SATBAYEV UNIVERSITY

Engineering Journal of Satbayev University

Volume 146 (2024), Issue 5, 54-60

https://doi.org/10.51301/ejsu.2024.i5.07

Comparative analyzing the technology of predicting reservoir properties according to seismic data based on linear and nonlinear prediction algorithms

A.N. Dzhangirov[1], G.K. Bekbaltina[1*], G.K. Umirova[2], R.G. Temirkhanova[2], F.N. Abdoldina[2]

[1]*LLP Professional Geo Solutions Kazakhstan, Almaty, Kazakhstan*
[2]*Satbayev University, Almaty, Kazakhstan*

**Corresponding author: bekbaltinagk@gmail.com*

Abstract. The article deals with the results of dynamic interpretation of 3D CDPM seismic data in combination with logging data. The authors were faced with the task of comparing the results of pre-stack seismic inversion and neural learning technology in the conditions of the Arykty gas condensate field. The reason for this was the low seismic knowledge of the studied area, the fairly good predicted prospects for oil and gas content in the region, and the need to study the criteria for selecting a particular dynamic interpretation procedure. In this regard, an attempt was made to consider the structure and oil and gas content of the Arykty gas condensate field from the point of view of a comparative analysis between pre-stack inversion, which is currently actively used in the geological exploration industry within the framework of a standard interpretation graph, and neural machine learning. Justification for the relevance of the studies performed is availability of new wells and updated logging data, the ability to update and to compare the results of synchronous pre-stack inversion, and the ability to test neural learning algorithms. The conducted studies make it possible to identify criteria for the preferential use of machine learning in the conditions of the Arykty field, to take a fresh look at the features of the internal structure of the rocks that make up the productive part of the section, and to demonstrate physically the advantages of machine learning results in comparison with pre-stack seismic inversion.

Keywords: *Arykty gas condensate field, Shu-Sarysu sedimentary basin, dynamic interpretation, neural networks, pre-stack seismic inversion.*

1. Introduction

The economy of Kazakhstan still depends on the development of the mineral resources complex. At the same time, one should consider that the search and exploration of mineral resources is carried out in complicated conditions of increasing the depth of studies aimed at detecting complex reservoirs and missed intervals. The depletion and water content of most oil and gas fields in Kazakhstan play their role, too. But the needs of the present-day economy for hydrocarbon raw materials are indisputable, and work to replenish oil and gas reserves must continue. Traditionally, the Caspian, Mangyshlak and the other sedimentary basins are considered potential zones with high prospects for oil and gas. For example, in 2023, the largest volume of gas production occurred in the Atyrau region (11.5 billion cubic meters of gas). The West Kazakhstan region was in the second place (9.3 billion cubic meters of gas). The top three for gas in liquid or gaseous state is completed by the Aktobe region, and in natural gas by the Mangistau region.

However, the available geological and geophysical data of the oil and gas bearing areas of Southern Kazakhstan (the Shu-Sarysu, the Ili, and the Balkhash sedimentary basins) show that it is necessary to reconsider and to carry out a serious revision of ideas about the prospects of these territories[**Ошибка! Источник ссылки не найден.**]. For example, the Shu-Sarysu gas-bearing region includes the Ucharal and Muyunkum gas-bearing districts. The region gas prospects were proven by the discovery of the first Pridorozhnoe gas field in 1971, and by 1986, eight gas fields had already been identified. The Pridorozhnoe, the Amangeldy and the Arykty fields are the most significant of them.

Based on the results of more than 40 years of exploration work, the Shu-Sarysu basin has a very complex geological structure, a tense geodynamic history. The degree of geological and geophysical knowledge of the Shu Sarysu basin territory does not allow giving a reasonable assessment of its generation capabilities in relation to hydrocarbons. The proximity of the Shu-Sarysu basin to a number of large cities and industrial centers of Central and Southern Kazakhstan will make it an ideal source of Kazakh gas supplies if sufficient reserves are discovered [[2]].

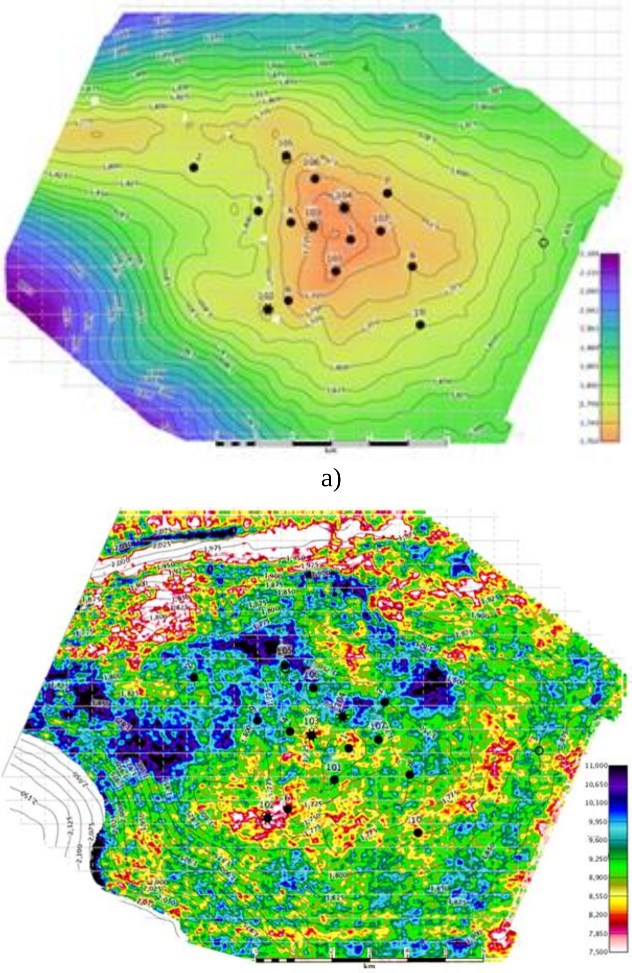
1.1. Relevance

The relevance of the presented research is justified by several factors. Firstly, the draft Roadmap for increasing commercial gas volumes provides for launching several fields of the QazaqGaz national company. Active work is underway at the Anabay field that is located in the Moyynkum district of the Zhambyl region. Its commissioning is planned for the third quarter of 2023. The Pridorozhnoye field that is located in the Sozak district of the Turkestan region, also has high gas prospects. Here, at the end of 2024, construction and mounting work of an integrated gas treatment plant (GTP) begins. Secondly, according to geologists, the Shu-Sarysu, Mangyshlak and Zaisan sedimentary basins can provide the basis for global leadership in the field of sustainable energy development.

Thirdly, the studied area is characterized by rather low geophysical knowledge. In particular, the structure of Arykty was first identified in 1967 by the inflection of layers on seismic profile 5-67. Through the Ili geophysical expedition, the structure was confirmed and studied in detail in 1970 by the network of search seismic profiles. Seismic profiling in the work area traced reflecting horizons II (base of the Lower Permian salt-bearing strata), III (base of the Visean carbonates), IV (base of the Famennian). Only reflecting horizon III is regionally consistent throughout the entire area of the Shu-Sarysu depression, while the rest ones are traced uncertainly and are studied rather poorly. Deep prospecting wells confirmed the structural plan as a whole and established a relative error in making the structural plan up to 50 m in the southern part of the structure, on the basis of which a reinterpretation of seismic survey materials was carried out. It did not note any fundamental changes in the structure along the roof of the structure. in 2008, detailed seismic exploration work of CDPM 2D was carried out by the Kazakh Geophysical Company LLP, as a result of which the geological structure in the area was clarified and structural maps were constructed for the target reflecting horizons. The inherited nature of the territory development and the Late Hercynian time of formation of local structures were confirmed with recommendations for continued study of the Sultankuduk, Kashkynbay and Kashkynbay Western, Zharkum, Kumyrly and Koskuduk, Arykty and Anabay structures. The field seismic surveys of CDPM 3D were carried out only in 2016 by the GEOKOM LTD; the processing and interpretation of these materials was carried out by the Professional Geo Solutions Kazakhstan LLP in 2017. Thus, at the present stage, the field is characterized by rather low knowledge [**Ошибка! Источник ссылки не найден.**].

Fourthly, according to statistical calculations by specialists, the potential of the Shu-Sarysu basin is quite high. 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 [[2]].

Finally, since the level of production of the Amangeldy field does not ensure full utilization of the gas processing facility, the Amangeldy Gas LLP subsoil user made the decision on additional exploration and commissioning of gas fields that are small in size, and reserves that are located in close proximity to the Amangeldy field. Such a field can be considered the Arykty gas condensate field that is located within the Moyynkum district of the Zhambyl region of the Republic of Kazakhstan, 170 km north of the city of Taraz. It was discovered and then opened in 1971. The field was studied in detail by CDPM 2D seismic exploration and its industrial gas content is confined to the Lower Visean and Tournaisian stages of the Carboniferous and terrigenous deposits of the salt-bearing Permian of the Muyunkum depression. Studying the gas content of the Permian deposits was carried out by structural prospecting, and of the Lower Carboniferous deposits by deep prospecting drilling. The deposits are strata domed, tectonically shielded. The Upper Devonian and Lower Permian reservoirs are represented by sandstones with 10-18% porosity, the Lower Carboniferous (Visean-Serpukhovian) ones are represented by fractured limestones with porosity of up to 4%, the extraction and study of which in modern conditions is the focus of the operator's efforts. The stock and published literature states that the Arykty gas field is confined to a brachyanticlinal structure of a very simple isometric shape complicated by faults (Figure 1, a).



a)

b)

Figure 1. Structural map (a) of the top of the Lower Visean deposits and the result of seismic data inversion (b) superimposed on the structural map

However, the observed well flow rates allow drawing some conclusions about the non-anticlinal model of the field [**Ошибка! Источник ссылки не найден.**]. Among the 8 deep exploration wells, gas inflows with flow rates from 10 to 70 thousand m3/day (from the Lower Visean horizon) were obtained in wells 1, 6, and non-industrial inflows were obtained in wells 2, 7. In the interval from 2016 to 2020, a weak gas influx was obtained from well 101 that is located in the dome of the structure. CDPM 3D seismic surveys carried out in 2017 proved the optimal structural conditions for the location of well 101 (Figure 1, a), which, however, was not confirmed by the results of dynamic analysis of seismic amplitudes (Figure 1, b). Quite high production volumes were shown by drilling wells 102 and 103 that were laid according to the results of seismic studies (Figure 2), while it should be noted that well 102 is located on the periphery of the structure. Further drilling of several wells did not produce significant flow rates. With such drilling results, it is obvious that for the Arykty field, alongside with the structural factor, the facies distribution factor in the Lower Visean interval is no less decisive, which makes it possible to characterize confidently the deposits as non-anticlinal type traps [**Ошибка! Источник ссылки не найден.**].

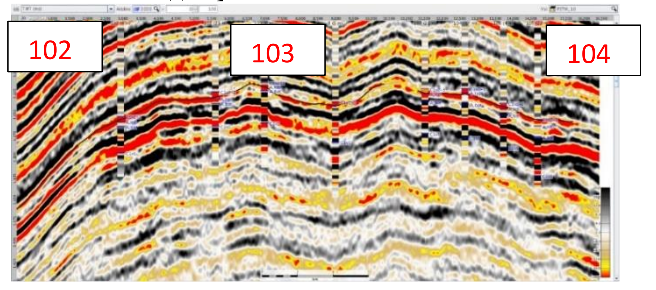


Figure 2. Seismic section along the well line. Wells with different initial flow rates are shown in red

The purpose of the presented study is to predict hydrocarbon deposits in terrigenous reservoirs associated with non-anticlinal traps based on reprocessing and reinterpretation of CDPM 3D seismic data.

The purpose was achieved by solving the following tasks:

1) analyzing the features of the reprocessing graph in the conditions of the Arykty field;

2) studying the results of the analysis of elastic properties at the level of the Serpukhov and Lower Visean reservoirs based on pre-stack seismic inversion;

3) comparative analysis of the technology for predicting reservoir properties from seismic data based on linear and nonlinear prediction algorithms.

The basis for reprocessing and reinterpretation of the 2017 CDPM 3D seismic data was a high level of interference of various natures and a low signal-to-noise ratio. To solve these problems, there was used the Professional Geo Solutions Kazakhstan LLP software package with special procedures. A comprehensive analysis of testing results and careful selection of parameters made it possible to select the optimal sequence of the procedures used, which helped improving the quality of the final results and solving the tasks assigned to processors. Here there are considered some features of the selected processing graph.

1. Noise attenuation. Low-frequency interference waves were effectively suppressed by 3D procedures, linear noise with the use of an FK filter, interference waves and random residual noise with the use of the Omnis procedure in a cascade version. Through extensive testing, as well as application of the results to data from both the cross-matching, CDPM and global removal domains, extensive attribute analysis, and ongoing quality control, noise was successfully suppressed.

2. The processes that consider the effect of surface conditions. To perform more effectively the noise analysis and multiple wave suppression, such procedures as surface-consistent amplitude balancing (Scscale), amplitude scalars, and deconvolution with different prediction intervals for the upper target part of the data were widely used.

Since the work area is characterized by a complex geological structure, four stages of speed analysis were performed in the studied area. At the fourth stage, automatic high-density velocity picking was used, which made it possible to obtain a velocity function and to improve the quality of horizon tracing. The analysis of kinematic corrections was carried out over the area using the own software package, which made it possible to select the most optimal speeds and to obtain a standard speed cube. Thanks to four stages of the speed analysis, the final kinematic corrections introduced resulted in flat boundaries in the CDPM region, and ensured the construction of an optimal image in the stacking region. A separate issue is that of correcting residual statics. The adoption of the optimal version for entering static corrections made it possible to improve the quality of horizon traceability.

3. Improved representation of all the single waves and identification of low-amplitude faults and other tectonic disturbances. Isotropic pre-stack time migration with true amplitude preservation using curved ray paths in travel time calculations (TAPSTM) was used.

4. Interpolation in the CDPM area filled the “holes” and qualitatively improved the data. This type of interpolation made it possible to formulate full-fledged regular removal plans.

5. Q-compensation. The use of phase Q-compensation (before deconvolution) ensured that a wide spectrum of the signal was obtained.

In addition to temporary processing, seismic data from the Arykty site were processed using the GMDS technology. The depth-velocity model was formed on the basis of seismic velocities, tomography algorithms with calibration to the velocity data available for that year in wells 8 and G-4.

Thus, special surface-matched procedures in addition to various amplitude scalars and spectral balancing allowed for improved dynamics and data quality.

The authors of the article would like to dwell on some procedures for the dynamic interpretation of seismic data, since their results are quite interesting from the point of view of the stated purpose of the study. Synchronous pre-stack inversion was updated to provide the comparative analysis based on new well data, as this process produced results related to longitudinal and transverse impedances, which are directly related to the physical properties of the medium. The 2017-time cube was used as the source database.

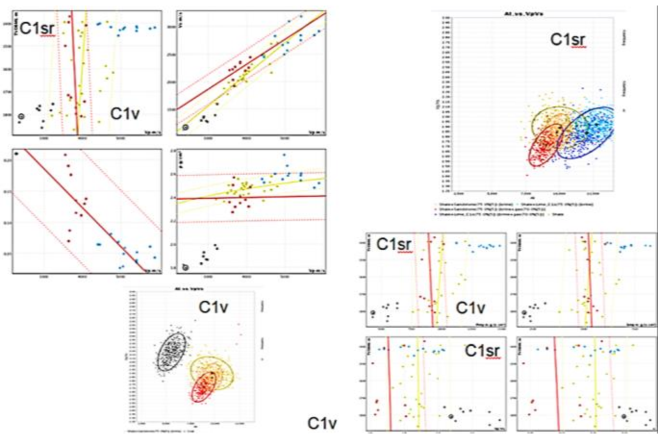
All the present-day seismic inversion techniques use momentum estimated from seismic data. The expected shape of the seismic pulse can significantly affect the result of seismic inversion and the subsequent assessment of the reservoir properties. The resulting pulse is used to estimate seismic reflection coefficients during the seismic inversion process [[3]]. Since the amount of well data was limited, a stable pulse was obtained based on a series of statistical pulses dependent on offsets (angles) extracted from the angle sums. When calculating the pulses for each angular sum, decreasing the amplitudes with distance (angle) was considered. In general, the obtained pulses allowed obtaining good correlation coefficients.

It is known that seismic data is characterized by limitations in frequency band, which leads to decreasing the seismic resolution of the record and quality, therefore, to limit the results of inversion outside the seismic frequency band, a low-frequency component is added to the data. To expand the frequency range, log data (longitudinal component of sonic logging), pre-stack time or depth migration rates, or regional gradient are used. First, the log curves are processed and edited to ensure an appropriate relationship between the impedance curves and the desired properties. Then the curves are converted to the time domain, filtered to fit the seismic frequency band, corrected for wellbore effects, balanced and quality classified.

Although many geological structures can have similar acoustic impedance characteristics, few geological formations have the same combination of acoustic and shear impedance properties to enhance interpretation. In this case, the strategy is simple and formed by the experience of using inversion results in similar geological conditions: decreasing the longitudinal impedance within a homogeneous formation can correspond to improving the reservoir properties, and in the best case is a sign of hydrocarbon saturation.

In addition to acoustic impedance, shear impedance can be obtained by using the pre-stack seismic resolution inversion procedure. The inversion algorithm first estimates sequences of incident angle-dependent longitudinal wave reflection coefficients for the input partial sums. These are then used in the full Zoeppritz equation (or the Aki-Richards type approximation) to determine the reflection coefficients for non-zero angles over a limited frequency band [[4]]. These are then mixed with their low frequency counterparts taken from the model. The approximate result is then improved by performing a final inversion with respect to longitudinal impedance, transverse/shear impedance and density, subject to various constraints controlled by the interpreters. As a result of synchronous inversion, cubes of longitudinal and transverse impedances are obtained.

For the Lower Visean reservoir, longitudinal impedance can be considered a good indicator, but the section contains coals that are characterized by lower values. Therefore, a more complicated parameter to calculate but at the same time more informative, is the Vp/Vs ratio (Figure 3). It should be noted that the superimposing between the properties of clays and sandstones is equal to the standard deviation, i.e. the superimposing is significant.



Carbonates, clays, sandstone, coals

Figure 3. Result of analyzing elastic properties at the level of the Serpukhovian and the Lower Visean reservoirs

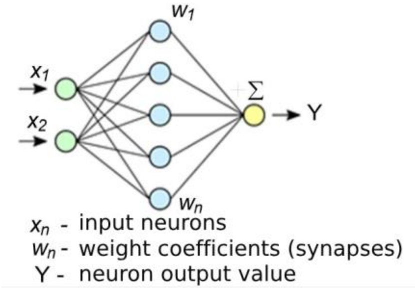
As part of these studies, a neural machine learning procedure was carried out. The basic element of classical neural networks is the mathematical neuron [[5]-[6]], the formula of which can be expressed as a nonlinear transformation of a weighted sum of input signals using an activation function, as shown in equation (1):

$$y = f\left(\sum_{i=0}^{n} x_i w_i\right) \quad (1)$$

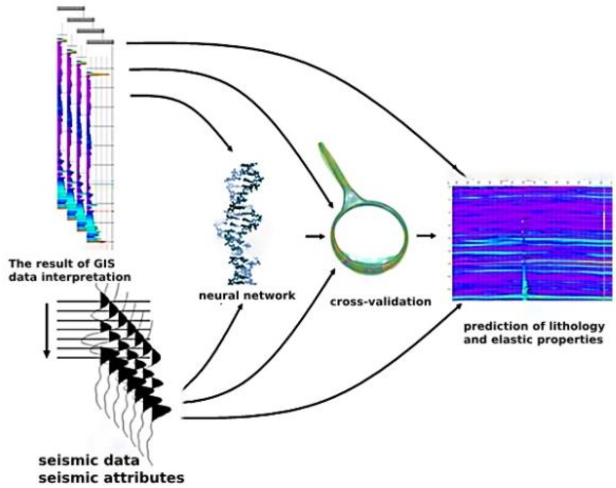
where n is the amount of neuron inputs, x_i is the value of the neuron input signals w_i is weight coefficients, *f()* is the nonlinear activation function, y is the neuron output value.

A schematic representation of a classical neuron is presented in Figure 4, a.

The transformation function of input signals $f_i(x_i)$ is specified as a numerical construction in the form of a table (array) of pairs: the argument value is the function value.



a)



b)

Figure 4. Explanations on the use of neural machine learning: a) schematic representation of a classical neuron; b) prediction of lithological and elastic properties using the Kolmogorov proprietary neural networks

To train such neural networks, the technology is used that has been developed on the basis of mathematical techniques set forth in the Kolmogorov theorem using hybrid stochastic optimization methods to increase the probability of finding the global minimum of the objective function.

The neural network learning scheme for predicting the target parameter is presented in Figure 4, b. For learning, an array of pairs is determined: a reference well-seismic field in a given window around the forecast point in the center of this window (Figure 4, a). Such an array is determined for each point located in the wellbore with known pore pressure values. The step along the wellbore should not be less than the measurement interval of the seismic cube. If the cube has a time scale, then the well must also be time referenced.

To predict lithological and elastic properties, one or more seismic cubes can be used in the form of total and angular sums or in the form of some attributes, including the results of inversion transformations [[5]-[6]]. For the studied interval of the Lower Carboniferous deposits, the cubes of porosity, longitudinal impedance, transverse impedance and their ratio were calculated (Figure 5). They were selected based on the results of petroelastic logging analysis, when it was concluded that the ratio of longitudinal and transverse impedances was related to saturation and conditionally to well production.

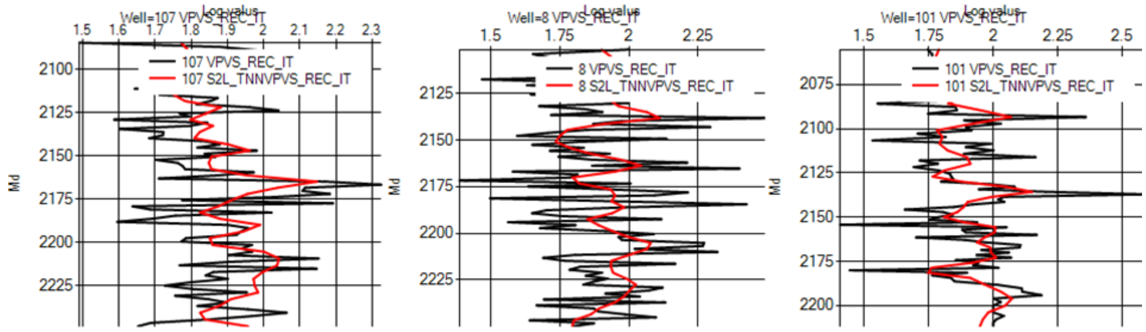
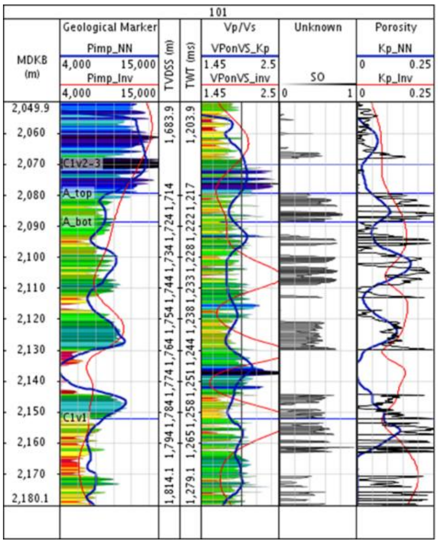
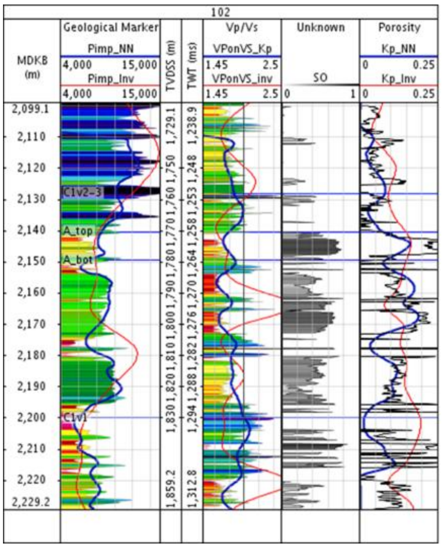


Figure 5. Examples of neural network learning results at well points. The Vp/Vs parameter

For the subsequent comprehensive analysis, a comparison was made of the target characteristics (petroelastic properties and porosity) calculated with the use of the synchronous inversion algorithm and neural network forecasting algorithms [[7]-[8]], on the basis of which it was found that the results of neural network learning have a number of advantages in terms of accuracy and resolution (Figure 6).



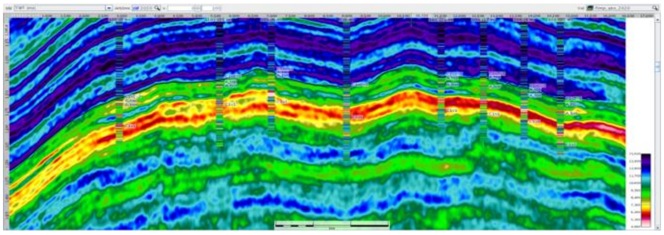
a) well 101



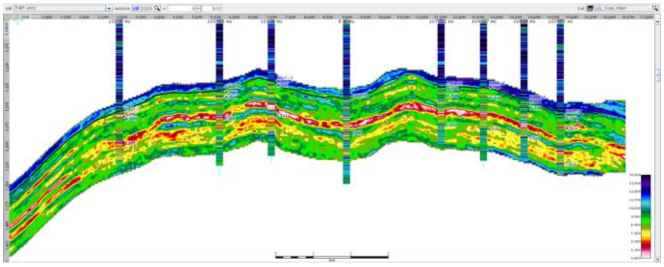
b) well 102

Figure 6. Comparing the 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

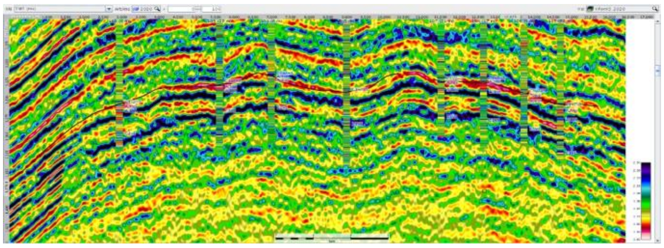
Thus, for the comprehensive analysis, the results of neural network learning were selected that not only had better convergence in the absolute values of logging curves but also had greater resolution (Figure 7, a-d).



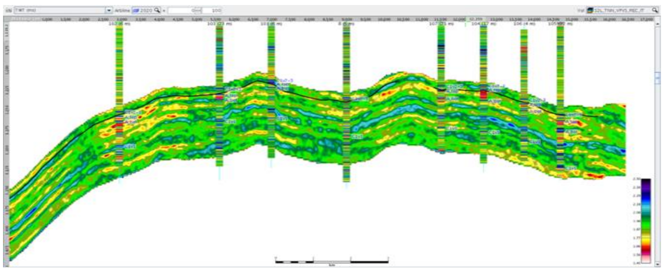
a)



b)



c)



d)

Figure 7. Summary sections along the line of wells: (a) – summary section of longitudinal impedance along the line of wells (pre-stack synchronous inversion algorithm); (b) – summary

section of longitudinal impedance along the line of wells (neuron learning algorithmm); (c) – summary section of the Vp/Vs ratio along the line of wells (synchronous inversion algorithm); (d) – summary section of the Vp/Vs ratio along the line of wells (neuron learning algorithm). In wells, color represents the ratio Vp/Vs

4. Conclusions

The studies carried out made it possible to identify a number of shortcomings in performing inversion forecast constructions in the process of comprehensive interpretation of seismic data and measurement data in wells. All of them are mainly associated with the presence of nonlinearity in the connection of the seismic field with the predicted parameters calculated in the wells.

1. A 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. The absence of theoretical developments on inversion constructions under conditions of nonlinear distortions in seismic fields.

3. The presence of complex nonlinear relationships between the distribution of seismic fields and elastic, filtration-capacitance and lithofacies parameters in wells.

Considering these effects of seismic nonlinearity in classical inversion technologies is the main factor in the better resolution of neural networks.

In addition, the proprietary technology used has the ability of neural network construction 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 re of the result.

References

[1] Taskinbayev, K.M., Dzhangirov, A.N., Bogomazov, A.E., Zhaldaev, N.K., Ihsanova, N.K. & Sapaev, Zh.E. (2020). New vision of structure and oil and gas potential field Airakty. *Neft I gaz, 6(120), 35-51.* https://doi.org/10.37878/2708-0080/2020-5.037

[2] Tleubergenova, A., Umirova, G.K., Karpenko, O. & Maussymbayeva, A. (2023). Geoelectrical model of the earth's crust along the Shu-Sarysu geotraverse according to magnetotelluric soundings. *Nauk. Visnyk Natsionalnoho Hirnychoho Universytetu, (3), 5-10.* https://doi.org/10.33271/nvngu/2023-3/005

[3] Gunning, J., Glinsky, M.E. (2006). Wavelet extractor: A Bayesian well-tie and wavelet extraction program. *Computers and Geosciences, 32 (5), 681-695.* https://doi.org/10.1016/j.cageo.2005.10.001

[4] Seismic inversion: Dictionaries and encyclopedias on Akademik. *Retrieved from:* https://dic.academic.ru/dic.nsf/ruwiki/1332697 (accessed on: 24.01.2024)

[5] Priezzhev I.I., Stanislav E. (2018). Application of machine learning algorithms using seismic data and well logs to predict reservoir properties. *80th EAGE Conference and Exhibition 2018.* https://doi.org/10.3997/2214-4609.201800920

[6] Priezzhev, I. (2020). New age, Kolmogorov full functional neural network usage for nonlinear predictive seismic inversion. *Saint Petersburg 2020 - Geosciences: Converting Knowledge into Resources*

[7] Ratov, B.T., Chudik, I.A., Fedorov, B.V., Sudakov, A.K. & Borash, B.R. (2023). Results of production tests of an experimental diamond crown during exploratory drilling in Kazakhstan. *SOCAR Proceedings, (2), 023–029.* https://doi.org/10.5510/OGP20230200842

[8] Pavlychenko, A. V., Ihnatov, A. O., Koroviaka, Y. A., Ratov, B. T. & Zakenov, S. T. (2022). Problematics of the issues concerning development of energy-saving and environmentally efficient technologies of well construction. *IOP Conference Series: Earth and Environmental Science, 1049(1), 012031.* https://doi.org/10.1088/1755-1315/1049/1/012031

Сызықтық және сызықтық емес болжау алгоритмдеріне негізделген сейсмикалық деректер бойынша коллекторлардың қасиеттерін болжау технологиясын салыстырмалы талдау

А.Н. Джангиров[1], Г.К. Бекбалтина[1*], Г.К. Умирова[2], Р. Г. Темирханова[2], Ф.Н. Абдолдина[2]

[1]*Professional Geo Solutions Kazakhstan ЖШС, Алматы, Қазақстан*
[2]*Satbayev University, Алматы, Қазақстан*

**Корреспонденция үшін автор:* bekbaltinagk@gmail.com

Аңдатпа. Мақалада каротаж деректерімен бірге МОГТ (жалпы тереңдік нүктесінің әдістемесі) 3D сейсмикалық деректерін динамикалық интерпретациялау нәтижелері қарастырылады. Авторлардың алдында Арықты газ конденсатты кен орны жағдайында нейрондық оқыту технологиясы мен жинақталғанға дейін сейсмикалық инверсия нәтижелерін салыстыру міндеті тұрды. Бұған зерттеу аймағының төмен сейсмикалық зерттелуі және аймақтың мұнай мен газдың болжамды перспективалары және динамикалық интерпретацияның белгілі бір процедурасын таңдау критерийлерін зерттеу қажеттілігі негіз болды. Осыған байланысты қазіргі уақытта геологиялық барлау саласында стандартты интерпретация графигі мен нейрондық машиналық оқыту шеңберінде белсенді қолданылатын жинақталғанға дейінгі инверсия арасындағы салыстырмалы талдау тұрғысынан Арықты газ конденсаты кен орнының құрылымы мен мұнай-газдылығын қарастыруға әрекет жасалды. Жүргізілген зерттеулердің өзектілігінің негіздемесі жаңа ұңғымалардың және заманауи каротаж деректерінің болуы, синхронды инверсия нәтижелерін жинақтауға дейін жаңарту және салыстыру мүмкіндігі, нейрондық оқыту алгоритмдерін сынақтан өткізу мүмкіндігі болып табылады. Жүргізілген зерттеулер Арықты кен орны жағдайында машиналық оқытуды басым пайдалану критерийлерін бөліп көрсетуге, қиманың өнімді бөлігін құрайтын тау жыныстарының ішкі құрылымының ерекшеліктеріне жаңа көзқараспен қарауға, жинақталғанға дейін сейсмикалық инверсиямен салыстырғанда машиналық оқыту нәтижелерінің артықшылықтарын физикалық тұрғыдан көрсетуге мүмкіндік берді.

Негізгі сөздер: *Арықты газ конденсатты кен орны, Шу-Сарысу шөгінді бассейні, динамикалық интерпретация, нейрондық желілер, жинақталғанға дейінгі сейсмикалық инверсия.*

Сравнительный анализ технологии прогнозирования свойств коллекторов по сейсмическим данным на основе линейных и нелинейных алгоритмов предсказания

А.Н. Джангиров[1], Г.К. Бекбалтина[1*], Г.К. Умирова[2], Р.Г. Темирханова[2], Ф.Н. Абдолдина[2]

[1]ТОО Professional Geo Solutions Kazakhstan, Алматы, Казахстан

[2]Satbayev University, Алматы, Казахстан

**Автор для корреспонденции:* bekbaltinagk@gmail.com

Аннотация. В статье рассматриваются результаты динамической интерпретации сейсмических данных МОГТ 3D в комплексе с каротажными данными. Перед авторами стояла задача сравнения результатов сейсмической инверсии до суммирования и технологии нейронного обучения в условиях газоконденсатного месторождения Арыкты. Основанием этому послужила и низкая сейсмическая изученность района исследований, и достаточно хорошие прогнозируемые перспективы нефтегазоносности региона, и необходимость изучения критериев выбора той или иной процедуры динамической интерпретации. В этой связи была предпринята попытка рассмотреть строение и нефтегазоносность газоконденсатного месторождения Арыкты с точки зрения сравнительного анализа между инверсией до суммирования, которая на данный момент в геологоразведочной отрасли активно используется в рамках стандартного графа интерпретации, и нейронного машинного обучения. Обоснованием актуальности выполненных исследований является наличие новых скважин и современных данных каротажа, возможность обновления и сравнения результатов синхронной инверсии до суммирования, возможность апробации алгоритмов нейронного обучения. Проведенные исследования позволили выделить критерии преимущественного использования машинного обучения в условиях месторождения Арыкты, по-новому взглянуть на особенности внутреннего строения пород, слагающих продуктивную часть разреза, физически показать преимущества результатов машинного обучения в сравнении с сейсмической инверсией до суммирования.

Ключевые слова: *газоконденсатное месторождение Арыкты, Шу-Сарысуйский осадочный бассейн, динамическая интерпретация, нейронные сети, сейсмическая инверсия до суммирования*.

Received: 11 June 2024
Accepted: 15 October 2024
Available online: 31 October 2024