

## ANNOTATION

of the dissertation for the degree of Doctor of Philosophy (PhD)  
in the specialty: 8D07201 – *Geology and Exploration of Mineral Deposits*

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### **GEOLOGICAL STRUCTURE AND STRUCTURAL - FORMATIONAL COMPLEXES OF THE SOUTH TORGAI BASIN IN RELATION TO THE ASSESSMENT OF OIL AND GAZ POTENTIAL**

**Relevance.** Most oil, gas, and gas-condensate fields of the South Torgai Basin (hereinafter - STB) are currently at a late stage of development, which in the near future may complicate the stable functioning of the region's fuel and energy sector. Under these conditions, the issue of ensuring a stable supply of hydrocarbons (hereinafter - HC) from domestic resources becomes particularly important.

The main ways to replenish and expand the hydrocarbon resource base are the identification, detailed exploration, and subsequent development of new oil and gas accumulations. The STB is one of the key petroleum-bearing regions of eastern and southeastern Kazakhstan. It is confined to a submeridionally elongated zone of the Torgai–Syrdarya tectonic belt, which also includes the North Torgai and Syrdarya basins. Tectonically, the STB occupies an intermediate position between the Ulytau uplift and the Lower Syrdarya arch at the basement level, which determines its complex block-faulted structure and the high heterogeneity of the sedimentary cover.

Previously conducted geological exploration works (hereinafter - GEW) do not allow for an unambiguous and comprehensively substantiated assessment of the petroleum potential of the Paleozoic and Mesozoic rock complexes, nor of the mechanisms governing the formation of hydrocarbon systems. To date, a number of unresolved issues remain, including the features of the lithological and stratigraphic structure of the section, depositional environments, patterns of organic matter distribution, and the degree of its catagenetic transformation.

The conditions of hydrocarbon generation, migration, and accumulation, the timing of trap formation, and the role of tectonic factors in hydrocarbon localization also remain insufficiently studied.

At present, particular interest as a potential reserve for discovering new accumulations and expanding the resource base of the STB is associated with the pre-Jurassic (pre-rift) complex and weathered basement formations. In this context, clarifying the formation patterns of such accumulations requires an integrated analysis of the internal structure of the section, depositional environments, as well as the petrophysical and geochemical characteristics of the rocks.

In this regard, a relevant task is to refine the structural and evolutionary model of the South Torgai Basin (STB) based on structural-formational complexes (SFC), as well as the geochemical characteristics of sedimentation and basin

development. Solving this task is of significant importance both for the advancement of the oil and gas industry and for strengthening the energy independence of the Republic of Kazakhstan.

**The aim of the work** is to substantiate the structural-formational model of the South Torgai basin and assess the oil and gas potential based on the analysis of geodynamic evolution and pyrolytic data on the generation potential of oil and gas source strata.

**The object of the study** is the sedimentary cover of the South Torgai Basin.

The subject of the study includes the conditions of oil and gas accumulation formation, as well as the patterns of their distribution and the petroleum potential of the South Torgai Basin.

***To achieve the stated aim, the following tasks were addressed:***

- analysis of the level of geological and geophysical exploration and newly obtained data for the study area;
- characterization of the internal and deep structure, and substantiation of structural-formational complexes;
- refinement of the petrophysical properties of reservoir rocks and sealing rocks;
- analysis of the distribution patterns of petroleum-bearing complexes and the localization of oil and gas accumulations;
- geochemical characteristics of the sediments of the reservoir section, the degree of thermal maturity and conditions for the formation of oil and gas accumulations;
- prediction of zones with potential local oil and gas traps;
- substantiation of recommendations for priority exploration activities and detailed studies.

#### **Scientific novelty**

1. The boundaries and spatial distribution of the pre-rift, rift, and platform structural–formational complexes of the South Torgai Basin have been refined.
2. The rift nature of regional structures and their role in the formation of hydrocarbon accumulation zones have been substantiated.
3. Based on pyrolytic (Rock-Eval) studies, the type of organic matter, its thermal maturity, and the generative potential of the main petroleum-bearing complexes have been determined.
4. The structural control of hydrocarbon accumulation zones by areas of horst–graben interaction has been identified, which allowed for refinement of the petroleum prospectivity zoning.

**The following scientific statements are proposed for defense:**

1. In the geological history of the South Torgai Basin, pre-rift, rift, and Mesozoic structural–formational complexes are distinguished, which define the main stages of sedimentation and the rift nature of regional structures.
2. The paleogeographic diversity of depositional environments is a controlling factor in the variation of geochemical zonation and the composition of organic matter (from sapropelic to mixed types), which is reflected in differences in the hydrocarbon generation potential of the SFC deposits.

3. The formation of oil and gas accumulations was dominated by processes of vertical and subvertical hydrocarbon migration. Hydrocarbon accumulation zones are confined to areas of horst–graben interaction and, partially, to the central, most subsided parts of graben-synclines.

4. The results of laboratory studies (Rock-Eval, biomarker analysis) indicate a mature state of organic matter in source rock formations (primary oil), which characterizes the SFC deposits by a relatively high generative potential.

**Factual material.** The dissertation was carried out at the Department of Geology and Exploration of Mineral Deposits of the Abylkas Saginov Karaganda Technical University during the period 2022–2026.

The study is based on materials from previously conducted geological and geophysical investigations, as well as the results of analyses of Mesozoic and pre-Mesozoic oil samples from the sections of the Aksai and Ashchisay horst-anticlines, and the Akshabulak and Bozingen graben-synclines of the Arys-kum depression within the South Torgai Basin (STB).

The work also incorporates results of studies carried out in recent years (2020–2024) by *Ayrau Branch of KMG Engineering LLP* (Sarsenbekov N., Uteev R.N., et al.).

The scientific conclusions are additionally supported by the analysis and processing of data from new oil samples (5) obtained from wells: No. 111 East Kumkol (1000–1005 m, J-IV horizon), No. 5014 South Kumkol (1005–1200 m, J-III horizon), No. 549 Konys (1255–1261 m, J-0-I horizon), and No. 72 Aksai (1569–1572 m, M-I horizon).

During 2023–2024, with the participation of the author, pyrolytic and biomarker studies were conducted on these samples, which made it possible to determine and refine the geochemical characteristics and generative potential of the deposits, as well as the elements of hydrocarbon systems within the STB.

The study also utilized archival materials on geological and geochemical investigations of the STB from previous years. The works of numerous researchers were taken into account, including U.A. Akchulakov, Yu.A. Volozh, S.Zh. Daukeev, G.Zh. Zholtaev, S.M. Ozdoev, A.A. Abdulin, Kh.Kh. Paragulgov, B.M. Kuandykov, T.Kh. Paragulkov, V.V. Korobkin, A.A. Bakirov, E.Zh. Seitkaziev, G.P. Filippyev, A.A. Alpaev, K.Kh. Makazhanov, A.A. Privalov, O.S. Turkov, S. Zhilkaidarov, A.K. Buvalkin, Kh.A. Bespaev, A.Sh. Nazhmetdinov, R.B. Sapozhnikov, S.A. Nigmatova, A.B. Bigaraev, and others.

In preparing the dissertation and substantiating the theoretical conclusions, the author also considered the results of studies by foreign scientists and specialists in the oil and gas industry, which made it possible to significantly refine the geological history of the region, the features of its tectonic evolution, and the patterns of hydrocarbon system formation.

**Practical significance.** The characteristics, evaluation criteria, and quality indicators of potential source rocks within the South Torgai Basin (STB) section have been refined. The obtained conclusions and results provide a basis and prerequisites for implementing a systematic approach to assessing the generative

potential of deposits within various structural–formational complexes (SFCs), thereby improving the reliability of exploration forecasts for oil and gas.

The newly obtained geochemical data constitute valuable material for practical exploration activities and contribute to the improvement of methods for predicting перспективные локальные объекты within the basement, pre-rift, and post-rift complexes of the STB. This ensures an integrated approach to studying the geological structure of the sedimentary basin and analyzing lithological-stratigraphic complexes. As a result, the accuracy of predicting hydrocarbon-localizing structures and accumulation zones is significantly enhanced.

The developed methodology for analyzing hydrocarbon systems facilitates more accurate correlation between oil fields and enables the identification of genetic “oil–oil” relationships. Evidence of hydrocarbon generation by Mesozoic deposits provides a well-founded basis for evaluating reserves and the forecast potential of both pre-Mesozoic and Mesozoic formations. This, in turn, creates additional opportunities for a more objective assessment of prospective resources and for optimizing the economic efficiency and development strategy of hydrocarbon fields in the region.

#### **Approbation of the study.**

The results of the conducted research were presented at international and national scientific and practical conferences, including industry-specific conferences such as “Sedimentary Systems: Stratigraphy, Geochronology, Paleoclimate, Hydrocarbon Resources” (Kazan, Russian Federation), “Satpayev Readings” (Almaty), the XV and XVI Saginov Readings (Karaganda), and others.

The author’s scientific statements are based on new data obtained from laboratory studies of oil samples, analysis of new geological, geophysical, and geochemical data, as well as the generalization of accumulated information and refinement of regional and local characteristics of fields and prospective structures.

#### **Publications.**

A total of 16 publications have been produced on the topic of the dissertation, including: 2 papers published in journals indexed in the international database *Scopus*, 6 papers published in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan (CQASHE). An additional 9 works (conference papers) have been published in the proceedings of international and national scientific and practical conferences.

#### **Structure and scope of the dissertation.**

The dissertation consists of an introduction, five chapters, and a conclusion. The total length of the dissertation is 106 pages and includes 33 figures and 13 tables. The list of references comprises 120 sources.