

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)

**NEWS OF THE NATIONAL ACADEMY
OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF
GEOLOGY AND TECHNICAL SCIENCES**

№5

2026

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)



N E W S
OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN,
SERIES OF GEOLOGY AND TECHNICAL
SCIENCES

5 (479)

September – Oktober 2026

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, 2026



Scopus®



The scientific journal News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences has been indexed in the international abstract and citation database Scopus since 2016 and demonstrates stable bibliometric performance.

The journal is also included in the Emerging Sources Citation Index (ESCI) of the Web of Science platform (Clarivate Analytics, since 2018).

Indexing in ESCI confirms the journal's compliance with international standards of scientific peer review and editorial ethics and is considered by Clarivate Analytics as part of the evaluation process for potential inclusion in the Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (AHCI).

Indexing in Scopus and Web of Science ensures high international visibility of publications, promotes citation growth, and reflects the editorial board's commitment to publishing relevant, original, and scientifically significant research in the fields of geology and technical sciences.

«Қазақстан Республикасы Ұлттық ғылым академиясының Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналы 2016 жылдан бастап халықаралық реферативтік және ғылымиметриялық Scopus дерекқорында индекстеледі және тұрақты библиометриялық көрсеткіштерді көрсетіп келеді.

Сонымен қатар журнал Web of Science платформасының (Clarivate Analytics, 2018) халықаралық реферативтік және наукометриялық дерекқоры Emerging Sources Citation Index (ESCI) тізіміне енгізілген.

ESCI дерекқорында индекстелуі журналдың халықаралық ғылыми рецензиялау талаптары мен редакциялық этика стандарттарына сәйкестігін растайды, сондай-ақ Clarivate Analytics компаниясы тарапынан басылмды Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) және Arts & Humanities Citation Index (AHCI) дерекқорларына енгізу қарастырылуда.

Scopus және Web of Science дерекқорларында индекстелуі жарияланымдардың халықаралық деңгейде жоғары сұранысқа ие болуын қамтамасыз етеді, олардың дәйексөз алу көрсеткіштерінің артуына ықпал етеді және редакциялық алқаның геология мен техникалық ғылымдар саласындағы өзекті, бірегей және ғылыми тұрғыдан маңызды зерттеулерді жариялауға ұмтылысын айқындайды.

Научный журнал «News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences» с 2016 года индексируется в международной реферативной и наукометрической базе данных Scopus и демонстрирует стабильные библиометрические показатели.

Журнал также включён в международную реферативную и наукометрическую базу данных Emerging Sources Citation Index (ESCI) платформы Web of Science (Clarivate Analytics, 2018).

Индексирование в ESCI подтверждает соответствие журнала международным стандартам научного рецензирования и редакционной этики, а также рассматривается компанией Clarivate Analytics в рамках дальнейшего включения издания в Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) и Arts & Humanities Citation Index (AHCI).

Индексирование в Scopus и Web of Science обеспечивает высокую международную востребованность публикаций, способствует росту цитируемости и подтверждает стремление редакционной коллегии публиковать актуальные, оригинальные и научно значимые исследования в области геологии и технических наук.

EDITOR-IN-CHIEF

ZHURINOV Murat Zhurinovich, Doctor of Chemical Sciences, Professor, Academician of IAAS and NAS RK, General Director of the Research Institute of Petroleum Refining and Petrochemicals (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>; <https://www.webofscience.com/wos/author/record/2017489>

DEPUTY EDITOR-IN-CHIEF

ABSADYKOV Bakhyt Narikbayevich, Doctor of Technical Sciences, Professor, Academician of NAS RK, Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>; <https://www.webofscience.com/wos/author/record/2411827>

EDITORIAL BOARD:

ABSAMETOV Malis Kudysovich, Doctor of Geological and Mineralogical Sciences, Professor, Academician of NAS RK, Director of the U.M. Akhmedsafa Institute of Hydrogeology and Geoecology (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>; <https://www.webofscience.com/wos/author/record/1937883>

ZHOLTAEV Geroy Zholtaevich, Doctor of Geological and Mineralogical Sciences, Professor, Honorary Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>; <https://www.webofscience.com/wos/author/record/1939201>

SNOW Daniel, PhD, Associate Professor, Director, Aquatic Sciences Laboratory, University of Nebraska (Nebraska, USA), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>; <https://www.webofscience.com/wos/author/record/1429613>

SELTMAN Reimar, PhD, Head of Petrology and Mineral Deposits Research in the Earth Sciences Department, Natural History Museum (London, Great Britain), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>; <https://www.webofscience.com/wos/author/record/1048681>

PANFILOV Mikhail Borisovich, Doctor of Technical Sciences, Professor at the University of Nancy (Nancy, France), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>; <https://www.webofscience.com/wos/author/record/1230499>

SHEN Ping, PhD, Deputy Director of the Mining Geology Committee of the Chinese Geological Society, Member of the American Association of Economic Geologists (Beijing, China), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>; <https://www.webofscience.com/wos/author/record/1753209>

FISCHER Axel, PhD, Associate Professor, Technical University of Dresden (Dresden, Germany), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>; <https://www.webofscience.com/wos/author/record/2085986>

AGABEKOV Vladimir Enokovich, Doctor of Chemical Sciences, Academician of NAS of Belarus, Honorary Director of the Institute of Chemistry of New Materials (Minsk, Belarus), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

CATALIN Stefan, PhD, Associate Professor, Technical University of Dresden (Dresden, Germany), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>; <https://www.webofscience.com/wos/author/record/1309251>

JAY Sagin, PhD, Associate Professor, Nazarbayev University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>; <https://www.webofscience.com/wos/author/record/907886>

FRATTINI Paolo, PhD, Associate Professor, University of Milano - Bicocca (Milan, Italy), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

NURPEISOVA Marzhan Baysanovna, Doctor of Technical Sciences, Professor of Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>; <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

RATOV Boranbay Tovbasarovich, Doctor of Technical Sciences, Professor, Head of the Department of Geophysics and Seismology, Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>; <https://www.webofscience.com/wos/author/record/1993614>

RONNY Berndtsson, Professor, Director of the Centre for Advanced Middle Eastern Studies, Lund University (Lund, Sweden), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>; <https://www.webofscience.com/wos/author/record/1324908>

MIRLAS Vladimir, PhD, Professor, Eastern R&D Center, Ariel University (Ariel, Israel), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>; <https://www.webofscience.com/wos/author/record/53680261>

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Owner: «Central Asian Academic Research Center» LLP (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan № KZ50VPY00121155, issued on 05.06.2025
Thematic scope: *geology, hydrogeology, geography, mining and chemical technologies of oil, gas and metals*
Periodicity: 6 times a year.

<http://www.geolog-technical.kz/index.php/en/>

© «Central Asian Academic Research Center» LLP, 2026.

БАС РЕДАКТОР

ЖҰРЫНОВ Мұрат Жұрынулы, химия ғылымдарының докторы, профессор, ХҒАҚ және ҚР ҰҒА академигі, Мұнай өңдеу және мұнай-химиясы ғылыми-зерттеу институтының бас директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>; <https://www.webofscience.com/wos/author/record/2017489>

БАС РЕДАКТОРДЫҢ ОРЫНБАСАРЫ:

АБСАДЫҚОВ Бақыт Нәрікбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>; <https://www.webofscience.com/wos/author/record/2411827>

РЕДАКЦИЯ АЛҚАСЫ:

ӨБСӘМЕТОВ Мәліс Құдысұлы, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, У.М. Ахмедсафин атындағы Гидрогеология және геоэкология институтының директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>; <https://www.webofscience.com/wos/author/record/1937883>

ЖОЛТАЕВ Герой Жолтайұлы, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА құрметті академигі (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>; <https://www.webofscience.com/wos/author/record/1939201>

СНОУ Дэниел, PhD, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры (Небраска, АҚШ), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>; <https://www.webofscience.com/wos/author/record/1429613>

ЗЕЛБТМАНН Раймар, PhD, Жер туралы ғылымдар бөлімінің петрология және пайдалы қазбалар кен орындары саласындағы зерттеулерінің жетекшісі, Табиғи тарих мұражайы (Лондон, Ұлыбритания), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>; <https://www.webofscience.com/wos/author/record/1048681>

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры (Нанси, Франция), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>; <https://www.webofscience.com/wos/author/record/1230499>

ШЕН Пин, PhD, Қытай геологиялық қоғамының Тау-кен геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі (Бейжің, Қытай), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>; <https://www.webofscience.com/wos/author/record/1753209>

ФИШЕР Аксель, PhD, қауымдастырылған профессор, Дрезден техникалық университеті (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>; <https://www.webofscience.com/wos/author/record/2085986>

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

КАТАЛИН Стефан, PhD, қауымдастырылған профессор, Дрезден Техникалық университеті (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>; <https://www.webofscience.com/wos/author/record/1309251>

САҒЫНТАЕВ Жанай, PhD, қауымдастырылған профессор, Назарбаев университеті (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>; <https://www.webofscience.com/wos/author/record/907886>

ФРАТТИНИ Паоло, PhD, қауымдастырылған профессор, Бикокк Милан университеті (Милан, Италия), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

НҮРПЕЙІСОВА Маржан Байсанқызы, техника ғылымдарының докторы, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университетінің профессоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>; <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

РАТОВ Боранбай Товбасарович, техника ғылымдарының докторы, профессор, «Геофизика және сейсмология» кафедрасының меңгерушісі, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>; <https://www.webofscience.com/wos/author/record/1993614>

РОННИ Беридтссон, профессор, Таяу Шығысты заманауи зерттеу орталығының директоры, Лунд университеті (Лунд, Швеция), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>; <https://www.webofscience.com/wos/author/record/1324908>

МИРІАС Владимир, PhD, профессор, Ариэль университетінің Шығыс ғылыми-зерттеу орталығы (Ариэль, Израиль), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>; <https://www.webofscience.com/wos/author/record/53680261>

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Меншіктеуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 05.06.2025 ж. берілген № KZ50VPY00121155 мерзімдік басылым тіркеуіне қойылу туралы куәлік. Тақырыптық бағыты: *геология, гидрогеология, география, тау-кен ісі, мұнай, газ және металдардың химиялық технологиялары*

Мерзімділігі: жылына 6 рет.

<http://www.geolog-technical.kz/index.php/en/>

ГЛАВНЫЙ РЕДАКТОР

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик МАН и НАН РК, Генеральный директор НИИ нефтепереработки и нефтехимии (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>; <https://www.webofscience.com/wos/author/record/2017489>

ЗАМЕСТИТЕЛЬ ГЛАВНОГО РЕДАКТОРА

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, академик НАН РК, Казахский национальный исследовательский технический университет им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>; <https://www.webofscience.com/wos/author/record/2411827>

РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

АБСАМЕТОВ Малис Кудысович, доктор геолого-минералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>; <https://www.webofscience.com/wos/author/record/1937883>

ЖОЛТАЕВ Герой Жолтаевич, доктор геолого-минералогических наук, профессор, почетный академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>; <https://www.webofscience.com/wos/author/record/1939201>

СНОУ Дэниел, PhD, ассоциированный профессор, директор Лаборатории водных наук Университета Небраски (Небраска, США), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>; <https://www.webofscience.com/wos/author/record/1429613>

ЗЕЛЬТМАНН Раймар, PhD, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Великобритания), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>; <https://www.webofscience.com/wos/author/record/1048681>

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>; <https://www.webofscience.com/wos/author/record/1230499>

ШЕН Пин, PhD, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>; <https://www.webofscience.com/wos/author/record/1753209>

ФИШЕР Аксель, PhD, ассоциированный профессор, Технический университет Дрезден (Дрезден, Берлин), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>; <https://www.webofscience.com/wos/author/record/2085986>

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

КАТАЛИН Стефан, PhD, ассоциированный профессор, Технический университет Дрезден (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>; <https://www.webofscience.com/wos/author/record/1309251>

САГИНТАЕВ Жанай, PhD, ассоциированный профессор, Назарбаев университет (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>; <https://www.webofscience.com/wos/author/record/907886>

ФРАТТИНИ Паоло, PhD, ассоциированный профессор, Миланский университет Бикокк (Милан, Италия), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

НУРПЕИСОВА Маржан Байсановна, доктор технических наук, профессор Казахского национального исследовательского технического университета им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>; <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

РАТОВ Боранбай Товбасарович, доктор технических наук, профессор, заведующий кафедрой «Геофизика и сейсмология», Казахский национальный исследовательский технический университет им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>; <https://www.webofscience.com/wos/author/record/1993614>

РОННИ Берндтссон, профессор, Директор Центра современных ближневосточных исследований, Лундский университет (Лунд, Швеция), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>; <https://www.webofscience.com/wos/author/record/1324908>

МИРЛАС Владимир, PhD, профессор, Восточный научно-исследовательский центр, Университет Ариэля (Ариэль, Израиль), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>; <https://www.webofscience.com/wos/author/record/53680261>

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Собственник: ТОО «Центрально-Азиатский академический научный центр» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан № KZ50VPY00121155, выданное 05.06.2025 г.

Тематическая направленность: *геология, гидрогеология, география, горное дело и химические технологии нефти, газа и металлов*

Периодичность: 6 раз в год.

<http://www.geolog-technical.kz/index.php/en/>

© ТОО «Центрально-Азиатский академический научный центр», 2026.

CONTENTS

Akbayeva L.KH., Akhmetova Zh.A., Doskenova B.B., Aktayev M.R., Baubek N.A. Assessment of the Radiocapacity of Atomic Lake at the Semipalatinsk Nuclear Test Site.....	8
Aliyev I.N., Kazimov Sh.P., Mammadova G.G., Manafov R.G., Gurbanov G.A. Measures for Removing Carbonate Scale Deposits Formed in the Wellbore and Downhole Equipment.....	26
Azizov B.M., Mammadov H.N. Some Aspects of Predicting Underground Hydrocarbon Reserves Based on Multispectral Satellite Imagery.....	45
Baibatsha A.B., Duczmal-Czernikiewicz A., Bulegenov K., Muratkhanov D. Geology of the Formation of Mineral Associations in the Arganat'y Ore Occurrence (Eastern Balkhash), Kazakhstan.....	62
Bashirov R., Zakenov S., Rzaev E., Bashirova G., Nurshakhanova L. Scientific Principles for Selecting Powder Materials for Laser Cladding in the Restoration of Components in the Oil and Gas Industry.....	74
Beisseyev S.A., Dossaliyev K.S., Tulekbayeva A.K., Alsheriyeu E.T., Ivakhnyuk G.K. Recommendations for Hazard Identification and Occupational Safety Risk Analysis Considering Geological and Technical Factors.....	89
Dossymbekova Zh.B., Issayeva L.Z., Assubayeva S.K., Zhumabay N.Zh., Baudagulova G.T. Petrophysical Characteristics of Bayan Deposit Rocks and Scheelite Deposition with Rare Earth Impurities.....	109
Galiyev S.Zh., Annakulov T.J., Sabirova L.B., Axanaliyev N.E. Mathematical Modeling of the Dependence of Open-Pit Excavator Productivity on Particle Size Distribution and the Loosening Coefficient of Blasted Rock Mass.....	125
Guvalov A.A., Aghazade M.E., Ibraimbayeva G.B., Stanevich V.T., Vyshar O.V. Study of Ash Obtained from Household Waste Incineration as a Mineral Additive.....	142
Iovbak A.S., Sennikov M.N. Modelling of Hydraulic Flow Redistribution in Parallel Pump Systems.....	160
KosolapYu.G., KropisYu.N., Nikitina V.A., Kononenko R.V., Komar E.V. Prediction of the Thermal Conductivity of Aqueous Electrolyte Solutions for Calculations of Mining and Geological Systems.....	177
Krasikov V.A., Losev A.N., Nikanorov M.S., Kukartseva S.V., Tsyganko E.N. Prediction of Crushing Equipment Productivity at Mining Enterprises Using the Random Forest Algorithm.....	192

Kurashkin S.O., Korableva G.V., Vakhrusheva I.A., Cherniaeva P.D., Lepekina Y.A. Prediction of Energy Consumption of a Mining Enterprise Crushing and Screening Complex Using Machine Learning Methods.....	208
Kurmanbayev O., Baidautetova G., Jangulova G., Sarsembekova Z., Bayanbek R. Concept of Processing Static GNSS Measurements in Geodynamic Monitoring of Almaty.....	224
Makhmarejabov D., Kuttybayev A., Umirzokov A., Daminov T., Sharopov Kh. Evaluation of the Compositional Differences of Fuel Types Obtained from the Angren Coal Mine.....	243
Mukaliyev Zh.K., Zhumatayeva Zh.M., Turganaliyev S.R. GIS-Based Geomorphometric Assessment of Topographic Erosion Potential at the Semipalatinsk Test Site.....	256
Mukhambetov B., Nasiyev B., Kanat T., Zhumin B. Geocological Assessment and Phytomeliorative Restoration of Degraded Arid Lands in the Atyrau Region of Western Kazakhstan.....	273
Murtazin Ye.Zh., Toktar A.T., Rakhimova V.S., Sapargaliyev D.S. Assessment of Groundwater Recharge and Resources in Mangystau Sand Massifs, Western Kazakhstan.....	290
Oralbekova L.M., Baibotayeva A.D., Kenzhalieva G.D., Naukenova A.S., Kocherov E.N. Intelligent Digital Platform for Solid Waste Management: Shymkent Smart Waste.....	309
Oralova A.T., Tshshkovskaya Ye.A., Tsoy N.K., Matonin V.V., Timoshenko P.S. Research on the Fractional Composition of Oil by Spectroscopic Methods.....	325
Panfilov I.A., Gorbachev S.I., Puchkova O.S., Oleynikova O.O., Modina M.A. Prediction of the Technical Condition of Bearing Units of Mining Equipment Using Vibration Parameters and Machine Learning.....	340
Ratov B.T., Khomenko V.L., Kuttybayev A.E., Kamyshatskyi O.F., Zhailiyev A.O. Hydraulic Characteristics of an Improved System for Real-Time Drilling Fluid Density Measurement.....	356
Ryszhana A., Amangossova A.G., Kadasheva Zh.K., Yessenamanova Zh.S., Abdinov R.Sh. Geocological-Chemical Assessment of Technogenic Contamination of the “Tukhlaya Balka” Filtration Fields Area.....	376
Shutkina E.V., Babkina A.V., Zhuravlev M.V., Kleshko I.I., Kozenkova G.L. Automatic Assessment of Crushed Rock Particle Size Distribution Based on Computer Vision Methods.....	398
Zholtayev G.Zh., Umarbekova Z.T., Mashrapova M.A., Amanbaev R.A., Karatayeva G.M. Model of Gold Mineralization Formation at the Bestobe Deposit (Northern Kazakhstan).....	414

NEWS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF GEOLOGY AND TECHNICAL SCIENCES

ISSN 2224-5278

Volume 5.

Number 479 (2026), 109–124

<https://doi.org/10.32014/2026.2518-170X.693>

UDC: 691.34

IRSTI: 67.09.55

©Dossymbekova Zh.B., Issayeva L.Z., Assubayeva S.K.*, Zhumabay N.Zh.,
Baudagulova G.T., 2026.

Satbayev University, Almaty, Kazakhstan.

*E-mail: s.assubayeva@satbayev.university

PETROPHYSICAL CHARACTERISTICS OF BAYAN DEPOSIT ROCKS AND SCHEELITE DEPOSITION WITH RARE EARTH IMPURITIES

Dossymbekova Zhansaya — PhD student, Satbayev University, Almaty, Kazakhstan,

E-mail: z.dossymbekova@satbayev.university, <https://orcid.org/0009-0000-6683-4604>;

Issayeva Lyudmila — Doctor of Geological and Mineralogical Sciences, Professor, Satbayev
University, Almaty, Kazakhstan,

E-mail: l.issayeva@satbayev.university, <https://orcid.org/0000-0001-7184-6351>;

Assubayeva Saltanat — Candidate of Geological and Mineralogical Sciences, Associate Professor,
Satbayev University, Almaty, Kazakhstan,

E-mail: s.assubayeva@satbayev.university, <https://orcid.org/0000-0003-3658-715X>;

Zhumabay Nurbakyt — PhD student, Satbayev University, Almaty, Kazakhstan,

E-mail: zhumabaynurbakhyt@gmail.com, <https://orcid.org/0000-0002-0409-4695>;

Baudagulova Gulfairus — Master of Technical Sciences, Satbayev University, Almaty, Kazakhstan,

E-mail: g.t.baudagulova@satbayev.university, <https://orcid.org/0000-0001-8385-085X>.

Abstract. Relevance. The growing demand for rare and rare-earth metals requires improved exploration criteria for deposits in which rare-earth elements occur not only as independent minerals but also as impurities in ore minerals. At the Bayan tungsten deposit, scheelite is the principal ore mineral and contains rare-earth elements. However, the physical properties of the host rocks and ore-localizing environments controlling scheelite deposition have not been sufficiently systematized. **Objective.** To develop a petrophysical model of the unaltered and altered rocks of the Bayan deposit and identify the petrophysical factors associated with scheelite deposition and the incorporation of rare-earth elements into its crystal structure. **Methods.** Published geological descriptions, reference petrophysical data, borehole gamma-logging results, and information on the mineral composition of rocks and ores were analyzed and synthesized. Density, magnetic susceptibility, apparent electrical resistivity, radioactivity, and induced polarization were compared for metamorphic, intrusive, sedimentary,

hydrothermally altered, and metasomatic rocks. *Results and Conclusions.* Unaltered amphibole- and biotite-bearing schists, amphibolites, and gneisses have the highest densities of 2.81–3.08 g/cm³, whereas granite-gneisses and leucocratic granites have densities of approximately 2.65 and 2.54 g/cm³, respectively. The rocks are generally weakly magnetic, with the magnetic susceptibility of the Zerenda Series ranging from 8 to 75×10^{-6} CGS. Altered sulfide-bearing rocks show elevated induced polarization values of up to 15–20%. Skarnoids hosting skarnoid ores have a density of 2.96 g/cm³, while hydrothermally altered ore-localizing rocks reach 3.01 g/cm³. Quartz-feldspar stockworks have a density of 2.72 g/cm³ compared with 2.65 g/cm³ for the enclosing granite-gneisses. Thus, the density contrast between the ore-bearing rocks and ore-localizing environments is only 0.05–0.07 g/cm³, reflecting their similar mineral composition. This weak density differentiation is identified as a petrophysical factor favoring scheelite deposition and the incorporation of rare-earth elements. The developed model provides a basis for the integrated interpretation of gravity, magnetic, electrical, induced-polarization, and radiometric data during further exploration of the Bayan deposit.

Key words: rare-earth elements, scheelite, Bayan deposit, petrophysical characteristics, petrophysical model

Funding: *This research is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. BR27199165—Scientific substantiation of the expansion and replenishment of mineral resources of priority and critical minerals as the basis for the innovative development of Kazakhstan).*

For citations: Dossymbekova Zh.B., Issayeva L.Z., Assubayeva S.K., Zhumabay N.Zh., Baudagulova G.T. *Petrophysical Characteristics of Bayan Deposit Rocks and Scheelite Deposition with Rare Earth Impurities. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences.* 2026. No.5. Pp. 109–124. DOI: <https://doi.org/10.32014/2026.2518-170X.693>

©Досымбекова Ж.Б., Исаева Л.Д., Асубаева С.К.*, Жұмабай Н.Ж.,
Баудагулова Г.Т., 2026.

Сәтбаев университеті, Алматы, Қазақстан.

*E-mail: s.assubayeva@satbayev.university

БАЯН КЕН ОРНЫ ТАУ ЖЫНЫСТАРЫНЫҢ ПЕТРОФИЗИКАЛЫҚ ҚАСИЕТТЕРІ ЖӘНЕ СІРЕК ЖЕР ЭЛЕМЕНТТЕРІМЕН ҚОСПАЛАНҒАН ШЕЕЛИТТІҢ ТҮЗІЛУІ

Досымбекова Жансая — PhD докторант, Сәтбаев университеті, Алматы, Қазақстан,
E-mail: z.dossymbekova@satbayev.university, <https://orcid.org/0009-0000-6683-4604>;

Исаева Людмила — геология және минералогия ғылымдарының докторы, профессор, Сәтбаев университеті, Алматы, Қазақстан,

E-mail: l.issayeva@satbayev.university, <https://orcid.org/0000-0001-7184-6351>;

Асубаева Салтанат — геология және минералогия ғылымдарының кандидаты, қауымдастырылған профессор, Сәтбаев университеті, Алматы, Қазақстан,

E-mail: s.assubayeva@satbayev.university, <https://orcid.org/0000-0003-3658-715X>;

Жұмабай Нұрбақыт — PhD докторант, Сәтбаев университеті, Алматы, Қазақстан,

E-mail: zhumabaynurbakhyt@gmail.com, <https://orcid.org/0000-0002-0409-4695>;

Баудагулова Гулфайрус — техника ғылымдарының магистрі, Сәтбаев университеті, Алматы, Қазақстан,

E-mail: g.t.baudagulova@satbayev.university, <https://orcid.org/0000-0001-8385-085X>.

Аннотация. *Өзектілігі.* Сирек және сирек жер металдарына сұраныстың артуы сирек жер элементтері жеке минералдар түрінде ғана емес, кен минералдарының құрамындағы қоспалар ретінде де кездесетін кен орындарын іздеу критерийлерін жетілдіруді талап етеді. Баян вольфрам кен орнында шеелит негізгі кен минералы болып табылады және оның құрамында сирек жер элементтері кездеседі. Алайда шеелиттің түзілуін бақылайтын кен сыйыстырушы жыныстар мен кен шоғырланатын орталардың физикалық қасиеттері жеткілікті дәрежеде жүйеленбеген. *Зерттеудің мақсаты.* Баян кен орнының өзгермеген және өзгерген тау жыныстарының петрофизикалық моделін әзірлеу, сондай-ақ шеелиттің түзілуі мен сирек жер элементтерінің оның кристалдық құрылымына енуіне байланысты петрофизикалық факторларды анықтау. *Әдістері.* Жарияланған геологиялық материалдар, анықтамалық петрофизикалық деректер, ұңғымалардағы гамма-каротаж нәтижелері және тау жыныстары мен кендердің минералдық құрамы туралы мәліметтер талданып, қорытындыланды. Метаморфтық, интрузиялық, шөгінді, гидротермалдық өзгерген және метасоматиттік жыныстардың тығыздығы, магниттік қабылдағыштығы, көрінерлік электрлік кедергісі, радиоактивтілігі мен поляризацияланғыштығы салыстырылды. *Нәтижелері мен қорытындылары.* Өзгермеген амфиболды және биотитті тақтатастар, амфиболиттер мен гнейстер ең жоғары тығыздықпен — 2,81–3,08 г/см³ сипатталады, ал гранит-гнейстер мен лейкократты граниттердің тығыздығы тиісінше шамамен 2,65 және 2,54 г/см³ құрайды. Жыныстар негізінен әлсіз магнитті; Зеренді сериясы жыныстарының магниттік қабылдағыштығы $8\text{--}75 \times 10^{-6}$ CGS аралығында өзгереді. Сульфидтермен байытылған өзгерген жыныстардың поляризацияланғыштығы 15–20%-ға дейін жоғарылайды. Скарноидты кендерді сыйыстырушы скарноидтардың тығыздығы 2,96 г/см³, ал гидротермалдық өзгерген кен шоғырландырушы жыныстардың тығыздығы 3,01 г/см³ құрайды. Кварц-дала шпатты штокверктердің тығыздығы 2,72 г/см³ болса, оларды сыйыстырушы гранит-гнейстердің тығыздығы 2,65 г/см³. Демек, кен сыйыстырушы жыныстар мен кен шоғырланатын орталар арасындағы тығыздық айырмасы небәрі 0,05–0,07 г/см³ құрайды, бұл олардың минералдық құрамының ұқсастығымен түсіндіріледі. Тығыздықтың осындай әлсіз дифференциациясы шеелиттің түзілуіне және сирек жер элементтерінің

оның құрамына енуіне қолайлы петрофизикалық фактор ретінде анықталды. Өзірленген модель Баян кен орнын одан әрі зерттеу кезінде гравиметриялық, магниттік, электрлік, поляризациялық және радиометриялық деректерді кешенді интерпретациялауға негіз болады.

Түйін сөздер: сирек жер элементтері, шеелит, Баян кен орны, петрофизикалық сипаттамалар, петрофизикалық модель

©Досымбекова Ж.Б., Исаева Л.Д., Асубаева С.К.*, Жумабай Н.Ж.,
Баудагулова Г.Т., 2026.

Satbayev University, Алматы, Казахстан.

*E-mail: s.assubayeva@satbayev.university

ПЕТРОФИЗИЧЕСКИЕ ХАРАКТЕРИСТИКИ ПОРОД МЕСТОРОЖДЕНИЯ БАЯН И ОТЛОЖЕНИЕ ШЕЕЛИТА С ПРИМЕСЯМИ РЕДКИХ ЗЕМЕЛЬ

Досымбекова Жансая — докторант PhD, Satbayev University, Алматы, Казахстан,

E-mail: z.dossymbekova@satbayev.university, <https://orcid.org/0009-0000-6683-4604>;

Исаева Людмила — доктор геолого-минералогических наук, профессор, Satbayev University, Алматы, Казахстан,

E-mail: l.issayeva@satbayev.university, <https://orcid.org/0000-0001-7184-6351>;

Асубаева Салтанат — кандидат геолого-минералогических наук, ассоциированный профессор, Satbayev University, Алматы, Казахстан,

E-mail: s.assubayeva@satbayev.university, <https://orcid.org/0000-0003-3658-715X>;

Жумабай Нурбакыт — докторант PhD, Satbayev University, Алматы, Казахстан,

E-mail: zhumabaynurbakhyt@gmail.com, <https://orcid.org/0000-0002-0409-4695>;

Баудагулова Гулфайрус — магистр технических наук, Satbayev University, Алматы, Казахстан,

E-mail: g.t.baudagulova@satbayev.university, <https://orcid.org/0000-0001-8385-085X>.

Аннотация. *Актуальность.* Рост спроса на редкие и редкоземельные металлы обуславливает необходимость совершенствования поисковых критериев для выявления месторождений, в которых редкоземельные элементы присутствуют не только в составе самостоятельных минералов, но и в качестве примесей в рудных минералах. На вольфрамовом месторождении Баян основным рудным минералом является шеелит, содержащий редкоземельные элементы. Вместе с тем петрофизические характеристики вмещающих пород и рудолокализирующих геологических сред, определяющих условия отложения шеелита, остаются недостаточно систематизированными. *Цель.* Разработать петрофизическую модель неизменных и гидротермально измененных пород месторождения Баян, а также выявить петрофизические факторы, связанные с отложением шеелита и включением редкоземельных элементов в его кристаллическую структуру. *Методы.* Проведены анализ и обобщение опубликованных геологических материалов, справочных петрофизических данных, результатов гамма-каротажа скважин и сведений о минеральном

составе горных пород и руд. Выполнен сравнительный анализ плотности, магнитной восприимчивости, кажущегося электрического сопротивления, радиоактивности и поляризуемости метаморфических, интрузивных, осадочных, гидротермально измененных и метасоматических пород. На основе сопоставления полученных характеристик определены петрофизические различия между вмещающими породами и рудолокализирующими геологическими средами. *Результаты и выводы.* Установлено, что неизменные амфибол- и биотитсодержащие сланцы, амфиболиты и гнейсы характеризуются наиболее высокими значениями плотности - 2,81–3,08 г/см³. При этом плотность гранит-гнейсов и лейкократовых гранитов составляет приблизительно 2,65 и 2,54 г/см³ соответственно. Исследуемые породы в целом характеризуются слабой магнитной восприимчивостью, значения которой для пород зерендинской серии варьируются от 8×10^{-6} до 75×10^{-6} ед. СГС. Поляризуемость гидротермально измененных сульфидсодержащих пород достигает 15–20 %. Плотность скарноидов, вмещающих скарноидные руды, составляет 2,96 г/см³, тогда как плотность гидротермально измененных рудолокализирующих пород достигает 3,01 г/см³. Для кварц-полевошпатовых штокверков установлена плотность 2,72 г/см³, что несколько превышает соответствующий показатель вмещающих гранит-гнейсов (2,65 г/см³). Таким образом, плотностной контраст между отдельными типами рудовмещающих пород и рудолокализирующих геологических сред составляет 0,05–0,07 г/см³, что связано с близостью их минерального состава. Выявленная слабая плотностная дифференциация рассматривается как один из петрофизических признаков, характеризующих условия локализации шеелитового оруденения. Разработанная петрофизическая модель может служить основой для комплексной интерпретации гравиметрических, магнитных, электрических, поляризационных и радиометрических данных при дальнейшем геологическом изучении месторождения Баян.

Ключевые слова: редкоземельные элементы, шеелит, месторождение Баян, петрофизические характеристики, петрофизическая модель

Introduction. The Bayan deposit has a complex and multi-stage geological history, forming within the Precambrian metamorphic formations. Metamorphic rocks form the basis of the deposit, but there are also areas of sedimentary formations (clays and loams) and zones of weathered rocks.

The Bayan ore field is subdivided into several prospective zones, within which ore bodies are developed. Main zones: *Northern zone*: ore bodies vary in thickness from 2 to 98 meters and in length from 50 to 1500 meters. These bodies are composed of actinolite-epidote-scheelite metasomatites in skarns and stockwork zones of quartz-feldspar-scheelite formations. *Intermediate zone*: thickness of ore bodies - from 1 to 35 meters, length - from 50 to 1500 meters. Ore bodies are represented by scheelite-silicate metasomatites. *Central zone*: thickness of ore bodies - from 1 to 50 meters, length - from 50 to 1500 meters. The bodies consist

of amphibole-shelitic metasomatites and stockwork quartz zones. *Western zone*: thickness of ore bodies - from 1.5 to 25 meters, length - from 50 to 1500 meters. (Fig.1,2) (Shcherba et al., 1988; Bespaev and Miroshnichenko, 2004).

There are two natural types of ores at the deposit depending on the petrographic composition of the source rocks: skarnoid and quartz-feldspar. The first type includes ores found in skarnoids, amphibolites, amphibole schists and gneisses, while the second type is associated with ores found in granodiorite-gneisses, granite-gneisses, granites and other quartz-feldspar rocks of the gneiss-shale complex.

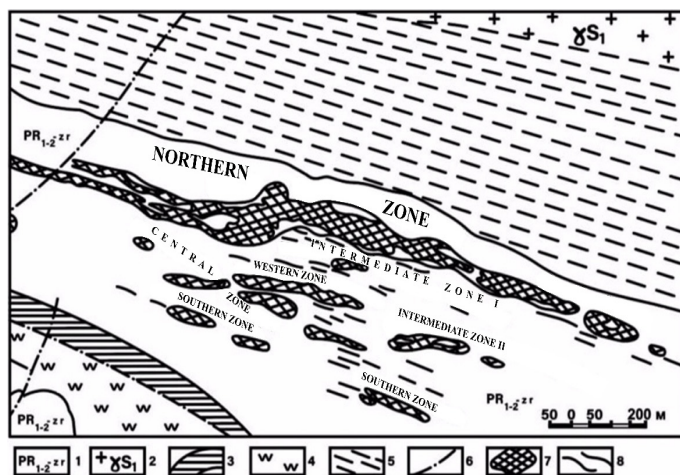


Figure 1. Bayan deposit according to H. Adamyan.

- 1 - Zerenda Series: gneisses, granite-gneisses, amphibolites; 2 - Granites of the Zerenda Complex;
 3 - Garnet and pyroxene skarns; 4 - Quartzites; 5 - Zones of intense fracturing, brecciation, and mylonitization of rocks; 6 - Tectonic disturbances; 7 - Ore-bearing zones; 8 - Ore bodies.

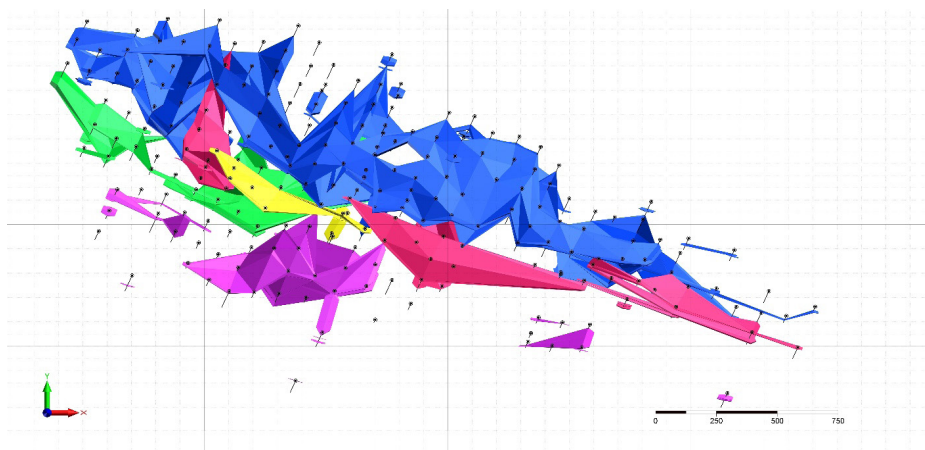


Figure 2. Frame model of ore-bearing zone of Bayan deposit in plan (Dossymbekova et al., 2024).

The main ore mineral is scheelite (CaWO_4), and it is noted in four generations, the main ones are - I, II, the first is common in actinolite-epidote ores, contains up to 23g/t rare earths, the second is noted in ore veins and quartz-epidote-phlogopite metasomatites, where the content of rare earths reaches up to 600g/t. (Shcherba et al., 1988).

Earlier we considered geological factors of rare earths inclusion in scheelite composition at Bayan deposit. We noted the following factors: 1) geochemical conditions under which scheelites are formed; 2) crystallochemical conditions where it is energetically advantageous for the scheelite crystal lattice to get a trivalent REE ion (TR^{3+}) with high energy coefficient instead of divalent calcium cation (Ca^{2+}); 3) thermodynamic conditions under which ore minerals, including scheelite, crystallized, where the remoteness of ore-localizing structures from the source of thermal energy (granite intrusion) is the main factor in the manifestation of thermodynamic disequilibrium during their crystallization, leading to isomorphic entry of other ions into the crystal lattices of scheelite. (Dossymbekova et al., 2024).

At this stage the actual task is petrophysical peculiarities of medium of scheelite deposit with content of rare earths (mainly yttrium, cerium, gadolinium).

Materials and Methods. Information on physical characteristics of rocks and ores of Bayan deposit are presented in detail in the works of Sheyanov A.K. and etc. (1982). Besides there is a reference book of physical properties of rocks of Kazakhstan (Kurskeev, 1983). Therefore, we will use literature and reference data on petrophysical properties of rocks developed in the area of this deposit. The main method of research is scientific analysis and synthesis of materials on petrophysical characteristics of rocks of the ore district. On the basis of this scientific method, we will try to solve the main task of the study, dividing it into two parts: 1) construction of petrophysical model of unaltered rocks of the ore district; 2) systematization of petrophysical characteristics of altered rocks in the area of this deposit. As a result, we evaluate the petrophysical characteristic of the environment of scheelite deposition as the main concentrator of rare earth elements. (Issayeva et al., 2019; Issayeva et al., 2025)

Results. The petrophysical model of the Bayan deposit area was developed using data from previous studies of the petrophysical characteristics of rocks and reference data on the physical properties of rocks in Kazakhstan. These materials were processed using scientific analysis and data synthesis methods. It should also be noted that the electrical properties of the rocks in the model are represented by their chargeability. The geophysical data were subsequently integrated with geological information, including the stratigraphic column, which reflects the geological evolution of the area.

A petrophysical model of unaltered rocks of the Bayan deposit area was constructed on the basis of the stratigraphic column. As it is known, zerendin series of metamorphites ($\text{PR}_{\text{I,Zr}}$), where this deposit is localized, is composed of a number of crystalline schists, amphibolites, gneisses and granite-gneisses (Table 1).

This petrophysical model reflects such petrophysical characteristics as *density, magnetic susceptibility, and radioactivity* of unaltered rocks of this ore district.

1) *Density of metamorphic rocks.* This petrophysical model shows that such metamorphic rocks in the section of the Zerendin series (PR₁₋₂Zr) as *amphibole and biotite schists, amphibolites* have densities ranging from 2.81 to 3.08 g/cm³. They are the highest density within the deposit area and are composed with rock-forming minerals such as biotite, amphibole, microcline, and plagioclase. These metamorphic rocks are widespread within the deposit and play an important role in the development of the ore process as ore-bearing medium, which is controlled by mineralization (skarnoids). Among them amphibolites are the least widespread within the deposit. (Istekova, 2024)

Among metamorphic rocks, *gneisses* are the second most abundant in the section of the Zerendinsky series; they were formed at the early stage of granitization on mica and amphibole schists. The mineral composition of amphibole gneisses contains plagioclase and ferruginous hornblende, totaling from 60 to 90%. (Adamyan, 1989). Therefore, amphibole gneisses are dense rocks and their density is determined within 2.87 g/cm³.

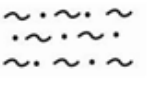
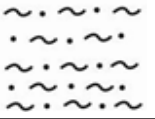
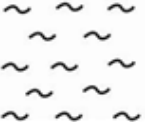
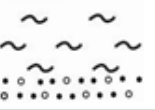
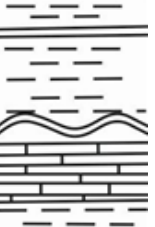
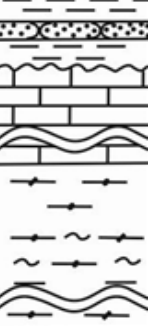
Biotite gneisses, formed on mica schists, differs from amphibole gneisses in petrodensity characteristics, where their density according to reference data is noted within 2.65 g/cm³. (Kurskeev, 1983). Gneisses also play a role in the ore process as ore-bearing medium for ore stockworks. (Omirserikov et al., 2017; Kurmangazhina et al., 2026)

Quartzites have a limited distribution at the deposit. In the southern part of the ore field, a quartzite interlayer was mapped. The density of quartzites according to reference data is indicated within 2.68 g/cm³. (Kurskeev, 1983).

2) *Density of intrusive formations.* The intrusive formations include leucogranites, injected-metasomatic granite-gneisses, pegmatoidal quartz-feldspar rocks and gneissogranodiorites. *Granite-gneisses* are the most widespread among these rocks. Granite-gneisses are small, elongated bodies with thickness from fractions to tens of meters. In the composition of the rocks are large separations of sericitized oligoclase, microcline and quartz. The total amount of them in the rock reaches up to 92-96%, the share of other minerals - biotite, epidote, chlorite, apatite calcite and sphene is less than 4-8%. The density of such rocks in the area of Bayanskoye deposit is determined within 2.65 g/cm³.

The late *leucocratic granites* are associated with the formation of ore stockworks (Shcherba et al., 1988). The density of leucocratic granites is determined within 2.54 g/cm³. (Oitseva et al., 2023).

Table 1. Petrophysical model of the Bayan deposit area.

Group	System	Series	Index		Capacity, m	Chara- cter- ization of rocks	Den- sity, g/cm³	Magnetic suscep- tibility, 10 ⁻⁶ CGS	Pola- riza- tion, %	Radio- activity micro R/h
	NEOGENE QUATER- NARY		O _{III}		3-15	loams clays	2.53	5		12
CAINOZOIC		MIOCENE – PLIOCENE	N ₂ ³ -Q _{II}		63	clays				
			N ₁₋₂ pv		25	clays				
			N _I trm		28	clays				
			N _I trs		20	clays sands				
PROTEROZOIC			PR ₃ ³ sh		1300	various schists marb- leized limestone	2.47- 2.65 2.68	6-31 3		
			PR ₁₋₂ zr		1500	schists: amphibole biotite amphi- bolites gneisses: amphibole biotite quartzites granitic gneiss granites leucocr.	3.08 2.81 3.02 2.87 2.65 2.68 2.57 2.54	19 27 41 29 58 10 82 40	0.77 0.36 1.01 3.06 0.47	18-34 10-30 16-22

Thus, the unaltered rocks in this ore field are subdivided into three groups by density:

1- group - rocks with relatively high density ($2.81 - 3.08 \text{ g/cm}^3$), these are metamorphic amphibole-bearing and biotite-bearing schists and gneisses;

2- group of rocks with average density ($2.68 - 2.65 \text{ g/cm}^3$), these are metamorphic rocks: quartzites, intrusive formations: granite-gneisses;

3- group - rocks with low density within 2.54 g/cm^3), these are leucocratic granites.

In addition, rocks of the *Sharyk Formation* (PR_3^{sh}) are found in the area of the Bayan field, among which the following predominate: shales of phyllite-like structure, microshales of different composition, metamorphosed siltstones, marbleized limestones, and their density according to reference data varies within 2.47 to 2.65 g/cm^3 depending on the mineralogical composition of shales. The densest rocks of the Sharyk Formation are marbleized limestones with density of 2.68 g/cm^3 . (Kurskeev, 1983).

As it was noted, the Bayan deposit is concentrated in the section of metamorphic strata, and only *clays and loams* are established from sedimentary formations in the deposit area. (Table 1). (Adamyan, 1989).

Magnetic susceptibility of unaltered rocks. As noted by researchers, the Zerendin series is composed of very weakly magnetic schists, amphibolites, and gneisses. (Kurskeev, 1983). The analysis of actual materials of amphibolite facies metamorphism shows that these rocks are devoid of ferromagnetic minerals, so they belong to very weakly magnetic formations. In the area of Bayan deposit magnetic susceptibility of rocks of this series, according to reference data varies from 8 to $75 \cdot 10^{-6} \text{ CGS}$.

The rocks of the Sharyk Formation are also weakly magmatic, with magnetic susceptibility varying from $3-31 \cdot 10^{-6} \text{ CGS}$

Apparent resistivity of unaltered rocks. Low electrical resistivity ($5-10 \text{ Ohm}$) is characteristic of Quaternary sandy-clayey rocks, while weathering crusts have resistivities on the order of $20-40 \text{ Ohm}$. Fractured granites, granodiorites and granitogneisses typically have resistivities of 1000 to 5000 Ohm . Fracture zones, often coinciding with ore intervals, are characterized by reduced electrical resistivity of up to several hundred Ohm .

Radioactivity of unaltered and hydrothermally altered rocks of the deposit (Tables 1,2). Radiometric observations in boreholes and mine workings were carried out at the Bayan deposit (Adamyan, 1989). In 1976–1982 during detailed prospecting works for tungsten in the area of Bayan deposit by Ruzayevskaya FST CKSGGE was revealed 15 radioactive anomalies with intensity $100-230 \text{ microR/h}$, confined to gneisses and biotite-amphibole schists. The anomalies are preferably associated with redistribution and small uranium supply during calichepatization of rocks. (D'yachkov et al., 2021)

The nature of the anomalies is uranium, thorium and potassium-uranium. The main method of mass prospecting was gamma logging of boreholes. As a result of

gamma logging in the exploration contour of Bayan deposit about 150 anomalous intervals with maximum intensity from 100 to 297 microR/h against the background of 15–35 microR/h in gneisses, granite-gneisses, skarnoids, migmatites and other rocks were revealed. Moreover, they are observed extremely rarely in the upper part of the section. This, apparently, can explain the fact no radioactive anomalies were detected in trenches and near-surface underground mine workings. The thickness of ore intervals is from the first tens of centimeters to 1.5-20m and rarely 5-10 meters. (Dyachkov et al., 2020; Kenzhetaev et al., 2026)

Characteristically, the thickest intervals with high activity are found at depths of 390-528 m (wells 17, 49, 65).

Generalization of radiometric data obtained at the deposit during its preliminary exploration allowed to localize a number of areas of increased contamination of rocks with uranium-thorium mineralization within the northern extremities of lines 0-III, IX-XII, XIX-XXI, XXIU.

According to the results of separate radiometric analysis of samples taken from anomalous intervals, it was found that all tested anomalies of mixed nature with thorium predominating over uranium by 2-5 and more times. The intervening rocks are characterized by low values of uranium $10^{-4}\%$, thorium $10^{-4}\%$. This is significantly below the regional geochemical zone.

The equilibrium between uranium and radium is significantly shifted towards radium. Uranium companion elements are noted only in single anomalies and are represented by Rv, Mo, P, Ag, Si, Zn, W, Sn, Cr. Despite the dense network of drilling and mine workings, the anomalous intervals are not linked and have insignificant (first tens of meters) dimensions along the strike.

Based on all of the above, they concluded that the radiometrically surveyed area within the Bayanskoye deposit is unpromising for the discovery of commercial uranium deposits. When developing the deposit, one should only take into account the presence of some areas with increased contamination by uranium-thorium mineralization.

But as a result of *gamma logging* data processing, information on radioactivity of rocks and ores of the deposit was obtained.

Its values for *gneisses*, *granite-gneisses*, and shales vary from 10 to 30 microR/h. Low values (8–14 microR/h) are characteristic of unaltered or quartzed, migmatized and dissimilarities, as well as strongly quartzed migmatized shales and gneisses. Values of 18–24 microR/h are characteristic of rocks affected by calichepatization, metasomatically altered.

Amphibole schists, *skarnoids* have higher values of radioactivity (from 18 to 34 microR/h). The lowest values have clays of Neogene age (12 microR/h). *Granites* and *granodiorites* of the Bayan massif are characterized by moderate radioactivity in the range from 16 to 22 microR/h. Granite dikes in the gneiss-shale formation have a wide range of radioactivity values from 16 to 32 microR/h.

The ores of Bayan deposit are practically not radioactive, their radioactivity is commensurate with the background values of radioactivity of rocks in the area

Analysis of petrophysical characteristics of altered rocks in the area of Bayan deposit. Hydrothermally and metasomatically altered rocks are usually enriched with sulfides such as pyrite, pyrrhotite, chalcopyrite, magnetite and other minerals, and are characterized by increased density, polarizability and magnetic susceptibility (Table 2). (Issayeva et al., 2025; Sirazhev et al., 2025; Togizov et al., 2026)

Polarizability of altered rocks. Ore zones formed by vein and disseminated sulfidization of rocks usually have elevated (up to 15–20%) polarizability values as measured by IP logs. Also, high polarizability is characteristic of some ancient metamorphic rocks, such as gneisses and schists, which often contain pyrite.

Density of altered rocks. Altered rocks in the area of Bayan deposit were formed at the final stages of granitization and ore deposition.

Among metamorphic rocks, hydrothermally altered gneisses have densities in the range of 3.01 g/cm³.

Hydrothermally altered become low-density rocks, and depending on the mineral composition their density varies from 2.48 to 2.59 g/cm³.

Skarnoids cover a complex of metasomatically transformed rocks of epidote-pyroxene, pyroxene-granate-epidote composition, including aposcarnet metasomatites. They are not only the main ore-controlling factor, but also ore-bearing medium, as richer tungsten ores are more often concentrated in skarnoids, which were formed at the expense of amphibole-bearing rocks (amphibole schists and gneisses, amphibolites) at the testamentary stage of granitization. The density of skarnoids at this deposit was determined within the limits of 2.96 g/cm³. As can be seen, the main ore-bearing medium is also high-density. (Amralinova et al., 2023; Togizov et al., 2019)

Greisen is accompanied by leucogranites. Intrusive leucogranites and quartz-feldspar rocks show quartz-muscovite greisen mineralization in the form of small and rare veins, and the density of greisen is determined within 2.78 g/cm³. (Gulyaev, 1980; Shcherba and Gubaidullin, 1984; Kuzmina et al., 2025).

Stockworks. The vein mineralization in stockworks is represented by various types of veins, such as scheelite-pyrite-quartz, scheelite-epidote-phlogopitquartz and scheelite-quartz, which are usually of small thickness. They intersect various strata of metamorphic rocks of this deposit. According to researchers, the density of stockwork zones is determined within 2.72 g/cm³. (Gulyaev, 1980; Shcherba and Gubaidullin, 1984; Kurmangazhina et al., 2026).

Table 2. Petrophysical characteristics of altered rocks at Bayan field.

Name of altered rocks	Density, g/cm ³	Magnetic susceptibility, 10 ⁻⁶ CGS	Polarization, %	Radioactivity microR/h
Hydrothermally altered gneisses	3.01	672	5.88	18 to 24
Granite-gneisses of chloritic and mucovitosir.	2.59	60		18 to 24
Granite-gneisses zeolitize.	2.48	30		18-24

Cataclasites	2.45	5		
Skarnoids	2.96	21-1700	0.80	16-34
Graysens	2.78	13	2.48	
Stockworks	2.72			

Discussion. As a result of the analysis of petrophysical characteristics of altered and unaltered rocks of the Bayan deposit area, some of its petrophysical features should be noted:

1) the deposit is localized in a metamorphic medium with high petrodensity characteristics with density up to 3.08 g/cm³;

2) The ore-bearing medium for skarnoid ores is metasomatites in skarnoids, where their petrodensity characteristic is determined within 2.96 g/cm³.

3) The ore-bearing medium for quartz-feldspar ores is granite-gneiss and gneiss with petro-density characteristic of 2.65g/cm³;

4) the main sources of tungsten are the host medium with high petrodensity characteristics within the range of 2.81-3.08g/cm³ and intrusive formations with lower petrodensity characteristics within the range of 2.54g/cm³;

5) amphibole schists and skarnoids, i.e. denser metamorphic rocks and their altered varieties, are characterized by relatively elevated values of radioactivity from 18 to 34 microR/h;

6) granites are characterized by moderate radioactivity in the range from 16 to 22 microR/h.

7) rocks within the deposit are weakly magnetic but highly resistive.

Conclusion. In our previous study, we examined the geological factors controlling the incorporation of rare-earth elements (REEs) into scheelite and identified the following principal factors (Dossymbekova et al., 2024):

1. Geochemical conditions of tungsten mineral formation, under which scheelite crystallizes in near-neutral to weakly alkaline environments;

2. Crystal-chemical conditions under which the heterovalent substitution of divalent calcium (Ca²⁺) by trivalent rare-earth ions (REE³⁺) in the scheelite crystal lattice may be energetically favorable, provided that appropriate charge compensation occurs;

3. Thermodynamic conditions governing the crystallization of ore minerals, including scheelite. The distance between ore-localizing structures and the source of thermal energy was considered one of the factors contributing to thermodynamic disequilibrium during crystallization. Such conditions may promote higher crystal-growth rates and the incorporation of trace ions into mineral crystal lattices.

The present study focuses on the petrophysical characteristics of the environment in which scheelite mineralization was formed.

These features allowed us to draw conclusions about the petrophysical peculiarity of the environment of scheelite deposition as a concentrator of rare earths in this deposit:

1) *in skarnoids.* As is known, the deposit distinguishes two main differences

of metasomatic rocks formed by skarnoids: quartz-epidote-actinolite and quartz-epidote-phlogopite metasomatites, on which there were re-deposits of tungsten ore (scheelite) from the host medium. Consequently, the ore-bearing rock is skarnoids with a density of 2.96 g/cm³, and aposcarn metasomatites, i.e. hydrothermally altered rocks are ore-localizing medium with a density of 3.01 g/cm³. (Table 2).

In such a case between them appears relatively insignificant differentiation by their petrodensity characteristic within 0.05 g/cm³, and the reason is their close mineralogical composition. For example, quartz-epidote-phlogopite metasomatites with scheelite, the REE concentrator, contain all minerals occurring in skarnoids and quartz-epidote-actinolite metasomatites: relict minerals of source rocks, sulfides, fluorite, calcite, sphene, apatite.

2) *in stockworks*. The main mass of scheelite is concentrated in pyrite, pyrite - quartz veins and veins developed among granite-gneisses and gneisses, forming quartz-feldspar ores. The leading minerals of this type of ores are feldspars in total their content reaches up to 92%. The role of other minerals such as epidote, actinolite, garnet, pyroxene, phlogopite scheelite, pyrite is sharply subordinated. The petrodensity characteristic of rare-metal ore stockworks is indicated by many researchers in the range of 2.72 g/cm³.

Granite-gneisses, where the ore stockwork is localized, consists of quartz and feldspars, where their total amount in the rock reaches up to 92-96%. Petrodensity characteristics of such rocks for this ore district are determined within 2.65 g/cm³. Then when scheelite is deposited in stockworks between ore-bearing rock (granite-gneisses) and ore-localizing structure (stockworks) there appears insignificant petrodensity differentiation within 0.07 g/cm³, the reason is close content of feldspars in their mineralogical composition (Table 2).

In general, insignificant petrodensity differentiation within the range from 0.05 to 0.07 g/cm³ between ore-bearing rocks and ore-localizing media, formed due to their close mineralogical composition, is one of the petrophysical factors of rare earths inclusion in the composition of scheelites at Bayan deposit.

References

- Adamyan N.H. (1989) Bayanskoye mestorozhdeniye volframa v Kokchetavskoy oblasti KazSSR [Bayan deposit of tungsten in Kokchetau region of KazSSR]. (in Rus.).
- Amralinova B., Agaliyeva B., Lozynskiy V., Frolova O., Rysbekov K., Mataibaeva I., Mizernaya M. (2023). Rare-Metal Mineralization in Salt Lakes and the Linkage with Composition of Granites: Evidence from Burabay Rock Mass (Eastern Kazakhstan). Water. – Vol. 15. – P. 1386. <https://doi.org/10.3390/w15071386> (in Eng.).
- Bespaev H.A., Miroshnichenko L.A. (2004) Atlas modeley mestorozhdeniy poleznykh iskopaemykh [Atlas of models of mineral deposits]. Alma-Ata: Nauka. –135 p. (in Rus.).
- D'yachkov B.A., Bissatova A.Y., Mizernaya M.A., Khromykh S.V., Oitseva T.A., Kuzmina O.N., Zimanovskaya N.A., Aitbayeva S.S. (2021). Mineralogical Tracers of Gold and Rare-Metal Mineralization in Eastern Kazakhstan. Minerals. – Vol. 11. – P. 253. <https://doi.org/10.3390/min11030253> (in Eng.).
- Dossymbekova Zh.B., Issayeva L.Z., Togizov K.S., Muratkhonov D.B., Maksutov O.N. (2024). The specifics of rare earth inclusion in ore minerals of rare metal deposits of Kazakhstan. NEWS

of National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. – Vol. 6(467). – P. 99-113. <https://doi.org/10.32014/2024.2518-170x.463> (in Eng.).

Dyachkov B.A., Aitbayeva S.S., Mizernaya M.A., Amralinova B.B., Bissatova A.E. (2020). New data on non-traditional types of East Kazakhstan rare metal ore. *Nauk. Visnyk Natsionalnoho Hirnychoho Universytetu*. – Vol. 4. – P. 11-16. <https://doi.org/10.33271/nvngu/2020-4/011> (in Eng.).

Gulyaev A.P. (1980) Rudovmeshchayushchie skarnoidy Bayanskogo mestorozhdeniya (Kazakhstan) [Ore-bearing skarnoids of the Bayan deposit (Kazakhstan)]. *Petrology of ore-bearing metasomatites*. Frunze: Ilim. – P. 42-48. (in Rus.).

Issayeva L., Istekova S., Tolybaeva D., Togizov K., Saurykov Z., Issagaliyeva A. (2025). Petrophysical characteristics of geological formations of the Zhezkazgan Ore District (Kazakhstan) and their relationship with mineralization. *Minerals*. – Vol. 15(11). – P. 1106. <https://doi.org/10.3390/min15111106> (in Eng.).

Issayeva L.D., Asubaeva S.K., Kembayev M.K., Togizov K.S. (2019). The formation of a geoinformation system and creation of a digital model of Syrmabet rare-metal deposit (North Kazakhstan). *SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings*. – P. 609-616. <https://doi.org/10.5593/sgem2019/1.1/s01.075> (in Eng.).

Istekova S., Aidarbekov Z., Togizov K., Saurykov Z., Sirazhev A., Tolybaeva D., Temirkhanova R. (2024). Lithophysical characteristics of productive strata of cupriferous sandstone within Zhezkazgan Ore District in the central Kazakhstan. *Mining of Mineral Deposits*. – Vol. 18(3). – P. 9-17. <https://doi.org/10.33271/mining18.03.009> (in Eng.).

Kenzhetayev Z., Toksanbayev B., Togizov K., Zhapabayev K., Mukatay B., Kurmangazhina M., Svetlakova K. (2026) Assessment of Rare Earth Elements Fractionation in Sandstone and Magmatic Uranium Ores: Implications for Deposit Typing. *Minerals*. – Vol. 16(4). – P. 362. <https://doi.org/10.3390/min16040362> (in Eng.).

Kurmangazhina M., Peregudov V., Sukurov B., Togizov K., Arshamov Y., Muratkhonov D. (2026) Mineralogical and Technological Characteristics of Tin-Bearing Weathering Crusts of the Syrmabet Deposit and Prospects for Their Processing by Thermal Activation. *Minerals*. – Vol. 16. – P. 708. <https://doi.org/10.3390/min16070708> (in Eng.).

Kurskeev A.K. (1983) *Spravochnik fizicheskikh svoystv gornyx porod Kazakhstana* [Reference book of physical properties of rocks of Kazakhstan]. – Alma-Ata: Nauka. – 286 p. (in Rus.).

Kuzmina O., Mizernaya M., Oitseva T., Shayakhmetova Z., Ageyeva O. (2025). Magmatic, structural, and mineralogical-geochemical factors in the formation of rare-metal pegmatites of the Kalba-Naryn belt (Eastern Kazakhstan). *SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings*. – Vol. 25(1.1). <https://doi.org/10.5593/sgem2025/1.1/s01.08> (in Eng.).

Oitseva T., Serikbayev D., Mizernaya M., Oitseva T., Mizernaya A. M., Kuzmina P. O. (2023). Prospects of the Medvedko-Akhmetkinsky ore field for rare metal lithium mineralization (East Kazakhstan). In *Proceedings of the 23rd SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings*. <https://doi.org/10.5593/sgem2023/1.1/s01.15> (in Eng.).

Omirserikov M. S., Duczmal-Czernikiewicz A., Isaeva L. D., Asubaeva S. K., Togizov K. S. (2017). Forecasting resources of rare metal deposits based on the analysis of ore-controlling factors. *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*. – Vol. 3(423). – P. 35-43. (in Eng.).

Shcherba G.N., Gubaidullin F.G. (1984) K proiskhozhdeniyu sheelitovogo mestorozhdeniya Bayan [To the origin of scheelite deposit Bayan]. *Geology of ore deposits*. – Vol. 5. – P. 20-27. (in Rus.).

Shcherba G.N., Kudryashov A.V., Senchilo N.P. (1988) Redkometallnoye orudneniye Kazakhstana [Rare-metal mineralization of Kazakhstan]. – Alma-Ata: Nauka. – 221 p. (in Rus.).

Sirazhev A., Istekova S., Tolybaeva D., Togizov K., Temirkhanova R. (2025) Methodology and Results of Detailed 3D Seismic Exploration in the Zhezkazgan Ore District. *Applied Sciences*. – Vol. 15(2). – P. 567. <https://doi.org/10.3390/app15020567> (in Eng.).

Togizov K., Muratkhonov D., Aksholakov Y. (2020). Rare-earth element concentration conditions

in the rare-metal deposits of the Karakamys ore district. SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings. – P. 271-278. <https://doi.org/10.5593/sgem2020/1.1/s01.034> (in Eng.).

Togizov K., Zholtayev G., Zhumabay N., Muratkhanov D., Tleubergen A., Zhumabay A. (2026) Petrophysical Characteristics of Geological Complexes in the Southeastern Part of the Sarysu–Teniz Uplift (Central Kazakhstan) and Their Significance for Ore Mineralization Prospecting. Minerals. – Vol. 16. – P. 706. <https://doi.org/10.3390/min16070706> (in Eng.).

Togizov K.S., Zholtayev G., Isaeva L.D. (2019) The role of three-dimensional models of deposit and thermodynamic conditions of its formation at selecting and evaluating resources of perspective sites. NEWS of National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. – Vol. 5(437). – P. 169-176. <https://doi.org/10.32014/2019.2518-170X.139> (in Eng.).

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the journals of the Central Asian Academic Research Center LLP implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The Central Asian Academic Research Center LLP follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/ or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Requirements for articles design for publication in the journal are available on the websites:

**[www:nauka-nanrk.kz](http://www.nauka-nanrk.kz)
<http://www.geolog-technical.kz/index.php/en/>
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)**

Managing Editor: *T. Apendiyev*
Editors: *D.S. Alenov, A.Shormakova*
Computer layout: *G.D. Zhadyranova*

Signed for print: Oktober 14, 2026
Format: 70×90 1/16. 26.5 printed sheets. Order No. 5.