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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
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ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
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ЧФ «Халық»

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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»!

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.

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Satbayev University. Geology and oil–gas business institute named after K. Turyssov.
E-mail: dauletmuk@.mail.ru

HISTORY OF THE GEOLOGICAL EVOLUTION OF THE SOUTH TURGAY BASIN IN THE PRE–CRETACEOUS

Abetov A.E. — Doctor of Geological and Mineralogical Sciences. Associate Professor Geology and Oil–gas Business. Institute named after K. Turyssov, Department of "Geophysics". Almaty. Kazakhstan
E-mail abetov.auez@mail.ru, https://orcid.org/0000–0002–1866–7677;
Mukanov D.B. — MSC, Senior Researcher, International Center for Fields Analysis and Development. 1st category geologist. Almaty. Kazakhstan
E-mail dauletmuk@mail.ru, https://orcid.org/0000–0002–9628–2588.

Abstract. This article analyzes the history of the geological structure and the geological development of the Upper Proterozoic, Paleozoic and Mesozoic deposits of the South Torgay sedimentary basin, and determines their geodynamic stages of development based on the study of lithological and stratigraphic complexes of the sedimentary basin itself, as well as adjacent folded structures. Vendian – Early Paleozoic and Jurassic stages of rifting processes in the development are identified and described. The fundamental difference between these stages of rifting is that in the Vendian–Early Ordovician manifested themselves accordiFsing to the classical scheme with intense subsidence and extension at the early stages of development (the formation of molassoids, tillites in the Vendian, then siliceous–carbonaceous–terrigenous and siliceous–carbonate rocks) and compression, tectonic inversion, active dislocations and widespread magmatism in the final stages. At the Jurassic stage of rifting, intensive tectonic dislocations occurred in the South Torgai paleobasin, which resulted in active movements of differently oriented Paleozoic and Pre–Paleozoic faults, the split of the ancient Proterozoic–Lower Paleozoic basement, which initiated formation of grabens. However, the genesis of the graben system was completed without the introduction of magmatic bodies and intensive tectonic deformations. Thus, the South Torgay paleobasin can be considered as a zone of inherited rifting, a tectonic structure that twice survived the stages of rift development, in the Late Proterozoic–Early Paleozoic and in the Jurassic The article also presents lithological and paleogeographic maps of various geological eras based on geological and geophysical data, which confirm that the formation of the sedimentary basin and lithological and stratigraphic complexes of the South Turgay were significantly influenced by rifting processes.

Keywords: South Turgay, geological development, stages of rifting, graben – syncline, horst – anticline, folding, sedimentation, magmatism, tectonic deformations, Paleozoic and Mesozoic eras

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Қ. Тұрысов атындағы Геология және мұнай-газ ісі институты.
Алматы, Қазақстан.
E-mail: dauletmuk@.mail.ru

ОҢТҮСТІК ТОРҒАЙ БАССЕЙНІНІҢ БОР КЕЗЕҢДЕГІ ДЕЙІНГІ ГЕОЛОГИЯЛЫҚ ДАМУ ТАРИХЫ

Әбетов А.Е. — Профессор.Қауымдастырылған профессор. Қ. Тұрысов атындағы Геология және мұнай-газ ісі институты. Геофизика кафедрасы
E-mail abetov.auez@mail.ru, https://orcid.org/0000–0002–1866–7677;
Мұқанов Д.Б. — Магистр. Аға ғылыми қызметкер. 1-ші санатты геолог
E-mail dauletmuk@mail.ru, https://orcid.org/0000–0002–9628–2588.

Аннотация. Мақалада Оңтүстік Торғай шөгінді алабының жоғарғы протерозой, палеозой және мезозой шөгінділерінің құрылымы мен геологиялық даму тарихы талданады, олардың осы алаптың және оған іргелес қатпарлы құрылымдардың дамуындағы геодинамикалық кезеңдері анықталады. Литологиялық зерттеулер негізінде жыныстың стратиграфиялық жыныстары. Оңтүстік Торғай шөгінді алабындағы рифтинг процестерінің дамуының вендия–ерте палеозой және юра кезеңдері анықталып, сипатталған. Рифтингтің бұл сатыларының түбегейлі айырмашылығы вендиандық-ерте ордовикте олар классикалық схема бойынша дамуының алғашқы фазаларында қарқынды шөгумен және созылумен (молассоидтердің, тиллиттердің, одан кейін кремнийлі–көміртекті–терригенді және кремнийлілердің түзілуі) көрінді. – карбонатты жыныстар) және сығылу, тектоникалық инверсия, белсенді дислокациялар және соңғы кезеңдердегі магматизмнің кең көрінісі. Оңтүстік Торғай палеобайгын рифтингтің юра сатысында қарқынды тектоникалық дислокациялар орын алып, олар әртүрлі бағытталған палеозой және палеозойға дейінгі жарықтар бойымен белсенді қозғалыстарға, ежелгі протерозой–төменгі палеозойлық іргетастың ыдырауына әкеліп соқты, соның нәтижесінде грабендер төселді. Бірақ грабен жүйесінің қалыптасуы магмалық денелердің енуінсіз және қарқынды тектоникалық деформацияларсыз аяқталды. Осылайша, Оңтүстік Торғай палеобайгын рифтогенез аймағы ретінде қарастыруға болады–рифт дамуының екі кезеңінен өткен тектоникалық құрылым, кеш протерозойда–ерте палеозойда және Юра дәуірінде. Сондай–ақ мақалада Оңтүстік Торғайдың шөгінді алабы мен литологиялық–стратиграфиялық кешендерінің қалыптасуына рифтинг процестерінің айтарлықтай әсер еткенін растайтын геологиялық–геофизикалық деректер негізінде жасалған әртүрлі геологиялық дәуірлердің литологиялық–палеогеографиялық карталары берілген.

Түйін сөздер: Оңтүстік Торғай, геологиялық даму, рифтогенез кезеңдері, грабен–синклиналь, уыс–антиклиналь, шөгу, шөгу, магматизм, тектоникалық деформациялар, палеозой, мезозой

Институт геологии и нефтегазового дела им. К. Турысова, Алматы. Казахстан.
E-mail dauletmuk@mail.ru.

ИСТОРИЯ ГЕОЛОГИЧЕСКОГО РАЗВИТИЯ ЮЖНО-ТУРГАЙСКОГО БАССЕЙНА В ДОМЕЛОВОЕ ВРЕМЯ

Абетов А.Е. — Доктор геолого-минералогических наук. Профессор. Ассоциированный профессор Институт геологии и нефтегазового дела им. К. Турысова. Кафедра Геофизики.Алматы. Казахстан
E-mail abetov.auez@mail.ru, https://orcid.org/0000–0002–1866–7677;
Муканов Д.Б. — Магистр, Старший научный сотрудник. Геолог 1-категории. Satbayev University. Алматы.Казахстан
E-mail dauletmuk@mail.ru, https://orcid.org/0000–0002–9628–2588.

Аннотация. В настоящей статье проведен анализ строения и истории геологического развития верхнепротерозойских, палеозойских и мезозойских отложений Южного Торгайского осадочного бассейна, определены их геодинамические этапы развития этого бассейна и прилегающих складчатых сооружений.на основе изучения литолого–стратиграфических комплексов пород. Выделены и описаны венд–раннепалеозойский и юрский этапы развития процессов рифтогенеза в Южно–Торгайском осадочном бассейне. Коренное отличие этих этапов рифтогенеза заключается в том, что в венд–раннем ордовике они проявились по классической схеме с интенсивным прогибанием и растяжкением на ранних фазах развития (формированием молассоидов, тиллитов, затем кремнисто–углисто–терригенных и кремнисто–карбонатных пород) и сжатием, тектонической инверсией, активными дислокациями и широким проявлением магматизма на заключительных этапах. На юрском этапе рифтогенеза в Южно–Торгайском палеобассейне происходили интенсивные тектонические дислокации, повлекшие за собой активные подвижки вдоль разноориентированных палеозойских и допалеозойских разломов, расколу древнего протерозойско–нижнепалеозойского фундамента, следствием чего явилось заложение грабенов. Однако формирование системы грабенов завершилось без внедрения магматических тел и ингтенсивных тектонических деформаций. Таким образом, Южно–Торгайский палеобассейн можно рассматривать как зону унаследованного рифтогенеза–тектоническую структуру дважды пережившую этапы рифтового развития, в позднем протерозое–раннем палеозое и в юрское время. В статье также представлены литолого–палеогеографические карты различных геологических эпох, построенные на основе геолого–геофизических данных, которые подтверждают, что на формирование осадочного бассейна и литолого–стратиграфических комплексов Южного Тургая значительное влияние оказали процессы рифтогенеза.

Ключевые слова: Южный Тургай, геологическое развитие, этапы рифтогенеза, грабен–синклиналь, горст–антиклиналь, скадчатость, осадконакопление, магматизм, тектонические деформации, палеозой, мезозой

Introduction

The South Turgay sedimentary basin is bounded along the perimeter by the system of mountain structures of the Ural–Mongolian foldbelt. Features of its tectonic evolution, lithological and stratigraphic differences and the thickness of the sedimentary filling make it possible to attribute this depression to an intracontinental type of sedimentary basin, genetically related to the "unstable" massif of the Caledonian consolidation (Shlygina et al., 1991; Volozh et al., 2016).

Such a land mass is characterized by high mobility, which contributes to the expansion of the stratigraphic range and lithological diversity of rock–layer associations and an increase in the thickness of sedimentary filling (Bykadorov et al., 2016).

According to drilling data of deep and parametric wells, it is generally accepted that the basement of the South Torgay Basin (Fig 1) consists of deeply metamorphosed crystalline schists, gneisses, granite gneisses, amphibolites, Riphean–Vendian porphyroids and Middle–Upper Paleozoic carbonates (developed within the northwestern sector of the Aryskum trough and the western half of the Mynbulak saddle} and is divided into a series of tectonic blocks. (Changcheng et. al., 2020).

Fig 1. Tectonic map of the South Torgay depression Horst anticlines: Aksai, Akshabulak, Ashisai, Graben–synclines Aryskum, Akshabulak, Bozingen

Geological development in the Vendian–Paleozoic

Several plate tectonic models have been suggested for the evolution of the area known as the Altaids, of which South Turgay forms a small part (Zonenshain et al., 1990; Dobretsov et al., 1995; Sengor & Natal'in, 1996). Of these, the last outlines a comprehensive model which has been adopted for this paper. The area was disassembled into a series of tectonic units, each consisting of a strip of Pre–Altaid continental crust with a south to southwest facing subduction–accretion complex. By matching magmatic fronts from segment to segment, these were reassembled into an island arc termed the Kipchak Arc which reached its maximum extent in the Late Cambrian. The segments were juxtaposed along strike–slip faults formed during the collapse of the arc during the remainder of the Palaeozoic (Moseley and Tsimmer, 2000).

By the end of the Cambrian, rifting led to the formation of the Sakmar–Lemvinsky basin with oceanic crust, which in the Ordovician transformed in the Ural paleoocean. By the Late Ordovician, South Turgai block became the western margin of the Kazakhstan microcontinent with the accumulation of a thick flyschoid terrigenous strata (Atlas of lithological–paleogeographic, structural, palinsprastic and geoecological maps of Central Eurasia., 2002).

According to (Bykadorov et al., 2002) in the Ordovician of the South Turgay basin, there was a region of undifferentiated shelf area, which is supported by the foot of the continental slope in the East and the area of island arcs in the West (Fig 2).

A similar point of view is defended by (Allen et al., 2001; Zhemchuzhnikov et al., 1986; Sargaskaev et al., 1988; Cook et al., 1991), who believe that several carbonate platforms were formed in the early Paleozoic, presumably in the Karatau, Ulutau and South Torgay areas.

The location of these platforms was not controlled by the KTF (Karatau–Talas–Ferghana fault extending for 1500 km from Turgai to western Tarim is one of the world's largest intracontinental strike–slip faults, since they were located on either side of the fault system with no obvious signs of shear (Zhemchuzhnikov et al., 1986; Sargaskaev and Ergaliev et. al., 1988; Cook et al., 1991).

The existence of an ocean between Siberia and Baltica in the latest Neoproterozoic is confirmed by the presence ophiolites in Kazakhstan and th Altai, as pointed out by (Bykadorov et al., 2003).

The Late Ordovician of the South Torgay paleobasin was marked by regression and the beginning of the closure of the Paleoasian Ocean. Late Ordovician compressive deformations terminated the Early Paleozoic sedimentation in this paleobasin (Windley et al., 2007). As a result of these processes in the Late Ordovician, a number of other terranes (Kokchetav, Ulutau) and island arcs (Chingiz, Boshekul) were joined to the South Torgay block from the east – northeast. These events led to the formation of a large Kazakhstani Early Paleozoic continent with an orogeny, magmatism and general uplifting.

According to (Burtman et al., 1980), an important role in these tectonic events was played by the Karatau sinistral strike–slip belt, periodically activated since the Early Proterozoic.

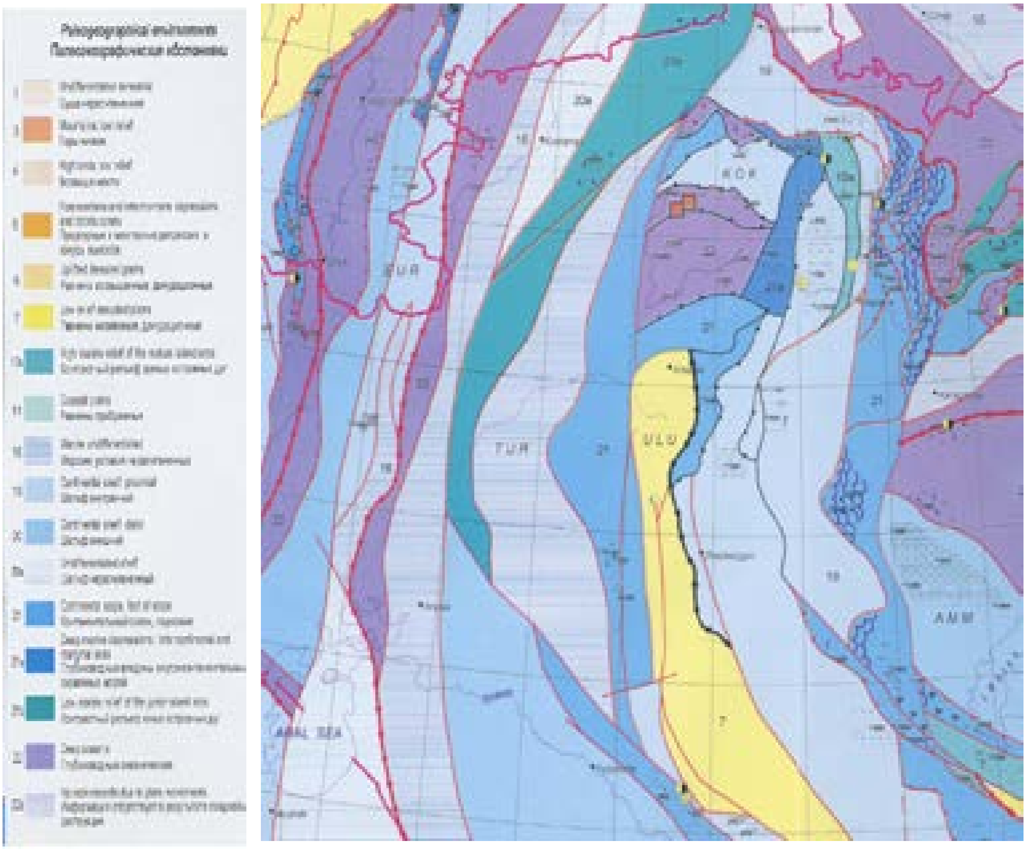

Fig 2. Lithologic–paleographic map of the area of South Turgay in the Early Ordovician (arenig–llanvirn) Compiled according to the data of (Bykadorov et al., 2002)

In the Silurian–Middle Devonian, the region of South Torgay was an elevated dry–land with intense denudation. This is confirmed by the data of (Moseley et al., 2000), according to which the Upper Devonian and Lower Carboniferous marine carbonates lie unconformably on the Ordovician and earlier marine and non–marine terrigenous deposits.

However, there is an alternative point of view, according to which, in the Famennian time, the Southern Turgay was an uplifted triangular zone bounded by faults and expressed by the Pre–Karelian block in the western half and the Early Caledonian block in the eastern half of the zone. (Kudaykulov et al., 2011). Limestones accumulated along the western flank of the South Torgay paleo–uplift, and red–colored molasse with a salt–bearing stratum along the eastern side.

According to data of (Kudaykulov et al., 2011)., during the Tournaisian time, the sea covered significant territories of the South Turgay. Slope deposits included redeposited members of unsorted angular carbonate fragments in a calcareous–clay matrix.

The deposits indicate insignificant syndepositional tectonic activity in the form of calcite–filled veins cutting through the strata, but not the matrix (Moseley et. al., 2000).

Drilling data indicate that such a platform system was characteristic of the western part of South Turgay, implying a southwest–facing passive carbonate margin along the MKF(The northern segment of the KTF, also known as the Main Karatau Fault).

In the Early–Middle Visean time, the transgression intensifies and the sea completely covers the South Turgay basin (Fig. 3).

In the Late Visean–Serpukhovian time, the regression of the sea begins, which leads to the outflow from the water level of the pre–Karelian block in the northwest and the Karelian–Caledonian block in the southeast of the basin.

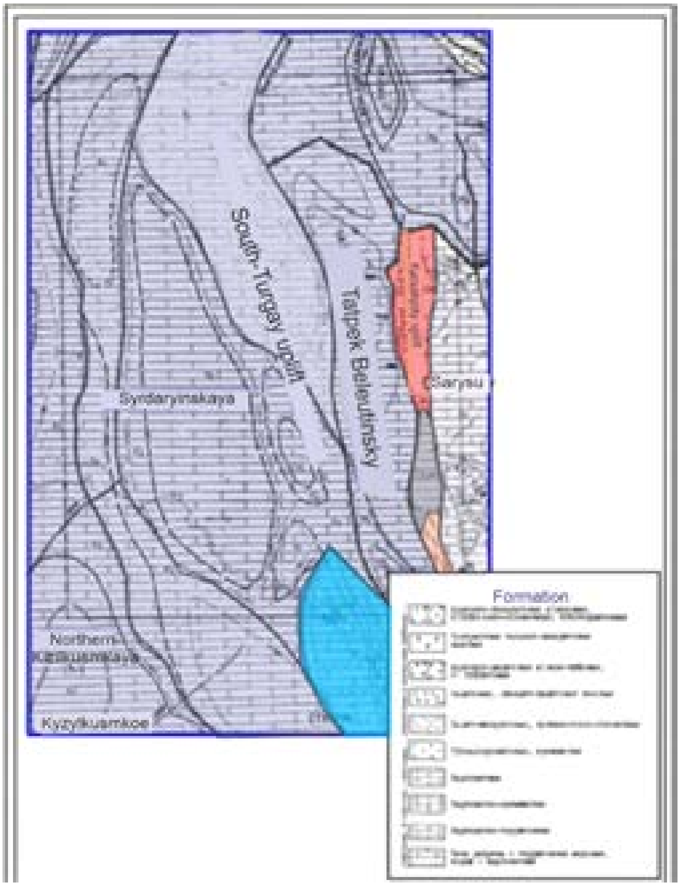

Fig 3. Paleoreconstruction at the end of the Middle Visean.
Compiled according to the data of Kudaykulov Kh.M., V.V. Zorin, O. Manakov.
"Estimates of oil and gas prospects of the basement for the Akshabulak, Nuraly, Aksai fields (Carey, 2002)

By the end of the Early Carboniferous, active subduction resumed along the western flank of Turgay–Syrdarya region with the formation of the Valerian–Kuramin marginal continental volcanic belt, and collision and orogenesis began in the middle of the Carboniferous (Volozh et al., 2016).

This period of development includes the collision of the Kazakhstan continent and various arcs and micro–continents with the East European craton with the formation of the Ural orogen, which resulted in the termination of the development of extensive subduction, accumulation of the accretionary complex in Central Kazakhstan and inception of the formation of the Kazakhstani orocline (Carey et al., 2013).

The timing and ramifications of many of these events are still poorly understood. Presumably, carbonate sedimentation ceased in South Torgay in the early Bashkirian period, when a variety of debris was deposited, including thick conglomerate layers of alluvial deposits in the northern part of South Torgay, which indicates significant subaerial erosion by the time (Cook et al., 1995).

In the Middle Carboniferous, the tendencies of plate movement of the end of the Early Carboniferous period continued. Regression occurs throughout the territory of the Kazakhstan continent, as a result of which denudation processes intensify with the formation of a sharply dissected relief of the ground surface. (Volozh et al., 2016).

During the Middle Carboniferous–Triassic period, the territory continued to rise and the intensive erosion of previously accumulated deposits continued. The progress is of a differentiated nature

At the turn of the Early and Middle Carboniferous epochs in the South Torgay region, the activation of tectonic movements manifested itself in the “continentalization” of the conditions of accumulation of the Middle Carboniferous formations, in the gradual uplift of studied area under the influence of epirogenic movements. (Zholtaev et al., 2016).

In the northeastern part of the South Turgai paleobasin, a peneplain formed, which most likely corresponded to the southwestern part of the Ulytau anticlinorium. Terrigenous sediments incl. conglomerates are deposited everywhere in the southern part of the basin.

By the end of the middle–beginning of the Late Carboniferous, tectonic dislocations intensified, which manifested itself in the differentiation of the South Torgay region into relatively raised and lowered blocks, fixed by fluctuations in the thickness and lithological diversity of accumulated sediments.

At the end of the Late Paleozoic, when the South Tien Shan Ocean closed, a large–scale dextral strike–slip movement occurred in the Karatau strike–slip belt. (Burtman, 1980).

However, in some local paleotroughs, remnants of Paleozoic sediments are preserved, which are exposed by a number of wells and are represented by marls, limestones, dolomites, mudstones, carboniferous–Lower Permian siltstones) (Bykadorov et al., 2002).

Apparently, the South Torgay middle massif throughout the entire Late Carboniferous and Early Permian was a low plateau with the development of weakly pronounced processes of denudation and sheetflood.

However, it is not excluded that low–amplitude subsidence with sedimentation characteristic of the middle massifs predominates in the indicated intervals of geological time within its limits (Li et al., 2017).

Permian and Triassic — the time of the highstand of South Turgai and denudation. As a result, Famennian–Lower Carboniferous deposits were preserved in places only in the form of small troughs. (Antipov et al., 2015).

In the Triassic period, the result of a sharp uplift and accompanying processes of physicochemical weathering was the denudation of the Upper Paleozoic and, in some areas, deep disintegration of the Precambrian rocks that make up the foundation of the South Torgay paleobasin. (Cook et al., 1995).

At this time, the entire territory was an alluvial–denudation peneplain with weakly expressed processes of physical–chemical weathering and sheetflooding.

At the final stage of the Hercynian tectogenesis within the boundaries of South Torgay, there was a revival of tectonic activity along the planes of Pre–Paleozoic and Paleozoic disjunctive disturbances, which led to the differentiation of the territory of the entire framing into relatively uplifted and lowered mostly linear blocks.

The movements, carried out along regional long–lived deep faults of submeridional and sublatitudinal orientations, led, on the whole, to a significant rise in the entire territory of the southeast of the Torgay depression.

In this way, at the final stage of the Hercynian tectogenesis as a whole, the framework of the Early–Middle Mesozoic rift system was established, expressed in the development of a system of graben–like structures.

Jurassic rifting. Tectonic inversion movements were timed to the turn of the Triassic and Jurassic periods with prevailing upward movements were replaced by immersion, accompanied by extension and alternating movements of individual large geoblocks along the faults, marking the beginning of the South Pacific Rifting paleobasin.

The deposition of rift structures in the region under consideration by the beginning of the Jurassic period is inextricably linked with the migration of tectonic activity from the north to south, which was expressed in the diverse development of various deep Paleozoic and Pre–Paleozoic faults in various parts of the Southern–Torgai Trough. (Yin Wei1 et al., 2012., Luo et al., 2005, Zhou et al., 2005) which included the split and stretching of the ancient Proterozoic–Lower Paleozoic basement with the fragmentation of the Proterozoic–Paleozoic middle massif into numerous blocks, which resulted in the deposition of sedimentary areas in the form of narrow grabens (Aryskum, Akshabulak, Bozingen), separated by Jurassic rifting. (Aryskumsky, Akshabulaksky, Bozingen), divided between two relatively elevated foundation blocks (Aksai, Akshabulaksky and Aschisaysky).

Multidirectional differentiated movements contributed to the formation of graben–synclines, and horst–anticlines in the modern structural plane.

Accumulation of predominantly coarse detrital rocks (Sazymbai, lower part of the Aibalinskaya formation) is evidence of a dissected topography, formed as a result of alternating tectonic movements. The stage corresponds to the deposition time of the South Torgay rift system.

From the new global tectonics standpoint, it is believed that the cause of the Mesozoic rifting in the South Turgai basin in the Early Jurassic is considered to be the renewal of the dextral strike–slip fault along the KTF (Karatau–Talas–Fergana fault), which actively manifested itself in South Kazakhstan and the Western Tien Shan, (Moseley, 2000), which led to the beginning of the formation of a system of "pull–apart" style grabens. The process continued until the Late Jurassic. Grabens are filled with thick (up to 5 km) Jurassic terrigenous gray–colored deposits, (Volozh et al., 2016; Burtman, 1980; Moseley, 2000).

It is important to note that narrow graben–synclines of northwestern and submeridional orientation, developed along long–lived deep faults, tend mainly to the Aryskum trough, while polygonal and isometric ones run to Zhylanshik trough (Fig 4).

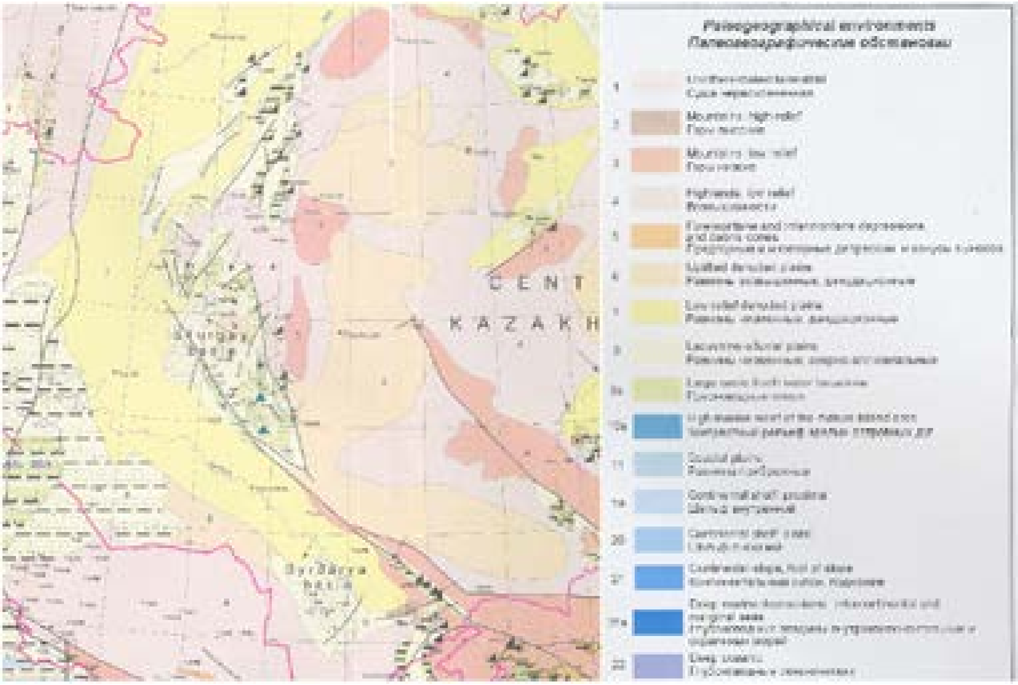

Fig 4. Scheme of facies–paleogeographic situations in the Middle Jurassic (Aalen–Bat). Compiled according to the data of (Bykadorov et al., 2002)

According to the existing point of view, four stages are distinguished in the processes of rifting: the initial (deposition), middle (subsidence), final, and the stage of formation of over–rift depressions (Juye et al., 2016., Абдулин et al., 1980).

At the initial stage of rifting (in the Early Jurassic), in the South Torgay trough, almost all faults of both pre–Paleozoic and Paleozoic deposition time are revived. The center of activation is shifted to the Aryskum trough, which is marked by the manifestation of predominantly extension processes.

At the stage of subsidence (Early–Middle Jurassic), there is a significant increase in the rate of sedimentation and the volume of sedimentary formations, with a contemporaneous expansion of the area of rift structures.

Constant stable subsidence caused intense sinking of the graben bottoms at a high (about 60 meters / million years) sedimentation rate with a gradual increase in the area of sedimentation due to the expansion of grabens (the stage of subsidence of rifts) (Fig 4).

The main faults bounding the graben dip at an angle of about 50–60 °, indicating that they were formed during extension. However, they were often accompanied by subvertical faults with a slight vertical displacement, which clearly indicates their strike–slip nature (Otto et al., 1997).

The process gradually weakens from the Early Jurassic to the Late Jurassic. Transtensional movements were replaced by alternating movements that caused the dismemberment of the region under consideration, which were distinguished within the limits of the modern Aryskum trough.

The rift phase effectively finished by the end of the Middle Jurassic in the opinion of some researchers and in the Late Jurassic – according to others.

In general by this time tectonic activity ceased, subsidence gradually slowed down and the rate of sedimentation throughout the basin was steady.

It was followed by a period of inversion, probably associated with the continuation of the dextral strike–slip fault along the MKF. (Yin Wei1 et al., 2022)

At this stage of development, active upward movements resumed. These events led to the fragmentation of large geoblocks into smaller ones by numerous regional and local faults.

By the beginning of the Cretaceous, the stage of isostatic compensation and the formation of the main structural elements and traps terminated.

By the end of the Neocomian, the inversion stage of development and the formation of all the main traps of the Jurassic–Cretaceous sedimentary cover have been completed. The thickness of the accumulated sediments by this time is 800–1300 m. All source rocks of the Lower–Middle Jurassic in graben–synclines reached the main phase of oil formation. Later, traps formed in Akshabulak, etc. uplifts were filled with migrated hydrocarbons.

Subsequent geodynamic stages did not lead to significant structural changes in the area. They are characterized by a slow and steady subsidence of the central parts of the South Turgai syneclise, which favored the preservation of the formed oil and gas deposits.

The northern part of the territory and the Vostochny Akshabulak area, where the thickness of the accumulated Jurassic sediments reaches 450–500 m in the most submerged parts, underwent the greatest submersion by this time. In the vaults of the Akshabulak Central and Akshabulak South areas, the thickness of the Jurassic sediments is 140–160 m. (Cook et al.,1995)

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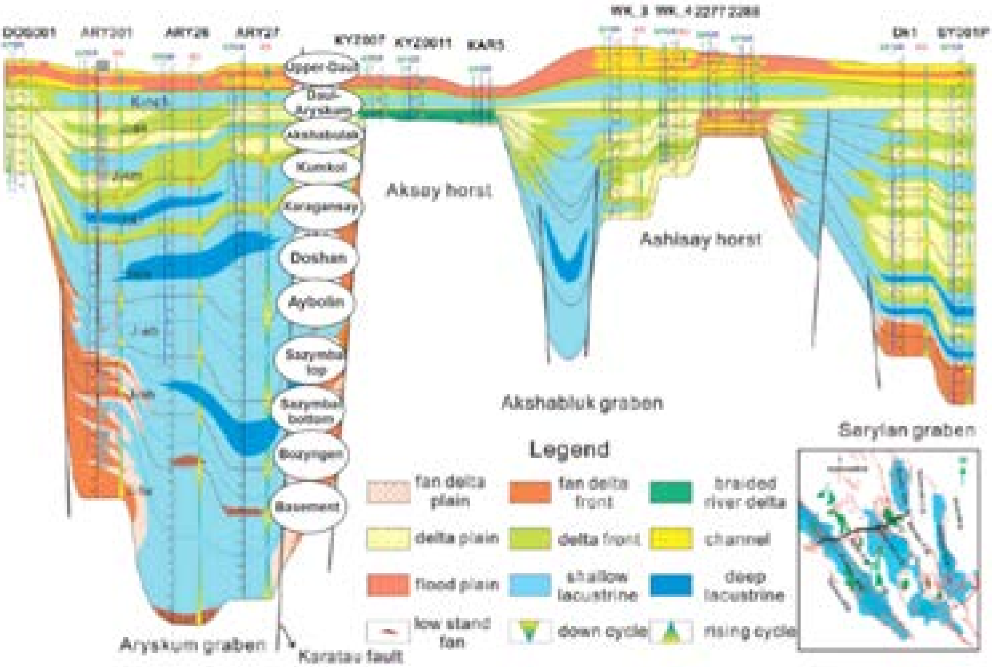

Fig 5. Section along AB profile showing the filling pattern of the South Turgay sedimentary basin. Based on data from (Juye et al., 2016)

A similar concept was presented by (Juye et al., 2016) (Fig 5), according to which, in the South Torgay paleobasin, starting from the Lower Jurassic, regression took place, as a result of which coastal shallow–water sediments accumulated here, were replaced with deep–water and medium depths deposits, which may indicate a decrease in tensile stress.

In the Middle Jurassic, the South Torgai paleobasin was filled with fan delta facies and lacustrine facies (Fig 6).

In the Upper Jurassic of the South Torgay paleobasin, the rate of subsidence along the fault planes slowed down. This epoch was dominated by the deltaic plains facies. Sediments were carried away from nearby horst–anticlines, which is confirmed by the appearance of coarse–clastic facies (Juye et. al., 2016)

Substantial thicknesses of Jurassic deposits accumulated at the rift stage, characterized by an increased content of organic matter (OM) with a predominance of the sapropel type. They are almost completely localized in grabens and grabens–synclines and are "sealed" by shale formations of the Akshabulak Formation, crowning the rift complex, which, together with the anomalous geothermal regime of Earth interior (3.5–4.20 s /

100 m) led to the formation of autonomous focal points of oil and gas formation in the contours of grabens and grabens–synclines, where already in the Late Jurassic the oil and gas source formations, associated with the depositional stage, began to generate liquid hydrocarbons.

As a result of the above–described concept of geological development, in the presence of a favorable combination of reservoirs and seals, numerous accumulations of oil and gas were formed. To date, 27 hydrocarbon fields have been discovered in the South Torgay basin.

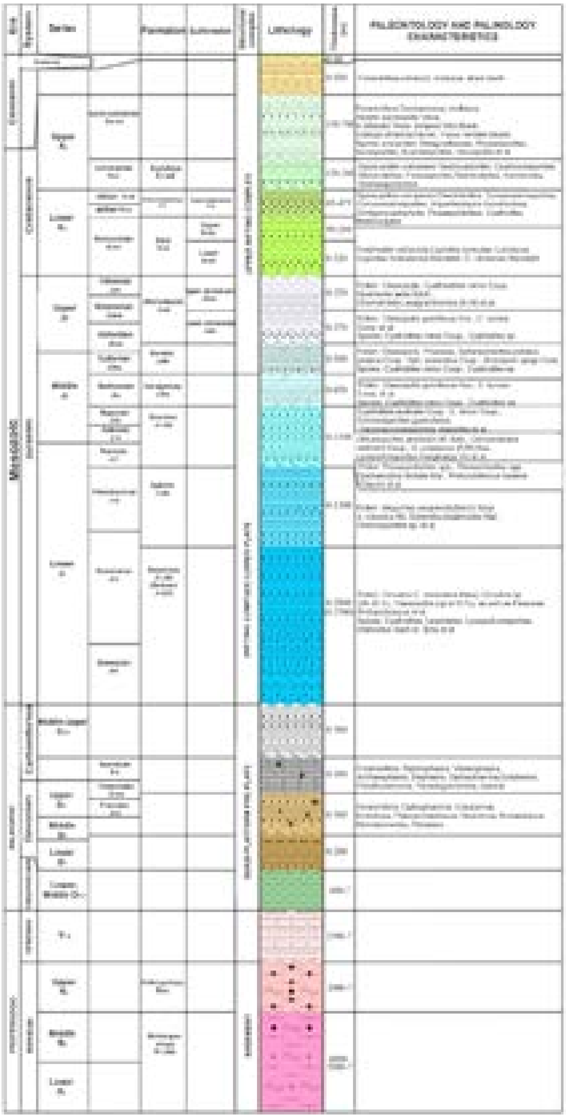

Fig 6. Stratigraphic characteristics of Jurassic to Cretaceous in the South Turgay Sedimentary basin. (Paragulgov et al., 2013)

The oil reservoirs of these fields are associated with various lithological and stratigraphic complexes of Jurassic–Cretaceous sediments (Kumkol, Nuraly, Akshabulak, etc.), Devonian–Lower Carboniferous formations (Kyzylkiya, Kenlyk, Kokbulak, Doschan and others) and disintegrated basement highs (Karavanchi,Aryss koe,Priozernoe, etc.).

Results and diccussion

Based on the studies on the history of the evolution of the South Torgay sedimentary basin presented in this paper, significant differences in issues related to the age and depth of the basement in this basin become apparent.

According to (Changcheng Han et.al., 2020), the drilling data from deep and stratigraphic wells suggests that the basement of the South Torgay basin is composed of heavily metamorphosed crystalline schists, gneisses, granite–gneisses, amphibolites, porphyroids of the Riphean–Vendian age and Middle–Upper Paleozoic carbonates (developed within the northwestern sector of the Aryskum trough and the western half of the Mynbulak saddle) and is divided into a series of tectonic blocks. (Zholtaev et al., 1996), theorize that in the Aryskum graben–syncline the basement of the basin is of a Precambrian age and of a heterogeneous material composition, with an average depth of up to 5–7 km.

In our opinion, the basement of the South Torgay basin in the troughs is of the pre–Middle Paleozoic age, while the uplifts are Upper Paleozoic. This can be confirmed from reflection time sections where below the top of the Paleozoic at depths of about 3–4 km, the troughs are characterized by rather sustained and continuous reflections, which is characteristic of sedimentary basin deposits. Although it should be noted that the depth of the basement in the troughs requires clarification using 3D seismics with an increased recording time.

In regards to the Paleozoic history of geological development, opinions of researchers also differ significantly. One group of researchers — (Alekseev, 1997; Bykadorov et al., 2017) believe that the South Turgai block of the continental crust in the Vendian was probably part of the East European continent.

In the Vendian–Early Ordovician, intensive rifting occurred and was accompanied with the formation of molassoids, tillites, and then flyschoid siliceous–carbonaceous–terrigenous and siliceous–carbonate rocks. In the Ordovician, an area of undifferentiated shelf existed on the present site of the South Torgay sedimentary basin.

(Zhemchuzhnikov, 1986; Sargaskaev et al., 1988; Cook 1991; Allen, 2001), suggest that in the early Paleozoic, several carbonate platforms formed in the approximate area of Karatau, Ulutau and South Torgay.

The results of our study of outcrops in the Greater Karatau, confirm that rifting, in fact, occurred in the Cambrian and at the beginning of the Ordovician. In the Middle Ordovician, this area was transformed into the continental shelf. In the late Ordovician, it became the westernmost part of the margin of the Kazakhstan microcontinent with the accumulation of a thick flyschoid terrigenous sequence.

The geological history of South Torgay during the Middle Paleozoic is also a subject of discussion. (Moseley et al., 2000), Zholtaev et al., 1996) believe that in the Silurian–

Middle Devonian (up to the Famennian, inclusive) in the region corresponding to the South Torgay trough elevated land with intense denudation was present, bounded by faults and manifested by a pre–Karelian block in the western half and an Early Caledonian block in the eastern half (Kudaykulov et al., 2011). Limestones accumulated along the western side of the South Torgay paleouplift, while red–colored molasse with a salt bed deposited along the eastern margin.

However, other authors suggest that from the end of the Early Devonian to the beginning of the Middle Devonian a spreading zone formed in the Turkestan paleoocean, causing the formation of an active continental margin with the Turgai Devonian volcanic belt along the southern and southeastern edges of the Kazakhstan paleocontinent (Moseley et al., 2000).

Another concept is presented by (Cook, 1994), according to which the Devonian carbonate deposits are a platform–slope–basin system with bioherm platform deposits, which are analogous to the carbonate reservoirs found in the Pre–Caspian basin. Due to the extremely limited data, it is difficult to go into detail regarding the concept of geological evolution in the Middle Paleozoic.

In the Famennian–Early Carboniferous, the South Turgai paleobasin and more eastern territories were submerged by a shelf sea with terrigenous–carbonate sedimentation (Volozh et al., 2002).

In the late Visean–Serpukhov time, marine regression commenced, leading to the exposure of the pre–Karelian block in the northwest and the Karelian–Caledonian block in the southeast of the South Torgay basin above the sea level.

By the end of the Early Carboniferous, active subduction resumed along the western margin of the Turgai–Syrdarya region concurrent with the formation of the Valerianovsko–Kuraminsk marginal continental volcanic belt. This was followed by collision and orogeny from the Middle Carboniferous (Volozh et al., 2002).

(Kudaykulova et al., 2011) argue that in the Early Middle Visean time the transgression intensified and the sea completely submerged the South Turgai basin. In the Tournaisian time, the sea covered large parts of South Turgay. Slope sediments included redeposited sequences consisting of unsorted angular carbonate clasts in a calcareous–argillaceous matrix.

When it comes to the geological history of the Jurassic in the South Torgay paleobasin, no serious disagreements between different authors were found.

According to (Juye Shi et al., 2016) in the early Jurassic, tectonic movements along the KTF (Karatau–Talas–Ferghana Fault) resumed in the South Turgai trough, which triggered the formation of a "pull–apart" type graben system that continued up until the late Jurassic. Grabens are filled with thick (up to 5 km) Jurassic terrigenous gray–colored deposits (Volozh et al., 2002; Burtman et al., 1980; Moseley et al., 2000).

According to (Otto, 1997), in the Early Jurassic, both pre–Paleozoic and Paleozoic faults reactivated in the South Torgay Trough. The center of fault activity migrated to the Aryskum trough. During this period extension processes were prevalent in the area.

During the subsidence stage (Early–Middle Jurassic), a significant increase in the rate and volume of sedimentation was coeval with a simultaneous expansion of rift structures. (Otto, 1997).

According to (Yin Wei1 et al., 2012) the rifting phase was mostly over by the end of the Middle Jurassic according to some researchers and in the Late Jurassic according to others.

For the most part, fault activity had ceased at that time, while the subsidence gradually slowed down, and the rate of sedimentation throughout the South Torgay basin was stable. It was followed by a period of inversion, probably associated with the continuation of the right–lateral strike–slip along the KTF.

At this stage, active uplift resumed. These events led to the fragmentation of large geoblocks into numerous smaller regional and local faults. (Yin Wei1 et al., 2012).

Conclusions

Based on the results of studies performed on paleo–reconstruction of facies–paleogeographic and paleotectonic conditions in the Late Precambrian, Paleozoic and Triassic–Jurassic, it was established that the South Torgay basin was subjected to rifting at least twice, in the Vendian–Early Paleozoic and in the Jurassic.

The fundamental difference between the stages of rifting is that in the Vendian–Early Ordovician they manifested themselves according to the classical scheme with intense subsidence and extension in the early phases of evolution and compression, tectonic inversion, active dislocations, and a wide occurrence of magmatism in the final stages.

At the Jurassic stage of rifting, active tectonic dislocations occurred in the South Torgai paleobasin, which led to the splitting of the ancient Proterozoic–Lower Paleozoic basement and formation of grabens. However, formation of the graben system ceased without intrusions of igneous bodies and intense tectonic deformations.

A limited scale of rifting incidents at the end of the Early–Beginning of the Middle Devonian may be considered, when a spreading zone was formed in the Turkestan Ocean, under the influence of which an active continental margin within the Turgai–Devonian volcanic belt which arose along the southern and southeastern margins of the Kazakhstan paleocontinent.

Thus, the South Torgai paleobasin can be considered as a zone of inherited rifting, a tectonic structure that has undergone two stages of rifting (according to some sources, three stages), in the Late Proterozoic–Early Paleozoic and then in the Jurassic.

The cycle in paleotectonic and paleogeographic settings in the South Torgai paleobasin predetermined the accumulation of sedimentary strata with a specific set of rocks, some of which can undoubtedly be considered as oil and gas source rocks, others as reservoir rocks.

Assumed weak deformations of the Upper Paleozoic rocks and Jurassic strata in the grabens of the South Torgai trough, the significant value of their subsidence, increased thicknesses, lithological composition, favorable thermobaric and geochemical conditions (high content of organic matter with a predominance of the sapropel type), the presence of zonal and local seals and hydrogeological isolation may have led to wide development of various genetic types of hydrocarbon traps in the flanks of grabens predetermined favorable conditions for the formation of petroleum systems.

At the same time, there is a lack of geological and geophysical knowledge on deep–seated rock units in the grabens of the South Torgai trough. In order to update the existing database, it is recommended to perform the following types of exploration work in stages.

In the first stage, we recommend conducting inexpensive geological exploration in the northeastern part of the South Torgai sedimentary basin, using geochemical mapping and remote sensing of the earth (airborne gamma spectrometry, gravity and magnetic exploration) on a large scale, which have proven themselves in the North and South Ustyurt regions (Abetov et al., 2017, 2020, 2021, 2022) with the mandatory calculation of the transformants of the gravitational and magnetic fields as well as Euler points to determine the depth of gravity and magnetically disturbing masses/any magnetic anomalies.

For the second stage of exploration work on individual areas, it will be necessary to carry out a high–resolution CDP–3D seismic survey and deep drilling with a full range of well logging and the most complete possible core sampling in order to identify new gas and oil pools in the Jurassic and Upper Paleozoic deposits.

Optionally, it is possible to consider the possibility of reinterpreting CDP 2D seismic profiles using innovative processing and modeling methods and more efficient software.

During the third stage of geological exploration, it is recommended to perform special (SCAL), standard (RCAL) and conventional (CCAL) types of core analysis, with the addition of additional experiments, in particular including biostratigraphic and paleontological methods for determining the age of rocks.

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