

GEOCHEMICAL CHARACTERISTICS OF DISSOLVED ORGANIC MATTER IN FORMATION WATERS OF THE FERGANA OIL AND GAS REGION AND THEIR SIGNIFICANCE FOR ASSESSING OIL AND GAS POTENTIAL

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ABSTRACT

This study investigates the hydrogeochemical characteristics and dissolved organic matter in formation waters of the Fergana Oil and Gas Region of Uzbekistan, with particular emphasis on Paleogene deposits. Formation waters interact with host rocks and hydrocarbons over geological time and can therefore provide important information about hydrocarbon migration, accumulation, and petroleum potential. The study aimed to determine the composition and concentration of dissolved organic matter, examine its spatial and depth-related distribution, and evaluate its relationship with oil and gas potential. The investigated Paleogene formations comprise Paleocene, Eocene, and Oligocene deposits consisting mainly of claystone, sandstone, siltstone, and carbonate rocks. The results demonstrate considerable spatial variations in the concentrations of organic carbon (Corg), naphthenic acids, phenols, benzene, iodinated organic compounds, and permanganate-oxidizable organic matter. The concentration of Corg ranged from 4.13 to 62.40 mg/L, with the maximum value recorded in the Achchiq field. Relatively high Corg concentrations were also identified in the Namangan, Bars-Qanibadam, Takibel, Digmay, and Izboskent fields. Elevated concentrations of other organic components were observed in several oil- and gas-bearing areas, suggesting possible influences of petroleum-derived fluids and hydrocarbon migration. High concentrations of iodinated organic compounds and permanganate-oxidizable organic matter were particularly recorded in Niyozbek, Takibel, Achchiq, Namangan, and Izboskan. Naphthenic acids reached their highest concentrations in the Niyozbek and Northern Qarachiqu fields, whereas relatively high phenol concentrations were observed in Niyozbek, Qizilrabot, Digmay, and Achchiq. Benzene concentrations were generally low, with comparatively elevated values occurring in Izboskent and Niyozbek. Variations in organic-matter concentrations with depth reflect differences in lithology, water-exchange conditions, mineralization, and local hydrogeochemical environments. The comparison of oil- and gas-bearing areas with water-bearing areas indicates that elevated concentrations of several organic components may be associated with hydrocarbon accumulations and migration pathways. The results further suggest that the preservation and transformation of dissolved organic matter are influenced by the mineralization and hydrogeochemical characteristics of formation waters. Anomalous concentrations of multiple organic indicators occurring together may provide a more reliable geochemical signal of petroleum influence than individual parameters considered separately. Therefore, the qualitative and quantitative characteristics of dissolved organic matter can serve as additional geochemical indicators for evaluating oil and gas potential. The findings demonstrate that integrated interpretation of organic-geochemical, geological, hydrogeological, and geophysical data can improve the assessment of petroleum potential and help identify prospective hydrocarbon-bearing structures in the Fergana Oil and Gas Region.

Keywords: *Formation Waters; Dissolved Organic Matter; Organic Carbon (Corg); Naphthenic Acids; Benzene; Hydrogeochemistry; Hydrocarbon Migration; Oil And Gas Potential; Fergana Oil And Gas Region; Paleogene Deposits*

INTRODUCTION

The investigation of the hydrogeochemical characteristics of formation waters is of great scientific and practical importance in the study of oil and gas fields. Formation waters interact with host rocks and hydrocarbons over long geological periods and are therefore considered natural indicators reflecting the processes occurring within petroleum-bearing geological systems. In particular, the study of the

composition and concentration of dissolved organic matter in formation waters is important for assessing the migration and accumulation of hydrocarbons.

Organic matter in formation waters is formed as a result of various geological and biogeochemical processes. It may include organic acids, hydrocarbons, aromatic compounds, and other organic components. Variations in the concentration and composition of dissolved organic matter may be associated with water–rock interaction, hydrocarbon migration, and the presence of oil and gas accumulations. Therefore, the study of dissolved organic matter can be used as an additional geochemical criterion for assessing oil and gas potential.

The Fergana Oil and Gas Region is characterized by a complex geological and hydrogeological structure and contains sedimentary deposits of different ages as well as numerous oil and gas fields. In particular, the hydrogeochemical characteristics of formation waters hosted in Paleogene deposits are of considerable importance for investigating the processes of hydrocarbon migration and accumulation. Although the chemical composition and mineralization of formation waters in the Fergana Region have been studied by previous researchers, the composition, quantitative distribution, and relationship of dissolved organic matter with oil and gas potential remain insufficiently investigated. Therefore, the study of dissolved organic matter in formation waters is important for identifying geochemical processes associated with hydrocarbon migration and oil and gas potential in the Fergana Oil and Gas Region.

Aim of the Study: The aim of this study is to investigate the composition and concentration of dissolved organic matter in formation waters of the Fergana Oil and Gas Region, determine the patterns of their spatial distribution, and assess their relationship with oil and gas potential.

Study Area: The study area is the **Fergana Oil and Gas Region**, located in the eastern part of Uzbekistan and encompassing the Fergana intermontane basin (Figure 1). The region is bounded by mountain ranges to the north and south. Its geological section consists of Mesozoic and Cenozoic sedimentary deposits overlying a Paleozoic basement.

The main object of this study is **formation waters hosted in Paleogene deposits**. The Paleogene section comprises Paleocene, Eocene, and Oligocene deposits, within which claystone, sandstone, siltstone, and carbonate rocks are widely distributed. The alternation of these lithological units has resulted in the development of diverse hydrogeological conditions.

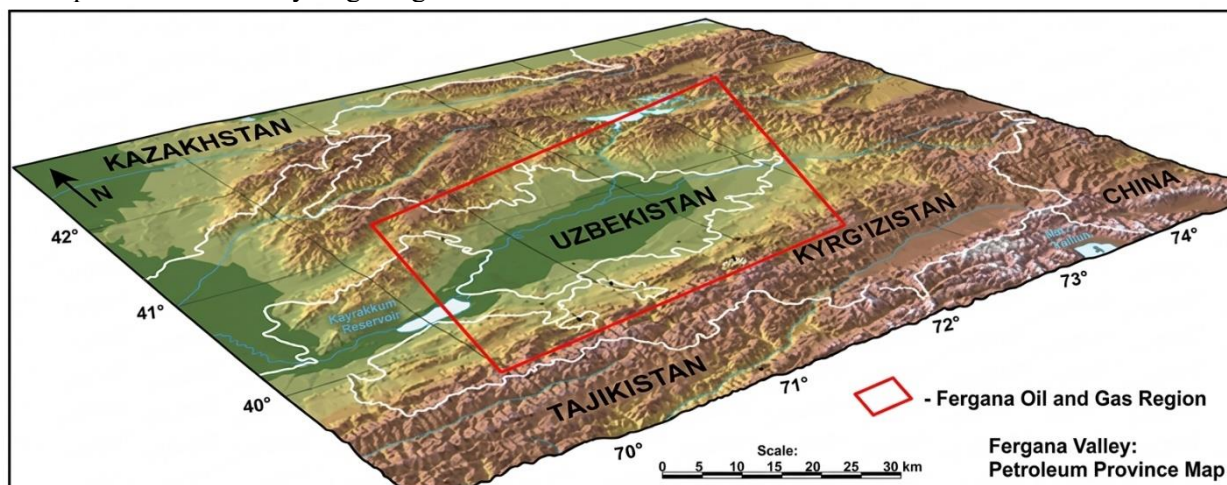


Figure 1: Location and position of the Fergana intermontane oil and gas region

MATERIALS AND METHODS

Study Area and Research Approach

The oil and gas fields in the Fergana Oil and Gas Region are mainly associated with anticlinal structures and tectonic faults. In this study, formation-water data from the Varik, Yaypan, Atamtov, Karadjida, Gumkhona, Mingbulak, Kosonsoy, Tergachi, Abadan, and Iskovat fields were used. The complex geological and hydrogeological conditions of the region provide an important basis for investigating the formation and distribution of dissolved organic matter in formation waters.

The total mineralization of formation waters was considered an important hydrogeochemical parameter in this study. Variations in mineralization were taken into account when assessing the formation conditions of the waters, their interaction with host rocks, and the hydrogeochemical processes occurring within the geological environment (Figure 2).

For the characterization of organic matter in formation waters, **Corg, naphthenic acids, benzene**, and other organic components identified through laboratory analyses were selected as the principal indicators. Their concentrations were compared with the mineralization of formation waters, lithological characteristics, and their spatial relationship to oil- and gas-bearing structures.

RESULTS AND DISCUSSION

The results of the study indicate that the concentration and distribution of organic matter in formation waters of the Paleogene deposits of the Fergana Oil and Gas Region are associated with the geological and hydrogeochemical conditions of the area. The concentrations of Corg, naphthenic acids, benzene, and other identified organic components vary considerably among different areas and wells.

Analysis of the spatial distribution of organic matter showed that, in some oil- and gas-bearing areas, its concentrations were higher than those observed in water-bearing areas. This pattern may be associated with hydrocarbon accumulations, hydrocarbon migration, and the geochemical environment of the formation waters.

Variations in the concentration of organic matter with depth can be explained by changes in the lithological composition of the formations, water exchange conditions, and the geochemical environment. With increasing depth, both increases and decreases in the concentrations of individual organic components were observed. The study also revealed that these variations do not follow the same pattern in all wells, indicating the influence of local geological, hydrogeological, and geochemical conditions.

Differences in the composition and concentration of organic matter are also observed among different hydrogeochemical zones. In formation waters with higher mineralization, the preservation and transformation of organic components may differ from those occurring under other hydrogeochemical conditions. Therefore, it is important to consider the mineralization and hydrogeochemical characteristics of formation waters when evaluating the distribution of dissolved organic matter.

Overall, comparison of data from oil- and gas-bearing areas with those from water-bearing areas indicates that the composition and concentration of organic components in formation waters may be used as additional geochemical indicators for assessing oil and gas potential. However, to further substantiate this relationship, the organic-matter indicators should be analyzed comprehensively in relation to mineralization, lithology, depth, and tectonic conditions.

Background values of organic substances dissolved in water of the Paleogene period in the Fergana oil and gas region, mg/l (Kh.N. Musaev)										
Organic carbon (Corg)	Phenols (Flet) _i	Naphthenic acids (NA)	Benzene (B)	Formation carbon (Cform)	Organic nitrogen (Norg)	Bitumen	Oil	Resin	O _{perm}	O _{yodat}
1	2	3	4	5	6	7	8	9	10	11
5,20	0,26	0,53	2,24	5,51	0,28	3,13	1,0	0,27	19,3	8,40

According to the data presented in Table 1, organic-matter concentrations exceeding the background values were identified as anomalous values. The concentration of organic carbon (Corg) ranged from 4.13 to 62.40 mg/l, with the highest value recorded in the Achchiq field. Relatively high concentrations were also observed in the Namangan (53.40 mg/l), Bars-Qanibadam (47.04 mg/l), Takibel (42.89 mg/l), Digmay (36.48 mg/l), and Izboskent (35.76 mg/l) fields. These elevated concentrations may indicate a relatively strong enrichment of formation waters with petroleum-related components in these areas.

Relatively elevated concentrations of organic components were also observed in several areas, including Avval (13.33 mg/l), Namangan (5.72 mg/l), and Izboskent (3.90 mg/l). These values may indicate a stronger influence of hydrocarbon migration or petroleum-derived fluids in these areas.

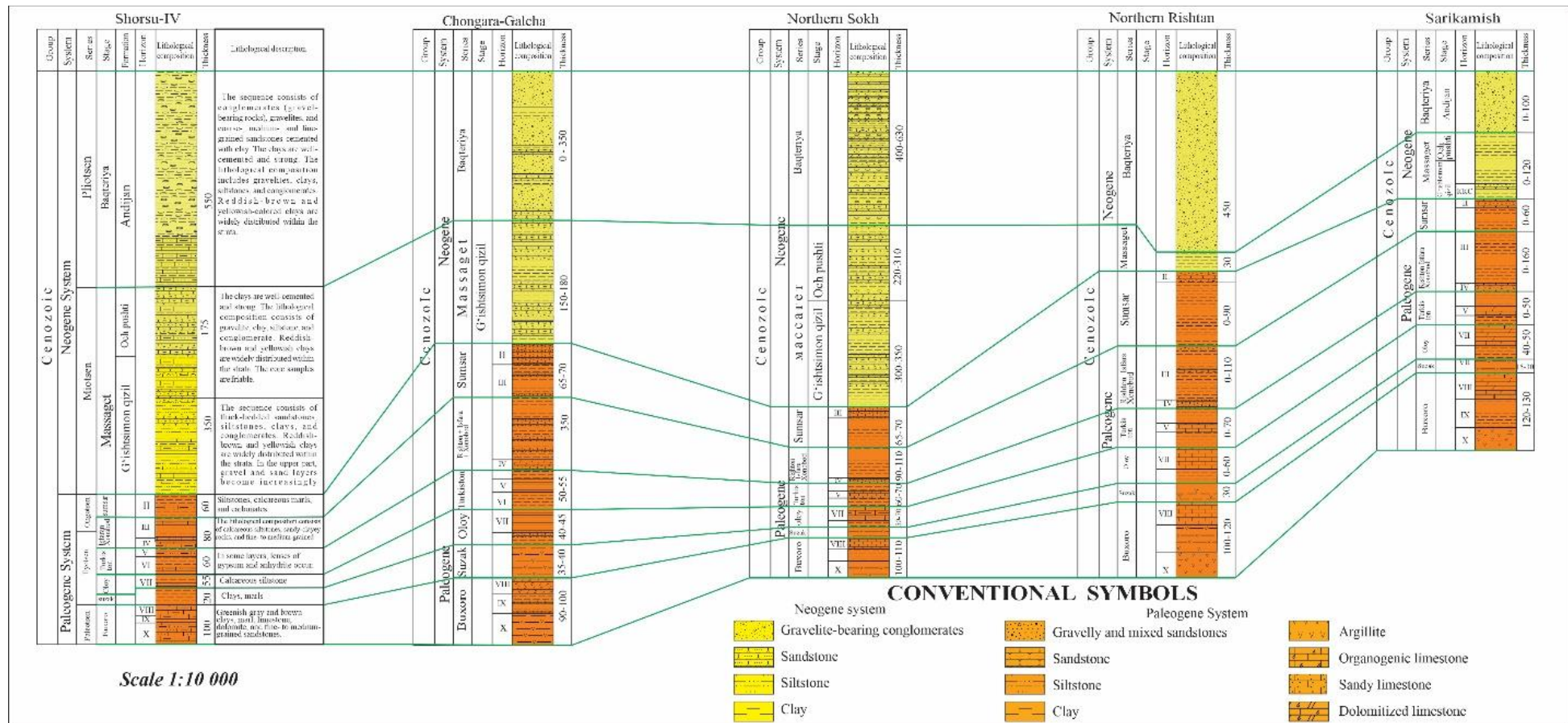


Figure 2: Comparative lithological correlation scheme of Cenozoic deposits in the Southern Fergana Region based on the Shorsu-IV, Chongara-Galcha, Northern Sokh, Northern Rishtan, and Sarikamish fields (compiled by K.B. Yusupov, 2025).

The concentrations of iodinated organic compounds (Oiod) and permanganate oxidation (Operm) also reached relatively high values in several fields. In particular, high concentrations were recorded in Niyozbek (346.60 and 76.80 mg/l), Takibel (295.40 and 137.30 mg/l), Achchiq (223.20 and 182.40 mg/l), Namangan (239.90 and 23.20 mg/l), and Izboskan (150.80 and 106.00 mg/l), respectively. These parameters indicate a relatively high proportion of oxidizable organic matter in the formation waters and may reflect their association with highly mineralized, petroleum-generating geochemical environments.

Naphthenic acids (NA) were detected at significant concentrations in several areas. The highest values were observed in the Niyozbek (9.40 mg/l) and Northern Qarachiqum (8.05 mg/l) fields. The highest concentrations of phenols (Flet) were recorded in Niyozbek (13.31 mg/l), Qizilrabot (9.45 mg/l), Digmay (8.35 mg/l), and Achchiq (7.20 mg/l). Benzene concentrations were generally low, with the maximum values recorded in Izboskent (4.40 mg/l) and Niyozbek (2.70 mg/l).

Overall, the data presented in the table indicate that the distribution of organic components in formation waters of the Fergana Oil and Gas Region is closely associated with the geological structure of the area, the degree of oil and gas potential, and hydrogeochemical conditions. The elevated concentrations of organic matter observed in certain fields may indicate a strong influence of petroleum fluids on formation waters.

CONCLUSION

The study of the composition and distribution of dissolved organic matter in formation waters of the Fergana Oil and Gas Region revealed their genetic and hydrogeochemical relationship with oil and gas accumulations. Variations in the concentrations of organic components in formation waters, particularly total organic carbon, naphthenic acids, benzene, and other hydrocarbon compounds, were observed in association with oil- and gas-bearing structures and potential hydrocarbon migration pathways.

Relatively high concentrations of dissolved organic matter may occur in formation waters associated with oil and gas accumulations or affected by hydrocarbon migration. Therefore, the quantitative and qualitative composition of dissolved organic matter can serve as an important additional geochemical criterion for assessing the oil and gas potential of formation waters. In particular, the simultaneous occurrence of anomalous values for several organic components may provide a more reliable indication for identifying prospective oil- and gas-bearing areas.

The results demonstrate that the organic-geochemical characteristics of formation waters in the Fergana Oil and Gas Region can be used to support hydrocarbon exploration, assess the petroleum potential of existing fields, and identify new prospective structures. At the same time, the integrated analysis of organic-geochemical indicators together with geological, hydrogeological, and geophysical data can improve the reliability of oil and gas potential assessments.

REFERENCES

- Akramkhodjaev A.M., Kirshin A.V., Kushnir M.I. (1978).** Typification of dissolved organic matter in the oil- and gas-source rocks of Uzbekistan and methods for separate assessment of the quantities of liquid and gaseous hydrocarbons migrated from them. *Uzbek Geological Journal*, (2), 6–8.
- Anonymous (2021).** Chemical characterization of non-volatile dissolved organic matter from oilfield-produced brines in the Nanyishan area of the western Qaidam Basin, China. *Chemosphere*, 268, 128804. DOI: 10.1016/j.chemosphere.2020.128804.
- Anonymous (2022).** Indication of Formation Water Geochemistry for Hydrocarbon Preservation: New Applications of Machine Learning in Tight Sandstone Gas Reservoirs. *ACS Omega*. DOI: 10.1021/acsomega.2c03827.
- Karimov A.K. (1974).** Bituminological Prerequisites for Oil Formation and Petroleum Potential of Sedimentary Deposits of Uzbekistan. Tashkent: Fan, p. 37.
- Seewald J.S. (2003).** Organic–inorganic interactions in petroleum-producing sedimentary basins. *Nature*, 426, 327–333.
- Shoimurotov T.Kh. (2013).** Some features of the geological and hydrogeological conditions in forecasting the petroleum potential of Paleozoic deposits of Uzbekistan. *Geology and Mineral Resources*, (4), 44–48.
- Shoimurotov T.Kh., Umarov Sh.A. (2020).** Dissolved organic substances in deep horizons of the sedimentary cover of the Fergana Depression as an additional source and form of hydrocarbon migration. *Proceedings of the International Conference “Current Problems of Geology and Geography of the Tien*

Shan and Adjacent Territories”, Dedicated to the 100th Anniversary of V.G. Korolev. Bishkek, pp. 263–267.

Sun Z., Yang Z. (2022). Geochemical Characteristics of Formation Water in Carbonate Reservoirs and Its Indication to Hydrocarbon Accumulation. *Geofluids*. DOI: 10.1155/2022/6095178.