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Regional geophysical works in the Ukrainian Carpathians

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Abstract: The deep geological model of Carpathian rock structure, Pre-Carpathian Trough and East-European Platform is presented on the base of complex interpretation of regional works using the method of common-depth-point. The block-stage plunge of Mesozoic and Paleozoic basement into the rock structure of the Carpathians in the south-western direction is confirmed. The depth of sedimentary layer is 12 – 18 km. The regional prediction of the parameters of oil- and gas-bearingness in the Western region is carried out. The main directions for regional works for the period of 2001-2010 are given.

Key words: Carpathian Province, Pre-carpathian Trough, Inner Zone, Outer Zone, seismoprospecting, gravimetry.

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Within the western areas of the Ukraine a stage of investigations of two oil and gas bearing regions are distinguished at present. Carpathian oil and gas bearing province and Volyn-Podillia perspective area.

The Carpathian oil and gas bearing province – this is the Ukrainian or Eastern Carpathians which are the part of the Carpathian arc with Subcarpathian and Transcarpathian Neogen deeps.

The Volyn-Podillia perspective area includes south-western margin of East-European platform where the Lviv Palaeozoic deep and Podillia-Bukovyna cross to the Carpathian elevation are recognized.

The main oil and gas exploration province is the Subcarpathian deep with its gas bearing Outer (Biltshe – Volytsia) and Inner (Boryslav-Pokuttia) zones.

The seismic investigations, carried out during many years in the western area of the Ukrainian, were mainly concentrated within the known oil and gas bearing zones of the Subcarpathian deep. This gave the opportunity of discovering the significant oil deposits in upper units of flysch structures of Inner (Boryslav-Pokuttia) zone and gas deposits in the Neogene and Mesozoic rocks of Outer (Biltshe-Volytsia) zone. Besides, it in mesozoic and palaeogene rocks of the Outer zone-under the overthrust of the Pokuttia-Bukovyna Carpathians – the Lopushna oil deposit was discovered. This widens the perspectives of the discovery of the new, significant by dimension hydrocarbon deposits in the analogical rocks of the autochtone of the major part of the Ukrainian Carpathians.

Folded Carpathians (Skiba and Krosno zones), where the new great deposits of oil and gas may be discovered, are much less studied by both regional and prospecting investigations. In this connection the most important in geological-geophysical studies of the western areas of the Ukraine is the investigations of the deep geological structure of the region and recognition of the processes of its evolution. The laws of the presence of the mineral resources deposits were studied too.

Within the Carpathian region great volume of the geological-geophysical investigations was carried out. However a lot of question are still studied or are not studied at all. They are follows:

- hypothetical is the question of the Carpathian mountain system;
- not completely is elucidated the thickness of the sedimentary complex – the main reservoir of oil and gas deposits;
- the structure of the lower part of the sedimentary sequence and its correlation with the basement needs more studies;
- the fault tectonics of the region, which plays the main part in hydrocarbon migration, is not sufficiently investigated.

It is known that investigation of the territory in regional plane, without the recognition of the most important features of the structure of the region, the effectiveness of prospecting works is not always optimal. The regional study of the general geological structure of the Ukrainian Carpathians, using the geophysical prospecting methods, was started by Western Ukrainian Geophysical Exploration Expedition (WUGEE) in 1949 by introducing the magnetometric investigations. As a results of these work it was started that Carpathians are characterized by the nonmagnetic fields expect Vyhorlat-Hura ridge. This is the evidence of the occurrence of the magnetically active rocks in the basement.

In 1960 investigations of the deep structure of the Carpathians by gravimetric method began. In general the Carpathians are characterized by the presence of the regional minimum of gravity, the axes of which stretch from

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Dobromyl, which is on the border with Poland, to Biloberizky, which is on the western slope of the Bukoviny elevation. It is situated within the SubCarpathian deep, so it is replaced regarding to mountain building. On the other hand the Vorohta area comes another branch of the axe of the regional gravity minimum, which is distinguished already on Skiba and Chornohora zones of the Carpathians through village Shepit to the territory of Romania to the Audia zone.

The gravity survey of the Carpathians, SubCarpathian and TransCarpathian deeps with the density of observation 500x500 m and accuracy of the determination of Bouguer anomalies ± 0,2-0,25 mGal have gave opportunity to distinguish the system of the specific gravity „steps" and local anomalies.

The quantitative interpretation of the distinguish peculiarities of gravity field was made by different methods, including the use of the computer. It gave us the possibility to construct the „Schematic structual-tectonic map of the Mesozoic-Palaeozoic basement (autochtone) of the Carpathians and adjacent deeps".

The regional seismic investigation by refraction correlation method and deep seismic sounding (RCM-DSS) on Volyn-Podillia and in Subcarpatian deep were started by WUGEE in 1959. In 1965-1968 3 regional TransCarpathian profiles were done through the Carpathians. As the results of these works the main features of the tectonic structure of deep sequeence were studied [1,2,3,4,5,6].

The seismic survey, which was done by WUGEE, using method of joint (MJDP), which corresponded with the regional profiles RCM-DSS and also the results of gravity survey in the scale 1:50000, gave different results concerning the depth of occurrence of autochtone in different zones. Taking this in to account new direction of prospecting works in WUGEE during the last years projected. Two TransCarpathian regional profiles by MJDP have been measured. These profiles, P1 (Uzhok-Pitbuzh-Velyki Mosty) and P2 (Slavsk-Taniava-Peremyshliany), were located within Krosno and Skiba zones of the Central Carpathians, Boryslav-Pokuttia (Inner) and Biltshe-Volytsia (Outer) zones of the Subcarpathian deep and also in Lviv Palaeozoic deep (East – European platform).

On the time section on regional profiles P1 and P2 in Krosno zone the reflected waves of good quality on time 0,6000-6,000 sec, which correspond to the depths of 0,9-1,5 km are recorded. Very clear boundary, which can be correlated with Pre-alpine, Mesozoic-Palaeozoic basement top, is observed here on time 3,4 and more seconds (what corresponds to the depths of 7000 m and more). It occurs relatively steeply and by quality it is different along the profiles. On one interval the waves are intense, on the other very week, or completely absent.

On the top of the sequence the reflected waves from the allochtone part are obtained, which are characterized by more clear occurrence, medium intensity, in individual cases specific in the form of the record. After survey the Bitlia-1, Borynia-1 wells were bored on the profile, which discovered the Oligocene rocks characteristic for Krosno zone structure.

In Skiba zone - in the upper part the sequence up to depths 7000-8000 m (3,3-3,8 sec) – rather intense waves with relatively rapid slope are fixed. These waves correspond to the thrusted allochtone part of the flysch folds. This upper part of the allochtone of the Skiba zone was discovered by the range of wells, which were situated on profiles P1 (Smilna-2, Nyzhni Popely-1 and others) and P2 (Shevchenkovo-1, Taniava-100, Dolyna-416, Yankiv-101 within Oriv and Berehova sheets. The rocks of Skiba zone are composed there by deposits of Upper Cretaceous, Eocene and Oligocene. The structure is very complex. Lower part of the sequence, beginning in the depths 7000-8000 m and more, the waves which characterizes more sloping occurrence of sedimentary sequence were observes. Here only in some intervals of profiles they are rather intense and specific. The time of the recording is 3,3-3,7 sec, which correspons to the part of the sequence.

The flysch thrusted part of Boryslav-Pokuttia zone, which from the top is usually covered by Skiba Carpathians, on the time sections is represented by intense and characteristic by form of recording reflected waves. These waves correspond to already known, borred Palaeogene folds. The time of the recording is 0,5-4,0 sec, The rocks of Boryslav-Pokuttia zone are very well studied by range of wells, which are bored in this zone and which discovered a number of oil deposits. At present on profiles P1 and P2 – the Flysch productive sequence under the Skiba zone was discovered by the above mention wells. The main oil bearing rocks are the sandstones of Menilite formation of Oligocene, Bystritsa and Vyhoda formations of Eocene. In the base of Boryslav-Pokuttia zone – on times 4,0 sec and more (depth of occurrence over 8,000 m), on the great intervals of profiles – the intense reflected waves, dynamically well developed, are recorded. They are related to Mesozoic-palaeozoic basement.

In Biltse-Volytsia zone, in its major part covered by the Sambir sheet, the reflected waves from Mesozoic (Jurassic, Cretaceous) and Neogene (Sarmatian, Tortonian) are recorded. These deposits steeply – along faults – hypsometrically arise towards the Lviv Palaeozoic deep from depths of 7000 m to the depths of 500 m. The Neogene and Mesozoic rocks were discovered by wells which are situated on the profiles P1. Zalyzhany 31, 37, rudky-20, 300; P2 Didushytcy-2, Dashava-100 and others. In this zone the main gas deposits are situated. They are related to Sarmatian-Tortonian deposits, and also to Cretaceous and Lower Jurassic rock. The regional profiles are stretching through the such great gas deposits as Rudkivske (Jurassic, profile P1) and Dashava (Sarmatian, Tortonian, profile P2.

The Lviv Palaeozoic deep, filled by the deposits of Proterozoic, Cambrian, silurian, Devonian, Carboniferous, Jurassic and cretaceous, was discivered by wells Dubliany-1, Nesteriv-2 and Stremin-1. On the section the reflected waves from the deposits of cambrian, Devonian, Carboniferous and Jurassic are surely observed on which the structural constructions were done. The time of the recording is 1.7-2.0; 0.9-1.0; 0.6-0.8; 0.5-0.6; sec.

The geological structure of Inner and Outer Zones and their platform basement was studied upto the depth of

3.5-5 km according ti the results of complex interpretation of geological-geophysical data. The block-stage plunge of Mesozoic and Palaeozoic basement into the rock structure of the Carpathians is confirmed. The depth of sedimentary layer of the trough is estimated to be 13-158 km. The zone of highly perspective oil- and gas-bearing flysch structures within the Inner Zone that can be easily predicted was found. The disjunctive dislocations of hogher order are traced in heterogenenous basement and sedimentary layer. The above is done on the base of regional profiles of common-depth-point method and gravimetric modeling.

For the future it should be worked out atandard net of regional profiles for making the correlation of reflected waves on closed polygons, which will gicňve oportunity to carry out more precise interpretation of seismic materials. Previously was decided to realize within the Ukrainian Carpathians the net of regional profiles of regional profiles of five main TransCarpathian direction and five connecting one. The connecting profiles are oriented along the Carpathian and situated in different structural tectonic zones: Transcarpathian deep, in zones – Krosno, Skiba, Boryslav-Pokuttia, Biltse-Volytsia and Lviv Palaeozoic deep.

According to the international programme of the investigations of underthrust part of the Ukrainian Carpathians it is planned to work out three regional Trans Carpathian profiles, of the total length nearly 250 km, situated in Krosno, Skiba, Boryslav-Pokuttia and Biltse-Volytsia zones.

First-on north-west corresponds to work out by WUGEE P1 on the area Uzhok-Pidbuzh-Drohobytch.

Second- crosses the Ukrainian in the part along the line Mizhiria-Dolyna.

Third- on south-east part runs along the line Hryniava-Storozhynets.

While carrying the seismic prospecting study on regional profiles in the Carpathian region it is necessary to consider the following most effective methods of field works: central system of observation, distance between channels 25 km, grouping on 18-20 seismic detector on base 25 m, distance between pickets of explosion 100 m, divisible 8, method of stimulation- explosive, quantity of channels not less than 240, medium weight of charge 10 kg, medium of explosive well 25 m.

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