GEOINFORMATICS 2020

EAGE

18364

On the prospects of hydrocarbon accumulations detection in traditional reservoirs in deep horizons of cross-section within shale gas production areas

M. Yakymchuk *(Institute of Applied Problems of Ecology, Geophysics and Geochemistry)*, ***I. N. Korchagin** *(Institute of Geophysics of Ukraine National Academy of Science)*

SUMMARY

The results of experimental studies on some shale gas production areas in the USA, Argentina, and England are presented. The investigations have been conducted with using the technology of integrated assessment of the oil and gas prospects of large blocks and local areas, which include methods of frequency-resonance processing of satellite images and vertical sounding (scanning) of a cross-section in order to determine the depths and thicknesses of predicted hydrocarbon accumulations and rock. The results of studies at local sites in Eagle Ford and Vaca Muerta shale basins indicate the presence of hydrocarbon accumulations at these basins in traditional reservoirs in the lower horizons of the cross-section. Within all the examined shale gas production areas, deep channels of migration of fluids, chemical elements and minerals, filled with 1-6 groups of sedimentary rocks, were found. The materials of the work performed can be considered as additional evidence in favor of the concept of deep (abiogenic) synthesis of hydrocarbons, including those located in shale formations. Of particular interest is the survey site in England, within which there is a significant number of local zones of visible hydrogen degassing. It is advisable to conduct additional studies on its territory with the aim of a more detailed study of these local zones.

Introduction. From the standpoint of the deep (abiogenic) origin of hydrocarbons within the framework of the concept of deep degassing of the Earth (Muslimov et al., 2019; Shestopalov et al., 2018), it can be assumed that in shale basins deposits of oil, condensate and gas also exist in deep horizons of the cross-section. In this regard, in 2019, reconnaissance studies were carried out at some shale gas production areas in the USA, Argentina, and England using mobile direct-prospecting methods. The results of the experimental work performed are presented in this report.

Research Methods. Experimental reconnaissance studies at shale gas exploration and production sites in the USA, Argentina, and England were carried out using frequency-resonance technology of satellite and photo images processing and decoding and integrated methods of the oil and gas prospects of local sites and large blocks assessing. The features of the used mobile direct-prospecting methods, as well as the results of their testing and practical application are described in articles (Yakymchuk et al., 2019; Yakymchuk and Korchagin, 2019).
At local sites in shale gas production basins, work was carried out to detect possible (predicted) accumulations of hydrocarbons (oil, gas, condensate, amber) in traditional reservoirs in the lower (including deep) horizons of the cross-section.

Eagle Ford Basin (USA). Satellite images of this basin (Figure 1) were taken from the site (Eagle…). Comparison of Figure 1b and 1c allows you to form an idea of how many wells have been drilled in individual areas of the basin over 15 years.
When processing a fragment of a basin image with wells (Figure 1c), responses from oil, condensate, gas and amber, as well as 1, 2, 3, 4, 5, 6 and 12 groups of sedimentary rocks were recorded; there were no signals from igneous rocks.
By fixing the responses from 2nd group of sedimentary rocks at various depths, the root of the sedimentary channel was established at a depth of 470 km.
On a surface of 56.9 km, responses were received from oil, condensate, gas and amber, and at a depth of 57 km from oxygen, hydrogen, carbon, nitrogen, phosphorus (there were no signals from oil).
At a surface of 57 km from the upper part of the cross-section, only responses from phosphorus were obtained; there were no signals from oxygen, hydrogen, carbon, and nitrogen.
By scanning from the surface (step 1 m) responses from oil were received from intervals: 1) 380-650 m; with 1 km step 5 m, 2) 2270-3550 m; 3) 5200-7600 m; 4) 11250-14700 m (up to 15 km traced).

a) *b)* *c)*

Figure1 *Satellite images of the Eagle Ford shale basin and its individual site (rectangular outline) (Eagle…). a) - February 15, 2016; b) - December 17, 2000; c) - December 18, 2015.*

The gas intervals by scanning were also determined: 1) 380-650 m; with 1 km step 5 m, 2) 2270-3550 m; 3) 5200-7600 m; 4) 11250-14700 m (up to 15 km traced). Condensate responses were obtained from the interval of 585-765 m.
Signals from the 1st group of sedimentary rocks were recorded by scanning in the interval 410-630 m. In the interval 2270-3550 m, no responses from the 1st group of sedimentary rocks were received; signals from 2nd group are recorded in the range of 2270-3580 m.
Additionally, a small fragment of the dark image in Figure 1a was processed. Responses from the 1st sedimentary group were obtained from the interval 350–650 m (approximately). When scanning the cross-section with a step of 10 cm, gas signals were recorded from the interval 370-634 m.
A very intense signal was received from gas and the 1st group of sedimentary rocks; the responses from these components were recorded from the interval 345–650 m (approximately). This made it possible to draw a preliminary conclusion that shale gas is gas in the first group of sedimentary rocks.

A little later, additional experiments were carried out to determine which samples from the first group of sedimentary rocks contained gas. Responses were received from only one sample from the 1st group of sedimentary rocks - mudstone breccia. The signals from this sample were recorded by scanning from the interval 380-625 m; from 2000 m there were no signals from breccia.
It is advisable to pay attention to the following circumstance. Figure 2 shows the individual counties in different states of the USA with the largest volumes of hydrocarbon production (including shale formations) (Lea …). When processing satellite images of all seven of these areas, responses from breccia and shale gas were recorded.

Vaca Muerta Basin (Argentina). A photograph of the shale gas production site in the Vaca Muerta basin is shown in Figure 3 (Vaca…). During its frequency-resonance processing, responses were obtained from gas, condensate, oil, amber, coal, breccia (mudstone), as well as 1, 2, 3, 4, 5, 6 and 12 (weak) groups of sedimentary rocks. Signals from igneous rocks not received.
By fixing the responses from the 2nd group of sedimentary rocks at various depths, the root of the sedimentary channel was established at a depth of 470 km.

Figure 2 *A map showing the location of counties in various US states that produce the largest volumes of hydrocarbons in shale plays) (Lea …).*

Figure 3 *A photograph of a shale gas production site in the Vaca Muerta basin (Argentina) (Vaca…).*

Oil responses were obtained at a surface of 56.9 km; they were absent at a depth of 57 km.
Argillite (mudstone) breccia signals were recorded by recording the responses at various depths and scanning in the interval 345-730 m
By scanning (1 m step), responses from oil were recorded in the intervals: 1) 1120-3820 m; 2) 7300-10250 m (traced up to 15 km).
On the surface of 800 m, signals from shale gas (gas + breccia) were not received, but from the gas were recorded. Gas responses were obtained in the range of 960–1130 m; deeper signals were absent.
On the surface of 1130 m, responses were received (weak) from condensate from the upper part of the cross-section, and there were no signals from the lower part.

Large gas production areas in the USA. Satellite images of seven counties (Figure 2) of gas production in the USA (Lea …) are presented in Figure 4. The frequency-resonance processing of all these images was performed in order to assess the prospects of oil and gas potential in the deep horizons of the cross-section.
When processing satellite images of survey units in Figure 4 from the surface on all blocks the signals of oil, condensate, gas, amber, oil shale and coal were received; there were no signals from rock with gas hydrates, ice, hydrogen, and salt on all blocks. Weak signals from anthracites are recorded at the Midland and Eddy blocks.
Signals from 1-6 groups of sedimentary rocks are recorded on all blocks and from the first group of igneous (granites) - only on the Lea block. The roots of sedimentary channels on all blocks except the Lea block are set at a depth of 200 km.
On the Lea block, the root of the sedimentary channel is located at a depth of 470 km, and the granite channel is at a depth of 996 km. On the surface of 56 km, responses from oil and amber were recorded on all blocks, and at a depth of 57.1 km signals were already absent.
The results of fixing (determining) the intervals of responses from oil by scanning a cross-section from the surface with a step of 1 m up to 5 km and a step of 5 m to 15 km are reduced to the following (the values of the intervals are indicated below in meters).

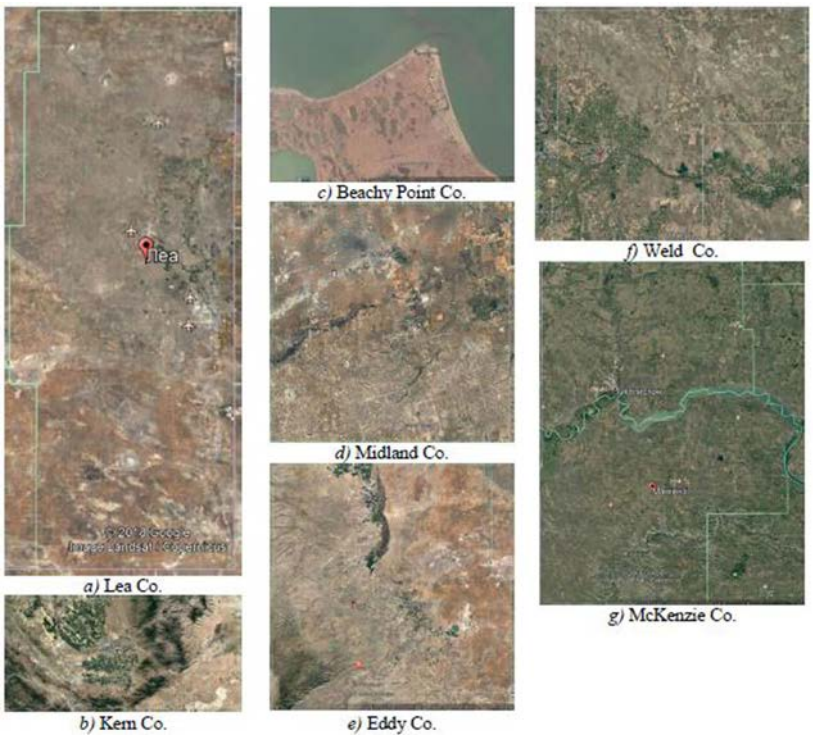

Figure 4 *Satellite images of individual regions (counties) in various US states in which the largest volumes of hydrocarbons have been produced in shale formations (Lea …).*

Beachy Point Block: 1) 680-940 m; 2) 1330-1860; 3) 2145-2240; 4) 2500-3170; 5) 3415-3650; 6) 4140-4420; 7) 5730-6400; 8) 8670- (strong) -10750; 9) 13530-15130 m.
Weld block: 1) 800-980; 2) 1330-1550; 3) 2400-2700; 4) 4800-5430; 5) 10650- (strong) - (very strong) -14400.
Kern block: 1) 490-1160; 2) 1470-1735; 3) 1890-2330; 4) 2690-2780; 5) 5240-6780; 6) 7760-8680; 7) 14730-16800 m.
Lea block: 1) 550-770; 2) 1270-2650; 3) 3330-3500; 4) 5050-9200; 5) 13000-15100 m.
McKenzie block: 1) 430-1300; 2) 1700-2100; 3) 3880-4220; 4) 9150-11500; 5) 13750-14300 m.
Midland block: 1) 470-520; 2) 1430-1770; 3) 2330-2620; 4) 3200- (strong) -3760; 5) 4020-4375; 6) 8750-9400 m.
Block Eddy: 1) 930- (strong) - (very strong) -1500; 2) 2180- (strong) -2510; 3) 3060-3180; 4) 3660-3780; 5) 4370-4470; 6) 6430-8950; 7) 12520-13850 m.

Shale gas production site in England. In early October, information appeared on the Internet sites about the termination by Cuadrilla Resources (Cuadrilla…) of hydraulic fracturing (fracking) in the well at Preston New Road (Lancashire, England) (Fracking). The main reason for this situation is the earthquake after a series of hydraulic fractures in August 2019. In this regard, it became expedient to decide to process a photograph and a satellite image of the well location. The photograph for processing (Figure 5) was borrowed from the information message (Fracking), and the satellite image (Figure 6) was taken from the Cuadrilla Resources website (Cuadrilla…).
The analysis of the satellite image of the site (Figure 6) shows that within it the local areas (shaded areas) of visible hydrogen degassing are recorded.
At the initial stage, only the presence (absence) of oil, condensate, gas and amber was determined within the survey site.
When processing a photograph of a well location (Figure 5), responses were recorded from oil, condensate, gas, shale gas, amber, as well as 1-6 groups of sedimentary rocks. The root of the channel (volcano) of sedimentary rocks is set at a depth of 470 km.
Signals from oil, condensate, gas and amber were recorded up to 57 km.
During a satellite image processing of the well location (Figure 6), responses were recorded from oil, condensate, gas, shale gas, amber, coal, anthracite, and hydrogen. Signals were also received from 1-6

groups of sedimentary rocks. The root of the channel (volcano) of sedimentary rocks is determined at a depth of 470 km.
Responses from basalts were also recorded; they were recorded up to 95 km.

Figure 5 *A photograph of a well at the Preston New Road (Lancashire, England).*

Figure 6 *Satellite image of the well at the Preston New Road (Lancashire, England).*

We draw attention to the following circumstance. When processing a satellite image of the site, responses from hydrogen and basalts were recorded (group 6 of igneous rocks). This indicates that the darkened areas in the image (Figure 6) are actually local zones of hydrogen degassing.
Given this, the images of eight such local zones, indicated in Figure 6 by rectangular contours, were processed separately. As a result, responses from hydrogen and basalts were recorded within each of these zones. Signals from basalts were recorded in this case up to 95 km.

Conclusions. 1. The conducted experimental studies on shale gas production areas are of reconnaissance character. A limited volume of "search" operations was performed at all survey sites.
2. Within all the examined shale gas production areas, deep channels of migration of fluids, chemical elements and minerals, filled with 1-6 groups of sedimentary rocks, were found.
3. The materials of the work performed can be considered as additional evidence in favor of the concept of deep (abiogenic) synthesis of hydrocarbons, including those located in shale formations.
4. Of particular interest is the survey site in England, within which there is a significant number of local zones of visible hydrogen degassing. It is advisable to conduct additional studies on its territory with the aim of a more detailed study of these local zones.
5. In general, the results of work performed at local sites in shale basins suggest that mobile direct-prospecting methods of frequency-resonance processing of satellite and photo images can be used during the search and exploration of industrial accumulations of "shale" hydrocarbons.

References

Muslimov R.Kh., Trofimov V.A., Plotnikova I.N., Ibatullin R.R., Goryunov E.Yu. The role of deep degassing of the Earth and the crystalline basement in the formation and natural replenishment of oil and gas deposits / R.Kh. Muslimov, V.A. Trofimov, I.N. Plotnikova, R.R. Ibatullin, E.Yu. Goryunov - Kazan: Publishing House "FEN" of the Academy of Sciences of the RT, 2019. - 264 p. (in Russian).

Shestopalov V.M., Lukin A.E., Zgonik V.A., Makarenko A.N., Larin N.V., Boguslavsky A.S. Essays on the degassing of the Earth. Kiev, comrade "BADATA-Intek service." 2018. 632 p. (in Russian).

Yakymchuk N.A., Korchagin I.N., Bakhmutov V.G., Solovjev V.D. [2019]. Geophysical investigation in the Ukrainian marine Antarctic expedition of 2018: mobile measuring equipment, innovative direct-prospecting methods, new results. Geoinformatika, 1, 5-27. (in Russian)

Yakymchuk, N. A., Korchagin, I. N. [2019]. Technology of frequency-resonance processing of remote sensing data: results of practical approbation during mineral searching in various regions of the globe. Part I. Geoinformatika, 3, 29-51; Part II. Geoinformatika, no. 4, pp. 30-58 (in Russian).

Eagle Ford: Shale Revolution: As Clear as Night and Day https://earthobservatory.nasa.gov/images/87725/shale-revolution-as-clear-as-night-and-day

Fracking equipment removed from Cuadrilla site after operations suspended: 'Work at this site could soon be at an end' https://www.independent.co.uk/environment/fracking-cuadrilla-lancashire-preston-new-road- suspended-equipment-removed-a9126671.html

Cuadrilla…https://cuadrillaresources.com/our-sites/lancashire/

Vaca… http://www.biodiversidadla.org/Documentos/Argentina_Vaca_Muerta_un_megaproyecto_que_se_extiende

Lea advances to nation's No. 2 county in oil production https://www.hobbsnews.com/2019/05/14/lea-advances-to-nations-no-2-county-in-oil-production/