

*Irina N. Samchuk,*  
*ScM, Senior Lecturer,*  
*V N. Karazin Kharkiv National University*

## Materials on History of Geological Development of Orchik Paleodepression of DDB in Connection with Low Permian Halolithes Oil and Gas Bearing

**Key words:** *Orchik depression, oil and gas, non-arched traps, DDB.*

**Annotation:** *he history of Orchik paleodepression geological development that is located in the south-eastern part of the Dnieper-Donets basin is described in details since its inception. Paleodepression spatial boundaries are justified and fundamental differences, which do not allow combining Bahmutskiy and Kalmius-Toretskyi basin with Orchik paleodepression, are given. Based on the sedimentation characteristics the latter is considered as a separate area for searching new deposits of hydrocarbons of not arched types.*

**Introduction:** The issue of increase of Ukrainian hydrocarbons potential was always quite up to date.

One of the most promising research areas and hydrocarbons deposits exploration is at present undexplored terrigenous-chemogenic section part of Lower Perm formation that is occurred within Orchik depression in the south-eastern part of Dnieper-Donets basin (DDB).

Chemogenic formation of the Lower Perm is a unique matter in the geological section of such a big salt-dome area as DDB. The processes of salt plugs history development are reflected in its structure as its development peak is dated from Lower Permian times.

Due to the number of objective reasons (discrepancy of the Palaeozoic and Mesozoic structural plans, rapid fluctuations of depositions along the lateral plane, complexity of the geophysical interpretation of the inconsistent by the composition rock masses, frequent occurrence of the anomalously high formation pressures etc.) the search of hydrocarbon deposition in the Lower Permian rocks requires detailed investigation of the section and even though at small deposition depths represents quite complex objective.

The object of the detailed investigation of the hydrocarbons deposits exploration perspectives is the Orchik depression located in the southeast of DDB. The Lower Permian top carbonaceous oil and gas bearing complex has a widespread development in this part of DDB. The distribution of the initial hydrocarbon reserves over the stratigraphic complexes gives place to the high prospectivity of the Lower Permian stratigraphic range of the rocks occurrence. By the percentage ratio of oil-and-gas content in all productive stratum the Lower Permian top carboniferous complex takes the second place (31,4%) only slightly lagging behind the Upper Viséan Serpukhovian. Oil-and-gas content of the namely terrigenous-chemogenic formation of the Lower Perm may contain up to 15 % of capacity of the whole DDB.

Geological development history of this part of DDB was marked by increased activity during the Hercynian folding stage. During the whole of Early Permian stage, it was the deepest within BBD.

There are different names for this area in the literal sources. When referred in the context of oil-and-gas content it is most often called Mashinsk-Shebelynsky oil-and-gas bearing region BBD thus indicating only the spatial location of the hydrocarbon deposits in the Orchik paleodepression area. The research object is referred to Mashinsk-Shebelynsky area of oil-and-gas accumulation from the point of view of oil-and-gas geological zoning of the basin (1). When defining the deposition circumstances and zoning by litho-stratigraphic principle the name Orchik depression (2, 3, 5) is most commonly used thus reflecting not only spatial boundaries but also deposition circumstances. From the point of view of the issues under consideration, this name is the most acceptable and will be used hereafter for identification of the research area.

Stratigraphic interval of the most active development stage of the Orchik paleodepression corresponds to the terrigenous-carbonate-halogenous formation of the Lower Perm that is traditionally considered as a part of the Lower Permian upper carbonaceous oil-and-gas bearing complex (P<sub>1</sub>-C<sub>3</sub>).

It must be at the same time noted that identification of the boundary between carbonaceous and Permian systems is a disputable question. In the new version of stratigraphic scheme of the Ukrainian Lower Perm the lower boundary of the Permian system is marked along the limestone Q<sub>8</sub> (4) that serves as a high grade limit by the change of palynological complexes. Oil and gas industrial companies, which are located in the south-east of Ukraine, take into account somewhat different stratigraphic scheme according to which the boundary between the Lower Permian and upper carbonaceous depositions is considered to be the angular misalignment in the toe of the limestone Q<sub>4</sub> (frontmelickivskyi misalignment) (8). Taking into account oil-and-gas geological focus of the investigation presented in the article, hereafter we will use the scheme that is used by oil and gas industrial companies in the eastern part of Ukraine.

Lower Permian part P<sub>1</sub>-C<sub>3</sub> of the oil and gas bearing complex that comprises the south-eastern part of DDB is historically referred to as Backmutskyi range. Stratigraphical departments, which it is comprised of, is started with Melickivkyi rock formation bedded with stratigraphical and angular discrepancy on denuded carbon depositions of different age. Melickivskyi formation with stratigraphical discrepancy (5) is overlapped by Mykytivksa rock formation (Sviatogirska and Torska bands). Higher in the succession Slovianska formation is bedded (Pidbriantsivska, Briantsivska, Nadbriantsivska, Nyzhniobriantsivska and Verhniobriantsivska). The section of the Backmutska formation is ended with Kramatorska rock formation. Old-type denudation of this kind of section is location within Backmutskyi basin by the name of which a range was named.

The start of Orchik paleodepression formation as a separate element of the basin must be related to melickivsky times. During the late carbonaceous age, which preceded Melickivkyi, the region of maximum sag was located to the east of Orchik depression namely in the area of Backmutskyi basin.

The amplitude growth of axial zone of the basin sag in relation to near edge zones in the late carbonaceous times comprised 1000-1500 m. In the north-east, it was within 150-200 m. At the

same time, the formation of many structures in the south-eastern part of DDB is observed (West-Chrestyshynska, West-Medvedivska, North-Volvenkivska, Spivakivska, Slavianska). Intensive growth of already existing middle-size and small structures continues. The largest of the local rises of the central part of the basin have increased their amplitudes by 100-150 m (Kachanivske, Bilske) and even by 250-300 m (Mashivske).

At the same time the first signs of the Donetsk basin inversion start are observed, it has led to separation of the unique sedimentational basin into two tectonic elements: Dniprovko-Donetskyi basin and Donbass.

The end of the late carbonaceous stage in the area of future Orchik paleodepression was marked by changes in tectonic setting leading to the pause in sedimentation and, as a result, partial erosion of the deposited rocks during the carbonaceous time. This event is confirmed by the angular discrepancy between carbonaceous rocks (slope angle 18-25) and overlapping rocks of Melickivkyi formation (1-2°).

In the early Permian age, the zone of maximum sagging has moved to the area of Orchik depression. Sedimentational basin of this time, the same as carbonaceous, had symmetrical location in relation to the marginal distortions but in contrast to such distortions, it has quite different distribution boundaries in the south-east.

The sag of the sedimentational basin was not regular which led to appearance of the zones with increased gradients of thickness. Thus, the growth of thickness towards the axial zone makes up 10 m/km while in some passive structures it comprises 40-50 m/km. The internal architecture of Orchik paleodepression (that will assimilate it at later stage) is formed. Sags, which have appeared during that time, would develop at later stages into future Kratenivsko-Grygorievsku, Grebenivsku-Kominternivske and Horolsko-Lyhachivsku depressions. At that point, these were local basins without clear merging into uniform passive structures. Beside this, a big quantity of compensatory paleomoulds have been developed near salt plugs, which were compensating extruded at surface masses of saliferous rock. The distinctive peculiarity of the moulds is displacement along the plane or even disappearing at some stages according to development stages of salt diapirs. The maximum sags happened to be during the active intensification of the plugs, which are widely developed in the area of Orchik paleodepression. Irregularity of the modern structural plans and historical moulds plans shows the compensatory nature of the latter.

The beginning of transgressive deposition in Orchik depression goes back to Melickivkyi times. Sediments, deposited during this period, with angular and stratigraphical discrepancy, were deposited on different carbon bedding planes. Angular discrepancy that lies in the toe of Melickivkyi formation is proved and justified (7, 8).

Melickivskyi formation is included to the Backmutskyi range (7, 8). According to the decision of ISC It was accepted to consider the toe of the Melickivkyi formation as a boundary between Lower Permian and Upper Carbonaceous depositions.

Thus, it is practicable to consider Melickivkyi period as the time of appearance of Orchik depression.

Formational composition, spatial location of subformation (terrigenous-calcium-saliferous type in the east, and mainly terrigenous, off-shore in the west), high speed of sagging of its middle

part, change of the disposition of zones of maximum sagging (from Melickivkyi to Kramatorskyi times) - all these factors give ground to think that in the Early Permian times the Orchik depression was fulfilling the role of the periclinal submontane sagging of Donetsk folded structure (2).

Starting from the end of the Sakmarian age the Orchik depression was subject to upraise and denudation. During the pause in sedimentation process deposits of carbon and perm were denuded and those, which preserved, were covered with Triassic bright-coloured depositions.

This stage of Orchik depression, though marked by massive inversion movements, has retained the basin as a passive structure. The evidence of this may be the decreasing of the rock age (which are denuded at pre-triassic surface) from the periphery to centre.

Inversion stage of DDB is marked by substantial upraise of the southern slope of the basin resulting in erosion from 300 to 2200 m of the depositions of lower perm, upper and partly middle carbon.

For deposits of Carbonaceous time the effect of pre-triassic erosion was facilitated by Pre-Early Permian (Pre-Melickivkyi) erosion.

Because of upraise of the southern part of Dnieper-Donetsk basin the displacement of the axial part of paleobasin has taken place in the northern direction in the way that it became asymmetrical. This displacement was set by distribution of maximums of formations, which retained after pre-triassic denudation and it does not describe the geometry of the sedimentation basin.

Activity of the boundary distortions, which separate slopes from the basin, was completely different during this period. Northern slope developed as a folding system and was not very active while southern, due to inversion movements of near edge zone, was obtaining a flexure structure accompanied by drops. This is observed in the areas of Zachepylivkyi, Myhailivskyi and other uplifts where near edge distortion has distinct exposures along the foundation roof.

During the pre-triassic pause passive structures were formed due to lower upraise of their near-axial part but not due to sagging.

Thus, we may conclude that paleotectonic frameworks, under influence of which Backmutskyi range was formed, were the most favourable for development of non-anticlinal structural forms, which might be connected with non-arched plugs and accumulation of hydrocarbon. Different genetic groups of non-arched plugs were formed within paleodepression under the influence of tectonic and paleogeomorphic factors.

From north-west, the boundary of the research object is marked by expansion of the depositions of Melickivkyi formation that coincides with submeridional Kachaniska zone of the deep fissures. In the north-west and south-east the boundaries are demarcated also according to the widest preserved area of Backmutskyi range, after pre-triassic erosion.

As far as south-eastern boundaries are concerned than the use of the same principle will be not quite correct.

The rocks of Backmutskyi range, which are located outside the Orchik depression, are developed also in Backmutskyi and Kalmius-Toretskyi basin but the history of their geological development and peculiarities of structural framework don't allow joining these objects into one structural-tectonic complex. The structures of Backmutskyi basin - is in a majority brachyantycline folds and sags, (which separate these structures) subordinated to the main tectonic lines of Donbass of western and northern-western extension; their overlapping due to convergence covers eastern plunges of the neighbouring upraises in a echelon-like manner similar to the structure of the northern Donbas.

The structure of Kalmius-Toretskyi basin are also subordinated to the general directions of Dotetsk folding. Such features as undulation or sliding forward of the axes of folds under plunges of the neighbouring ones, separation and joining of the structural headlands and flexures, are common for such structures.

However, for Orchik paleodepression such features of the geological structure are not common. Almost all of its structures are the result of blocks movements and closely related to the exposure of saline diapirism. Orchik paleodepression, during its formation in Zaalish phase of Hercunian folding, was in the zone responsible for periclinal submontane sagging of the future Donetsk folding structure (2).

The next Alpine folding phase have not changed greatly the features of the Orchik paleodepression in contrast to Backmutskyi and Kalmius-Toretskyi basin. The majority of the described structural peculiarities of the basins formation have been developed during the Alpine folding stage.

The boundary between Orchik paleodepression and Backmutskyi and Kalmius-Toretskyi basins is considered as a zone of concentration of denuded paleozoic upraises - Korulska, Kovyshuval'ska, Volveniv'ska, Krasnooskolska and Novomeckililiv'ska structures.

**Conclusions:** The search for the traps of hydrocarbons in the mentioned area has to be conducted based on the genetic features of the structures formed, which are subordinated to paleotectonic and palaeogeographical peculiarities of the area development. Demarcation of the zones and areas (vertically and laterally) with occurrence of the endogenous (or) exogenous processes, which took place during the deposition, will substantially simplify the localization of the promising areas and forecasting certain types of hydrocarbon plugs within such areas.

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