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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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GEOCHEMICAL CHARACTERISTICS OF THE OIL OF THE EASTERN SIDE OF THE CASPIAN BASIN ACCORDING TO THE STUDY OF CARBON ISOTOPES AND BIOMARKERS

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Abstract. The study of the composition and distribution of hydrocarbons in oil and dispersed organic matter represents a key tool for determining their genetic features. This paper presents the results of complex geochemical studies carried out on oil samples from the eastern part of the Caspian depression. The methods of adsorption and gas chromatography with mass spectrometry were used to study hydrocarbons of different oil fractions, which allowed to determine their biomarker and isotopic composition. The study also included analysis of the calculated reflectivity of vitrinite to assess the degree of catagenetic

transformation of organic matter. The results obtained indicate the marine origin of the oil and distinguish its facies-genetic type, showing a predominantly marine and mixed genesis. Cross-correlation of isotope and biomarker data confirmed the genetic relationship between the oil and its potential sources. The calculated reflectivity of vitrinite allowed us to determine the degree of catagenesis of the petroleum parent rocks, indicating their early stage of catagenetic transformation. These results reflect the significance of geochemical methods of investigation for revealing the genesis of oil, its sources and the degree of catagenetic transformation, which is important for predicting the oil and gas content of sedimentary basins.

Keywords: oil geochemistry, hydrocarbon composition, biomarkers, carbon isotopes, vitrinite reflectivity, Caspian basin, marine origin of oil, genetic features, catagenesis, oil and gas content

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КӨМІРТЕГІ ИЗОТОПТАРЫ МЕН БИОМАРКЕРЛЕРДІ ЗЕРТТЕУ ДЕРЕКТЕРІ БОЙЫНША КАСПИЙ МАҢЫ ОЙПАТЫНЫҢ ШЫҒЫС БОРТЫНДАҒЫ МҰНАЙДЫҢ ГЕОХИМИЯЛЫҚ СИПАТТАМАСЫ

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Абилгазиева Алия — 8D07208 – «Геология және пайдалы қазбалар кен орындарын барлау» дайындау бағыты бойынша докторант, Ш. Есенов атындағы Каспий технологиялар және инжиниринг университеті, Ақтау, Қазақстан
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Аннотация. Мұнай мен шашыраңқы органикалық заттардағы көмірсутектердің құрамы мен таралуын зерттеу генетикалық ерекшеліктерін анықтаудың негізгі құралы болып табылады. Бұл мақалада Каспий маңы ойпатының шығыс бөлігінен мұнай сынамаларында кешенді геохимиялық зерттеулердің нәтижелері келтірілген. Масс-спектрометриямен адсорбциялық және газ хроматография әдістерімен мұнайдың әртүрлі фракцияларының көмірсутектерін зерттелді, бұл олардың биомаркерлік және изотоптық құрамын анықтауға мүмкіндік берді. Сонымен қатар органикалық заттардың катагенетикалық түрлену дәрежесін бағалау үшін витриниттің есептелген шағылысу қабілетін талдауды қамтыды. Нәтижелер мұнайдың теңізден шыққанын көрсетеді және оның фациальды-генетикалық түрін ажыратады, негізінен теңіз және аралас генезисін көрсетеді. Изотоптар мен биомаркерлер деректерінің кросс-корреляциясы мұнай мен оның әлеуетті көздері арасындағы генетикалық байланысты растады. Витриниттің болжамды шағылысу қабілеті мұнай жыныстарының катагенез дәрежесін анықтауға мүмкіндік берді, бұл олардың катагенетикалық түрленудің ерте сатысын көрсетті. Бұл нәтижелер мұнай генезисін, оның көздерін және шөгінді бассейндердің мұнай-газды болуын болжау үшін маңызды болып табылатын катагенетикалық түрлену дәрежесін анықтау үшін геохимиялық зерттеу әдістерінің маңыздылығын көрсетеді.

Түйін сөздер: мұнай геохимиясы, көмірсутек құрамы, биомаркерлер, көміртек изотоптары, витриниттің шағылысу қабілеті, Каспий маңы ойпаты, мұнайдың теңізден шығу тегі, генетикалық ерекшеліктері, катагенезі, мұнай-газдылығы

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ГЕОХИМИЧЕСКАЯ ХАРАКТЕРИСТИКА НЕФТИ ВОСТОЧНОГО БОРТА ПРИКАСПИЙСКОЙ ВПАДИНЫ ПО ДАННЫМ ИССЛЕДОВАНИЯ ИЗОТОПОВ УГЛЕРОДА И БИОМАРКЕРОВ

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Аннотация. Изучение состава и распределения углеводородов в нефти и рассеянном органическом веществе представляет собой ключевой инструмент для определения их генетических особенностей. В данной статье представлены результаты комплексных геохимических исследований, проведенных на пробах нефти из восточной части Прикаспийской впадины. Методами адсорбционной и газовой хроматографии с масс-спектрометрией были изучены углеводороды различных фракций нефти, что позволило определить их биомаркерный и изотопный состав. Исследование также включало анализ расчетной отражательной способности витринита для оценки степени катагенетической преобразованности органических веществ. Полученные результаты указывают на морское происхождение нефти и различают ее фациально-генетический тип, показывая преимущественно морский и смешанный генезис. Кросс-корреляция данных об изотопах и биомаркерах подтвердила генетическую связь между нефтью и ее потенциальными источниками. Расчетная отражательная способность витринита позволила определить степень катагенеза нефтематеринских пород, указывая на их раннюю стадию катагенетической преобразованности. Эти результаты отражают значимость геохимических методов исследования для выявления генезиса нефти, ее источников и степени катагенетической преобразованности, что имеет важное значение для прогнозирования нефтегазоносности осадочных бассейнов.

Ключевые слова: геохимия нефти, углеводородный состав, биомаркеры, изотопы углерода, отражательная способность витринита, прикаспийская впадина, морское происхождение нефти, генетические особенности, катагенез, нефтегазоносность

Introduction

The composition and distribution of hydrocarbons (HC) in oil and dispersed organic matter (DOM) are the basis for identifying their genetic features, and the "Oil-DOM" correlation allows us to determine the oil-maternal strata, the initial type of organic matter, and the level of its catagenetic transformation. As a rule, nowadays these questions are solved by studying biomarkers - steranes and terpanes of C19-C35 composition, as well as lighter hydrocarbons - normal alkanes (nC12-nC18) and isoprenoids (iC19 and iC20) - pristane and phytane by gas chromatography and chromato-mass-spectrometry methods (Petrov, 1994). Isoprenoids are a group of organic compounds that are used mainly to determine the facies-genetic nature of oil and DOM. One of the geochemical parameters that contain this information is the ratio of the amount of pristane to the amount of phytane, expressed by the Pr/Ph value.

The most copious source of pristane (C19) and phytane (C20) is the phytyl side chain of chlorophyll-a in phototrophic organisms and bacteriochlorophyll a and b in purple sulfur bacteria (Brooks et al., 1969; Powell and McKridy, 1973). The Pr/Ph ratio can be applied to ascertain redox conditions of sediments throughout the deposition period under the supposition that both pristane and phytane derive from phytol side chain of chlorophyll a. Low values of this ratio (Pr/Ph <1) in crude oils indicate anoxic environment of deposition (Didyk et al., 1978; Tissot and Welte, 1984; Hunt, 1996; Harris et al., 2004; Peters et al., 2005), particularly when accompanied by high porphyrin and sulfur contents, while Pr/Ph >1 designate oxic deposition (Didyk et al., 1978). The Pr/Ph ratio may undergo an increase under the influence of thermal maturity due to cracking of phytane compared to pristane or preferential net production of the former over the latter (Peters et al., 2005).

According to Tissot and Welte (1981), the pristane/phytane isoprenoid ratio (Pr/Ph) in oil from marine sources is approximately 1. If the oil contains continental organic matter, the Pr/Ph value increases to 1.5–2.0.

In addition to these, the carbon isotope composition of oil and gas is also analysed. This method is often used as a criterion for marine or continental depositional conditions. The relationships between carbon isotopes and the various components of oil have been studied for a long time. Generally, compounds with higher polarity show higher 13C isotope enrichment compared to saturated hydrocarbons (Stahl, 1978; Chung et al., 1981). Isotope-type curves (δ13C by compound class) are often used to infer genetic relationships between petroleum and potential petroleum sources (Stahl, 1978; Chung et al., 1981). Sofer (1984) noted that δ13C values are lowest on average for marine oils and used this observation to distinguish between “terrigenous” and “marine” oils. In this study, it was demonstrated that the δ13Csat-δ13Carom cross-plot can effectively separate marine and non-marine oils, and the line of separation obeys the formula δ13Carom= δ13Csat +5.46 (Sofer, 1984).

In complex geochemical investigations, the reflectivity of vitrinite is analyzed to determine an indicator of the thermal maturity of petroleum source rocks during catagenesis. This parameter enables the estimation of the maximum temperature reached by sediments during their burial history, thereby assessing the degree of catagenetic transformation of organic matter within them. Vitrinite reflectance is extensively utilized in petroleum geology to predict the hydrocarbon potential of sedimentary basins.

Materials and methods

To investigate the oils, their correlation, maturity assessment, and the depositional conditions of petroleum source rocks, 25 oil samples from the eastern part of the Pre-Caspian Basin (Fig. 1) were analyzed. Using adsorption chromatography, paraffinic and aromatic hydrocarbons, as well as NSO (nitrogen, sulfur, oxygen) fractions, were separated from the oil samples.

Column Chromatography of Crude Oils

The crude oil (50 mg) were fractionated into aliphatic hydrocarbons, aromatic hydrocarbons, NSO (nitrogen, sulfur and oxygen) and asphaltene & resins by column chromatography using silica gel as adsorbent. A glass column (40 cm x 1.2 cm) was packed with slurry of activated silica gel (105 oC, 24-hours; 5 g) in n-hexane (25 mL). The SOM adsorbed silica gel or crude oil was introduced on the top of the packed column. The saturated fraction was eluted with three bed volumes of n-hexane, the aromatics with three bed volumes of 95: 5; n-hexane: diethyl ether, NSO with three bed volumes of methanol and asphaltenes & resins with three bed volumes of chloroform. The separated fractions were recovered by

vigilant evaporation of the solvent on a sand bath (maximum 60 °C) followed by the elimination of residual solvent using nitrogen. The fractions were obtained in pre-weighed vials (Fazeelat and Saleem, 2007).

Deasphalted oil samples were analyzed using gas chromatography and gas chromatography-mass spectrometry (GC-MS) to determine the composition of biomarkers, including isoprenoids and steranes.

GC-MS analysis was performed using a Hewlett-Packard (HP) 5973 Mass Selective Detector (MSD) interfaced to a HP 6890 gas chromatograph (GC). A 60 m ×0.25 mm ID capillary column coated with a 0.25 μm 5 % phenyl 95 % methyl polysiloxane stationary phase (DB-5 MS, J & W scientific) was used for the analysis.

1μL of the saturated or aromatic fractions (1 mg/mL in n-hexane) was introduced into the split/splitless injector using the HP 6890 auto-sampler. The injector was operated at 280 in pulsed splitless mode. Helium maintained at a constant flow rate of 1.1 mL/min was used as carrier gas. The GC oven was programmed from 40 °C to 310 °C at 3 °C/min with initial and final hold times of 1 and 30 minutes, respectively. The transfer line between the GC and the MSD was held at 310 °C. The MS source and quadruple temperatures were at 230 °C and 106 °C, respectively. Data was acquired in SIM mode, with the MS ionization energy 70 eV and the electron multiplier voltage 1800 V.

To determine the isotopic composition of hydrocarbon fractions, isotope-ratio mass spectrometry (IRMS) was employed, which measures the relative abundance of isotopes in a sample. This technique involves ionizing the sample, separating the ions based on their mass-to-charge ratio, and detecting them using a mass spectrometer. The isotopic ratios of the sample were then compared to a known standard to determine the isotopic composition.

The carbon isotopic composition (in per mil, ‰) was reported relative to the Pee Dee Belemnite (PDB) standard, using the following equation:

$$\delta 13C=(13C/12C)_{sample}-(13C/12C)_{ст})/((13C/12C)_{ст})\cdot 1000,‰, \quad (1)$$

where the δ13C value indicates the difference between the isotopic composition of the sample and the standard.

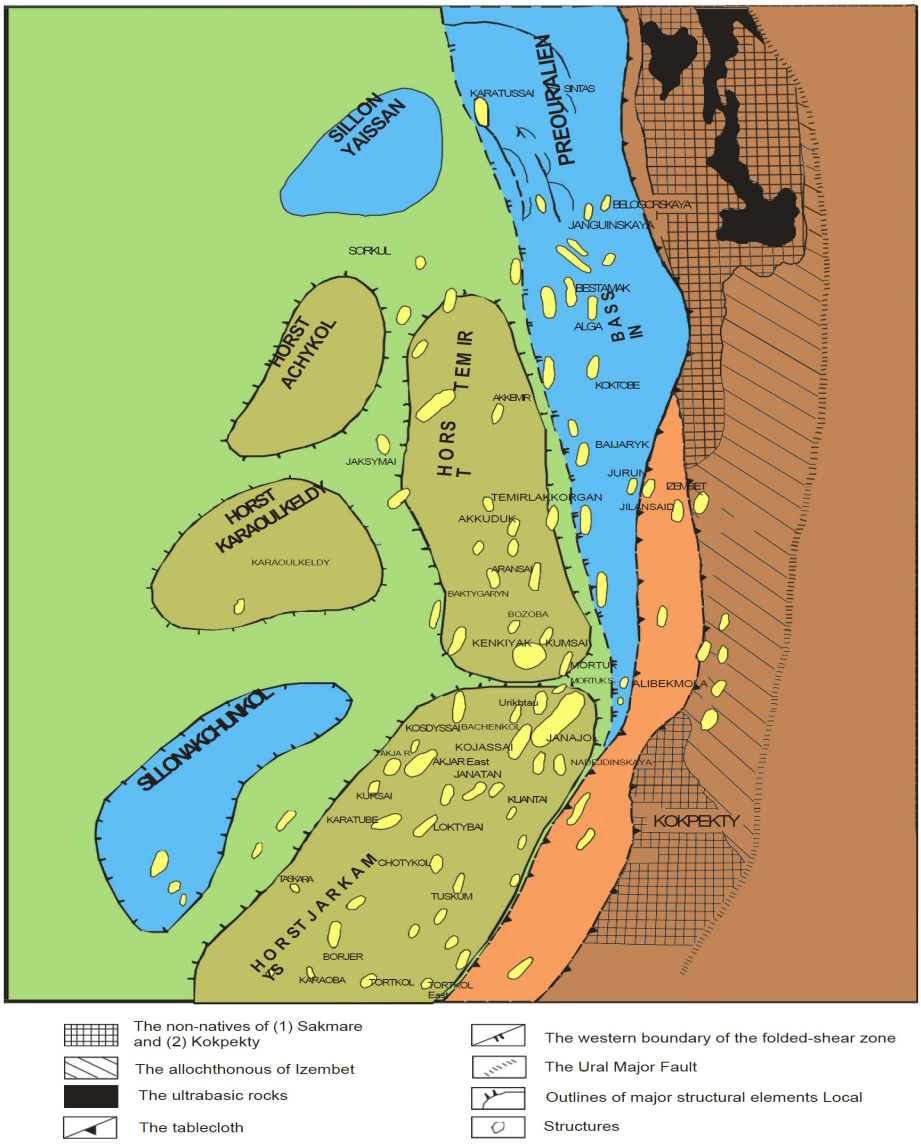

Figure 1 - Tectonic diagram of the eastern part of the Precaspian basin (modified according to the data of the company “Aktybneftegazgeologie”, Bulekbaev (1967) and Zholtayev (1992, 1999).

Results

The carbon isotopic compositions and Pr/Ph ratios for the saturated and aromatic fractions of various oils from the study area are presented in Table 1.

Table 1 - Carbon Isotopic Composition (‰ relative to PDB) and Isoprenoid Composition (Pr/Ph Ratios) of Saturated and Aromatic Fractions of Oils

Field	Age	Age	Location	δ13Csat	δ13Carom	Pr/ nC17	Ph/ nC18	Pr / Ph (C_{19}/C_{20})
Sarybulak	C_3	3680-3672	Intra-basin Zone	-30.1	-29.4	0.76	0.61	1.43
Karatobe	P_2	4337-4341	Intra-basin Zone	-30.2	-29.5	1.15	1.75	1.64
Karatobe	P_1	2711-2737	Intra-basin Zone	-30.3	-29.7	1.17	1.8	1.67
Karatobe	P_1	2765-2795	Intra-basin Zone	-30.3	-29.6	1.27	1.79	1.62
Karatobe	P_1	2576-2712	Intra-basin Zone	-30.2	-29.7	1.18	1.92	1.77
Karatobe	P_1	2870-2910	Intra-basin Zone	-30.5	-30	1.4	2.23	1.73
Kussay	P_2	4620-4650	Intra-basin Zone	-29.5	-28.8	0.77	0.99	1.85
Akzhar V	P-C	5177-5200	Intra-basin Zone	-29.7	-28.8	1.51	2.2	1.64
Alibekmola	C_2	3292-3306	Zhanazhol Carbonate Shelf	-29.9	-29.3	0.66	0.67	1.05
Kozhasay	C_2	1933-1960	Zhanazhol Carbonate Shelf	-29.4	-29.6	0.63	0.6	1.13
Mortuk Yu	T_1	3292-3306	Zhanazhol Carbonate Shelf	-30	-29.4	0.64	0.49	1.43
Sinelnikovskaya	C_2	4432-4440	Zhanazhol Carbonate Shelf	-30.1	-30.1	0.61	0.51	1.32
Zhanazhol	C_2	3824-3834	Zhanazhol Carbonate Shelf	-30.1	-29.5	0.6	0.48	1.34
Laktybay	C_1v_2	4754	Zhanazhol Carbonate Shelf	-30.2	-29.7	1.39	1.84	1.42
Laktybay	C_1v_2	3972-3983	Zhanazhol Carbonate Shelf	-30.7	-29.7	1.3	2.31	1.89
Laktybay	C_1v_2	4117-4143	Zhanazhol Carbonate Shelf	-30.3	-29.7	1.43	2.39	1.92
Laktybay S	C_2	4290-4318	Zhanazhol Carbonate Shelf	-30.3	-29.7	1.47	2.35	1.9
Mortuk S	C_2	4307-4323	Zhanazhol Carbonate Shelf	-27.2	-28.2	3.38	3.07	1.01
Alibekmola	C_2	3232	Zhanazhol Carbonate Shelf	-29.4	-29	1.65	1.66	1.18
Kozhasay	C_1	3635-3675	Zhanazhol Carbonate Shelf	-29.9	-29.5	1.9	1.91	1.05
Kenkiyak	P_1ar	3680-3672	Temir Carbonate Platform	-30.3	-28.9	0.63	0.51	1.32

Kenkiyak	C_2	4432-4440	Temir Carbonate Platform	-30.1	-29.1	0.14	0.45	1.59
Karaukel'dy	C_3	6110-6140	Temir Carbonate Platform	-30.6	-30.1	1.23	1.76	1.69
Kumsay	P_1ar	4275-4290	Temir Carbonate Platform	-29.6	-29.2	1.71	2.21	1.45

Based on the obtained data, the dependence of δ13C sat on δ13C arom was plotted on a "Sofer-plot" (Figure 2).

In Figure 2, the x-axis represents the δ13C values of the saturated fractions, while the y-axis represents the δ13C values of the aromatic fractions. Each data point corresponds to a specific oil sample from the study area. The plot illustrates the correlation between the isotopic compositions of these two fractions, which can be used to interpret the origin and maturation of the oils.

Except for one sample, all specimens are below the separation line, indicating a marine origin for the oil. This suggests a unified marine origin for both supersalt and subsalt deposits within the Zhanaozen and Temir carbonate platforms, as well as the intrabasinal zone.

The graph depicting the relationship between the facies-genetic type of the initial organic material and the outcomes of carbon isotopes analysis was employed. Specifically, it utilized the Pr/C17 ratio against the Ph/C18 ratio as a means of illustration. This approach is valuable because it allows for a visual representation of how different facies-genetic types of organic matter relate to their isotopic signatures, which can reveal information about their origins, thermal history, and depositional environments.

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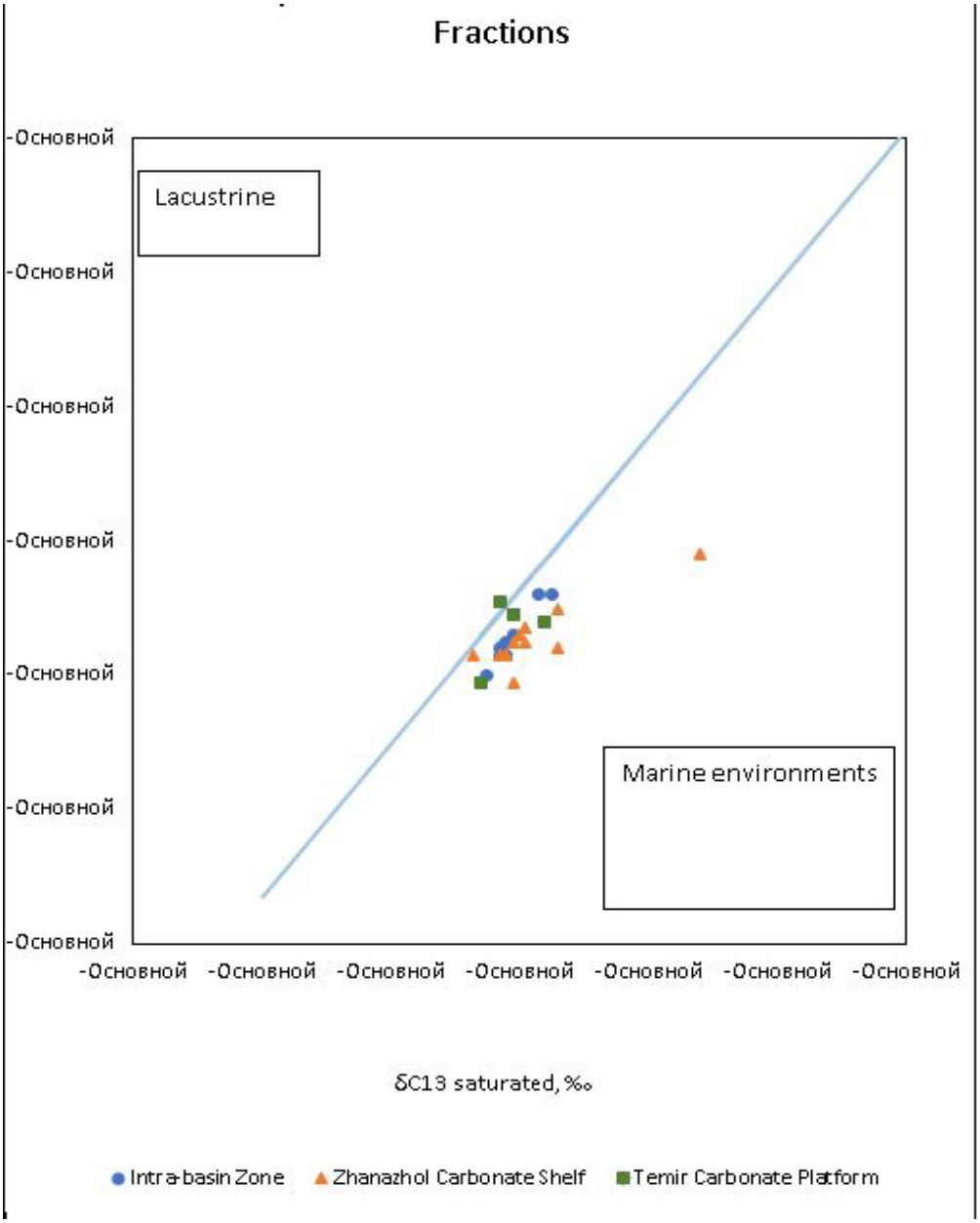

Figure 2 - Isotopic Composition of Carbon in Saturated and Aromatic Fractions of Oil.

The graph depicting the relationship between the facies-genetic type of the initial organic material and the outcomes of carbon isotopes analysis was employed. Specifically, it utilized the Pr/C17 ratio against the Ph/C18 ratio as a means of illustration. This approach is valuable because it allows for a visual representation of how different facies-genetic types of organic matter relate to their isotopic signatures, which can reveal information about their origins, thermal history, and depositional environments

As shown in Figure 3, the investigated oil samples from the Eastern Caspian Basin originate from mixed sources, including marine and sapropelic-humic types.

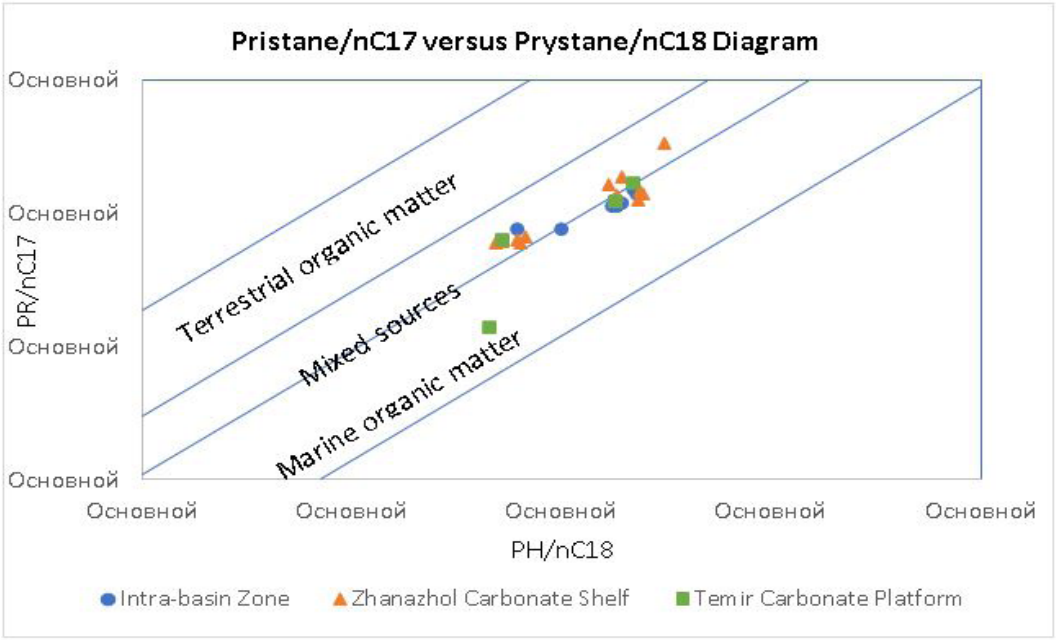

Figure 3 - Pristane/nC17 vs Prystane/nC18.

The dependency of Pr/C17 on Ph/C18 correlates well with the values of pristan-iC19/phytane-iC20 (P/F). According to this correlation, the oil samples taken within the Zhanazhol carbonate platform area are predominantly of marine genesis, while the oil samples from the Temir carbonate platform and intra-basin zone show coastal-marine genesis. This indicates the diversity of sources and formation conditions of oil in these research areas.

The reflectance ability of vitrinite (VRE) is considered as an indicator of the degree of catagenetic transformation of organic matter in deposits, allowing for the determination of the maximum heating temperature of deposits during geological history. In this study, the degree of catagenesis was studied based on the values of sterane isomers, from which the reflectance ability of vitrinite was calculated using the equation VRE=0.5S/R+0.35 (Philp RP, et al., 2005), as presented in Table 2.

Table 2. The paleotemperature conversion based on the values of isomer ratios from

Field	Age	Location	Field	C29 S/R	VRE
Sarybulak	C3	3680-3672	Intra-basin Zone		
Karatobe	P2	4337-4341	Intra-basin Zone	0.97	0.83
Karatobe	P1	2711-2737	Intra-basin Zone	0.94	0.82
Karatobe	P1	2765-2795	Intra-basin Zone	0.88	0.79
Karatobe	P1	2576-2712	Intra-basin Zone	0.98	0.84
Karatobe	P1	2870-2910	Intra-basin Zone	0.99	0.84
Kursay	P2	4620-4650	Intra-basin Zone	0.83	0.76
Akzhar E	P-C	5177-5200	Intra-basin Zone	0.96	0.83

Alibekmola	C2	3292-3306	Zhanazhol Carbonate Shelf	0.92	0.81
Kozhasay	C2	1933-1960	Zhanazhol Carbonate Shelf	0.95	0.83
Laktybai	C1v2	4754	Zhanazhol Carbonate Shelf	0.84	0.77
Laktybai	C1v2	3972-3983	Zhanazhol Carbonate Shelf	1.01	0.85
Laktybai	C1v2	4117-4143	Zhanazhol Carbonate Shelf	1.12	0.91
Laktybai S	C2	4290-4318	Zhanazhol Carbonate Shelf	1.11	0.91
Mortuk S	C2	4307-4323	Zhanazhol Carbonate Shelf	0.78	0.74
Karaukeldy	C3	6110-6140	Temir Carbonate Platform	1.16	0.93
Kumsay	P1ar	4275-4290	Temir Carbonate Platform	1.11	0.9

The conversion of vitrinite reflectance data to the degree of catagenesis is typically done using established scales such as the MK1-MK3 scale. Each level on this scale corresponds to a certain range of vitrinite reflectance values, indicating different degrees of thermal maturity and catagenesis in organic matter.

Here is a general guideline for interpreting vitrinite reflectance values in terms of catagenesis levels:

MK1: Vitrinite reflectance typically ranges from 0.5 % to 0.6 %. This level indicates the early stage of catagenesis, with organic matter experiencing low to moderate thermal alteration.

MK2: Vitrinite reflectance ranges from around 0.6 % to 1.2 %. This level represents a moderate degree of catagenesis, indicating a moderate to high level of thermal alteration in organic matter.

MK3: Vitrinite reflectance values above 1.2 % fall into the MK3 category, indicating a high degree of catagenesis. Organic matter at this level has undergone significant thermal alteration and maturity.

Conclusion

The comprehensive analysis of oil data allows us to conclude that the studied oil from the eastern margin of the Caspian Depression, both from subsalt and supersalt deposits, is primarily generated from mixed-type organic matter. This organic matter accumulated in coastal-marine and marine environments. The isotopic analysis results correlate well with the Pr/C17 ratio and suggest an early stage of oil's catagenetic transformation.

The majority of oil samples, except for one, show a marine origin below the separation line, indicating a unified marine origin for various deposits within the Zhanaozen and Temir carbonate platforms and the intrabasinal zone. The graphical representation using the Pr/C17 ratio against the Ph/C18 ratio provides valuable insights into the facies-genetic types of organic matter and their isotopic signatures, shedding light on their origins, thermal histories, and depositional environments.

Moreover, the correlation between Pr/C17 and Ph/C18 aligns with the pristan-iC19/phytane-iC20 (P/F) values, further confirming the marine genesis of oil samples from the Zhanazhol carbonate platform and indicating coastal-marine genesis for samples from the Temir carbonate platform and intra-basin zone. This diversity in sources and formation conditions underscores the complexity of oil genesis in these regions. The conversion of vitrinite reflectance data into catagenesis levels using established scales such as the MK1-MK3 scale further enhances our understanding of the oil's maturity and thermal history.

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