (D15R, D20R) nT per year) near Horodok deep fault in a contact zone between Carpathian Foredeep and young West European Platform. In a location of Rava-Ruska deep fault slight negative $\Delta\Delta F$ anomaly (0.9 nT per year on

D36R) was observed. On the $\Delta\Delta F$ diagram for June, 2011 – June, 2013 total increasing of field was observed, what partly is connected with temporal variations on the base point. It is necessary underline a general trend of $\Delta\Delta F$ increasing in the NE part of the profile up to 2.7 nT (D41R).

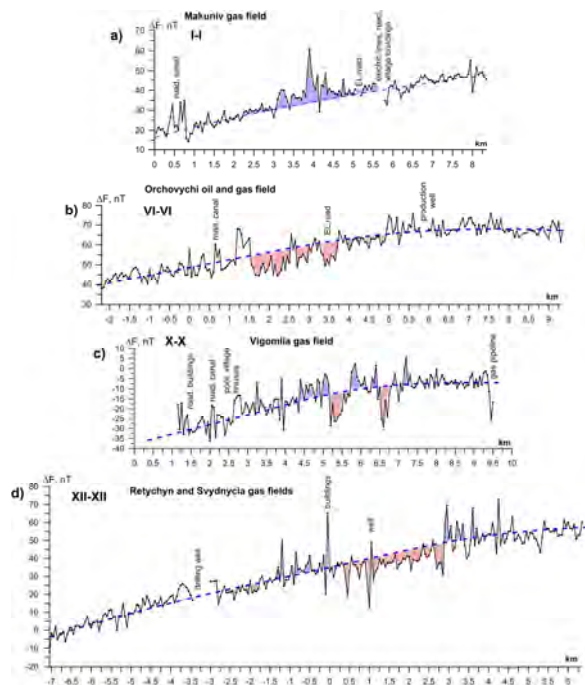


Fig. 2. Anomalous magnetic field on few profiles and the basic types of small amplitude local magnetic anomalies ΔF_a associated with nearsurface magnetic sources in area of hydrocarbon fields of Bilche-Volytsia zone of Carpathian Foredeep, Ukraine.

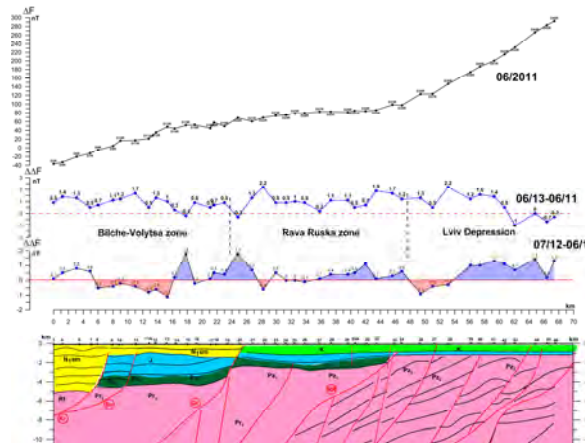


Fig. 3. Anomalous magnetic field ΔF along Malniv-Ugniv profile, difference $\Delta\Delta F$ during July 2012-June 2011, June 2013-June 2011 and the fragment of geological crosssection through the line Chop-Gorochiv

Defined local magnetic anomalies upon the deposits in the Carpathian foredeep and Dniepronets Basin [Kuderavets et al., 2008, 2009] are very

similar by intensity and spatial sizes what marks their same nature. Low amplitude and small spatial sizes confirm shallow source locations of local anomalies. During interpretations of defined ΔF_a local anomalies upon hydrocarbon deposits the results of rocks magnetic susceptibility investigations were taking into account, also as a number of theoretical models [Schumacher and Abrams, 1996, Machel and Burton, 1991], which predict existence upon oil and gas deposits areas with differentiated magnetic features of environment.

Studies of magnetic features of covering sedimentary rocks, mineral structure of shallow rocks and rocks, covering deposit are necessary for interpretation of defined anomalies what can be useful for future investigations of magnetic anomalies nature upon oil and gas fields.

The nature of temporal field variations can be explained by an influence of electric currents of electric-kinetic origin from crumbling fluid-saturated rocks.

Summary

The results of investigations allow to conclude about deformations and fluid-dynamic processes in active fault zones, which can be detected in different geophysical and other fields and may be indicators of oil-and-gas content.

The suggested methods of anomalous magnetic field studying allow to obtain additional information about structural-dynamic peculiarities of the crust. This can be used for upgrading of effectiveness in oil and gas searching.

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ДОСВІД МАГНІТОМЕТРИЧНИХ ДОСЛІДЖЕНЬ НАД РОДОВИЩАМИ ВУГЛЕВОДНІВ У ПЕРЕДКАРПАТСЬКОМУ ПРОГІНІ, УКРАЇНА

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Аналізуються результати магнітних досліджень над родовищами вуглеводнів у Зовнішній зоні Передкарпатського прогину. Над родовищами нафти та газу виявлені статичні та динамічні магнітні аномалії, які контролюються розломною тектонікою. Зроблений висновок про генетичний зв'язок між локальними магнітними аномаліями та нафтогазоносністю.

Ключові слова: магніторозвідка; аномальне магнітне поле; локальні аномалії; вуглеводні.

ОПЫТ МАГНИТОМЕТРИЧЕСКИХ ИССЛЕДОВАНИЙ НАД МЕСТОРОЖДЕНИЯМИ УГЛЕВОДОРОДОВ В ПРЕДКАРПАТСКОМ ПРОГИБЕ, УКРАИНА

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Анализируются результаты магнитных исследований над месторождениями углеводородов во Внешней зоне Предкарпатского прогиба. Над месторождениями нефти и газа обнаружены статические и динамические локальные магнитные аномалии, которые контролируются разломной тектоникой. Сделан вывод о генетической связи между локальными магнитными аномалиями и нефтегазоносностью.

Ключевые слова: магниторазведка; аномальное магнитное поле; локальные аномалии; углеводороды.

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