

ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Satbayev University

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

1 (451)

JANUARY – FEBRUARY 2022

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

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. Web of 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.

Бас редактор

ЖҰРЫНОВ Мұрат Жұрынұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қазақстан Республикасы Ұлттық Ғылым академиясының президенті, АҚ «Д.В. Сокольский атындағы отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан) Н = 4

Редакциялық алқа:

ЖӘРМЕНОВ Әбдірәсіл Алдашұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА академигі, ҚР минералдық шикізатты кешенді қайта өңдеу жөніндегі Ұлттық орталығының бас директоры (Алматы, Қазақстан) Н = 4

КҮЛДЕЕВ Ержан Итеменұлы, геология-минералогия ғылымдарының кандидаты, қауымдастырылған профессор, Қ.И. Сатпаев атындағы ҚазҰТЗУ Корпоративтік даму жөніндегі проректоры, (Алматы, Қазақстан) Н = 3

ӘБСАМЕТОВ Мәліс Құдысұлы, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, «У.М. Ахмедсафина атындағы гидрогеология және геоэкология институтының» директоры (Алматы, Қазақстан) Н = 2

ЖОЛТАЕВ Герой Жолтайұлы, геология-минералогия ғылымдарының докторы, профессор, Қ.И. Сатпаев атындағы геология ғылымдары институтының директоры (Алматы, Қазақстан) Н=2

СНОУ Дэниел, Ph.D, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры (Небраска штаты, АҚШ) Н = 32

ЗЕЛЬТМАН Реймар, Ph.D, табиғи тарих мұражайының Жер туралы ғылымдар бөлімінде петрология және пайдалы қазбалар кен орындары саласындағы зерттеулердің жетекшісі (Лондон, Англия) Н = 37

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры (Нанси, Франция) Н=15

ШЕН Пин, Ph.D, Қытай геологиялық қоғамының тау геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі (Пекин, Қытай) Н = 25

ФИШЕР Аксель, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) Н = 6

КОНТОРОВИЧ Алексей Эмильевич, геология-минералогия ғылымдарының докторы, профессор, РҒА академигі, А.А. Трофимука атындағы мұнай-газ геологиясы және геофизика институты (Новосибирск, Ресей) Н = 19

АБСАДЫКОВ Бахыт Нарикбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент-мүшесі, А.Б. Бектұров атындағы химия ғылымдары институты (Алматы, Қазақстан) Н = 5

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь) Н = 13

КАТАЛИН Стефан, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) Н = 20

СЕЙТМҰРАТОВА Элеонора Юсуповна, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент-мүшесі, Қ.И. Сатпаев атындағы Геология ғылымдары институты зертханасының меңгерушісі (Алматы, Қазақстан) Н=11

САҒЫНТАЕВ Жанай, Ph.D, қауымдастырылған профессор, Назарбаев университеті (Нұр-Сұлтан, Қазақстан) Н = 11

ФРАТТИНИ Паоло, Ph.D, Бикокк Милан университеті қауымдастырылған профессоры (Милан, Италия) Н = 28

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген № **KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19

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

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2022

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

Главный редактор

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик НАН РК, президент Национальной академии наук Республики Казахстан, генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского» (Алматы, Казахстан) Н = 4

Редакционная коллегия:

ЖАРМЕНОВ Абдурасул Алдашевич, доктор технических наук, профессор, академик НАН РК, генеральный директор Национального центра по комплексной переработке минерального сырья РК (Алматы, Казахстан) Н= 4

КУЛЬДЕЕВ Ержан Итеменович, кандидат геолого-минералогических наук, ассоциированный профессор, проректор по корпоративному развитию КазННТУ им. К.И. Сатпаева (Алматы, Казахстан) Н = 3

АБСАМЕТОВ Малис Кудысович, доктор геолого-минералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан) Н = 2

ЖОЛТАЕВ Герой Жолтаевич, доктор геолого-минералогических наук, профессор, директор Института геологических наук им. К.И.Сатпаева (Алматы, Казахстан) Н=2

СНОУ Дэниел, Ph.D, ассоциированный профессор, директор Лаборатории водных наук университета Небраски (штат Небраска, США) Н = 32

ЗЕЛЬТМАН Реймар, Ph.D, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Англия) Н = 37

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция) Н=15

ШЕН Пин, Ph.D, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай) Н = 25

ФИШЕР Аксель, ассоциированный профессор, Ph.D, технический университет Дрезден (Дрезден, Берлин) Н = 6

КОНТОРОВИЧ Алексей Эмильевич, доктор геолого-минералогических наук, профессор, академик РАН, Институт нефтегазовой геологии и геофизики им. А.А. Трофимука СО РАН (Новосибирск, Россия) Н = 19

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, член-корреспондент НАН РК, Институт химических наук им. А.Б. Бектурова (Алматы, Казахстан) Н = 5

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь) Н = 13

КАТАЛИН Стефан, Ph.D, ассоциированный профессор, Технический университет (Дрезден, Берлин) Н = 20

СЕЙТМУРАТОВА Элеонора Юсуповна, доктор геолого-минералогических наук, профессор, член-корреспондент НАН РК, заведующая лабораторией Института геологических наук им. К.И. Сатпаева (Алматы, Казахстан) Н=11

САГИНТАЕВ Жанай, Ph.D, ассоциированный профессор, Назарбаев университет (Нурсултан, Казахстан) Н = 11

ФРАТТИНИ Паоло, Ph.D, ассоциированный профессор, Миланский университет Бикокок (Милан, Италия) Н = 28

«Известия НАН РК. Серия геологии и технических наук».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан № **KZ39VPY00025420**, выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соединений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

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

© Национальная академия наук Республики Казахстан, 2022

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

Editor in chief

ZHURINOV Murat Zhurinovich, doctor of chemistry, professor, academician of NAS RK, president of the National Academy of Sciences of the Republic of Kazakhstan, general director of JSC “Institute of fuel, catalysis and electrochemistry named after D.V. Sokolsky» (Almaty, Kazakhstan) H = 4

Editorial board:

ZHARMENOV Abdurasul Aldashevich, doctor of Technical Sciences, Professor, Academician of NAS RK, Director General of the National Center for Integrated Processing of Mineral Raw Materials of the Republic of Kazakhstan (Almaty, Kazakhstan) H=4

KULDEEV Yerzhan Itemenovich, Candidate of Geological and Mineralogical Sciences, Associate Professor, Vice-Rector for Corporate Development, Satbayev University (Almaty, Kazakhstan) H = 3

ABSAMETOV Malis Kudysovich, doctor of geological and mineralogical sciences, professor, academician of NAS RK, director of the Akhmedsafin Institute of hydrogeology and hydrophysics (Almaty, Kazakhstan) H = 2

ZHOLTAEV Geroy Zholtaevich, doctor of geological and mineralogical sciences, professor, director of the institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) H=2

SNOW Daniel, Ph.D, associate professor, director of the laboratory of water sciences, Nebraska University (Nebraska, USA) H = 32

Zeltman Reymar, Ph.D, head of research department in petrology and mineral deposits in the Earth sciences section of the museum of natural history (London, England) H = 37

PANFILOV Mikhail Borisovich, doctor of technical sciences, professor at the Nancy University (Nancy, France) H=15

SHEN Ping, Ph.D, deputy director of the Committee for Mining geology of the China geological Society, Fellow of the American association of economic geologists (Beijing, China) H = 25

FISCHER Axel, Ph.D, associate professor, Dresden University of technology (Dresden, Germany) H = 6

KONTOROVICH Aleksey Emilievich, doctor of geological and mineralogical sciences, professor, academician of RAS, Trofimuk Institute of petroleum geology and geophysics SB RAS (Novosibirsk, Russia) H = 19

ABSADYKOV Bakhyt Narikbaevich, doctor of technical sciences, professor, corresponding member of NAS RK, Bekturov Institute of chemical sciences (Almaty, Kazakhstan) H = 5

AGABEKOV Vladimir Enokovich, doctor of chemistry, academician of NAS of Belarus, honorary director of the Institute of chemistry of new materials (Minsk, Belarus) H = 13

KATALIN Stephan, Ph.D, associate professor, Technical university (Dresden, Berlin) H = 20

SEITMURATOVA Eleonora Yusupovna, doctor of geological and mineralogical sciences, professor, corresponding member of NAS RK, head of the laboratory of the Institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) H=11

SAGINTAYEV Zhanay, Ph.D, associate professor, Nazarbayev University (Nursultan, Kazakhstan) H = 11

FRATTINI Paolo, Ph.D, associate professor, university of Milano-Bicocca (Milan, Italy) H = 28

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: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420**, issued 29.07.2020.

Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*

Periodicity: 6 times a year.

Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19

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

© National Academy of Sciences of the Republic of Kazakhstan, 2022

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN

SERIES OF GEOLOGY AND TECHNICAL SCIENCES

ISSN 2224-5278

Volume 1, Number 451 (2022), 83-90

<https://doi.org/10.32014/2022.2518-170X.144>

UDC 553.061.11

IRSTI 38.57.15

Oitseva T.A.^{1,2*}, D'yachkov B.A.^{1,3}, Kuzmina O.N.¹, Bissatova A.Y.^{1,2}, Ageyeva O.V.¹¹D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk, Kazakhstan;²Geos LLP, Ust-Kamenogorsk, Kazakhstan;³Altai Geological and Environmental Institute LLP, Ust-Kamenogorsk, Kazakhstan.

E-mail: tatiana.oitseva@gmail.com

LI-BEARING PEGMATITES OF THE KALBA-NARYM METALLOGENIC ZONE (EAST KAZAKHSTAN): MINERAL POTENTIAL AND EXPLORATION CRITERIA

Abstract. The paper focuses on the formation patterns of Li-bearing pegmatites in the Kalba-Narym metallogenic zone in East Kazakhstan, with exploration implications. The main types of rare-metal (Ta, Nb, Be, Li, Cs, Sn, W, TR) mineralization are structurally and genetically related with Permian postcollisional granitoids of the Kalba-Narym belt. According to the suggested geological model simulating multistage evolution of mineral assemblages from oligoclase-microcline to albite varieties, mineralization at the Bakennoye, Yubileinoe, and other deposits is related with 285 Ma Kalba alkaline granites and occurs in Cs-bearing spodumene pegmatites located in the upper part of the ore zone. The distribution of pegmatite fields has been controlled by a large-scale system of old regional W-E faults which were rejuvenated during the collisional activity. Rare-metal pegmatite mineralization can be traced from the presence of cleavelandite, lepidolite, spodumene, pollucite, color tourmalines, ixiolite, and other indicator minerals. In addition to the classical pegmatitic deposits associated with granites, older (305 Ma) plagiogranites and dikes of the Kunush complex host Li-bearing albite-spodumene pegmatites with secondary Sn, Ta, and Li mineralization (Akhmetkino, Tochka, Aldai, and other deposits). The indicators for this mineralization type include albite, cleavelandite, spodumene, cymatolite, and tantalite-columbite. Albite-spodumene pegmatites in the region can provide additional Li resources and are worth of further investigation.

Key words: Kalba-Narym zone, rare metals, granite, plagiogranite, pegmatite, Li resources, mineral exploration.

Introduction. The Kalba-Narym metallogenic zone is located in the Irtysh-Zaisan fold system in East Kazakhstan within the Great Altai, a part of the Central Asian Orogenic Belt [1]. The Great Altai region is remarkable for its complex geological structure and extremely rich mineralization, with abundant and diverse massive sulfide deposits of base, rare, and precious metals (Fe, Cu, Pb, Zn, Ag, Au, Ta, REE, etc.) which make basis for developed mining and metallurgical industries. As old shallow deposits are being depleted, advanced exploration of deep-seated mineral resources, including rare metals (Ta, Nb, Be, Li, Cs, etc.) demanded in the high technology sector, becomes the main challenge [2].

Estimating the potential of the region as to the *lithium resources* for future energy production operations is of special importance in this respect. Previously, spodumene pegmatites in East Kazakhstan were mined mainly for *Ta and Sn*, with associate microcline and muscovite (Bakennoye, Yubileinoe, Belaia Gora, Upper Baimurza, and other deposits), while other metals (Be, Li, Cs) were neglected and put out to tailings. However, the growing world demand for lithium and other rare metals requires additional exploration of spodumene pegmatite resources and reappraisal of some small deposits and occurrences in terms of *Ta-Be-Sn-Cs-Li mineralization* using new approaches and technologies. This study aims at gaining more insights into the formation patterns and mineral potential of spodumene pegmatites in the Kalba-Narym zone, for the case of the *Tochka area*, with implications for exploration and subsequent mining operations.

Materials and methods. Geological and metadological background. Additional exploration of Li pegmatites in the *Tochka area* can proceed from a wealth of available data collected since 1955 [3].

Mineralization occurs in the *Karagoin-Saryozek* ore zone which spans more than 200 m in the vertical dimension and stores several underexplored Ta, Nb, Be, Sn, Li albite-spodumene pegmatite deposits associated with small intrusions and dikes of the Kunush complex (Fig. 1). The zone includes a 5.4 m thick blind vein of albite-spodumene pegmatite discovered recently at a drilling depth of 303 m (Kenebay site), which boosts its potential. Economic amounts of lithium may exist at the reference *Akhmetkino deposit*, which has to be studied in detail and evaluated in response to the growing *Li* demand [4].

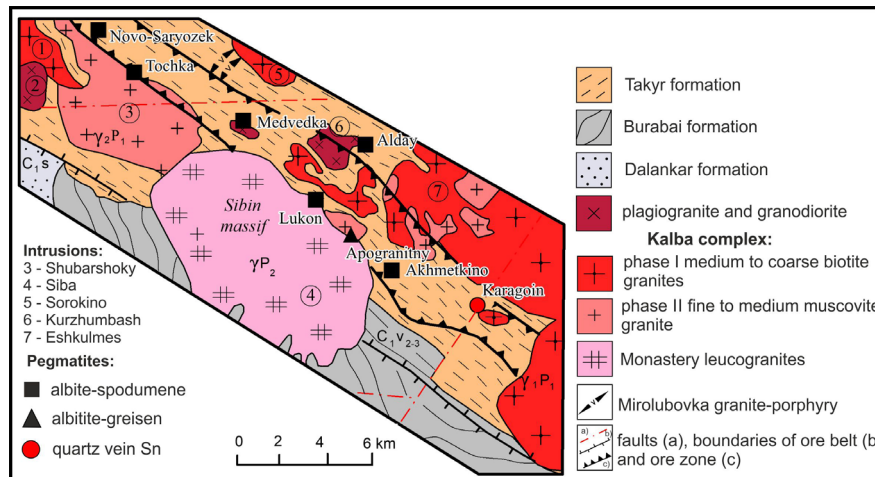


Figure 1 - Simplified local geology of the Karagoin-Saryozek ore zone (performed by Oitseva T. A.) [5]

The orebodies are mainly localized in faulted and metamorphosed black shales of the Takyr Fm. (D_3) and in plagiogranite intrusions (Fig. 2). The Kalguty garnet-biotite granitoids identified in previous models of magmatism [6] rather belong to the Kunush complex [2, 7]. The Kunush plagiogranites, which constitute a particular element in the magmatism of the Kalba area, have a collisional origin and host gold in the West Kalba zone or *secondary rare-metal mineralization* (Ta, Nb, Be, Sn, Li, W) in the Kalba-Narym zone [8, 9]. Plagiogranites are gray equigranular medium-grained varieties consisting of 59-62% plagioclase, 26-28% quartz, and small amounts of feldspar (2-4%), biotite (6.5%), and accessories (amphibole, apatite, zircon, arsenopyrite, etc., 0.3-0.6% in total). Their compositions differ in sodic alkalinity ($Na_2O/K_2O > 4$), a relatively low agpaite index ($Ka=0.89$) corresponding to the plumaistic series, and high contents of mafic components [10]. The rocks have elevated contents of Cu, Pb, and Zn and contain Au, Ag, Pd, and Sb: Ag in galena (6.3 ppm), monazite (1.6 ppm), and greisen quartz (37.31 ppm); PGE in apatite (4.17 to 13.84) and sferosiderite (2.31 ppm). The contents of Sn are 11.43 ppm, while rare alkalis (275.5 ppm $\sum Li+Rb+Cs$) are twice as low as in phase I granites of the Kalba complex. According to high Sr contents (up to 686-815 ppm) and isotope systematics, the Kunush plagiogranites are of crust-mantle adakite type [11, 12].

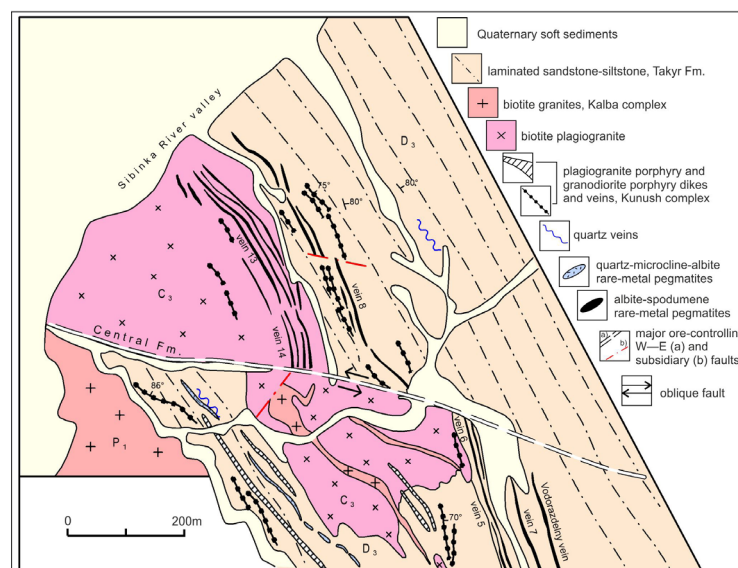


Figure 2 - Simplified local geology of Tochka deposit (northern part), after Osipova et al. (1990) [3]

Plagiogranites occur as two relatively large bodies separated by a W-E fault (Fig. 2) and are mainly buried under soft sediments in the northwest. Boreholes in the black shales strip individual offshoots and protrusions of plagiogranite (Barrier intrusion, etc.). The ore field comprises a system of the Kunush dike-shaped plagiogranite, granodiorite, and quartz porphyry alternated with the Kalba vein granites, aplites, aplite-pegmatites, pegmatites, and quartz veins [13]. The veins are 20-30 cm to 3-5 m thick (0.2-1 m in late quartz veins) and 250-300 long, strike in the NW direction (315-330°) concordantly with the host black shales, and dip mostly to the northeast at 70-85°.

The pegmatite veins are of (1) microcline, (2) microcline-albite, (3) albite, or (4) albite-spodumene types, or locally bear quartz-microcline-muscovite (greisen) assemblages. The albite-spodumene pegmatites that formed in the conditions of epidote-amphibolite metamorphism (500-600°C; 2-8 kbar) [14] have the highest Li potential.

The ore field is of supra-intrusion linear morphological type, with staircase veins in plagiogranites [3]. There are three NW pegmatite formations emplaced one below another: the Eastern (hanging wall), Central (axial), and Western (footwall) units. The mineralization is controlled mainly by the W-E Central zone which splits the deposit into the Northern and Southern blocks displaced for 380 m one relative to another (Fig. 2).

The *Central Fm.* appears to have the best prospects. It is composed mainly of albite-spodumene pegmatites occurring in two clusters of closely spaced veins, 170-200 m of total thickness, which form a single ore body. Pegmatite veins 13, 14, and some others crop out, while the mineralization as a whole is unevenly distributed and traceable to depths of 200-300 m or more. The contents of Li_2O in the veins reach at least 1 wt.%. Previous flame photometry data for pegmatite core samples [3] showed the relatively high contents of 1.050-1.111 wt.% Li_2O at 292 m core depth and 0.631 wt.% Li_2O at 335 m in borehole No. 19, etc, as well as at depths 140-316.5 m in boreholes at the Kenebay and Alday sites [15]. These data have been confirmed by more precise recent analyses of the Tochka albite-spodumene pegmatite samples at the IRGETAS (D. Serikbayev East Kazakhstan Technical University) and VNIItsvetemet laboratories (Ust'-Kamenogorsk). The Li contents vary from 0.62 to 1.43 wt.% in samples of vein 13 (0.98 wt.% average over 6 specimens) and reach 1.60 wt.% in those of trench 203. The vein interior parts accommodate stacked nests (>1 m) of spodumene which exceeds 50 vol.% (Fig. 3).

Lithium enrichment was also found in greisen *pegmatites and in xenoliths* of the host biotite-garnet-sericite shales (>0.1-0.3 wt.% Li_2O). The Li contents measured in lens-shaped Chudskaya and No. 9 veins are 0.63wt.% Li_2O for albite-spodumene pegmatite and as low as 0.019 wt.% Li_2O for greisen and albitite pegmatites.



Figure 3 - Nest of albite-spodumene pegmatite

Of special interest is the NE staircase-like Barrier vein located in a small NE plagiogranite intrusion in the southeastern flank of the ore field (Fig. 4). The vein encloses a long zone of albite-spodumene pegmatites in its interior part, with 0.22 to 0.79 wt.% Li_2O (0.35% on average over 8 analyses).

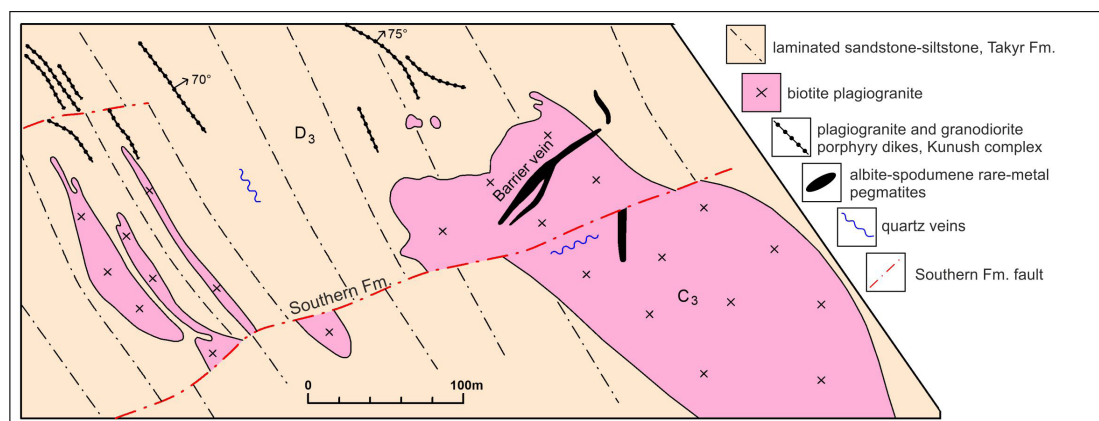


Figure 4 - Simplified local geology of Tochka deposit (southern part), after Osipova et al. (1990) [3]

The *Western Fm.* encompasses albite-spodumene pegmatites of vein 2, as well as albite and albite-microcline pegmatites of veins 1 and 3. The veins have shallow erosion cutout and dip at 20° in the NW direction. Vein 2 has the highest Li grades with 10,800-17,800 ppm or 1.08-1.78 wt.% Li₂O (Table 1, samples T-1, T-1a). These results were confirmed by AAS data (1.66-2.87 wt.%).

The *Eastern Fm.* is the most strongly eroded. It has 10-30 m long and 1.5-4 m thick lens-shaped bodies of albite-spodumene pegmatites in its northern part and lens- or plate-shaped veins, up to 5-6 m thick, in the Southern block. The albite-spodumene pegmatites of Vodorazdelny vein contain up to 0.63 wt.% Li₂O.

Table 1 - Trace element abundances (ppm) in Tochka rocks

Sample	Rock	Ta	Nb	Be	Li	Rb	Cs	Sn	W	Mo
T-1	Spodumene pegmatite	36.71	61.6	177.2	17800	80.00	12.87	29.43	1.43	1.58
T-1a	Spodumene pegmatite	37.99	75.5	137.9	10800	52.50	10.81	36.00	1.30	1.73
T-2	Quartz- muscovite-tourmaline hornfels	9.02	26.7	45.30	3130	961.0	308.6	101.4	2.08	1.98
T-3	Hornfels with thin pegmatite veins	32.26	56.9	58.20	1362	608.0	128.5	129.9	4.14	1.78
T-6	Quartz with spodumene	2.72	3.37	3.41	425	45.7	12.72	7.78	0.40	211.56
T-7	Quartz in a muscovite coat	16.69	14.87	5.40	622	159.9	26.90	50.90	1.85	1.17
T-8	Plagiogranite	0.57	0.81	1.33	413	41.20	22.19	9.57	0.75	1.37
T-9	Fine albitite	2.58	1.92	14.96	104.3	71.00	10.55	14.20	0.74	1.22
T-10	Greisen albitite	22.05	26.32	52.40	903	789.0	77.70	215.2	20.64	1.46
T-11	Streak of albite-tourmaline pegmatite	10.57	12.96	25.78	307.3	227.2	20.22	99.10	1.13	1.91
T-13	Sugar-like albitite	0.80	0.77	71.50	183.4	45.50	9.42	206.0	1.02	1.05

Results. Spodumene is the main metallic mineral reaching rock-forming percentages of 3-5 to 20-25% or more in albite-spodumene pegmatites from the Tochka area. White and pink spodumenes, within 3-5 cm in size, typically occurs in transverse bands across plate-shaped veins, while coarser crystals, up to 5-10 cm or longer and 1-3 cm wide, form nests in veins (Fig. 3) and are often replaced by eucryptite and cymatolite. Some spodumenes are as long as 1 m. Spodumene coexists with microcline (15-20%), sugar-like albite, cleavelandite, muscovite, gilbertite, or rarely with lepidolite, verdelite, etc. The Tochka pegmatites also contain 2-4 mm platy crystals of tantalite-columbite associated with quartz-albite-gilbertite assemblages. Furthermore, SEM images reveal rare-metal minerals (cassiterite, columbite, tantalite, microlite) and micrometer lumpy fluorapatite (Fig. 5), as well as microinclusions of galena, pyrite, apatite, and drop-shaped native irons.

Discussion. The existence of exposed and buried albite-spodumene pegmatite veins provides motivation for further exploration in the Tochka area. The veins were discovered in the course of previous surveys but have not been properly characterized, for several reasons.

First of all, the exploration in the Kalba-Narym zone from 1955 to 1994 targeted mainly at Ta and Sn ores, according to the demand of that time, but neglected other trace elements like Be, Li, Cs, or Rb. On the other hand, the potential of Li-bearing pegmatites in the area was estimated on sparse drilling networks (200 m × 150-200 m and 200 m × 400 m). That drilling coverage was insufficient for correlation of interceptions and for evaluation of albite-spodumene percentages in pegmatite veins and over the deposit as a whole, given the short length of the veins and their heterogeneity in morphology, thickness, and composition. Thus, the contours of the pegmatite veins remained poorly constrained along the flanks and at larger depths.

The Li grades in the available reports [3, 15] appear to be underestimated because of averaging over both barren and albite-spodumene pegmatites. Namely, the Li_2O contents at the Tochka site were reported to be 0.033 wt.% for the Western Fm. and 0.063 wt.% for the Central Fm., but flame photometry showed higher values in a range of 0.219 to 1.132%. The low average Li contents rather represent the bulk composition of mixed mineral assemblages in the pegmatites.

The methods of flame photometry and semi-quantitative spectral analyses used earlier failed to ensure sufficient analytical quality. Thus, the results call for revision on the basis of ICP-MS and AES data for the Tochka albite-spodumene pegmatites, which give 0.22 to 2.87 wt.% Li_2O . This range is comparable with the respective contents in the economic deposits of the Kalba-Narym zone (0.306 wt.% at Yubileinoe, 0.119 wt.% at Bakennoye, 0.76 wt.% at Akhmetkino) and in other countries (up to 2.9 wt.% at Green Bushes in Australia; 1.06 wt.% at Vishnevskoye in Russia, etc.) [4, 14, 16].

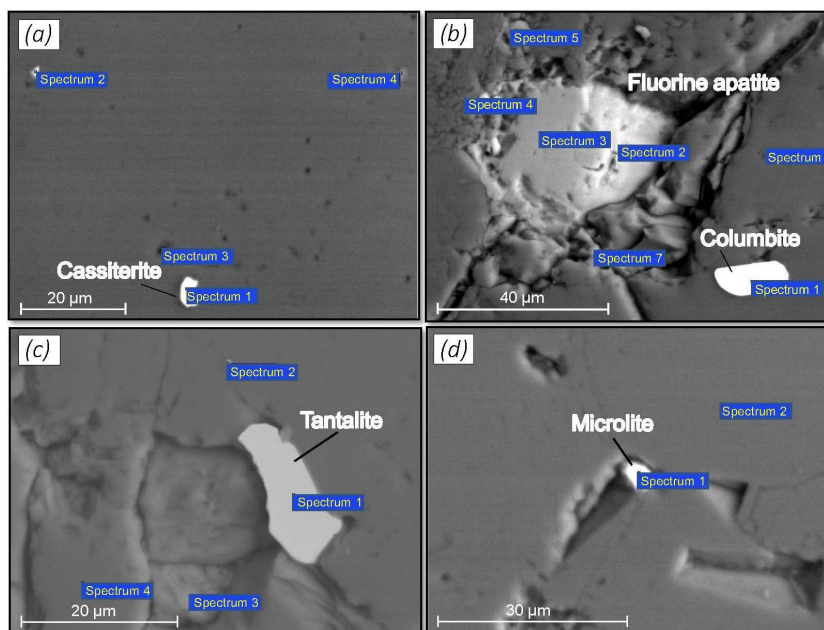


Figure 5 - Mineral microinclusions in albite-spodumene pegmatites from Tochka area.

Conclusion. Main types of mineralization in East Kazakhstan, mostly located within the Kalba-Narym granitoid belt, formed during the Late Paleozoic postcollisional events. Of special importance are rare-metal pegmatite deposits (Ta, Nb, Be, Li, Cs, Sn) related to the Kalba granites (P_1). However, a number of deposits operated previously by the Belgorod Mining and Processing Works (Bakennoye, Yubileinoe, Belaya Gora, etc.) have been tied up. Originally, the mining was targeted at Ta and Sn resources while other components, including Li, went to tailings. Currently, the interest to rare-metal pegmatites as a resource of lithium has been rekindled with growing demand for Li in the world markets.

Rare-metal mineralization developed mainly in the heavily deformed Central Kalba block in the conditions of tectonic activity. Li-bearing rocks are mostly located in the Ognevo-Bakennoye, Asubulak, and Belogorsk-Baimurza ore fields controlled by regional-scale W-E faults. Among these, albite-spodumene pegmatites are the youngest rocks occurring in the upper part of the ore zone. They are as rich in unique mineral species as world-known pegmatite deposits like Koktoay, Bernic Lake, Zimbabwe, etc. [17-22], though having lesser extent of mineralization, for different reasons.

The NW Karagoin-Saryozek ore zone in the southwestern flank of the Kalba-Narym rare-metal belt accommodates orebodies with secondary rare-metal mineralization (Ta, Nb, Be, Li, etc.), which are associated with small intrusions and dikes of the Kunush complex. [3, 4]. Economic potential can be expected from albite-spodumene pegmatites in supra-intrusion zones, offshoots, and staircase-like veins in small plagiogranite intrusions (Akhmetkino, Tochka, Aldai, Lukon, Novo-Saryozek, etc.). The mineralization can be traced from the presence of albite, cleavelandite, cymatolite, tantalite-columbite, and other indicator minerals. New SEM data for these pegmatites reveal relatively high lithium contents (>1 wt.% Li_2O). The albite-spodumene pegmatite bodies are worth further investigation for potential Li resources.

Funding: The study was supported by Geology Committee of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan (grants BR10264558).

Ойцева Т.А.^{1,2*}, Дьячков Б.А.^{1,3}, Кузьмина О.Н.¹, Бисатова А.Е.^{1,2}, Агеева О.В.¹

¹Д. Серікбаев атындағы Шығыс Қазақстан техникалық университеті, Өскемен, Қазақстан;

²«Геос» ЖШС, Өскемен, Қазақстан;

³«Алтай геология-экологиялық институты» ЖШС, Өскемен, Қазақстан.

E-mail: tatiana.oitseva@gmail.com

ҚАЛБА-НАРЫН АЙМАҒЫНЫҢ (ШЫҒЫС ҚАЗАҚСТАН) ЛИТИЙЛІ ПЕГМАТИТТЕРІН БОЛЖАУ ЖӘНЕ БАҒАЛАУ ӘДІСТЕМЕСІ

Аннотация. Мақалада Шығыс Қазақстандағы Қалба-Нарым аймағының литийлі пегматиттерін қалыптастыру ерекшеліктері, болжау және бағалау критерийлері қарастырылады. Пермь уақытының коллизиядан кейінгі (орогендік) геодинамикалық жағдайында қалыптасқан Қалба-Нарым белдеуінің гранитоидтарымен сирек кездесетін металл кен орындарының (Ta, Nb, Be, Li, Cs, Sn, W, TR) жетекші түрлерінің құрылымдық-генетикалық байланысы атап өтіледі. Геологиялық-генетикалық модель басты сирек металды пегматитті кен орындарының (Бакенное, Юбилейное және т.б.) төменгі плюмазитті агпаиттілікпен және орташа негізділікпен натрий-калий сериясының қалыпты қатарындағы Қалба кешенінің граниттерімен (285 млн. жыл) кеңістік-генетикалық байланысын көрсетеді, аймақтық кен колоннасының жоғарғы бөлігінде құрамында сподумен және цезий бар пегматиттер орналасуы мен олигоклаз-микроклиннен бастап (кенді емес) микроклин-альбит және альбит (кенді) дейінгі минералдық кешендерінің кезеңдік дамуын көрсетеді. Пегматит өрістерінің орналасуында орогендік сатыға белсендірілген ежелгі құрылыстың аймақтық ендік ақауларының регматикалық жүйесіне жетекші рөл беріледі. Типоморфты бірегей минералдар және сирек металды пегматит түзілуінің геохимиялық индикатор-элементтері (клевеландит, лепидолит, сподумен, поллуцит, түрлі-түсті турмалиндер, оксиолит және т.б.) келтіріледі. Дәстүрлі гранит пегматит кен орындарынан басқа, құрылымдық-литологиялық тұзақтардың (Ахметкино, Точка, Алдай және т.б.) маңызы болған кунуш кешенінің (305 млн. жыл) бұрынғы плагиограниттерімен және дайкаларымен байланыстыратын альбит-сподумен салынған минералдануымен (Sn, Ta, Li) литийлі пегматиттердің перспективалы түрі ерекшеленеді. Кенденуінің индикатор-минералдары: альбит, клевеландит, сподумен, циматолит, танталит-колумбит. Бұл нысандар литий шикізатының қосымша көзі ретінде қарастырылады және қосымша зерттеуді қажет етеді.

Түйінді сөздер: Қалба-Нарым аймағы, сирек металдар, граниттер, плагиограниттер, пегматиттер, литий шикізаты, болжау.

Ойцева Т.А.^{1,2*}, Дьячков Б.А.^{1,3}, Кузьмина О.Н.¹, Бисатова А.Е.^{1,2}, Агеева О.В.¹

¹Восточно-Казахстанский технический университет Д. Серикбаева, Усть-Каменогорск, Казахстан;

²ТОО «Геос», Усть-Каменогорск, Казахстан;

³ТОО «Алтайский геолого-экологический институт», Усть-Каменогорск, Казахстан.

E-mail: tatiana.oitseva@gmail.com

К МЕТОДИКЕ ПРОГНОЗИРОВАНИЯ И ОЦЕНКИ ЛИТИЕНОСНЫХ ПЕГМАТИТОВ КАЛБА-НАРЫМСКОЙ ЗОНЫ (ВОСТОЧНЫЙ КАЗАХСТАН)

Аннотация. Рассматриваются особенности формирования, критерии прогнозирования и оценки литиеносных пегматитов Калба-Нарымской зоны Восточного Казахстана. Подчеркивается структурно-генетическая связь ведущих типов редкометалльных месторождений (Ta, Nb, Be, Li, Cs, Sn, W, TR) с гранитоидами Калба-Нарымского пояса, сформированными в постколлизивной (орогенной) геодинамической обстановке пермского времени. Геолого-генетическая модель отражает пространственно-генетическую связь главных редкометалльных пегматитовых месторождений (Бакенное, Юбилейное и др.) с гранитами калбинского комплекса (285 млн. лет) нормального ряда натриево-калиевой серии, низкоплюмазитовой агпаитности и умеренной основности, стадийное развитие минеральных комплексов от олигоклаз-микроклинового (безрудного) до микроклин-альбитового и альбитового (рудных) с размещением сподуменсодержащих и цезиеносных пегматитов в верхней части зональной рудной колонны. В размещении пегматитовых полей ведущая роль придается

регматической системе региональных широтных разломов древнего заложения, активизированных в орогенную стадию. Приводятся типоморфные уникальные минералы и геохимические элементы-индикаторы редкометалльного пегматитообразования (клевеландит, лепидолит, сподумен, поллуцит, цветные турмалины, иксиолит и др.). Кроме традиционных гранитных пегматитовых месторождений, выделяется перспективный тип литиеносных пегматитов с наложенной альбит-сподуменовой минерализацией (Sn, Ta, Li), ассоциирующих с более ранними плагиогранитами и дайками кунушского комплекса (305 млн. лет), которые имели значение структурно-литологических ловушек (Ахметкино, Точка, Алдай и др.). Минералы-индикаторы оруденения: альбит, клеветландит, сподумен, циматолит, танталит-колумбит. Эти объекты рассматриваются в качестве дополнительного источника литиевого сырья и заслуживают дополнительного изучения.

Ключевые слова: Калба-Нарымская зона, редкие металлы, граниты, плагиограниты, пегматиты, литиевое сырье, прогнозирование.

Information about authors:

Oitseva T.A. – PhD (geology and exploration), Faculty of Earth and Environmental Sciences, D. Serikbayev East Kazakhstan Technical University; geologist, Geos LLP, Ust-Kamenogorsk, Kazakhstan; tatiانا.oitseva@gmail.com; ORCID ID: <https://orcid.org/0000-0002-7832-0309>;

Dyachkov B.A. – Academician of NAS RK, Doctor of Geological and Mineralogical Sciences, Professor, Faculty of Earth and Environmental Sciences, D. Serikbayev East Kazakhstan Technical University; Ust-Kamenogorsk, Kazakhstan;

Kuzmina O.N. – Candidate of Geological and Mineralogical Sciences, Faculty of Earth and Environmental Sciences, D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk, Kazakhstan; kik_kuzmins@mail.ru; ORCID ID: <https://orcid.org/0000-0002-5127-6408>;

Bissatova A.E. – PhD student, Faculty of Earth and Environmental Sciences, D. Serikbayev East Kazakhstan Technical University; geologist, Geos LLP, Ust-Kamenogorsk, Kazakhstan; bisatova.ainelya@mail.ru; ORCID ID: <https://orcid.org/0000-0003-2117-4731>;

Ageyeva O.V. – PhD student, Faculty of Earth and Environmental Sciences, D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk, Kazakhstan; ageyeva93@mail.ru; ORCID ID: <https://orcid.org/0000-0002-2677-0797>.

REFERENCES

[1] Shcherba G.H. (2000) The Great Altai, Book. 2. Metallogeny. RIO VAK RK, Alma-Ata. ISBN: 9965520445 (in Russ.).

[2] Dyachkov B., Oitseva T., Frolova O., Mataibaeva I., Kusmina O. Geotectonic position, and ore potential of intrusive-dyke belts in East Kazakhstan. Proceeding of 17th International multidisciplinary scientific geoconference, Bulgaria, 2017, pp. 239–246. DOI: 10.5593/SGEM2017/11/S01.030.

[3] Osipova G.F., Tupicyn A.V., Kijashko P.L., Rassolov S.M. (1990) Exploration in the area of Tochka deposit, 1988-1990. Technical Report. *Vostkazgeologiya* Production Geological Association, Ust-Kamenogorsk. (in Russ.).

[4] Lithium resources in Russia: Mineral potential, innovative technologies, and environmental safety (2011) Proceedings of Conference with International Participation, 24-26 May 2011, SB RAS, Novosibirsk. (in Russ.).

[5] Oitseva T.A., Dyachkov B.A., Vladimirov A.G., Kuzmina O.N., Ageyeva O.V. New data on the substantial composition of Kalba rare metal deposits. IOP Conf. Ser. Earth Environ. 2018, 110 (1), 0120183.

[6] Vladimirov A.G., Annikova I.Yu., Murzintsev N.G., Travin A.V., Sokolova E.N., Smirnov S.Z., Gavryushkina O.A., Oitseva T.A. (2019) Stage and duration of formation of the Kalguty Mo-W ore-magmatic system (Altai): termochronology and mathematical modeling, *Russian Geology and Geophysics*, 60(8): 890-910. DOI: 10.15372/RGG2019057.

[7] Lopatnikov V.V., Izokh E.P., Ermolov P.V., Ponomareva A.P., Stepanov A.E. (1982) Magmatism and metallogeny of the Kalba-Narym zone, East Kazakhstan. Nauka, Moscow. (in Russ.).

[8] Murzintsev N.G., Annikova I.Yu., Travin A.V., Vladimirov A.G., Dyachkov B.A., Maslov V.I., Oitseva T.A., Gavryushkina O.A. (2019) Thermochronology and mathematical modeling of the formation dynamics of rare-metal-granite deposits of the Altai collision system, *Geodynamics & Tectonophysics*, 10(2): 375-404. DOI: 10.5800/GT-2019-10-2-0419.

[9] Saleh Ibrahim Bute, Xiaoyong Yang, Xueming Yang, Musa Bala Girei, Amuda Abdulgafar Kayode,

Yigan Lu. (2021) Geochemistry, zircon U single bond, Pb ages and Hf isotopes of granites and pegmatites from Gubrunde region in the Eastern Nigeria Terrane: Insight into magmatism and tectonic evolution of the late Pan-African orogeny, *Geochemistry*. DOI: 10.1016/j.chemer.2021.125809.

[10] Sadovsky Yu.A., Stepanenko N.I., Pushko E.P., Mikhaylov A.G., Zimin O.G. (1978) Formation of rare-metal pegmatites: Main parameters and fluid regime. *Geologiya, Geokhimiya i Mineralogiya Mestorozhdenii Redkikh Elementov*, 5: 51-72 (in Russ.).

[11] Kuibida M.L., Kruk N.N., Vladimirov A.G., Nikolaeva I.V., Polyansky N.V., Nikolaeva I.V. (2009) U-Pb isotopic age, composition, and sources of the plagiogranites of the Kalba Range, Eastern Kazakhstan, *Doklady Earth Sciences*, 424 (1): 72-76. DOI: 10.1134/S1028334X09010152.

[12] Korobeynikov A.F., Gusev A.I., Rusanov G.G. (2010) Kalba adakite granitoids: Petrology and mineral potential. *Izv. TPU*, 316: 31-38 (in Russ.).

[13] Zagorsky V.E., Makagon V.M., Shmakin B.M., Makrygina V.A., Kuznetsova L.G. (1997) Granitic pegmatites. Book.2. Rare-metal pegmatites. Nauka, Novosibirsk. ISBN: 5-02-030859-5 (in Russ.).

[14] Dittrich Th., Seifert Th., Schulz B., Hagemann St., Gerdes Ax., Pfänder J. (2019) Archean Rare-Metal Pegmatites in Zimbabwe and Western Australia. *Springer Briefs in World Mineral Deposits*. Springer, Cham: Cham, Switzerland. ISBN: 978-3-030-10943-1.

[15] Rybina L.P., Volovikov S.A., Giptev S.S. (1994) Reappraisal and grading of discovered rare-metal occurrences in the Central Kalba area, 1992-1994. Report of Asubulak Geological Survey Group. (in Russ.).

[16] Cao M., Zhou Q.F., Qin K.Z., Tang D.M., Evans N. (2013) The tetrad effect and geochemistry of apatite from the Altay Koktokay No. 3 pegmatite, Xinjiang, China: implications for pegmatite petrogenesis, *Mineralogy and Petrology*, 107(6): 985-1005. DOI:10.1007/s00710-013-0270-x.

[17] Shmakin B.M. (1987) Pegmatite deposits of the world. Nedra, Moscow. ISBN: BBH 0310-BH2-050518-30 (in Russ.).

[18] Tkachev A. (2011) Evolution of metallogeny of granitic pegmatites associated with orogens throughout geological time. *Geological Society London Special Publications*, 350 (1): 7-23. DOI:10.1144/SP350.2 (in Eng.).

[19] Xin Zhang, Hui Zhang, Zhan-Long Ma, Yun-Long Liu. (2016) A new model for the granite-pegmatite genetic relationships in the Kaluan-Azubai-Qiongkuer pegmatite-related ore fields, the Chinese Altay, *Journal of Asian Earth Sciences*, 124: 139-155. DOI: 10.1016/j.jseaes.2016.04.020.

[20] Tang Y., Wang H., Zhang H., Lv Z.H. (2018) K-feldspar composition as an exploration tool for pegmatite-type rare metal deposits in Altay, NW China, *J. Geochem. Explor.*, 185: 130-138. DOI: 10.1016/j.gexplo.2017.11.015 (in Eng.).

[21] Guangchun Fei, Julian F. Menuge, Changsheng Chen, Yulong Yang, Yun Deng, Youguo Li, Luo Zheng. (2021) Evolution of pegmatite ore-forming fluid: The Lijiagou spodumene pegmatites in the Songpan-Garze Fold Belt, southwestern Sichuan province, China, *Ore Geology Reviews*, Part A: 104441. DOI: 10.1016/j.oregeorev.2021.104441 (in Eng.).

[22] Mikhailova J.A., Pakhomovsky Y.A., Goychuk O.F., Kalashnikov A.O., Bazai A.V., Yakovenchuk V.N. (2021) Pre-Pegmatite stage in peralkaline magmatic process: insights from poikilitic syenites from the Lovozero Massif, Kola Peninsula, Russia, *Minerals*, 11(9): 974. DOI: 10.3390/min11090974.

CONTENTS

Absametov M.K., Itemen N.M., Murtazin Ye.Zh., Zhexembayev E.Sh., Toktaganov T.Sh. FEATURES OF THE ISOTOPIC COMPOSITION OF GROUNDWATER IN THE MANGYSTAU REGION.....	6
Akimbek G.A., Aliyarov B.K., Badaker V.C., Akimbekova Sh.A. METHODOLOGY AND EXPERIMENTAL SETUP FOR THE STUDY OF RELATIVE ABRASIVENESS OF BULK SOLIDS.....	14
Baibolov K., Artykbaev D., Aldiyarov Zh., Karshyga G. EXPERIMENTAL INVESTIGATIONS OF THE COARSE-GRAINED SOIL IN THE DAM OF THE PSKEM HEP.....	21
Bolatova A., Kutybayev A., Kainazarov A., Hryhoriev Yu., Lutsenko S. USE OF MINING AND METALLURGICAL WASTE AS A BACKFILL OF WORKED-OUT SPACES.....	33
Hajiyeva G.N., Hajiyeva A.Z., Dadashova Kh.D. IMPACT OF URBAN LANDSCAPE POLLUTION ON HUMAN HEALTH.....	39
Hayitov O.G., Zokirov R.T., Agzamov O.O., Gafurov Sh.O., Umirzoqov A.A. CLASSIFICATION OF HYDROCARBON DEPOSITS IN THE SOUTH-EASTERN PART OF THE BUKHARA-KHIVA REGION, JUSTIFICATION OF ITS METHODOLOGY AND ANALYSIS OF THE RESULTS.....	46
Kabylbekov K.A., Abdrakhmanova Kh.K., Kuatbekova R.A., Makhanov T.S., Urmashiev B. COMPUTER SIMULATION OF RADIONUCLIDE ISOTOPE SEPARATION USED IN NUCLEAR ENERGY AND MEDICINE.....	53
Kassenov A.Zh., Abishev K.K., Absadykov B.N., Yessaulkov V.S., Bolatova A.B. ANALYSIS AND JUSTIFICATION OF THE LAYOUT OF A MULTIPURPOSE MACHINE FOR THE DEVELOPMENT OF MINERAL DEPOSITS.....	63
Kaumetova D.S., Koizhanova A.K., Toktar.G., Magomedov D.R., Abdyldaev N.N. STUDY OF THE FINELY-DISPERSED GOLD RECOVERY PARAMETERS.....	69
Rakhmanova S.N., Umirova G.K., Ablessenova Z.N. STUDY OF THE GREATER KARATAU'S SOUTH-WEST BY RANGE OF GEOPHYSICAL SURVEYS IN SEARCH OF THE CRUST-KARST TYPE POLYMETALLIC MINERALISATION.....	76
Oitseva T.A., D'yachkov B.A., Kuzmina O.N., Bissatova A.Y., Ageyeva O.V. LI-BEARING PEGMATITES OF THE KALBA-NARYM METALLOGENIC ZONE (EAST KAZAKHSTAN): MINERAL POTENTIAL AND EXPLORATION CRITERIA.....	83
Sarmurzina R.G., Boiko G.I., Lyubchenko N.P., Karabalin U.S., Demeubayeva N.S. ALLOYS FOR THE PRODUCTION OF HYDROGEN AND ACTIVE ALUMINUM OXIDE.....	91
Suleyev D.K., Uzbekov N.B., Sadykova A.B. MODERN APPROACHES TO SEISMIC HAZARD ASSESSMENT OF THE TERRITORY OF KAZAKHSTAN.....	99
Temirbekova M.N., Temirbekov N.M., Wojcik W., Aliyarova M.B., Elemanova A.A. THE USE OF ORGANIC FRACTION OF SOLID HOUSEHOLD WASTE TO GENERATE ETHANOL AND BIOGAS USING A SIMULATION MODEL.....	105

Tulegulov A.D., Yergaliyev D.S., Bazhaev N.A., Keribayeva T.B., Akishev K.M. METHODS FOR IMPROVING PROCESS AUTOMATION IN THE MINING INDUSTRY.....	115
Tulemisova G., Abdinov R., Amangosova A., Batyrbaeva G. STUDY OF THE BOTTOM SEDIMENTS OF RESERVOIRS OF URAL-CASPIAN BASIN.....	126
Turgazinov I.K. Mukanov D.B. ANALYSIS OF FLUID FILTRATION MECHANISMS IN FRACTURED RESERVOIRS.....	135
Uakhitova B., Ramatullaeva L.I., Imangazin M.K., Taizhigitova M.M., Uakhitov R.U. ANALYSIS OF THE LEVEL OF OCCUPATIONAL INJURIES ON THE EXAMPLE OF AN INDUSTRIAL ENTERPRISE OF A METALLURGICAL CLUSTER.....	145
Yurii Feshchuk, Vadym Nizhnyk, Valeriia Nekora, Oleksandr Teslenko IMPROVING THE SYSTEM FOR RESPONDING TO FIRE IN AREAS CONTAMINATED BY THE CHERNOBYL DISASTER.....	152
Sherov A.K., Myrzakhmet B., Sherov K.T., Absadykov B.N., Sikhimbayev M.R. METHOD FOR SELECTING THE LOCATION OF THE CLEARANCE FIELDS OF THE LANDING SURFACES OF GEAR PUMP PARTS WITH A BIAXIAL CONNECTION.....	159
Khamroyev J.Kh., Akmalaiuly K., Fayzullayev N. MECHANICAL ACTIVATION OF NAVBAHORSK BENTONITE AND ITS TEXTURAL AND ADSORPTION CHARACTERISTICS.....	167
Zhurinov M.Zh., Teltayev B.B., Aitbayev K.A., Loprencipe G., Tileu K.B. MODELING OF NON-STATIONARY TEMPERATURE MODE OF A MULTI-LAYER ROAD STRUCTURE.....	175

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

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 National Academy of Sciences of the Republic of Kazakhstan 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 National Academy of Sciences of the Republic of Kazakhstan 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 National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

[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)

Редакторы: *М.С. Ахметова, А. Ботанқызы, Д.С. Аленов, Р.Ж. Мрзабаева*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 14.02.2022.

Формат 60x881/8. Бумага офсетная. Печать – ризограф.

11,5 п.л. Тираж 300. Заказ 1.