Russian Journal of Earth Sciences

An Integrated Approach to Ranking the Development Potential of Petroleum Provinces

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Abstract: An expert-based methodology for constructing an integrated spatial ranking of oil fields within petroleum provinces is presented. The approach is based on the attributive integration of normalized geological and technological parameters together with a relative capital intensity index (CAPEX) implemented within a GIS environment. The proposed method enables consistent comparative ranking of development targets and their cartographic representation, supporting strategic planning of hydrocarbon resource development. The study demonstrates the differentiation of major oil fields based on a combination of reservoir properties, technological development parameters, and natural–climatic conditions affecting field operations. The results indicate that high values of the integrated index are typically associated with fields characterized by favorable reservoir filtration–capacity properties (porosity–permeability characteristics) and moderate burial depths, whereas complex deep carbonate reservoirs tend to exhibit higher relative capital intensity. The results confirm the applicability of the integrated ranking methodology for comparative evaluation and spatial prioritization of prospective areas within major petroleum provinces, including territories located in the Arctic zone of the Russian Federation.

Keywords: petroleum provinces, oil fields, geoinformatics, ranking, GIS, relative capital intensity index (CAPEX).

Citation: Odintsova A. A. and Tatarinov V. N. (2026), An Integrated Approach to Ranking the Development Potential of Petroleum Provinces, *Russian Journal of Earth Sciences*, 26, ES1009, EDN: ZLUQRE, https://doi.org/10.2205/2026es001108

Research Article

Received: January 15, 2026
Accepted: March 10, 2026
Published: March 20, 2026

1. Introduction

Currently, there is a growing demand for the development of advanced methods for the prospecting and exploration of giant and large oil fields, including those located in the Arctic region of the Russian Federation (ARF). Addressing this strategic challenge is being carried out within the framework of the Strategy for the Development of the Mineral Resource Base of the Russian Federation up to 2050. In accordance with Resolution No. 500-r of the Government of the Russian Federation dated March 4, 2025, the strategy provides for the implementation of digital technologies for geological data processing and the conduct of regional studies at all stages of exploration, including the development of predictive models to support the justification and selection of development strategies for petroleum provinces (Clause 31).

The advancement of geospatial geoanalytical methods [*Gvishiani et al.*, 2023; *Soloviev et al.*, 2016] facilitates the identification of objective and reliable patterns in large heterogeneous datasets [*Gvishiani et al.*, 2019], improves the accuracy of forecasting, and ensures reliable long-term data storage. Nevertheless, there remains a need for specialized GIS platforms designed for applied tasks in the petroleum industry, covering the entire workflow of spatially referenced data processing from storage and structuring to integrated analysis and interpretation.

One of the key directions of such studies is the identification of fundamental patterns in the spatial localization of the largest fields within petroleum provinces. The current stage of development of the petroleum industry, characterized by increasing competition in both domestic and international markets, requires well-justified strategies for the development of the resource base, including the optimal sequencing of field development and the optimization of production infrastructure placement. A critical factor in maintaining the competitiveness of the petroleum sector is the improvement of the technical and economic efficiency of exploration and field development, which necessitates the application of integrated methods for analyzing spatially distributed geodata [*Bondur*, 2011; *Krasnoperov et al.*, 2016; *Laverov et al.*, 2015; *Morozov et al.*, 2012; *Naumova et al.*, 2019].

This paper presents the testing of a developed methodological framework, taking into account the classification of giant oil fields and a previously developed GIS-based project [*Odintsova et al.*, 2018] aimed at supporting strategic decision-making in the development and operation of petroleum provinces. The objective of the study is to establish a unified criterion-based framework for the comparison of petroleum provinces, based on a geoinformation approach to the calculation of an integrated assessment of spatially distributed fields, followed by the development of a composite ranking of their development potential.

2. Methods

The identification of prospective areas for hydrocarbon exploration within petroleum provinces represents a multicriteria problem that must be addressed under conditions of high uncertainty in geological information [*Raaben*, 1978]. In this context, the formalization of expert knowledge and its subsequent integration into a GIS environment is of particular importance. For this purpose, an expert-based approach is applied to determine the relative significance (utility) of evaluation criteria used in the spatial ranking of major oil fields. In international practice, one of the widely used indicators for such assessments is the relative CAPEX indicator ($\mathrm{CAPEX}_{\mathrm{rel}}$, Capital Expenditures), which reflects the capital costs associated with the development and infrastructure deployment of oil and gas fields or investment projects [*Brealey and Myers*, 2003; *Damodaran*, 2012; *Gajere et al.*, 2024; *Guo et al.*, 2016; *Handhal et al.*, 2022; *Mastepanov*, 2017].

$\mathrm{CAPEX}_{\mathrm{rel}}$ is defined as the ratio of capital expenditures for exploration activities to a baseline parameter reflecting the scale of development of a petroleum province, such as resource potential, projected production volume, the area of the licensed territory, or the expected economic return

$$\mathrm{CAPEX}_{\mathrm{rel}} = \mathrm{CAPEX}_i / B_i,$$

where CAPEX_i – denotes the total capital expenditures of the i-th petroleum province over a specified period, and B_i – represents the baseline indicator of the development scale of the i-th province, which may include recoverable resources, projected production, the area of the licensed territory, discounted economic return, and other related parameters. It should be emphasized that this indicator is widely used as a spatially normalized criterion for the comparative analysis of development strategies for petroleum provinces, since it makes it possible to incorporate an economic component into the assessment without relying on direct cost indicators. This is particularly important in the present study, given the limited availability of publicly accessible data on capital expenditures associated with exploration and field development [*Agafonov et al.*, 2022].

To implement the evaluation framework, a multicriteria decision-making (MCDM) approach was applied, involving the formalization of expert judgments and incorporating selected elements of qualimetry and the theory of complex decision-making [*Agafonov*, 2019; *Agafonov et al.*, 2021].

The optimal decision space (I_k) is defined based on criteria whose relative importance may be interpreted differently, resulting in the presence of alternative, including potentially conflicting, ranking options (Figure 1): $I_k = f$ (decision parameters), $k = 1, 2, 3, \ldots$.

Decisions are often formed within a "conflict zone", where extreme values of individual indicators provide ambiguous interpretations of the decision parameters, implying the existence of a "compromise region". For evaluation, indicators I_1, I_2, I_3 are selected from the set $\{I_n\}$. Based on these indicators, a decision selection procedure is then applied to

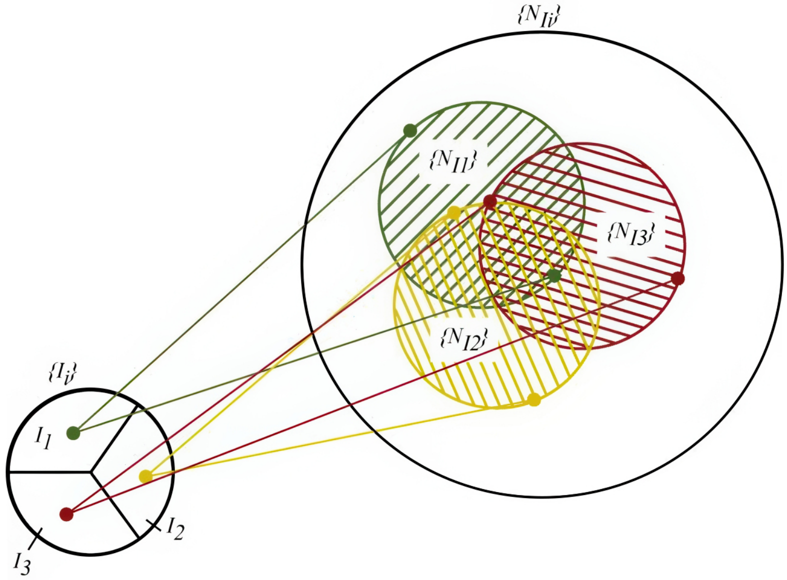

Figure 1. Identification of the conditionally optimal decision space using three criteria [*Agafonov et al.*, 2022].

identify N_1, N_2, N_3 from the set $\{NI_i\}$, resulting in the formation of subsets of alternatives NI_1, NI_2, NI_3.

Let P denote the decision-making region, formed by the intersection of the subsets:

$$P = NI_1 \cap NI_2 \cap NI_3.$$

It is evident that any decision from the set P fully satisfies all criteria. However, since the criteria carry different weights of significance ($I_1 > I_2 > I_3$), decisions are evaluated according to their assigned weights. By expanding the feasible decision space along the less significant criteria, a region is formed in which decisions remain optimal with respect to I_1 and approximately optimal with respect to I_2 and I_3 (Figure 2).

For the integrated assessment of petroleum provinces' performance, TEMs are employed. These models are functions of heterogeneous indicators characterizing resource potential, development conditions, economic outcomes, and sustainability, which are normalized to a comparable scale and aggregated into a single composite index. TEMs are used for: ranking petroleum provinces, justifying exploration and development priorities, assessing investment attractiveness, formulating strategies for sustainable development.

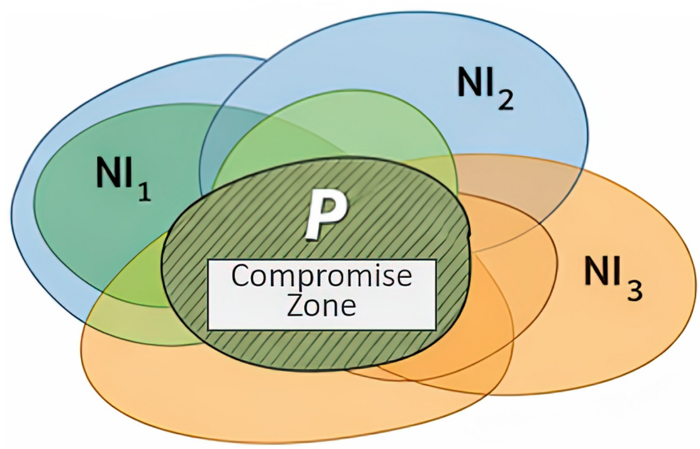

Figure 2. Compromise decision region considering criterion importance.

Total Efficiency Models

1. Two-Component Model

The total efficiency is represented as the sum of two components:

$$E_{\text{total}} = E_1 + E_2.$$

In this model, the first efficiency component is significantly smaller than the second and plays a subordinate role:

$$E_1 \ll E_2.$$

If we assume $E_1 \sim I_1$ and $E_2 \sim I_2$, the overall efficiency is predominantly determined by the second component: $E_{\text{total}} \approx E_2 \sim I_2$.

2. Multi-Component Model

For more complex objects, the total efficiency includes multiple m components:

$$E_{\text{total}} = \{E_i\}, \quad i = 1, 2, \ldots, m.$$

In this case, each component may be significantly smaller than the others, and the total efficiency can then be expressed as:

$$E_{\text{total}} \approx f(\{I_i\}), \quad i = 1, 2, \ldots, m.$$

If the indicators are partially independent, they can be evaluated and compared individually:

$$E_i \sim I_i, \quad i = 1, 2, \ldots, m.$$

In this case, the total efficiency does not exceed the sum of the individual indicators:

$$E_{\text{total}} \leq \sum_{i=1}^{m} E_i, \quad E_i \approx \sum_{i=1}^{m} I_i.$$

For complex objects, an integrated assessment is employed, which aggregates individual indicators into a single composite index:

$$E_{\text{total}} = f_{\text{int}}(\{I_i\}), \quad i = 1, 2, \ldots, m.$$

After calculating the integrated indicators, a comprehensive dataset is compiled for structured analysis. Within a petroleum province, the field corresponding to the lowest value of the integrated indicator is considered the most prospective, and its development should be prioritized accordingly [*Agafonov et al.*, 2022].

To formalize the selection process for development, production, and expansion strategies of petroleum provinces (PPs), all possible decisions can be represented within a three-dimensional space, implemented as a conceptual "strategy cube." The vertices and elements of the cube correspond to different combinations of integrated indicators of development feasibility, $\text{CAPEX}_{\text{rel}}$ values, and GIS-based provincial priority (Figure 3). For each PP, three coordinates are calculated, determining its position within this space. This creates a structured system of relationships between integrated criteria and the $\text{CAPEX}_{\text{rel}}$ indicator, which serves as the basis for selecting the most appropriate development strategy.

As a result of positioning all considered petroleum provinces (PPs) within the strategy cube, aggregated subgroups are formed, characterized by similar development conditions and investment attractiveness.

Subgroup 1a is characterized by minimal values of the integrated indicators of development feasibility and $\text{CAPEX}_{\text{rel}}$. For these PPs, development conditions and the reliability of resource potential are comparatively favorable. In such cases, large-scale capital investments are not required, and priority should be given to optimizing technical and

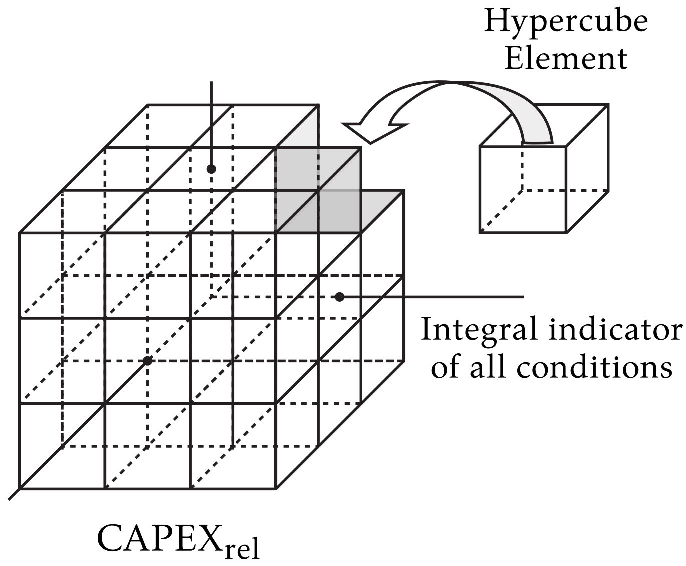

Figure 3. Cube of relationships between integrated indicators of field development feasibility and $CAPEX_{rel}$, highlighting the GIS-based priority of petroleum provinces.

technological processes and establishing an effective organizational and management structure. PPs in this subgroup are recommended for primary development priority.

Subgroup 1b exhibits poor development conditions and high $CAPEX_{rel}$ values. Developing these PPs requires substantial capital expenditures, most of which are directed toward mitigating adverse natural and geological factors. The implementation of development projects for these provinces is generally considered economically unfeasible.

Subgroup 1c includes PPs with moderate values of integrated indicators and $CAPEX_{rel}$. These are regarded as a reserve for improving efficiency through the introduction of advanced technical solutions. Although they do not possess high immediate prospects, they maintain a moderate, balanced level of investment attractiveness and may be considered for medium-term development initiatives.

This classification allows for the systematic grouping and prioritization of PPs, ultimately identifying those capable of delivering the maximum and rapid return on investment with minimal financial risk.

3. Results and Discussion

In accordance with the previously described methodology, a ranking assessment was conducted for a number of fields within the largest petroleum provinces, based on their key characteristics. Table 1 presents the results of this assessment. The last column shows the dimensionless relative indicator $CAPEX_{rel}$, which reflects the capital intensity of development conditions.

$$CAPEX_{rel} = (D_{norm} + \rho_{norm})/2,$$

where D_{norm} is the normalized reservoir depth (m), ρ_{norm} – is the normalized oil density (kg/m^3).

Essentially, $CAPEX_{rel}$ is a dimensionless value ranging from 0 to 100, similar to the integrated suitability index (I). Table 1 highlights the key differences among major petroleum provinces, providing a basis for comparative analysis of the development efficiency of the world's largest fields.

Analysis of the integrated suitability index (I) and the relative capital intensity indicator ($CAPEX_{rel}$) shows that the highest ranking scores are characteristic of oil fields with a favorable combination of reservoir filtration–capacity properties, moderate burial depths, and light crude oil. In contrast, fields with complex geological conditions and significant depths exhibit higher capital intensity in development.

At the top of the ranking are the largest and most technologically advanced fields, such as *Ghawar*, *Tengiz*, and *Prudhoe Bay*. Their high overall scores result from a combination of favorable geological characteristics (high porosity and permeability, moderate oil viscosity), extensive reservoir areas, and a well-developed infrastructure that enables efficient hydrocarbon extraction.

Russian fields in the West Siberian and Volga–Ural provinces (e. g., *Samotlor*, *Priobskoe*, *Romashkinskoe*) occupy intermediate positions in the integrated ranking. Despite less favorable reservoir properties and, in some cases, higher oil viscosity, the extensive well network and the application of reservoir pressure maintenance techniques ensure stable production and maintain the competitiveness of these fields.

Offshore fields, including those in the Arctic region, such as *Alpine*, *Kuparuk*, and *Safaniya*, are characterized by harsh climatic conditions, extreme temperatures, and a limited construction season, which reduces their integrated efficiency scores. Nevertheless, favorable reservoir geophysical properties partially offset the technological constraints.

The results confirm that reserve size and strong geological parameters alone do not guarantee the investment attractiveness of a field. Instead, the assessment of development efficiency should rely on a comprehensive analysis that incorporates geological, technological, and economic factors. Table 1 clearly illustrates this principle, allowing the identification of groups of oil fields with an optimal combination of development conditions and capital intensity.

Figure 4 presents the ranking of petroleum provinces according to the $CAPEX_{rel}$ parameter for the development of their respective largest fields. The lowest $CAPEX_{rel}$ values are observed in the Volga–Ural, Saharan, and Persian Gulf provinces.

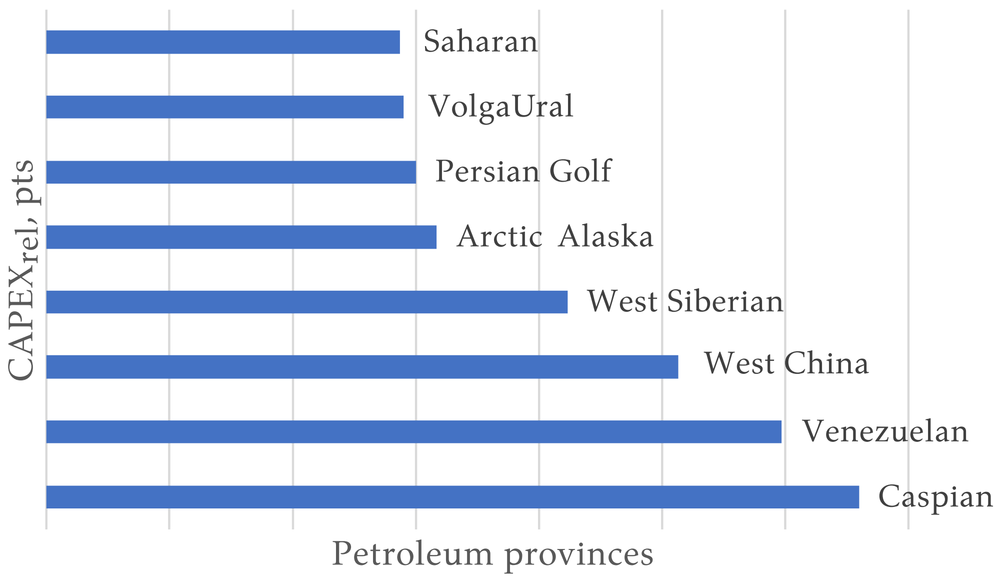

Figure 4. Ranking of petroleum provinces by average capital expenditure level $CAPEX_{rel}$.

Thus, this provides a methodological and analytical foundation for further generalizations and conclusions related to the assessment of sustainability, exploration prospects, and production potential within major petroleum provinces.

Table 1. Ranking assessment of fields in major petroleum provinces based on key characteristics

Petroleum province	Field	Dominant reservoir and age	Reservoir porosity, %	Reservoir permeability, mD	Oil density, kg/m^3	Viscosity, cP	Reservoir depth, m	Reservoir pressure, MPa	Temperature, °C	Reservoir area, km^2	Trap type/ structure	Technological features	Climatic conditions	Score (rating), pts	Integrated field suitability index (I), pts	CAPEX$_{rel}$
West Siberian	Samotlor	Sandstones and siltstones, J-K	20–25	~500	850	Low	1600–2500	20	~70–90	2500–3000	Anticlinal fold	Water injection, gas lift, infrastructure	Continental	8,9,7,7, 8,8,7,7, 7,8	76	30
	Fedorovskoe	Sandstones and siltstones, J	15–25	10–100	860–910	1–5	1888–3188	20	~70–90	~1900	Brachyanticline	Deep wells, water injection	Continental	7,8,7,7, 8,8,7,7 ,7,7	73	38
	Priobskoe	Terrigenous sandstones, J-K	5–20	0.03–15	Light oil	Low	3000–4000	23.5–25	~70–80	5466	Combined anticline	Gas lift, pumps, water injection	Subarctic	6,6,7,7 ,8,8,6,6, 6,7	67	59
Volga–Ural	Romashkinskoe	Sandstones, D-C	~19	~375	800–820	5–20	1600–1800	20–30	60–80	4200	Anticlinal	Water injection, well optimization	Moderately continental	7,8,7,7, 8,7,7,7, 7,8	73	28
	Arlanskoe	Sandstones, P-C	~10–18	10–100	840–894	~30	1500–2500	15–30	60–80	1320	Anticlinal	Water injection, separation	Moderately continental	6,7,7,7, 7,7,7,6, 6,7	67	32
	Tuimaziskoe	Sandstones and carbonates, D-C	15–25	10–100	890	10–30	1000–1700	15–30	30–50	800	Anticlinal	Peripheral and combined waterflooding, watercut management	Moderately continental	7,7,7,7, 7,7,7,6, 6,7	68	27
Persian Golf	Ghawar	Carbonates, J	High	High	Light	Low	1500–3000	51.7	80–120	8400	Anticlina	Water injection	Desert, subtropical	9,9,9,9, 9,9,8,9, 9,9	90	31
	Burgan	Fluvial sandstones, K-J	25–30	500–3000	857–872	Medium	1100–2600	High	70–90	1000	Anticlina	Water injection	Desert	8,9,8,8, 8,8,8,8, 8,8	81	32
	Safaniya	Shallow-marine sandstones, K	22.8–33.5	14–9700	880–890	6–8	1200–2100	High	60–90	750	Structural anticline	Water injection, ESP	Marine, arid	8,9,8,8, 9,8,8,8, 8,8	82	27

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Table 1. Ranking assessment of fields in major petroleum provinces based on key characteristics(Continued)

Petroleum province	Field	Dominant reservoir and age	Reservoir porosity, %	Reservoir perme-ability, mD	Oil density, kg/m^3	Visco-sity, cP	Reservoir depth, m	Reservoir pressure, MPa	Tempera-ture, °C	Reservoir area, km^2	Trap type/ structure	Technological features	Climatic conditions	Score (rating), pts	Integrated field suitability index (I), pts	$CAPEX_{rel}$
Arctic Alaska	Prudhoe Bay	Shale and sandstones, J	14–27	5–100	850–880	0.8	2400–2700	30–31	85–115	865	Structural anticline	Waterflood	Arctic, permafrost	8,7,7,7, 7,7,8,8, 8,7	74	42
	Kuparuk River	Shallow-shelf sandstones, K	Medium	Medium	882	4–6	1830–2130	25	22	520	Structural-stratigraphic	Secondary recovery methods	Arctic	7,7,7,7, 7,7,7,7, 7,7	70	36
	Alpine	Sandstones, J	15–23	1–160	874–848	Low	900–1200	20–25	60–65	14	Local anticline		Arctic	6,6,6,6, 6,6,6,6, 6,6	60	17
Venezuelan	Boyaca	Sandstones, N	25–35	High	1000–1020	2000–8000	5–10	40–55	10000–12000		Layered–lens	Thermal methods, upgrading	Tropical	8,8,8,8, 8,8,8,8, 8,8	80	66
	Bolivar	Sandstones, Miocene–Plioc	30–40	1000–8000	860–920	5–20	600–1500	12–18	50–65	1500–2000	Multilevel	Water injection, secondary recovery	Tropical	8,8,8,8, 8,8,8,8, 8,8	80	52
	El Furrial	Sandstones, N	Medium	Medium	840–880	Low	3000–5000	35–50	90–120	500–700	Anticlinal, multilevel	Gas gathering, secondary recovery	Tropical humid	7,7,7,7, 7,7,7,7, 7,7	70	61
Saharan (Algerian–Libyan)	Hassi Messaoud	Sandstones, D-J	High	High	870–880	10–12	600–1500	15–20	50–60	2000	Multilevel anticline	Water injection, secondary recovery	Hot, arid	8,8,8,8, 8,8,8,8, 8,8	80	31
	Serir	Sandstones, K	High	High	850–870	Low	1300–1800	18–25	55–65	10000–12000	Extended anticline	Waterflooding	Hot, sand-storms	8,8,8,8, 8,8,8,8, 8,8	80	33
	Ez-Zueitin	Sandstones and carbonates, J-K	Medium	Medium	Low and Medium	Low	900–1200	18–22	50–60	35	Anticlinal with monolithic oil	Pressure control	Hot	7,7,7,7, 7,7,7,7, 7,7	70	22

Continued on next page

Table 1. Ranking assessment of fields in major petroleum provinces based on key characteristics(Continued)

Petroleum province	Field	Dominant reservoir and age	Reservoir porosity, %	Reservoir permeability, mD	Oil density, kg/m^3	Viscosity, cP	Reservoir depth, m	Reservoir pressure, MPa	Temperature, °C	Reservoir area, km^2	Trap type/structure	Technological features	Climatic conditions	Score (rating), pts	Integrated field suitability index (I), pts	CAPEX$_{rel}$
Caspian	Tengiz	Carbonates, D	6.3	10	789	2.1	3800–5400	82		365	Brachyanticline	Multilayer drilling, horizontal wells, gas reinjection	Continental	7,7,7,7, 7,7,7,7, 7,7	70	91
	Kashagan	Carbonates, D-C	0.1–10.8	Low	Light	Low	4200	86	80	1360	Structural-stratigraphic	High pressure, complex platforms	Sharply continental	6,6,6,6, 6,6,6,6, 6,6	60	61
	Karachaganak	Carbonates, D-P	9.7–11.7	≈ 15	810–888	Medium	2000–4000	55–60	70–95	65	Massive carbonate anticline	Gas reinjection, pressure management	Dry climate	6,6,6,6, 6,6,6,6, 6,6	60	46
Western China	Tahe	Carbonates, D-C	Low	Medium	High	Low	2000–3500	18.8–36.2	80–120		Anticlines	Hydraulic fracturing, complex drilling	Sharply continental desert	6,6,6,6, 6,6,6,6, 6,6	60	38
	Karamay	Sandstones and carbonates, D-T	Medium	High	Heavy	High	800–1200	10–12	40–50		Anticlines	Water injection, secondary methods	Continental desert	6,6,6,6, 6,6,6,6, 6,6	60	16
	Tazhong	Dense carbonates, D1-2	Low	Low	High	Medium	4000–6000	70–120	120–160		Anticlines	Ultra-deep drilling, secondary recovery	Desert, arid	5,5,5,5, 5,5,5,5, 5,5	50	100

[1] In column 14, the values represent the sum of parameters that were actually evaluated by experts: Reservoir porosity, Reservoir permeability, Oil density, Oil viscosity, Reservoir depth, Reservoir pressure, Temperature, Reservoir area, Trap type/structure, Technological features.

4. Conclusions

A methodology based on expert judgment has been devised for constructing a spatially integrated ranking of oil fields within petroleum provinces. The approach integrates normalized geological and technological indicators with the relative capital intensity index ($CAPEX_{rel}$) in a GIS environment, providing a framework for systematic comparison of fields and their cartographic representation to support strategic planning.

Analysis of the data highlights the differentiation of major oil fields according to a combination of reservoir properties, technological development parameters, and natural–climatic conditions. Fields with favorable porosity–permeability characteristics and moderate burial depths achieve higher values of the integrated suitability index, while complex deep carbonate reservoirs are associated with increased relative capital intensity.

These outcomes confirm that the integrated ranking methodology is suitable for comparative evaluation and spatial prioritization of oil fields across petroleum provinces, offering a reliable tool for planning the development of hydrocarbon resources.

Acknowledgments. This work was carried out with the support of the Russian Science Foundation (project No. 21-77-30010-P).

References

Agafonov V. V. Integrated study of permanent conditions of coal reserves // Ugol'. — 2019. — No. 02. — P. 73–75. — https://doi.org/10.18796/0041-5790-2019-2-73-75. — (In Russian).

Agafonov V. V., Skripka A. V., Yakheev V. V., et al. Optimization of the production and logistics system of underground mines using simulation modeling // Ugol'. — 2022. — No. 05. — P. 68–71. — https://doi.org/10.18796/0041-5790-2022-5-68-71. — (In Russian).

Agafonov V. V., Yakheev V. V. and Varygin S. O. Integrated assessment of mine and excavation field preparation schemes // Ugol'. — 2021. — No. 12. — P. 38–40. — https://doi.org/10.18796/0041-5790-2021-12-38-40. — (In Russian).

Bondur V. G. Aerospace methods and technologies for monitoring oil and gas areas and facilities // Izvestiya, Atmospheric and Oceanic Physics. — 2011. — Vol. 47, no. 9. — P. 1007–1018. — https://doi.org/10.1134/s0001433811090039.

Brealey R. A. and Myers S. C. Principles of Corporate Finance. — 7nd. — McGraw-Hill Irwin, 2003. — 1120 p.

Damodaran A. Investment valuation: tools and techniques for determining the value of any asset. — John Wiley & Sons, 2012. — 1340 p.

Gajere J. N., Adekeye O. A., Tende A. W., et al. GIS-based multi-criteria decision models for barite exploration in Nigeria's Benue Trough // Scientific Reports. — 2024. — Vol. 14, no. 1. — https://doi.org/10.1038/s41598-024-63996-8.

Guo R., Luo D., Zhao X., et al. Integrated Evaluation Method-Based Technical and Economic Factors for International Oil Exploration Projects // Sustainability. — 2016. — Vol. 8, no. 2. — P. 188. — https://doi.org/10.3390/su8020188.

Gvishiani A. D., Kaftan V. I., Krasnoperov R. I., et al. Geoinformatics and Systems Analysis in Geophysics and Geodynamics // Izvestiya, Physics of the Solid Earth. — 2019. — Vol. 55, no. 1. — P. 33–49. — https://doi.org/10.1134/s1069351319010038.

Gvishiani A. D., Rozenberg I. N. and Soloviev A. A. Geophysical Processes in the Arctic and the System Analysis of their Impact on Operation and Development of the Transport Infrastructure // World of Transport and Transportation. — 2023. — Vol. 21, no. 3. — P. 6–34. — https://doi.org/10.30932/1992-3252-2023-21-3-1.

Handhal A. M., Ettensohn F. R., Al-Abadi A. M., et al. Spatial assessment of gross vertical reservoir heterogeneity using geostatistics and GIS-based machine-learning classifiers: A case study from the Zubair Formation, Rumaila oil field, southern Iraq // Journal of Petroleum Science and Engineering. — 2022. — Vol. 208. — P. 109482. — https://doi.org/10.1016/j.petrol.2021.109482.

Krasnoperov R. I., Soloviev A. A., Nikolov B. P., et al. Interactive web-application for complex studying of spatial information on Earth sciences from the geodatabase of GC RAS // Geoinformatics Research Papers. Proceedings of Geophysical Center RAS. — 2016. — Vol. 4. — BS4015. — https://doi.org/10.2205/2016BS039. — (In Russian).

Laverov N. P., Bogoyavlenskiy V. I. and Bogoyavlenskiy I. V. Hydrocarbons of the Arctic zone of the Russian Federation in the global oil and gas industry // The Arctic Herald. — 2015. — 3(14). — P. 46–53. — (In Russian).

Mastepanov A. M. On the competitiveness of Arctic offshore oil and gas projects in the context of low energy prices // Neftegaz.ru. — 2017. — Vol. 5(23). — P. 57–60. — (In Russian).

Morozov V. N., Kagan A. I., Kolesnikov I. Yu., et al. Forecasting the sites of hydrocarbons localization in the gradient fields of tectonic stresses // Exposition Oil & Gas. — 2012. — 5(23). — P. 57–60. — (In Russian).

Naumova V. V., Eremenko V. S., Platonov K. A., et al. Development of geographically distributed information-analytical geological environment // Russian Journal of Earth Sciences. — 2019. — Vol. 19, no. 6. — ES6012. — https://doi.org/10.2205/2019es000696.

Odintsova A. A., Gvishiani A. D., Rybkina A. I., et al. Dynamics of oil and gas industry development in the 20th century using the world's largest deposits as an example: GIS project and WEB service (Part II) // Geoinformatika. — 2018. — No. 1. — P. 3–10. — (In Russian).

Raaben V. F. The location of oil and gas in the regions of the world. — M. : Nauka, 1978. — 65 p. — (In Russian).

Soloviev A. A., Zharkikh J. I., Krasnoperov R. I., et al. GIS-oriented solutions for advanced clustering analysis of geoscience data using ArcGIS platform // Russian Journal of Earth Sciences. — 2016. — Vol. 16, no. 6. — P. 1–6. — https://doi.org/10.2205/2016es000587.