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HEAT FIELD AND DISTRIBUTION OF OIL AND GAS POOLS IN THE WEST UKRAINIAN OIL AND GAS REGION[1]

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The West Ukrainian oil and gas region is situated in the west of the Ukrainian SSR and forms part of the Carpathian oil and gas province. Tectonically, according to O. S. Vyalov, the area under consideration can be divided into the following parts: a) southwestern margin of the Russian platform, b) Carpathian foredeep in which Inner and Outer zones are recognizable, c) Carpathian fold zone, d) Transcarpathian inner trough. All known commercial accumulations of oil and gas are concentrated in the Carpathian foredeep; in other tectonic zones of the West Ukrainian oil and gas region only token occurrences of oil and gas have been detected. There is a strict pattern in the distribution of oil and gas pools in the Carpathian foredeep. All oil fields are confined to Cretaceous and Paleogene flysch of the Inner zone. The sole exceptions are the Kokhanovka and Sudova Vishnya oil pools confined to the upper part of jointed Jurassic limestone in the substrate of the Outer zone. It must be noted that oil from the Kokhanovka and Sudova Vishnya fields differs strongly in its physicochemical properties from that of the main fields in the Inner zone. It is very heavy (S. G. of up to 1.00), resinous (up to 80% asphalt tar) and sulfurous (up to 7% sulfur). It is, undoubtedly, a decomposition product of the pools formerly existing here, the oil of which was similar in physicochemical properties to that of the Inner zone of the foredeep. Gas fields are concentrated in the Outer zone of the Carpathian foredeep, among molasse of Tortonian and Sarmatian age and older sediments of the Mesozoic (Cretaceous, Jurassic). Gas and oil have recently been found in the Velikiye Mosty area in the southwestern extremity of the Russian platform, as have sizable gas accumulations in the Transcarpathian inner trough (Solotvino, Záluzh). Another feature of the Carpathian foredeep is the wide territorial extent of oil and gas. Thus, oil pools are known from the Staraya Sol' district in the northwest to the Sloboda Rungurskaya district in the southeast, and gas pools from Kokhanovka in the northwest to Kosov in the southeast.

Investigation of the heat fields of oil and gas provinces in different parts of the world has shown that the territorial distribution of oil and gas pools is a function of level of geothermal activity [2]. The geothermal gradients of oil and gas provinces vary widely, e.g., from 18 to 40 deg/km in oil and gas regions of the Ukrainian SSR and from 17 to 34 deg/km in those of the U. S. By virtue of the different geologic structure, each oil and gas region has its own geothermal conditions, but the territorial distribution of oil and gas pools nearly always has specific patterns. One of them is the fact that oil fields are generally confined to low-temperature zones of oil and gas regions, while gas fields usually occur in zones of higher temperature. This pattern is confirmed particularly clearly in the West Ukrainian oil and gas region. Geothermal investigations were first carried out here by G. Artstovskiy in the twenties. He constructed geothermal maps for the Borislav oil field and classified the various temperature measurements that had been made in different parts of the Ciscarpathian and Central Carpathian areas. These investigations have been continued by R. I. Kutas, S. D. Dumanskiy, D. I. Kul'chitskiy [1] and others. Through the material amassed it is now possible to describe in fair detail the heat flow in the West Ukrainian oil and gas region. The geothermal activity is highest in the Transcarpathian inner trough, where the temperature reaches 40 to 80° at depths of 1000 m. This stems from high geotectonic activity and the consequences of recent volcanism. The increase in temperature with depth is fairly smooth, and the geothermal gradient ranges from 50 to 80 deg/km. For lack of authentic information it is impossible to give a geothermal description of the central Carpathians, for this area has hardly been drilled at all. Data are available only for the Skibovyye Carpathians, where in the oil field zone the geothermal gradient ranges from 28 to 35 deg/km and the temperature reaches 35° at a depth of 1000 m. The Carpathian foredeep can be divided in a geothermal respect, as it can be structurally, into two parts. The Inner zone of the foredeep

[1]Translated from: Teplovoye pole i razmeshcheniye mestorozhdeniy nefti i gaza v Zapadno-Ukrainskoy neftegazonosnoy oblasti. Doklady Akademii Nauk SSSR, 1968, Vol. 179, No. 1, pp. 162-165.

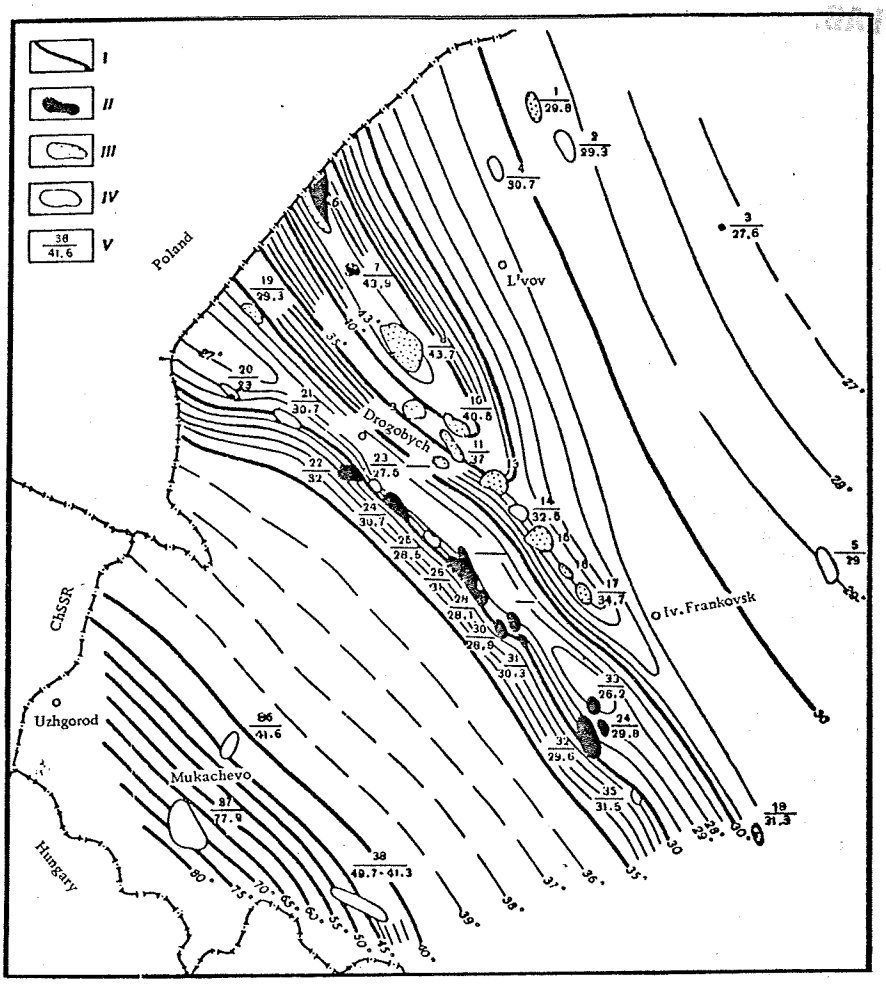

Fig. 1. Map of the distribution of temperatures and oil and gas fields in the western Ukraine. I) isotherms at a depth of 1000 m; II) oil fields; III) gas fields; IV) unproductive and reconnaissance areas; V) field characteristics (area in m^2 above line, temperature at a depth of 1000 m (°C) below it). Fields and areas: 1) Velikiye Mosty; 2) Kamenka-Bugskaya; 3) Olesko test area; 4) Nesterov; 5) Buchach; 6) Kokhanovka-Svidnitsa; 7) Sudova Vishnya; 8) Rudki; 9) Medynichi; 10) Vil'che-Volitsa; 11) Ugersko; 12) Kavsko; 13) Dashava; 14) Bolokhovo; 15) Kadobno; 16) Kalush; 17) Grinovka; 18) Kosov; 19) Khodnovichi; 20) Strel'bichi; 21) Volya-Blazhevskaya; 22) Borislav; 23) Dobryy Gost'; 24) Orov-Ulichno; 25) Tanyava; 26) Dolina; 27) North Dolina; 28) Obolon'ye; 29) Strutyn'; 30) Spas; 31) Ol'khovka; 32) Bitkov; 33) Starunya; 34) Pnev; 35) Delyatin; 36) Svalyava; 37) Zaluzh; 38) Danilovo-Tereblyan.

is considerably more epithermal compared with the Outer. Thus, the temperature at a depth of 1000 m is 26 to 32° in the Inner zone and 31 to 44° in the Outer, with the geothermal gradients also varying appropriately. Moreover, the temperature decreases in both zones from northwest to southeast. Thus, the temperature reaches 43.9° at a depth of 1000 m in the northwestern part of the Outer zone and 31.7° at the Kosov field in the southeast. In the Inner zone, at the same depth, the temperature is 32.0° at the Borislav field and 29.0° at the Biktov. The geothermal conditions at the southwestern extremity of the Russian platform have not been studied adequately, but it can already be assumed that they are similar to those in the Inner zone of the Carpathian foredeep. All oil and gas fields of the Carpathian foredeep are recognizable in the heat field described by their local positive temperature anomalies, the size of which is variable, averaging to 8 to 12° above the background temperature.

Presented in Fig. 1. as a sketch map of the distribution of temperatures and pools of oil and gas in the western Ukraine. It shows that oil fields in the Inner zone are confined to comparatively epithermal parts of the Carpathian foredeep, while gas fields of the Outer zone are situated in more hypothermal areas. The temperature difference at the same depth reaches 15 to

20°. Within the Outer zone the main gas pools are again located in areas of higher geothermal activity in the northwest of the foredeep. In the Inner zone of the foredeep there is a close relation between the variation in physicochemical properties of oil and the size of the geothermal gradient. As the temperature decreases from northwest to southeast, the gas factor decreases in stratal oil, the viscosity of oil increases, etc.

Such a pattern of oil and gas pool distribution in relation to the level of geothermal activity of oil and gas provinces is not fortuitous and has its own thermodynamic explanation. In the natural mode of occurrence of hydrocarbon deposits in the sedimentary layer of the crust their physicochemical properties are functions of the temperature and pressure: the temperature promotes the destruction of liquid hydrocarbon compounds, while the pressure impedes this process. For solitary oil and gas pools the pressure and temperature, as though neutralizing each other, give strictly specific physicochemical properties to hydrocarbon accumulations, and the disintegration of liquid hydrocarbon pools is very slow. Within large oil and gas provinces, however, the geothermal conditions are rather varied. Thus, in the Carpathian foredeep, the temperature is different at the same depth in the Outer and Inner zones, but the pressure is almost identical and equals the hydrostatic. Consequently, for oil pools situated at the same depths in the Inner and Outer zones, the conditions of survival are more favorable in the first case since the process of destruction is considerably slower at low temperatures. V. A. Sokolov [3] has made calculations showing that an increase in temperature of 10° inside the earth if the pressure remains constant will shorten the life of liquid hydrocarbon pools by four-fold.

Thus, from the example of oil and gas field distribution in the Carpathian foredeep, it is evident that conditions for the survival and existence of accumulations of oil and gas are most favorable in those areas of oil and gas regions where the temperature is, respectively, comparatively low and comparatively high. This relationship is traceable elsewhere in the Carpathian oil and gas province (Austria, Hungary, Romania) as well as in the East Ukrainian and Crimean oil and gas regions of the Ukrainian SSR, in Ciscaucasia, and in U. S. oil and gas provinces, etc.

Exposure of this pattern by means of geologic and geochemical data should make it possible to estimate more accurately the oil and gas potential of large areas. Because of the geothermal conditions in the West Ukrainian oil and gas region, it may be supposed that the prospects for detecting new oil fields here will be best at the southwestern extremity of the Russian platform, while the possibilities of finding new gas pools will be greatest in the zone where the southwestern extremity of the platform links up with the Outer zone of the foredeep and with the Transcarpathian trough.

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