ANNOTATION

Dissertation for the degree of Doctor of Philosophy PhD in the educational program 8D07201 - "Geology and exploration of mineral deposits"

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STUDY OF THE DEEP STRUCTURE OF THE SHU-SARYSU SEDIMENTARY BASIN BASED ON GEOLOGICAL AND GEOPHYSICAL STUDIES TO ASSESS THE PROSPECTS OF OIL AND GAS PERSPECTIVE

The relevance of the work. The oil and gas sector is one of the leading industries in Kazakhstan predetermining the industrial development of the country. Every year, the task of replenishing mineral reserves, in particular hydrocarbons, is becoming more and more urgent for Kazakhstan; its solution can only be achieved on the basis of further systematic studying the Republic's subsoil at the regional, zonal and local levels.

In the Decree of the Government of the Republic of Kazakhstan dated August 13, 2012, No. 1042, phased Geological Exploration Programs were developed in order to implement the Concept for the development of the country's geological industry.

The State Geological Exploration Program for 2021-2025 decided to assess the oil and gas potential of little-studied sedimentary basins based on the results of the Comprehensive Study of Sedimentary Basins of Kazakhstan (2015-2019), where the Shu-Sarysu sedimentary basin was classified as poorly studied in terms of degree of studying and as promising in terms of potential squares.

To study the deep structure of the Shu-Sarysu sedimentary basin, a geotraverse was selected that intersects the maximum number of basin structures that require detailed geological and geophysical studies, the results of which will be used to assess the prospects for the presence of hydrocarbons.

Over the more than 40-year history of prospecting work, the degree of geological and geophysical knowledge of the territory of the Shu-Sarysu basin does not allow giving a reasonable assessment of its generation capabilities. The Shu-Sarysu basin has a very complex geological structure, a tense geodynamic history and a low degree of geological and geophysical knowledge. The Shu-Sarysu basin has been satisfactorily studied in terms of oil and gas potential (the degree of knowledge is from medium to high). However, within its boundaries, only the southern outskirts of the Kokpansor and the central part of the Moyynkum troughs have been sufficiently studied. Well-known gas fields are associated with these territories. In this regard, it must be stated that more than 70% of the Shu-Sarysu basin area has been poorly studied.

The proven potential of the basin can be judged from the results of the works by U. Akchulakov ("Undiscovered oil and gas potential within the Shu-Sarysu basin", 2004), G.G. Zholtayev ("Atlas of oil and gas and promising sedimentary basins of the Republic of Kazakhstan", 2014), U.S. Karabalin ("Resource potential of the subsoil of Kazakhstan: state, problems, innovative vector of development and real prospects", 2015), A.B. Li ("Tectonic development and oil and gas prospects of the Shu-Sarysu depression", 1982).

The feasibility and effectiveness of conducting complex research, including aeromagnetic and gravimetric surveys ahead of prospecting, electrical prospecting using magnetotellurics and audiomagnetotellurics methods, has been convincingly proven by many years of successful practice of geological exploration in Kazakhstan (part of the methods), Russia and the other countries.

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 supplying Kazakhstan gas if sufficient reserves are discovered.

The purpose of the dissertation work is to study the deep structure of the Shu-Sarysu sedimentary basin to identify promising structures for the presence of hydrocarbons based on geological and geophysical studies.

The research objectives are as follows:

1. To identify connections between transgressive-regressive processes of development of the Shu-Sarysu sedimentary basin with sedimentation and the formation of structures promising for the presence of hydrocarbons.

2. To study the patterns of sedimentary formations distribution of the main lithological and structural units to identify promising structures based on geological and geophysical work.

3. To construct a generalized parametric model of the geoelectric section, and on its basis to study the lithological composition of local geological heterogeneities and their connection with subvertical transcrustal channels of increased permeability.

4. To establish patterns of promising structures location favorable for the discovery and localization of hydrocarbons in the Shu-Sarysu sedimentary basin.

The object of the study is the Shu-Sarysu sedimentary basin.

The subject of the study is a 100-kilometer strip along the regional profile (geotraverse).

Factual material and research methods. The work is based on the results of analyzing the paleogeographic evolution of the Shu-Sarysu sedimentary basin, carried out on the basis of existing maps of the lithologic-paleogeographic situation for the basin, compiled by U. Akchulakov. To clarify the geological structure of the geotraverse strip, to identify anomaly-forming objects, the depth of their location and size, and to determine the geological nature of their formation, modern geophysical research data were used. To identify transcortical channels and to determine their resistance, the data obtained from the results of electrical prospecting were used.

Scientific novelty

1. The patterns of location of structures that are promising for the presence of hydrocarbons in Carboniferous deposits have been established (Sozak-Baykadam trough (C_1v_1 , C_1v_{2-3} , C_1s), Tastin uplift (C_1 , C_2 , C_3), Moyynkum trough

(Mishta trough) (C_1v_{2-3} , C_1s), Lower Shu uplift (C_1 , C_2 , C_3), Tasbulak trough (C_1v , C_1s , C_2 , C_3), Devonian (Lower Shu uplift (D_3 fm), Permian (Talas uplift (P_2).

2. The connection of the folded-block structures of the region, forming a stepped structure of the basement surface with the occurrence of lens-shaped layers of Upper Devonian rock salt, including structures promising for the presence of hydrocarbons (Baykadam, Kokshui, Shabdan and Moyynkum troughs), has been confirmed.

3. A connection has been established between subvertical deep transcrustal channels up to 40 km with zones of low resistance, which are likely routes

Scientific provisions to be defended

The results of geological and geophysical studies of the paleogeographical setting of the Shu-Sarysu sedimentary basin along the selected geotraverse indicate that the accumulation of hydrocarbons occurred during the period of the end of the transgression - the beginning of regression; carbon deposits are promising structures for the presence of hydrocarbons (Sozak-Baykadam trough (C_1v_1 , C_1v_{2-3} , C_1s), Tastin uplift (C_1 , C_2 , C_3), Moyynkum trough (Mishta trough) (C_1v_{2-3} , C_1s), Lower Shu uplift (C_1 , C_2 , C_3), Tasbulak trough (C_1v , C_1s , C_2 , C_3), Devonian (Lower Shu uplift (D_3 fm), Permian (Talas uplift (P_2).

Based on geophysical research (gravity-magnetic survey work), the foldedblock nature of the structures of the region and the stepped structure of the foundation surface of the Shu-Sarysu sedimentary basin were confirmed. As a result of the interpretation of geophysical data, a connection was established between lens-shaped layers of Upper Devonian rock salt and promising structures (Baykadam, Kokshuy, Shabdan and Moyynkum troughs).

Based on the results of electrical exploration work (MTS, AMTS), a geoelectric section of up to 40 km along the geotraverse was constructed, in which geoelectrical subvertical heterogeneities characterized by low resistivity were identified, probably representing transcrustal channels for the movement of fluids and thermal flows in the Shu-Sarysu sedimentary basin.

Practical significance

The patterns of location of potential structures for the presence of hydrocarbons, established in the Shu-Sarysu sedimentary basin, provide the basis for planning detailed geological exploration work.

The research results were introduced into the geophysical and geological departments of the Azimuth Geology LLP, into the educational process in the lectures and practical classes in the discipline "Geology of Oil and Gas Fields" at the Geology and Exploration of Mineral Deposits Department at Abylkas Saginov Karaganda Technical University NJSC.

The end result of the research is conclusions on clarifying the geological structure of the Shu-Sarysu sedimentary basin, identifying promising structures for the presence of hydrocarbons within the geotraverse strip based on a complex of geological and geophysical studies with recommendations for detailed geological exploration and the possibility of transferring the sequence of studies to other areas of the sedimentary basin.

Personal contribution of the author consisted in collecting, processing, systematizing, summarizing and interpreting factual and stock materials; processing and interpreting the obtained databases on geophysical surveys (gravity survey, aeromagnetic survey, electrical survey); building models (geodensity, geomagnetic, geoelectric); constructing a geological section highlighting the boundaries of the foundation and main sedimentary complexes; substantiating the research work relevance; studying the distribution of magnetic anomalies, gravity anomalies with determining the probable geological nature of their formation.

Approbation of the work and publications. The main provisions of the dissertation work were reported:

- at the seminars of the Geology and exploration of mineral deposits department of Abylkas Saginov Karaganda Technical University;

- at the Navoi State Mining Institute;

-at the international scientific and practical conference "GLOBAL SCIENCE AND INNOVATIONS 2022: CENTRAL ASIA" (Astana, 2022);

- at the XXX international conference of students, graduate students and young scientists "Lomonossov" (Moscow, 2023);

- at the international scientific and practical conference "Integration of science, education and production - the basis for the implementation of the Nation's Plan" (Saginov Readings No. 14), (Karaganda, 2022);

- at the international scientific and practical conference "XV Saginov's Readings. Integration of education, science and production" (Saginov's Readings No. 15, Karaganda, 2023).

There was a scientific internship from April 4 to April 18, 2022 at the Navoi State Mining Institute, Uzbekistan, during which an article was written for a local journal and a lecture was given on the topic "Oil and gas potential of the Shu-Sarysu sedimentary basin" for 2-year master students.

The main provisions of the dissertation work were published in 9 scientific works, one of which in the publication recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Republic of Kazakhstan; four works in the proceedings of international conferences; two articles included in the Scopus database, an article included in the Web of Science database; a patent for an invention of the Republic of Kazakhstan (Appendix B).

The dissertation structure and volume. The dissertation is presented on 112 pages and consists of an introduction, three sections, a conclusion and a list of sources used that contains 93 titles. The dissertation work is illustrated with 50 figures and 8 tables.

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