DOI: https://doi.org/10.30836/igs.iies.2024.30

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SEISMIC FACIES ANALYSIS OF PERMIAN SEDIMENTS OF PIVDENNO-KHRESTYSCHE AREA (DNIPRO-DONETS BASIN, UKRAINE)

The Pivdenno-Khrestysche area located in the central axial part of the Dnipro-Donets basin (DDB, Ukraine). The DDB is a Late Palaeozoic intracratonic rift basin, with sedimentary thicknesses up to 19 km, displaying the effects of salt tectonics of Upper Devonian salt formation during its entire history, from Late Devonian rifting to the Tertiary. Hundreds of concordant and discordant salt structures formed during this time [3, 4, 6, 7]. There are three evaporite formations in the Dnipro-Donets depression: Upper Frasnian (lower saline stratum), Lower Famennian (upper saline stratum) and Lower Permian Formation. The postrift-platform Lower Permian Formation occupies the larger part of the depression. The depth of the formation base ranges from 50 to 4060 m and its thickness varies from 40 m in the NW to 1737 m in the SE part of the depression. The formation is underlain by the Kartamysh red-coloured terrigenous formation [3, 4]. The study area characterizes by high distribution of Lower Permian sediments that interact with Krestyschensky salt dome. Lower Permian formation is subdivided into two subformations: the rock-salt-bearing Mykytivka-Slovyansk and Kramatorsk K-Mg-salt-bearing ones. The rock-salt subformation, which is up to 1200 m thick, is represented by alternating layers of rock salt (up to 75 m thick), limestones, mudstones, marls, anhydrites and halopelites. The K-Mg-saltsubformation, up to 960 m thick, is composed of rock-salt with anhydrites, salt-siltstones, sandstones and halopelites, as well as K-Mg- and Mg-salt seams. Up to six large-scale cycles are distinguished in this subformation, with halite-siliciclastic rocks and/or anhydrites in the base and with thick rock-salt or salt-siliciclastic bed at the top. The lowest cycles are covered by the aforementioned K-Mg salt and bisschofite seams [3]. The Khrestysche salt structure is a mushroom-shaped dome consisting of Upper Devonian salt formation that penetrates into the Lower Permian formation. Mushroom-shaped diapirs have an overhanging bulb fringed by one or more skirts (peripheral pendant lobes), which can curl inward to form vortices capable of entraining cover rocks to various degrees [5]. The complex history of Lower Permian facies sedimentation and salt dome development lead us to made seismic facies analysis. The goal of this study is presenting new data on structure and tectonic settings of Lower Permian depositional environment and found areas with economic interests using seismic data.

Data and Methodology

The makeup of a seismic image reflects the interaction between the substrate geology and the seismic waves traveling through the rocks, modulated by the physical properties of the rocks. The amplitude, frequency, continuity, terminations, and distribution of reflectors define various seismic facies units, which were subsequently grouped into seismic facies associations defining progradational, retrogradational or aggradational geometries. They are controlled by the rate of accommodation and the sediment supply. In spite of the technological progress, seismic data still provide only indirect information lithology in the subsurface, so calibration with borehole data is essential for fine tuning the seismic facies-lithofacies relationship, for velocity measurements, or for time-depth conversions [1].

This study used 100 km^2 3-D seismic data set. All seismic data are displayed in milliseconds two-way travel time. Wireline-log and stratigraphic data from six boreholes in the basin constrain the composition and age of the salt and its overburden, and checkshot data tie this borehole information to our seismic data.

Results

Six seismic facies units have been differentiated in the Pivdenno-Khrestysche area of the Dnipro Donets Basin (Figure 1). Although the seismic characteristics depend on the seismic acquisition and processing methodology of various seismic data, a general pattern can be established [2]. All of them have special seismic amplitude and frequency characteristics described below (Figure 1). Some of the seismic facies contained rock salt that have special seismic reflection because diapiric salt is typically acoustically transparent. This acoustic characteristic of salt helps us rightly distinguish salt dome.

First three facies units subparallel fairly continuous, subparallel continuous to semicontinuous, parallel continuous (units 1,2 and 3) are characteristic for stable Permian «shallow water» basin with laminated anhydrite-carbonate (formed after bacterial gypsum-carbonate) [3, 4]. This three facies units distributed through all Pivdenno-Khrestysche area. We also can observe flaked Lower Permian salt in the third seismic facies unit. The fourth facies unit represented salt dome and show Devonian salt breakthrough Lower Permian sediments. Oblique (5) facies unit occurs near salt dome steam and it was formed by salt diaper developing. Sub-parallel hummocky facies unit (6) occur near steam, under main bulb, in “pocket” caused by complex geometry of salt dome (Figure 2, red circle). The location of the pocket we can see on the horizontal

reflection seismic slice. It situated between two salt walls. Also we can see part of mushroom-shaped salt dome in the left part of seismic section on the Figure 2. The part of seismic section beneath salt dome belongs to Lower Permian strata. The Triassic strata overlaps Khrestysche salt dome.

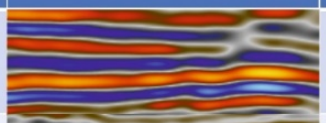
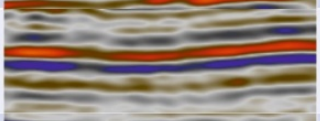
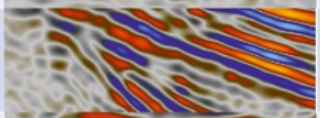
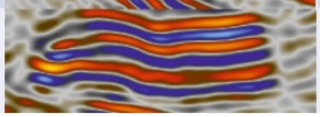
Seismic facies unit	Seismic examples	Amplitude and frequency characteristics	Spatial distribution, typical occurence
1. (Sub-) parallel fairly continuous		High amplitude, meduim to high frequency	Occurs beneath salt dome
2. Subparallel continuous to semicontinuous		Medium to high amplitude, Low to high frequency	Occurs beneath salt dome
3. Parallel continuous		High amplitude, high frequency	Occurs beneath salt dome
4. Chaotic discontinuous		Low to medium amplitude	Occurs inside salt dome (central part)
5. Oblique		Variable amplitude, Low to high frequency	Occurs near steam
6. Sub-parallel hummocky		High amplitude, meduim to high frequency	Occurs near steam

Fig. 1. Characteristic seismic facies units used in the seismic sequence stratigraphic interpretation

The most perspective for hydrocarbon prediction are facies units 5 and 6. Oblique (5) facies unit showed positive structure that can contain gas sealed by salt. Sub-parallel hummocky facies unit (6) also trapped by salt and have interesting inner structure that can point to good reservoirs.

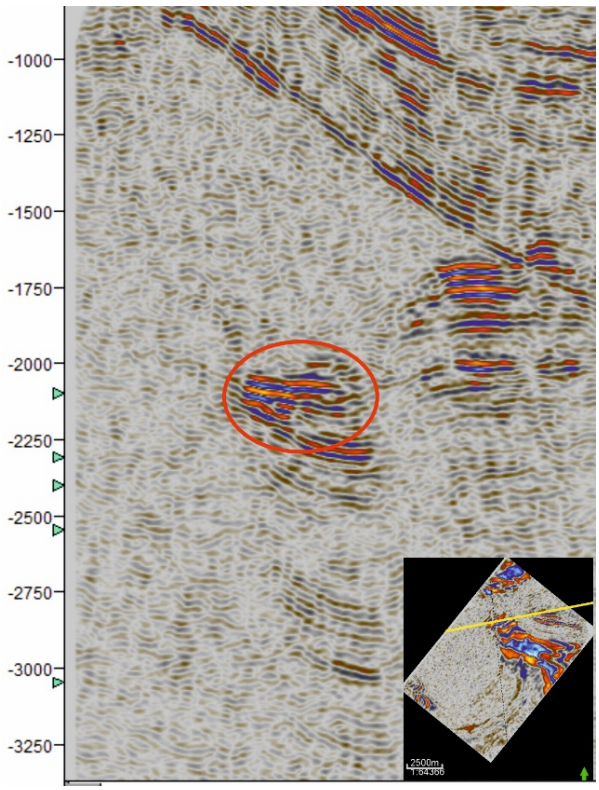


Fig. 2. Reflection seismic section across Krestysche salt dome

The seismic facies analysis helps us to understand depositional environment through Lower Permian time and also to distinguish two possible hydrocarbon traps. Diapiric salt acoustic transparent gave opportunity to outline a complex morphology of the Khrestysche salt dome. This method has to be using with other geological and geophysical methods to make the right conclusion and decision.

This study was carried out under the funding of the state budget program CPCEL 6541230 in the framework of the R&D Project "Strategic mineral raw materials for the recovery of the economy of Ukraine: analysis of resources and reserves, development of search criteria for increasing their mineral resource base".

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