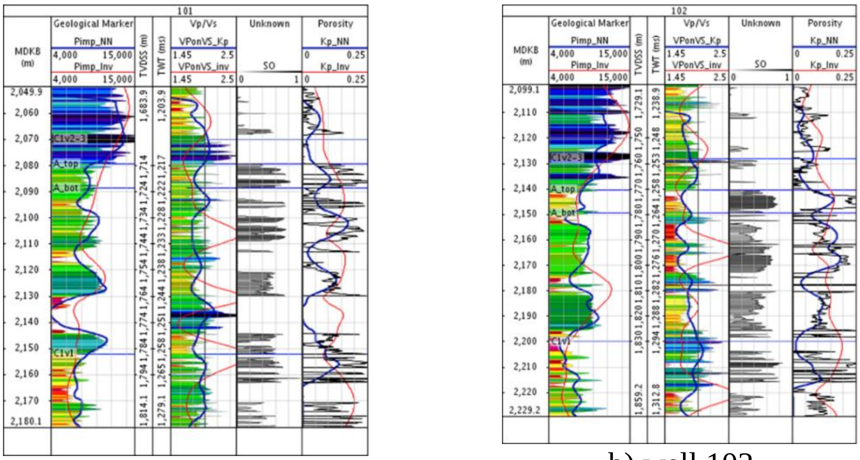
UDC 550.83.015

Bekbaltina Gulnaz – 1st year master's student of the EP "Oil, gas and ore geophysics"
Supervisor: Umirova G.K., Doctor Ph.D., Associate Professor of the Department of Geophysics and Seismology
Satbayev University, Almaty, Republic of Kazakhstan

PREDICTION OF RESERVOIR PROPERTIES FROM SEISMIC DATA BASED ON LINEAR AND NONLINEAR PREDICTION ALGORITHMS

The relevance of the research is justified by several factors: the launch of several fields of the national company QazaqGaz is planned; active work is underway at the Anabay field [1]; The Pridorozhnoye field is characterized by high gas prospects (at the end of 2024, work will begin on an integrated gas treatment unit (CGT)) [2]. On the other hand, according to geologists, the basis for world leadership in the field of energy can be provided by the Shu-Sarysu, Mangyshlak and Zaisan sedimentary basins. However, their reliability requires confirmation through a significant amount of complex geophysical work with delineation of local objects and oil and gas exploration drilling within them [3]. Since the level of production of the Amangeldy field does not ensure full utilization of the gas processing facility, a decision was made to further explore and put into operation gas fields that are small in size and reserves, located in close proximity to the Amangeldy field. This Airakty gas condensate field is located within the Moyynkum district of the Zhambyl region, 170 km north of the city of Taraz. The field has been studied in detail by CDP 2D seismic exploration and its industrial gas content is confined to the Lower Visean and Tournaisian stages of Carboniferous and terrigenous deposits of the salt-bearing Permian of the Muyunkum depression. The gas content of the Permian deposits was studied by structural prospecting, and that of the Lower Carboniferous deposits by deep prospecting drilling [1]. The deposits are strata domed, tectonically screened. The Upper Devonian and Lower Permian reservoirs are represented by sandstones with a porosity of 10-18%, the Lower Carboniferous (Visean-Serpukhovian) are represented by fractured limestones with a porosity of up to 4%, the efforts of developers are aimed at the extraction and study of which. The literature states that the Airakty gas field is confined to a brachyanticlinal structure of a very simple isometric shape, complicated by faults, however, the observed well flow rates allow us to draw conclusions about a non-anticlinal model of the field [3].

Let us dwell on some procedures for dynamic interpretation of seismic data, since their results are quite interesting from the point of view of predicting reservoir properties from seismic data based on linear and nonlinear prediction algorithms. Positive aspects for the procedures: 4 new wells were drilled with core sampling and logging, the velocity model was updated, the results of the old 3D seismic interpretation processing are available. Along with recalculating the prestack seismic inversion, which is a standard procedure when performing dynamic interpretation, a neural machine learning procedure was carried out. To train neural networks, a technology developed on the basis of mathematical techniques outlined in Kolmogorov's theorem was used. To predict the lithological and elastic properties for the studied interval of Lower Carboniferous deposits, the cubes of porosity, longitudinal impedance, transverse impedance and their ratio were calculated. This choice was made based on the results of petroelastic analysis of well logging, on the basis of which it was concluded that the ratio of longitudinal and transverse impedances is related to saturation and, conditionally, to well production [3]. For subsequent comprehensive analysis, a comparison was made of the target characteristics (petroelastic properties and porosity) calculated using the synchronous inversion algorithm and neural network forecasting algorithms, on the basis of which it was found that the results of neural network training have a number of advantages



a) well 101 b) well 102

Figure 1 - Comparison of PIMP, Vp/Vs and porosity parameters calculated by the synchronous inversion algorithm (red curve) and machine learning algorithms (blue curve) with real original logging curves

Thus, for a comprehensive analysis, the results of neural network training were chosen, which not only have better convergence in the absolute values of logging curves, but also have greater resolution. The completed studies made it possible to highlight a number of shortcomings in performing inversion forecast constructions in the process of comprehensive interpretation of seismic data and well measurements. All of them are associated mainly with the presence of nonlinearity in the connection of the seismic field with the predicted parameters calculated in the wells:

1. Nonlinear distortion of the seismic signal, associated with the complexity of the upper part of the section and the presence of distorting objects and factors (for example, salt structures, fault zones, steeply dipping structures, layers with increased absorption of seismic waves or with strong reflective properties, etc.);

2. Lack of theoretical developments on inversion constructions in conditions of nonlinear distortions in seismic fields and the presence of complex nonlinear relationships between the distribution of seismic fields and elastic, elastic, filtration-capacitive and lithofacies parameters in wells.

In addition, the proprietary technology we use has the ability to create a neural network model of a low-frequency model based on a structural model and well data. This construction is performed simultaneously with the use of seismic data to predict well data. This also greatly improves resolution compared to classical inversion, where the low-frequency model often accounts for 90% of the result.

References:

1. Biletskiy, M. T., Ratov, B. T., Khomenko, V. L., Borash, B. R., & Borash, A. R. (2022). Increasing the Mangystau peninsula underground water reserves utilization coefficient by establishing the most effective method of drilling water supply wells. News of the National Academy of Sciences of the Republic of Kazakhstan, 5(455), 51-62. https://doi.org/10.32014/2518-170X.217.

2. Ratov, B. T., Bondarenko, N. A., Mechnik, V. A., Prikhna, T. A., & Kolodnitsky, V. M. (2022). A study of the structure and strength properties of the WC-CO drill insert with different CrB_2 content sintered by Vacuum Hot Pressing. SOCAR Proceedings, (1), 037–046. https://doi.org/10.5510/ogp20220100626.

3. Taskinbayev, K. M., Dzhangirov, K. M., Bogomazov, A.E. & Sapaev Zh.E. New vision of structure and oil and gas potential field Airakty. April 2020. https://doi.org/10.37878/2708-0080/2020-5.037.