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DISTRIBUTION PATTERN OF MIOCENE-PLIOCENE DEPOSITS IN THE NORTHERN ABSHERON STRUCTURES

Rzayeva S.M.[1], Mirzeyev K.I.[2], Feyziyev K.B.[3]

[1]Department of oil and gas geology, Geological Exploration Faculty, Azerbaijan State Oil and Industry University, Azerbaijan
34, Azadlig Avenue, Baku, AZ1010: sevinch.rzayeva@asoiu.edu.az
[2]Ministry of Science and Education of the Republic of Azerbaijan, Institute of Geology and Geophysics, Department of biota evolution and geological events correlation, Azerbaijan
H. Javid Ave., 119, Baku, AZ1073: mirzeyevk36@gmail.com
[3]Master`s degree, Department of oil and gas geology, Geological Exploration Faculty, Azerbaijan State Oil and Industry University, Azerbaijan
34, Azadlig Avenue, Baku, AZ1010: kenanfeyziyev8@gmail.com

Summary. North Absheron region is a geologically rich and complex zone. In this area, sediments from the Miocene and Pliocene periods are widely distributed. During the Miocene period, marine conditions predominated, while in the Pliocene period, tectonic activity and erosion processes led to the formation of mixed marine-terrestrial sediments.

Key oil and gas fields in the region, such as the Absheron Bank and the Hamdam-Garabagh provide important insights into the distribution and development of Miocene and Pliocene sediments. Research conducted in these fields shows that the distribution of sediments is closely linked to tectonic uplifts and subsidence, as well as changes in sea level. Miocene sediments are primarily of marine origin consisting of clay and sandy layers, while Pliocene sediments are of mixed marine and terrestrial origin.

The spatial and lithological differentiation of Miocene–Pliocene sediments in the Northern Absheron reflects the region's dynamic tectonic evolution. Miocene deposits are predominantly marine and were formed under relatively stable subsidence conditions, whereas the Pliocene sediments record the increased tectonic activity and erosional input from continental sources. Structural highs and synclines played a fundamental role in controlling sediment accumulation and preservation.

Paleogeographic models demonstrate a shift from open marine to more restricted, deltaic and fluvial environments from the Miocene into the Pliocene. Facies analysis confirms the existence of porous sandstone reservoirs interbedded with clay-rich sealing units. These geological features enhance the hydrocarbon potential of the Miocene–Pliocene succession.

Keywords: *Miocene-Pliocene sediments, The Northern Absheron structures, Tectonic processes and sedimentation, Oil and gas potential, Stratigraphic correspondence.*

Introduction

The Northern Absheron region is geologically rich and structurally complex, forming a significant part of the South Caspian Basin. In this area, Miocene and Pliocene sediments are widely distributed and play an essential role in understanding the geological evolution and hydrocarbon potential of the region. These sediments reflect the influence of various geological processes, including tectonic activity, sea-level fluctuations, and changing sedimentation environments.

During the Miocene, marine depositional conditions predominated resulting in the accumulation of clayey, sandy, and coral-rich sediments. In contrast, the Pliocene period was marked by increased tectonic activity leading to the formation of mixed marine and continental deposits. This shift in depositional environments is clearly reflected in the sedimentary sequences observed in key structures such as the Absheron Sill, Hamdam, and Garabagh fields.

The aim of this study is to investigate the distribution patterns of Miocene–Pliocene sediments

within the Northern Absheron structures and to evaluate their hydrocarbon potential. Through stratigraphic, lithological, paleogeographic, and geophysical analyses, this paper seeks to provide a detailed understanding of sediment evolution in the region and to contribute to future geological mapping and resource exploration efforts.

Study Area

Geological background

The North Absheron uplift zone constitutes the offshore extension of the tectonic structures associated with the Greater Caucasus fold-thrust belt. This uplift is now regarded as an independent tectonic subzone situated at the southeastern-most margin of the Absheron–Pre-Balkhan zone. This reclassification reflects its distinct structural and geodynamic characteristics, which differentiate it from the main Absheron–Pre-Balkhan system. The unique position and geological features of the North Absheron uplift underscore its significance in the regional tectonic framework and justify its treatment as a separate structural entity. (Abbasov, Hüseynov, 2003).

Geologically, the North Absheron structure is located in the Azerbaijani sector of the Caspian Sea and includes a complex stratigraphic succession comprising sediments from the Cretaceous, Paleogene, Maikop, Miocene, and Productive Series. The North Absheron uplift developed on a monocline base to the northeast of the Absheron Sill Uplift. Notably, the lower section of the Productive Series is absent from the local stratigraphy. However, deeper drilling has revealed the presence of Miocene and even Cretaceous sediments beneath the “Fasila” suite at depths ranging from 2100 to 3000 meters (Али-заде и др., 1966).

Stratigraphy: Miocene and Pliocene sediments are widely spread in the area and mainly consist of terrigenous (sand, clay, gravel) and carbonate (coral, marl) materials. (Али-Заде и др., 1985).

Miocene Sediments: These are primarily marine in origin and more prevalent in the northern part of the region. Sandstone, clay, and coral-rich porous rocks dominate among Miocene deposits (Алиев и др., 1985).

Pliocene Sediments: Tectonic activity increased during the Pliocene leading to the formation of mixed marine and continental sediments. These deposits are mainly found in the southern part of the region (Şıxəlibəyli və b., 1981).

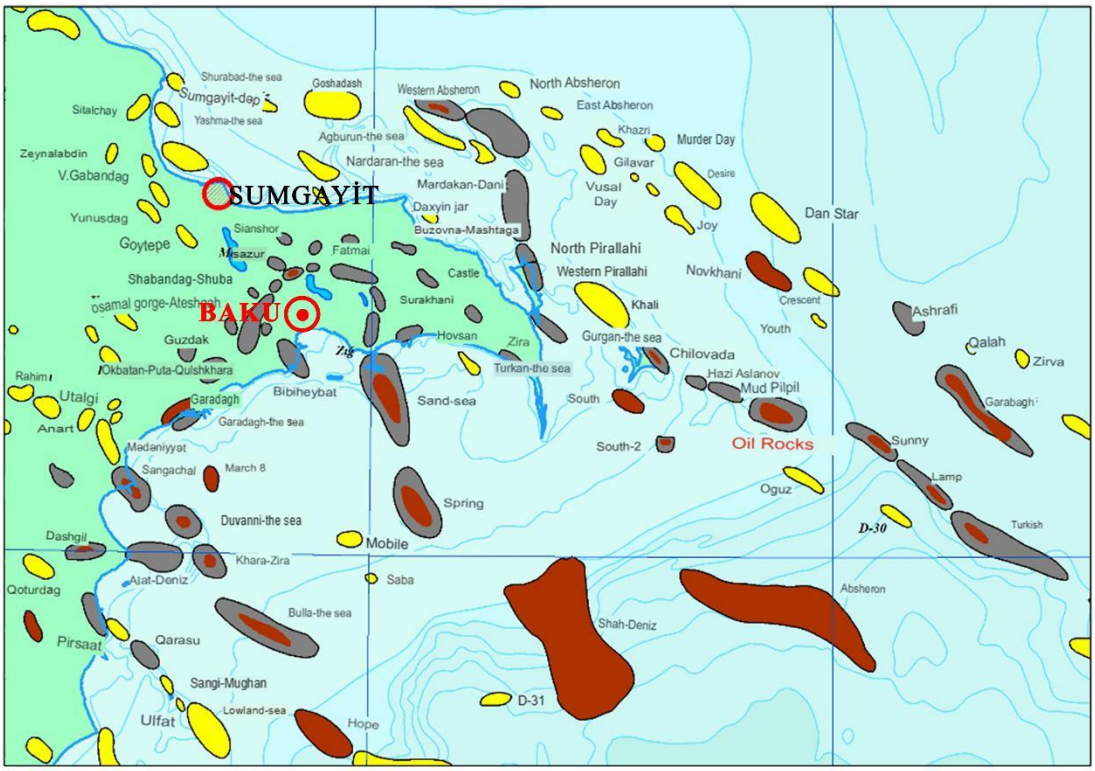

Fig. 1. Oil and gas fields of Absheron

Absheron Sill Field and the Distribution of Miocene–Pliocene Sediments

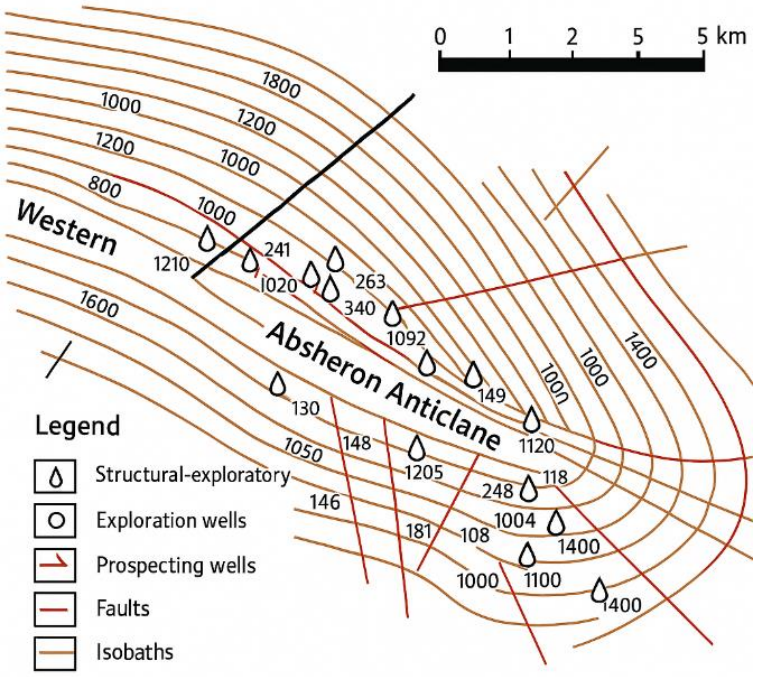

Fig. 2. Absheron Sill Field. Structural map of the roof of the Upper Productive Series (UPS)

The Absheron Sill field is located in the Caspian Sea in the northern part of the Absheron archipelago. It serves as an important example regarding the distribution of Miocene and Pliocene sediments. Geological and geophysical investigations in this field indicate a close relationship between these sediments and tectonic processes (Bağırzadə və b., 1987).

Miocene Sediments: The Miocene sediments of the Absheron Sill structure include the Maikop series, Chokrak clays, and Diatom layers, which are mainly composed of clay and sandy strata and were uplifted due to tectonic activity (Гаджиев, 2005).

Pliocene Sediments: The Pliocene sedimentary complex in the North Absheron region includes the Kala, Kirmaky, Kirmaky Upper Sandy and Kirmaky Upper Clay formations. These deposits were formed under the influence of alternating marine and continental depositional environments. Their stratigraphic architecture and spatial distribution were significantly controlled by regional tectonic uplift and subsidence processes, which influenced both the sediment supply and the accommodation space during the Pliocene epoch (Халилов, 1978).

Methodology

The primary objective of this study is to analyze the spatial distribution of Miocene–Pliocene sediments within the Northern Absheron structures and to assess their hydrocarbon potential. The research was conducted based on the following methodological approaches:

1. Stratigraphic and Tectonic Analysis

The geological evolution of the study area was examined through the analysis of the stratigraphic succession and tectonic framework of the sedimentary complexes. The lithological composition, depositional conditions, and unconformities of Miocene and Pliocene-aged formations were identified. This approach enabled the reconstruction of the paleotectonic development of the region.

2. Lithological and Lithofacies Analysis

The lithological composition of the sedimentary complexes was analyzed on the basis of data obtained from borehole samples and geological cross-sections. The vertical and lateral variations of clayey, sandy, sandy-clayey, and marly limestone layers were evaluated to determine their depositional environments and reservoir potential.

3. Paleogeographic Reconstruction

The depositional environments (marine, deltaic, continental, etc.) that existed during the Miocene and Pliocene periods were reconstructed using paleogeographic data. The distribution patterns and depositional rhythms of the sediments were analyzed to develop lithofacies models.

4. Interpretation of Geophysical Data

The subsurface structure of the study area was investigated using seismic exploration data and well log interpretations. These data were used to identify anticlinal and synclinal structures, major discontinuities, and hydrocarbon traps. Structural maps and profile sections were constructed accordingly.

5. Regional Comparative Analysis

The Northern Absheron structures were compared with adjacent geological regions (e.g., Absheron Ridge, Karabakh, Caspian offshore areas) to better understand the sedimentary and tectonic evolution at a regional scale. This comparative approach provided a broader context for interpreting the local geological framework.

6. Cartographic Representation and Modeling

The spatial dynamics and reservoir potential of the sedimentary units were modeled on the basis of structural and lithofacies maps. Stratigraphic cross-sections and sediment distribution schemes were developed to preliminarily assess potential hydrocarbon accumulations.

Results

Distribution Patterns

The distribution of Miocene-Pliocene sediments in North Absheron structures is governed by the following patterns:

- Tectonic activity plays a central role in sediment distribution. Sea-level changes and tectonic subsidence favored marine sedimentation during the Miocene. In the Pliocene, uplift and subsidence led to the mixed marine-continental sedimentation (Xuduzadə, 2016).
- The prevalence of marine conditions in the Miocene and increasing terrestrial conditions in the Pliocene defined sediment distribution (Исмайлов, Гасанов, 1966).
- Sediment distribution is also controlled by depositional environments. In the Miocene, slow sedimentation in marine settings led to thin-bedded deposits. In contrast, Pliocene deposits are thicker due to tectonic activity and erosion (Потапов, 1954).
- A stratigraphic conformity exists between Miocene and Pliocene layers reflecting the geological history and tectonic evolution of the region (Salmanov və b., 2011).

Hydrocarbon Potential of the Absheron Sill Field

Hydrocarbon deposits have been discovered in the Miocene and Pliocene sediments of the Absheron Sill field. Industrial-scale oil and gas flows have been obtained from wells drilled into the Maikop series of the Miocene, Kala and Kirmaky layers of the Pliocene (Salmanov və b., 2014). This field provides critical data to evaluate the hydrocarbon potential of the region.

The integration of stratigraphic, lithological, and geophysical data allowed the identification of key depositional trends within the Miocene–Pliocene sequences. The results confirm that sediment thickness and facies variations are strongly controlled by tectonic activity and paleogeographic conditions. Lithofacies analysis revealed the predominance of sandy-clayey facies in Pliocene formations, which correspond to favorable reservoir zones. Seismic and well log data delineated structural traps associated with the Absheron Sill and Hamdam-Garabagh uplifts. These traps are critical to understand hydrocarbon accumulation patterns in the region. Comparative analysis with adjacent regions reinforced the unique tectonic and sedimentary dynamics of the Northern Absheron. Cartographic modeling further validated the spatial correlation between uplift zones and hydrocarbon-bearing layers.

The Hamdam-Garabagh field located in North Absheron features a geologically complex structure. Miocene and Pliocene sediments are widespread throughout the area (Yusifzadə, 2012). According to the structural map prepared on the basis of the roof of the Qirmaki layer, the Garabagh structure appears as an independent uplift at the 3300 m closing isohypse, while at the 3400 m isohypse, the Hamdam and Garabagh uplifts form a single anticline. The Hamdam-Garabagh uplift is 16.6 km long, 2.0-2.3 km wide, and covers an area of 35.7 km². Dip angles in the Hamdam structure reach up to 12° on the northeast flank and up to 18° on the southwest flank (Yusifzadə, 2011).

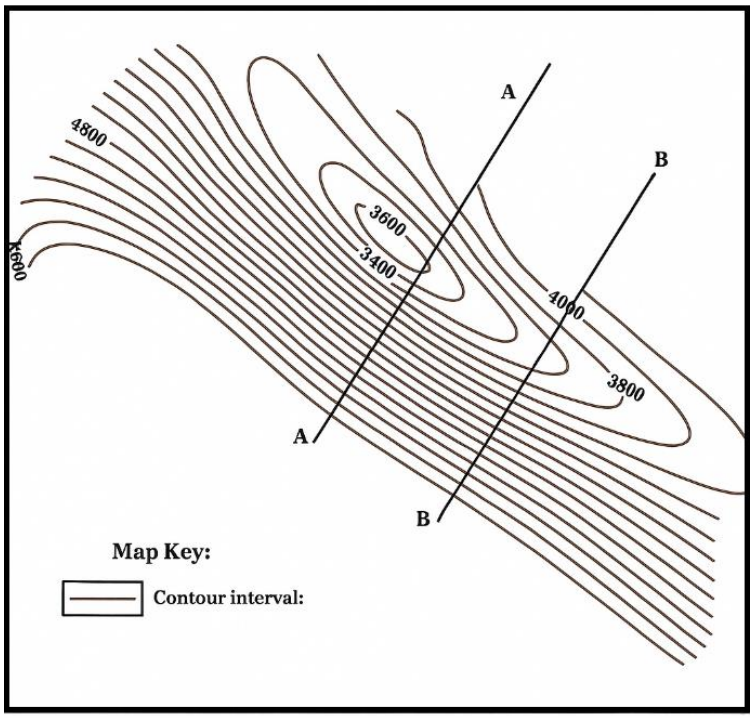

Fig. 3. Garabagh structure. Structural map based on SH-II (Upper Productive Series) horizon

Conclusion

The distribution of the Miocene-Pliocene sediments in Northern Absheron structures is closely related to tectonic processes, paleogeographic conditions, and sedimentation environments. Investigation of these sediments provides critical insights into the geological evolution of the region. Future studies can contribute to more precise geological mapping of the area and assist in the exploration of natural resources (Юсифзаде, 2014).

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ЗАКОНОМЕРНОСТИ РАСПРОСТРАНЕНИЯ МИОЦЕН-ПЛИОЦЕНОВЫХ ОТЛОЖЕНИЙ В СЕВЕРО-АБШЕРОНСКИХ СТРУКТУРАХ

Рзаева С.М.[1], Мирзоев К.И.[2], Фейзиев К.Б.[3]
[1]Кафедра геологии нефти и газа, Геологоразведочный факультет,
Азербайджанский государственный университет нефти и промышленности, Азербайджан
AZ1010, Баку,проспект Азадлыг, 34: sevinch.rzayeva@asoiu.edu.az
[2]Министерство науки и образования Республики Азербайджан,
Институт геологии и геофизики, Отдел эволюции биоты и корреляции
геологических событий, Азербайджан,
AZ1073, Баку, просп. Г.Джавида, 119: mirzeyevk36@gmail.com
[3]Магистр кафедры геологии нефти и газа, Геологоразведочный факультет,
Азербайджанский государственный университет нефти и промышленности, Азербайджан
AZ1010, Баку, просп. Азадлыг, 34,: kenanfeyziyev8@gmail.com

Резюме. Северный Абшеронский регион является геологически богатой и сложной зоной. Миоценовые и плиоценовые отложения широко распространены в этой области. Смешанные отложения образовались в результате доминирования морских условий в миоценовый период, а также тектонической активности и эрозионных процессов в плиоценовый период.

Распределение и развитие миоценовых и плиоценовых отложений на основных нефтегазовых месторождениях региона, таких как Абшерон Купеси и Хамдам-Карабах, предоставляют важную информацию для геологических исследований. Исследования, проведенные на этих месторождениях, показывают, что распределение осадков тесно связано с тектоническими поднятиями и опусканиями, а также с изменениями уровня моря. Миоценовые отложения в основном имеют морское происхождение и состоят из глинистых и песчаных слоев, в то время как плиоценовые отложения имеют смешанное морское и наземное происхождение.

Пространственная и литологическая дифференциация миоцен-плиоценовых отложений в Северном Абшероне отражает динамичную тектоническую эволюцию региона. Отложения миоцена преимущественно морского происхождения и сформированы в условиях относительно стабильного погружения, тогда как плиоценовые отложения свидетельствуют о возросшей тектонической активности и поступлении эрозионного материала с континента. Структурные поднятия и синклинали играли ключевую роль в аккумуляции и сохранении осадков. Стратиграфическая корреляция по основным месторождениям указывает на последовательные осадочные циклы, прерываемые региональными несогласиями.

Палеогеографические модели демонстрируют переход от открытых морских условий в миоцене к более ограниченным дельтовым и речным условиям в плиоцене. Фациальный анализ подтверждает наличие пористых песчаниковых коллекторов, чередующихся с глинистыми покрышками. Эти геологические особенности усиливают нефтегазовый потенциал миоцен-плиоценовой толщи**.**

Ключевые слова: *миоцен-плиоценовые отложения, структуры Северного Абшерона, тектонические процессы и седиментация, нефтегазоносность, стратиграфическое соответствие*

ŞIMALİ ABŞERON STRUKTURLARINDA MİOSEN-PLİOSEN ÇÖKÜNTÜLƏRİNİN PAYLANMA QANUNAUYĞUNLUĞU

Rzayeva S.M.[1], Mirzəyev K.İ.[2], Feyziyev K.B.[3]
[1]Azərbaycan Dövlət Neft və Sənaye Universiteti,
Neft-qaz geologiya kafedrası, Geoloji-kəşfiyyat fakültəsi, Azərbaycan,
Bakı şəh., Azadlıq prospekti, 34, AZ1010: sevinch.rzayeva@asoiu.edu.az
[2]Azərbaycan Respublikası Elm və Təhsil Nazirliyi, Geologiya və Geofizika İnstitutu,
Biota təkamülü və geoloji hadisələrin korrelyasiyası şöbəsi
Azərbaycan, H.Cavid pr., 119, Bakı, AZ1073: mirzeyevk36@gmail.com
[3]Azərbaycan Dövlət Neft və Sənaye Universiteti,
Magistr, Neft-qaz geologiya kafedrası, Geoloji-kəşfiyyat fakültəsi, Azərbaycan,
Bakı şəh., Azadlıq prospekti, 34, AZ1010: kenanfeyziyev8@gmail.com

Xülasə. Şimali Abşeron regionu geoloji baxımdan zəngin və mürəkkəb quruluşa malik bir zonadır. Bu ərazidə Miosen və Pliosen dövrlərinə aid çöküntülər geniş yayılmışdır. Miosen dövründə əsasən dəniz şəraitinin üstünlük təşkil etməsi, Pliosen dövründə isə tektonik fəallıq və eroziya prosesləri nəticəsində qarışıq növ çöküntüləri formalaşmışdır.

Abşeron küpəsi yatağı və Həmdəm-Qarabağ yatağı kimi regionun əsas neft-qaz yataqlarında Miosen və Pliosen çöküntülərinin paylanması və inkişafı geoloji tədqiqatlar üçün əhəmiyyətli məlumatlar təqdim edir. Bu yataqlarda aparılan araşdırmalar göstərir ki, çöküntülərin yayılması tektonik qalxma və enmələrlə, həmçinin dəniz səviyyəsinin dəyişməsi ilə

sıx əlaqədardır. Miosen çöküntüləri əsasən dəniz mənşəli olub, gilli və qumlu təbəqələrdən ibarətdir, Pliosen çöküntüləri isə qarışıq dəniz və quru mənşəlidir.

Miosen–Pliosen çökəntilərinin Şimal Abşeron bölgəsindəki məkan və litoloji diferensiasiyası regionun dinamik tektonik inkişafını əks etdirir. Miosen dövrünə aid çökəntilər əsasən dəniz mənşəlidir və nisbətən sabit çökmə şəraitində formalaşmışdır. Pliosen dövründə isə tektonik fəallığın artması və kontinental mənbəli eroziya materiallarının daxil olması müşahidə olunur. Strukturlu qabarıqlar və sinklinallar çökəntilərin yığılması və qorunmasında mühüm rol oynamışdır.

Paleocoğrafi modellər Miosendən Pliosinə keçid dövründə açıq dəniz şəraitindən delta və çay mühitlərinə doğru dəyişiklikləri göstərir. Geofiziki məlumatlar bu keçid zonaları ilə əlaqəli çoxsaylı karbohidrogen tələlərini üzə çıxarır. Fasiya təhlili, gil tərkibli örtü layları ilə növbələnmiş məsaməli qumdaşı kollektorlarının mövcudluğunu təsdiqləyir. Bu geoloji xüsusiyyətlər Miosen–Pliosen çökəntilərinin neft-qaz potensialını artırır.

Açar sözlər: *Miosen-Pliosen çöküntüləri, Şimali Abşeron strukturları, Tektonik proseslər və sedimentasiya, Neft-qaz potensialı, Stratiqrafik uyğunluq*