3D seismic velocity models distribution for complete complex of processing and interpretation of seismic data in Dnieper-Donets Basin

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Abstract – VSP data processing workflow for determining of velocity model is being reviewed in the paper, which can be used for processing of seismic data. Optimal graph of seismic data processing is proposed. The graph contains all the optimal procedures, which allows obtaining seismic images of high quality. Seismic images, obtained after processing, were used for seismic interpretation, which helped to specify geological structure of the prospects in the cutoff part of the Dnieper-Donets Basin.

Key words – 3D cube, SRM data, geometry, static, velocity, DMO transformation, Zero-phase deconvolution, migration, Data interpretation.

I. Introduction

Advanced understanding of geological structure of the fields of Dnieper-Donets Basin is one of the most important step in modern geological exploration hence it allows increasing of oil and gas resources and reserves. In return, this challenge became unreachable without precise processing of acquired seismic data and detailed understanding of velocity model prior migration.

Significant amount of geological and geophysical studies were held at the area of interest, including electrometric, magnetic, gravity and seismic surveys. Wildcat, parametric, and some production wells are drilled. [1]

Acquiring of these data allowed to create acceptable geological model of the area. Nevertheless, the most important issue related to depth conversion cannot be solved correctly solely by little amount of velocity data from certain fields, also we cannot rely completely on velocity models created based on velocity spectra analysis prior migration. Though such velocity cubes might be used later for depth conversion relatively easily using well-known Dix equation, we should take into account possible mistakes that might be introduced during velocity spectrum analysis. Thus, 5 % mistake in velocity estimated from velocity spectra can result in about 20 % mistake in interval velocities calculated via Dix equation. This is why using borehole seismic data is a crucial step for accurate depth models of petroleum prospects and leads.

II. Methodology of VSP data interpretation

The Collection and analysis of wellbore seismic data, mainly results of VSP research was first step in preparation data for velocity modeling. Authors have collected the data from more than 300 wells. Most of these wells located at the area of research, while some wells are located outside the area, but in “immediate” vicinity. These wells were incorporated into model in order to control extrapolation process at the borders of the research area. [2]

About 5 % of these data were not conditional – it was not possible neither re-interpret the data, nor even understand the readings. Therefore, we made conclusion that such oil fields may be considered as the ones without well velocity data.

Since all the VSP surveys were conducted in different time by different methodologies, we have decided to re-interpret the data – in order to have it in one standard.

In order to have all the VSP interpretation results we have developed following workflow:

- at the first stage vertical time travel curves were referenced to absolute depth level (sea level) and correction of an a priori mistakes was made.
- at the second stage corrected time travel curve was recalculated in the time travel curve with constant increment. If input time travel curve was reordered with a step of 20 meters and more, step of an output curve was set to 20 meters. If input time travel curve was reordered with increment of 10-15 meters and more, increment in the output curve was set to 10 meters. [3]
- at the third stage obtained data was transferred in digital and graphical form for further processing.

III. Data interpretation

Reinterpretation of 3D seismic data and formation properties at the Southern border of Dnieper-Donets Basin allowed to reveal new aspect of geological structure of the area, determine areas of petroleum leads and re-estimate formation properties of key productive horizons.

Today, when new technologies and equipment occur, both for seismic data acquisition and its processing and interpretations, it has become possible further research of Southern part of Dnieper-Donets Basin border. Interpretation was carried out on 20 seismic profiles (61-79, 81 2 02), which forms fairly uniform grid. For alignment of wells two profiles of past years - 19 43 81 and 70 43 90 were used. After processing of seismic data, and also reprocessing of profiles from previous years, in the ProMAX system, all materials were loaded into the database of interpretation package Integral Plus. The seismic reference datum of profiles is 150 m. [4]

For tying seismic boundaries with geological data at all deep drilling wells, as well as to determine the characteristics of the complex nature reflectors seismic modelling was carried out. [5]

For convolution of impulse traces 23 Hz Ricker wavelet was used, determined from seismic profiles 77 2 02. Calculation of synthetic traces was performed based on an acoustic borehole logging and generalized velocity curves. Results of seismic modelling showed that the lower and upper borders of Visean formations correspond to an acoustically hard surface. Stratigraphic boundaries coincide with the top of seismic vibrations' wavetrain. This conclusion is also confirmed by comparing calculated seismic traces with the real wave field. [6].

Conclusion

Modern software and interpretation methods of seismic data allow significant improving of mapping accuracy and tracing tectonic faults. Application of new techniques for the interpretation of data makes it possible to create 3D geological models, defining distribution of zones with better reservoir properties, predict values of porosity and zones of lithological substitutions. Using algorithms of seismic facies analysis allows much more reliable establishment of lithological substitution zones and estimate distribution of formations with similar porosity and permeability properties. As a result of seismic studies the geological structure of southern border of Dnieper-Donets Basin was clarified.

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