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

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

ҚАЙЫРЫМДЫЛЫҚ ҚОРЫ HALYK CHARITY FOUNDATION

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

ХАБАРЛАРЫ

ИЗВЕСТИЯ

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

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN
«Halyk» Private Foundation

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

5 (461)

SEPTEMBER – OCTOBER 2023

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. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

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

ЧФ «ХАЛЫҚ»

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

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

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

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

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

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

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

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

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

С уважением,
Благотворительный Фонд «Халык»!

«ҚР ҰҒА» РҚБ 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/

«Известия РОО «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 соеденений.*

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/

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/

NEWS of the National Academy of Sciences of the Republic of Kazakhstan
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224–5278
Volume 5. Number 461 (2023), 8–21
https://doi.org/10.32014/2023.2518-170X.327

UDC 622.24.063
UDC 550.383.2

© A.E. Abetov[1], N.B. Uzbekov[2], A.N. Uzbekov[3]*, 2023
[1]Satbayev University, Almaty, Kazakhstan;
[2]Institute of seismology MES RK, Almaty, Kazakhstan;
[3]Institute of Geophysical Research National Nuclear Center of Republic of Kazakhstan.
E-mail: *abl_21@mail.ru*

STRUCTURE AND INTERPRETATION OF THE ANOMALOUS GEOMAGNETIC FIELD OF CENTRAL KAZAKHSTAN

Abetov A.E. — Doctor of Geological and Mineralogical Sciences. Associate Professor Geology and Oil–gas Business. Institute named after K. Turyssov, Department of "Geophysics". Almaty. Kazakhstan
E-mail *abetov.auez@mail.ru*, *https://orcid.org/0000–0002–1866–7677*;
Uzbekov N.N. – PhD, Director of Science of Institute of Seismology of Emergency of Ministry Republic of Kazakhstan
E-mail *nursarsen@inbox.ru*, https://orcid.org/*0000–0001–5831–9303*;
Uzbekov A.N. – PhD, Senior Science, Institute of Geophysical Research of the National Nuclear Center Republic of Kazakhstan
E-mail abl_21@mail.ru, https://orcid.org/*0000–0001–6152–4068*.

Abstract. The anomalous geomagnetic field of Central Kazakhstan reflects the different level of magnetization of rocks, as well as their relative position, structure and occurrence depth. The highest contrast of ΔTa anomalies is observed above the outcrops to the ground surface of the pre-Mesozoic basement, where elements of the geological structure, deep faults, blocks of sedimentary-volcanic formations, areas of secondary changes in rocks, as well as some mineral deposits confined with them, are shown in the structure of the anomalous geomagnetic field. The morphology, intensity and size of geomagnetic anomalies give an opportunity for identification and geological prediction, while the differentiation of these anomalies, their gradient characterize the qualitative (structural) features of *causative magnetic bod*ies. The anomalous geomagnetic field of Central Kazakhstan is caused by inhomogeneously magnetized rocks lying at different depths in the Earth's crust. The high differentiation of this field reflects the geological structure of Central Kazakhstan and induces genetic and tectonic-magmatic aspects of its geological structure and geological evolution. In Central Kazakhstan, magnetic anomalies of various parameters are observed: a) in morphology: linear-elongated and arc-shaped, tortuous with a clearly expressed of the larger axis, polygonal, subisometric, oval, circular, mosaic and complex in configuration and in plan; b) in tension: intense

and low-intensity; low- and high-gradient (contrasting); c) in size: large, medium and small. There is a relationship between the magnetization of rocks and the vertical component Bz of the magnetic field with seismic activity and anomalies of the latest and modern movements of the earth's crust, with geophysical potential fields, including thermal fields. Earthquake sources are confined to deep faults or fault nodes and are characterized by violent changes in the signs of intensity and orientation of magnetic anomalies. The largest number of seismic events is confined with faults delimiting tectonic blocks with geomagnetic field anomalies of different intensity and sign.

Keywords: geomagnetic anomalies, deep faults, negative, positive, vertical component

© А.Е. Әбетов[1], Н.Н. Өзбеков[2], А.Н. Өзбеков[3]*, 2023
[1]Satbayev University, Алматы, Қазақстан;
[2] Қазақстан Республикасы Төтенше Жағдайларға Министрлігі Сейсмология Институты;
[3]Қазақстан Республикасы Ұлттық Ядролық Орталығы Геофизикалық Зерттеу Институты.
E-mail: *abl_21@mail.ru*

ОРТАЛЫҚ ҚАЗАҚСТАННЫҢ ГЕОМАГНИТТІК ҚРІСІ АНОМАЛИЯЛАРЫНЫҢ ҚҰРЛЫМЫ МЕН ТҮСІНДІРМЕСІ

Әбетов А.Е. — Профессор. Қауымдастырылған профессор. Қ. Тұрысов атындағы Геология және мұнай-газ ісі институты. Геофизика кафедрасы, Алматы, Казахстан
E-mail *abetov.auez@mail.ru*, *https://orcid.org/0000–0002–1866–7677*;
Өзбеков Н.Н. — PhD, Директордың ғылыми жөніндегі орынбасары, ТЖМ ҚР Сейсмология Институты, Алматы, Қазақстан
E-mail *nursarsen@inbox.ru*, https://orcid.org/*0000–0001–5831–9303*;
Өзбеков А.Н. — PhD, Аға ғылыми қызыметкер, ҚР ЯҰО ГЗИ, Алматы, Қазақстан
E-mail abl_21@mail.ru, https://orcid.org/*0000-0001–6152–4068*.

Аннотация. Орталық Қазақстанның қалыптан тыс геомагниттік өрісі тау жыныстарының магниттелуінің әртүрлі деңгейін, сондай-ақ олардың өзара орналасуын, құрылымын және пайда болу тереңдігін көрсетеді. ΔTa аномалияларының ең үлкен контрасты геологиялық құрылым элементтері, тереңдік ақаулары, шөгінді-жанартау түзілімдерінің блоктары, тау жыныстарының қайталама өзгеру аймақтары, сондай-ақ олармен шектелген кейбір пайдалы қазбалар кен орындары суретте көрсетілген домезозой іргетасының жер бетіне шығуларында байқалады, қалыптан тыс геомагниттік өрістің құрылымы. Геомагниттік ауытқулардың морфологиясы, қарқындылығы және өлшемдері сәйкестендіру және геологиялық болжау мүмкіндігін береді, ал бұл ауытқулардың дифференциациясы, олардың градиенті себеп-салдарлық магниттік денелердің сапалық (құрылымдық) ерекшеліктерін сипаттайды. Орталық Қазақстанның қалыптан тыс геомагниттік өрісі жер қыртысында әртүрлі тереңдікте жатқан гетерогенді магниттелген жыныстардан туындайды. Бұл кен орнының жоғары

сарлануы Орталық Қазақстанның геологиялық құрылымын көрсетеді және оның геологиялық құрылымы мен геологиялық эволюциясының генетикалық және тектоникалық-магмалық аспектілерін анықтайды. Орталық Қазақстанда әртүрлі параметрлердің магниттік ауытқулары байқалады: а) морфологиясы бойынша: сызықты-ұзартылған және доға тәрізді, айқын үлкен осі бар бұралған, көпбұрышты, субизометриялық, сопақша, дөңгелек, мозаикалық және конфигурациясы мен жоспары бойынша күрделі; б) кернеуі бойынша: қарқынды және төмен - қарқындылығы; төмен және жоғары градиенті (контраст); в) өлшемі бойынша: үлкен, орташа және кішкентай. Тау жыныстарының магниттелуі мен магнит өрісінің тік Bz компоненті арасында сейсмикалық белсенділікпен және жер қыртысының соңғы және қазіргі қозғалыстарының ауытқуларымен, потенциалды геофизикалық өрістермен, соның ішінде жылу өрістерімен байланыс бар. Жер сілкінісінің ошақтары терең ақаулармен немесе ақаулық түйіндерімен шектелген және магниттік ауытқулардың қарқындылығы мен бағдарлану белгілерінің күрт өзгеруімен сипатталады. Сейсмикалық оқиғалардың ең көп саны әртүрлі қарқындылық пен белгінің геомагниттік өрісінің ауытқулары бар тектоникалық блоктарды бөлетін ақауларға сәйкес келеді.

Түйін сөздер: геомагниттік ауытқулар, тереңдік ақаулары, теріс, оң, тік компонент

©А.Е. Абетов[1], Н.Н. Узбеков[2], А.Н. Узбеков*[3], 2023
[1]Satbayev University, Алматы, Казахстан;
[2]Институт Сейсмологии Министерства по чрезвычайным ситуациям Республики Казахстан;
[3]Институт геофизических исследований Национального Ядерного Центра Республики Казахстан.
E-mail: *abl_21@mail.ru*

СТРУКТУРА И ИНТЕРПРИТАЦИЯ АНОМАЛИИ ГЕОМАГНИТНОГО ПОЛЯ ЦЕНТРАЛЬНОГО КАЗАХСТАНА

Абетов А.Е. — Доктор геолого-минералогических наук. Профессор. Ассоциированный профессор Институт геологии и нефтегазового дела им. К. Турысова. Кафедра Геофизики. Алматы, Казахстан
E-mail *abetov.auez@mail.ru*, *https://orcid.org/0000–0002–1866–7677*;
Узбеков Н.Н. — PhD, Заместитель директора по науки, Институт Сейсмологии МЧС РК, Алматы, Казахстан
E-mail *nursarsen@inbox.ru*, https://orcid.org/*0000-0001–5831–9303*;
Узбеков А.Н. — PhD, Старший научный сотрудник, ИГИ НЯЦ РК, Алматы, Казахстан
E-mail abl_21@mail.ru, https://orcid.org/*0000-0001–6152–4068*.

Аннотация. Аномальное геомагнитное поле Центрального Казахстана отображает разную степень намагниченности горных пород, а также их относительное взаиморасположение, структуру и глубину залегания. Наибольшая контрастность аномалий ΔTa наблюдается над выходами на дневную поверхность домезозойского фундамента, где в структуре аномального геомагнитного поля

проявляются элементы геологического строения, глубинные разломы, блоки осадочно-вулканогенных формаций, места проявления вторичных изменений горных пород, а также приуроченные к ним некоторые месторождения полезных ископаемых. Морфология, напряженность и размеры геомагнитных аномалий предоставляют возможность проведения идентификации и геологического прогноза, тогда как дифференцированность этих аномалий и их градиентность характеризуют качественные (структурные) признаки магнитовозмущающих тел. Аномальное геомагнитное поле Центрального Казахстана обусловлено неоднородно-намагниченными горными породами, залегающими на разной глубине в земной коре. Высокая дифференцированность этого поля отражает геологическую структуру Центрального Казахстана и индуцирует генетические и тектоно-магматические аспекты его геологического строения и истории развития. В Центральном Казахстане наблюдаются самые различные по своим параметрам магнитные аномалии: а) по морфологии: линейно-вытянутые и дугообразные, извилистые с четко выраженным преобладанием большей оси, полигональные, субизометрические, овальные, кольцевые, мозаичные и сложные по конфигурации в плане; б) по напряженности: интенсивные и малоинтенсивные; низко-и высокоградиентные (контрастные); в) по размеру: крупные, средние и весьма незначительные по площади. Прослеживается взаимосвязь между намагниченностью пород и вертикальной компоненты Bz магнитного поля с сейсмической активностью и с аномалиями новейших и современных движений земной коры, с геофизическими потенциальными полями, в т. ч. с тепловыми полями. Очаги землетрясений приурочены к глубинным разломам или узлам разломов и характеризуются резкой сменой знакам напряжённости и ориентации магнитных аномалий. Наибольшее количество сейсмических событий приурочено к разломам, разграничивающим тектонические блоки с разными по интенсивности и знаку аномалии геомагнитного поля.

Ключевые слова: геомагнитные аномалии, глубинные разломы, отрицательные, положительные, вертикальная компонента

Introduction

When studying the deep structure of the earth's crust, a wide range of geological and geophysical methods are used, among which an important place is given to magnetic exploration, since the data obtained carry reliable information about the parameters of the basement that determines the direction and geological evolution of any region (Belkin et al., 1983).

The history of geomagnetic survey at the of Central Kazakhstan can be divided into several stages.

The first magnetic surveys with Tiberg-Talen magnetometers (M-1) were carried out by D.N. Redkin in 1932 at the Karazhal (Ustanynzhal), Bolshoy and Maly Ktai areas, where iron ore outcrops were known by that time.

In 1934–1936, magnetic survey was carried out in Central Kazakhstan by Atasu geophysical parties of "Kazakh Geology Corporate". In the process of subsequent analysis and integration of date based on the results of areal surveys of the anomalous

geomagnetic field, a number of hidden intrusive and subvolcanic bodies, faults of various directions and scales, overlain by sedimentary deposits of the Upper Devonian and Lower Carboniferous ages, buried horsts and grabens of various orders and other tectonic elements were revealed.

As a result of these works, information was obtained about the general structure of the geomagnetic field of Central Kazakhstan and a number of iron deposits were discovered on a total area of about 750 thousand square kilometers (Abetov et al., 2020).

Since 1950, regional (in scales 1:1 000 000; 1:500 000; 1:200 000) and exploration (in scale – 1:100 000) aeromagnetic surveys in Central Kazakhstan were carried out with ferrosonde aeromagnetometers AEM-49 by the All-Union Research Institute of Exploration Geophysics (Litvinova et al., 2002).

By the end of the 50s, almost the entire territory of Central Kazakhstan was captured by medium-scale regional and exploration aeromagnetic surveys with ferrosonde aeromagnetometers. The materials of these studies were the basis for the compilation and preparation for publication of sheet maps of the anomalous geomagnetic field of Kazakhstan in scales of 1:200 000 and 1:1000 000.

However, due to the fact that these surveys were carried out in most cases with visual reference to outdated 1:200000 scale topographic maps, the accuracy of the resulting maps is recognized as low.

In 1962–1966 «The Kazakh Geophysical Trust», KAZVIRG and the Volkov expedition in Central Kazakhstan fulfilled large-scale aeromagnetic surveys with aerial photograph navigation of routes with more modern ferrosonde aeromagnetometers AMF-21 (stations ASG-45, ASG-46, ASG-48, ASG-48-M2 and AM-13), which allowed to increase the accuracy of these surveys (± 15-25 nT) (Litvinova et al., 2002). Wide-angle aerial cameras began to be used for aerial photograph navigation and networks of frame routes began to develop.

In 1961 “The Kazakh Geophysical Trust” the electronic navigation of routes was tested, which allowed since 1963 to transfer to aeromagnetic surveys in a scale of 1:10000 with increased requirements for the accuracy of route linking (± 25 m) and the accuracy of active aircraft driving (± 30 m). The accuracy of these surveys has increased to ± 10-20 nT.

In general, multi-scale aeromagnetic surveys in Central Kazakhstan for the period 1955–1966 have overlaps both among themselves and for each individual site. In other words, large-scale surveys in most cases cover the areas of small- and medium-scale surveys fulfilled in previous years with ferrosonde aeromagnetometers of the first generations.

In 1966–1968 the Kazakh Geophysical Trust (V.N. Grigoriev) performed a critical analysis of materials made in Kazakhstan (including Central Kazakhstan) of aeromagnetic surveys as of 01.01.1967. As a result of these surveys, the cartograms of aeromagnetic study were compiled on the scales, and technical, and economic *features*, the results of aeromagnetic surveys of various types were compared with each other and with ground surveys. The questions of the method of interpretation of aeromagnetic data are considered.

Based on the above, aeromagnetic surveys were assigned to a certain scale of research. In 1965-1968, the "Kazakh Geophysical Trsut" compiled and prepared for publication a generalized map of the isodynamic anomalous magnetic field of Kazakhstan in a scale of 1:1 500 000 (M.V. Kuminova, A.M. Shurunova, V.M. Serdyukova, L.M. Krukhmaleva, A.E. Vasnetsov) the general editorship of M.D. Morozov. This generalized map was the first overview map of the anomalous magnetic field of Kazakhstan, reflecting various elements of its geological structure.

In the future, it was widely used in planning regional and prospecting geological and geophysical exploration, in performing various case studies, compiling integral maps of different geological contents: metallogenic, tectonic, magmatic formations, etc.

Smalle-scale aeromagnetic surveys with ferrosonde aeromagnetometers of the latest generation to assist geological exploration continued until 1978. Since 1964 they were performed in parallel with discrete measurements of the full vector quantity of the geomagnetic field. This made it possible to bring the relative measurements to the absolute values of the Earth's magnetic field.

In 1978, KAZIMS (N.Ya. Ekidina) carried out study to assess the quality of aeromagnetic studies with ferrosonde aeromagnetometers that were being completed in Kazakhstan (including in Central Kazakhstan) and surveys with proton and quantum aeromagnetometers that began at a qualitatively new level. As a result of this study on the scales of 1:500 000 and 1:3 000 000, cartograms of aeromagnetic knowledge for this period were compiled, on which certain reporting maps were assigned to a certain conditioned scale.

In addition to the exploration, the materials of small-scale aeromagnetic surveys were used in the ongoing compilation, preparation for redaction and publication of sets of sheet maps of the anomalous geomagnetic field in a scale of 1:200 000 in graphs and isolines, as well as at a scale of 1:1 000 000 in isolines (Litvinova et al., 2002).

In 1974, under the scientific editorship of Z.A. Makarova, a generalized map of the anomalous geomagnetic field of Kazakhstan was published in scales of 1:1 000 000 and 1:200 000. In 1978, by Z.A. Makarova published an explanatory report to this map, which was the final step of many years of work of cartographic parties on the compilation and preparation for publication of sets of magnetic maps of scales 1:200 000 and 1:1 000 000 (Daukeev et al., 2002).

In 2004, the 1:1 000 000 scale map of the anomalous magnetic field (ΔTa) of Kazakhstan was published. (Daukeev et al., 2002; Uzhkenov et al. 2004).

Findings. Inhomogeneously magnetized rocks of the consolidated Earth's crust, lying at different depths, are mainly reflected into the field of regional geomagnetic anomalies of Central Kazakhstan. The differentiation of rocks by the level of magnetization, their physical structure, and the depth of occurrence determine the morphology of the anomalous geomagnetic field of Central Kazakhstan, the structure of which mainly reflects inhomogeneously magnetized rocks of the consolidated Earth's crust (Belkin et al., 1983). The sedimentary cover, being practically non-magnetic or weakly magnetic, does not change the picture of the field created by the submerged parts of the Paleozoic structures.

In the anomalous geomagnetic field of Central Kazakhstan (isolated within the boundaries of the shield of the same name), geomagnetic anomalies of the most diverse morphology are observed: linear-elongated and arcuate, wavy with clearly defined predominance of the larger axis, alternating with subisometric, annular, mosaic and complex configuration in terms of anomalies (Fig 1) (Litvinova et al., 2002).

Linear anomalies, as a rule, can be traced for tens and hundreds of kilometers and in most cases are confined to zones of large anticline structures. Isometric, annular and oval anomalies conform to the batholiths and other intrusive rocks. Grouping in the form of mosaic, annular zones of isometric and multidirectional narrow-line anomalies reflect their confinedness to the arched uplifts of the Earth's crust.

The greatest contrast, expressiveness and informative values of are observed above the outcrops of the pre-Mesozoic crystalline basement on the ground surface, where elements of the geological structure are clearly displayed in the anomalous geomagnetic field. The intensity of the geomagnetic field here also sustains sharp variations. There are large and small-sized, intense and low-intensity anomalies, with low and high gradient changes in intensity profile (Belkin et al., 1983).

Linear anomalous zones. They form extended linearly elongated or arcuate anomalies. However, it is not uncommon for these zones to contain isometric and polygonal forms of ΔTa anomalies with increased or decreased values, located in chains, echelon-shaped or clearly oriented in a certain direction (Lugovenko et al., 1974; (Lugovenko et al., 1984). This type of anomalies is associated with large-sized anticline structures, deep faults.

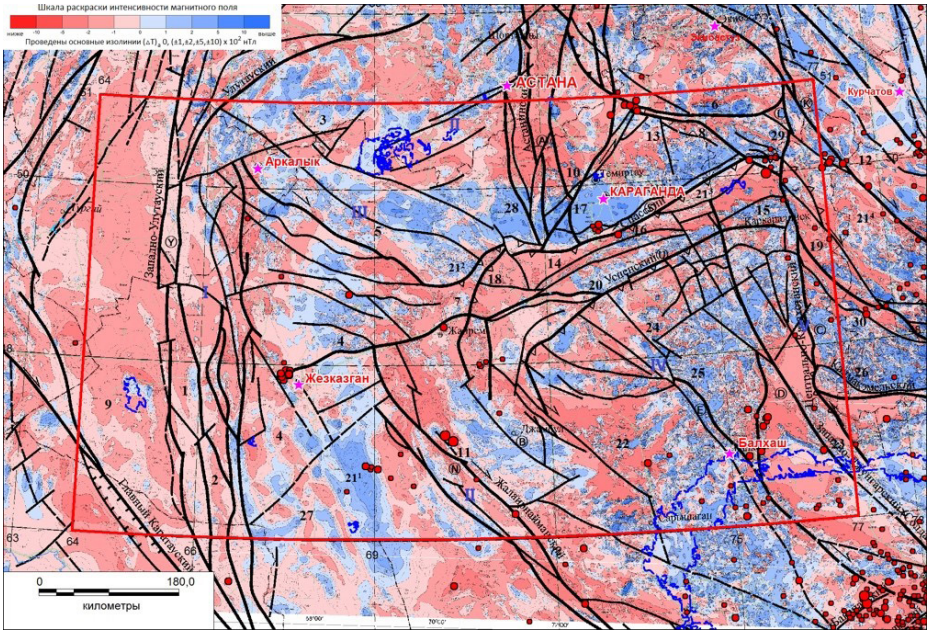

Fig 1. Fragment of the map of the anomalous magnetic field of Central Kazakhstan with elements of tectonics and seismicity.

Description: I-Metamorphic basement highs; II-Caledonian folded zones; III-Superimposed Hercynian structures on the Caledonides: IV-Hercynian Jungar-Balkhash system; V- Balkhash-Ili Late Paleozoic volcanic belt.

1-30. Tectonic elements.

I-Metamorphic basement highs: 1–2 - Ulutau;

II-Caledonian folded zones. Anticlinories: 6 - Ermentau, 8 - Boschekul, 12 - Chingiz, 27 - Betpakdalin, 28 - Maykain;

Synclinories: 9 - Baikonur, 10 - Seletin, 11 - Jalair-Naiman, 29 - Bayanaul;

III-Superimposed Hercynian structures in the Caledonides: 3 - Teniz depression, 4 - Dzhezkazgan (Chu- Dzhezkazgan) depression, 5 - Sarysu-Teniz zone of block folds; 7 - Karazhal trough, 13 - Shiderty depression, 17 - Karaganda depression; 21^1- 21^2 -21^3-21^4 - Devonian regional volcanic-plutonic belt.

IV-Hercynian Jungar-Balkhash system. Anticlinories: 14 - Spassk, 16 -Tekturmas, 18 - Atasu, 22 - Aktau-Mointy, 23 - North-Balkhash. Synclinories: 15 - Nurin, 19 - Karasor, 20 - Uspensk (with the same name crumpling zone), 24 - Zhaman-Sarysu;

V- Balkhash-Ili Late Paleozoic volcanic belt: Depressions: 25 -Tokrau, 26 - Kalmakemel, 30 - Bakanas.

Deep faults: Ⓐ- Astana, Ⓑ-Western Balkhash, Ⓒ-Central Kazakhstan, Ⓓ-West Junggar, Ⓔ-Kounrad-Borlyn,Ⓚ-Kalba-Chingiz, Ⓛ-Chingiz regional upthrust, Ⓝ-the Zhalair-Naiman, Ⓢ-Spassky, Ⓤ Uspensky, Ⓨ-West-Ulutau.

Red circles are earthquakes sources. Black lines are tectonic faults. The red line is the contour under study.

The highest contrast, expression or informativeness of ΔTa anomalies is observed over the outcrops of the pre-Mesozoic basement of Central Kazakhstan, where the structure of the anomalous geomagnetic field clearly shows such elements of the geological structure as magmatic formations of intermediate and basic composition, deep faults, blocks of sedimentary-volcanogenic formations, areas manifestations of secondary changes in rocks, as well as certain types of mineral deposits confined to them (Nusipov et al., 2007).

An example of a contrasting displays of fault tectonics into the positive anomalous geomagnetic field of Central Kazakhstan with an intensity from +150 to +600 nT and more is a meridional tectonic block containing intrusive of magnetic Upper Carboniferous leucogranites and a non-magnetic sedimentary rocks block located in its southeastern part. It is confined to a fragment of the Central Kazakhstan Fault, which traces toward northwestern direction (Fig 1).

The Spassky Thrust (the northwestern extremities of the Chingiz Thrust) and the Kalba-Chingiz Thrust-Strike - Slip, as well as the Balkhash and Zhalair-Naiman faults with the northwestern direction are quite confidently displayed the characteristic stepping down of AGMF, which are separated by dramatic negative linear anomalies ΔTa (Litvinova et al., 2002).

In the Zhalair-Naiman structural-tectonic zone along the fault of the same name, earthquake source recorded in the depth range of 18–22 km (Mikailova et al., 2018).

The linear anomalous zone of the magnetic field of the Spassk anticlinorium, confined to the fault of the same name, is oriented from north-east to south-west. The intensity of geomagnetic field anomalies here varies in the range of -50÷-650 nT or more (Fig 1).

In places, sporadically developed linear anomalies with positive sign (+50÷+600 nT and more) are observed. The orientation of the ΔTa anomalies is fully consistent with the spatial positioning of the Spassky anticlinorium. In some areas located in the area of the junction of the latter with the Karaganda depression, earthquake sources are recoded in the depth range of 15–24 km (Abetov et al., 2020; Mikailova et al., 2018).

At the Ulutau metamorphic basement high, ΔTa anomalies are genetically associated with intrusions of the main–medium composition or blocks of ultramafic and effusions of the main-medium compositions. The negative anomalies of the geomagnetic field here are oriented submeridionally, from the southeast to the northwest. The intensity of these anomalies varies in the range of -50÷-500 nT or more. Here, sporadically developed linear anomalies of a positive sign (+50÷+600 nT) are observed. The orientation of the ΔTa anomalies coincides with the extension of the Ulutau metamorphic basement high.

Earthquake sources are recorded in the depth range of 14-16 km in some areas of this high, located in the zone of its junction with the Zhezkazgan depression. In the southern part of the Devonian marginal volcanic-plutonic belt, positive geomagnetic field anomalies are oriented submeridially. Their intensity varies in a wide range +50 ÷+550 nT and more (Abetov et al., 2020).

There is no consistency in the extension of the southern part of the Devonian marginal volcanic-plutonic belt and the ΔTa anomalies isolated here. Hypocenters of seismic events were recorded in the depth range h=1-15 km (Mikailova et al., 2018). The anomalies of this belt are oriented an archwise. On its southern flank their north-western orientation is observed, on the southern – north-eastern (Fig 1).

The extension of the geomagnetic field anomalies here is consistent with the extension of the Devonian marginal volcanic-plutonic belt. The intensity of negative anomalies of ΔTa here varies in the range of -50÷-650 nT and more. Sporadically occurrence positive linear anomalies (+50 ÷ +550 nT and more) are observed. Earthquake sources recorded in the depth range of 18-20 km are observed in some areas.

In the northwestern part of the Devonian marginal volcanic-plutonic belt and in the Maykain anticlinory, areas of increased values of anomalies of complex polygonal shape with a tension up to +600 nT or more are isolated, more often elongated in the northwestern and sublatitudinal directions. The genesis of these anomalies may be associated with submerged intrusions of the basic-intermediate composition exposed to the north, as well as metasomatic and metamorphic changes.

In the north-east of the Karaganda depression, on the phon of positive variations of the anomalous of geomagnetic field (+500÷+600 nT), there are areas of inversion of this field with the value of anomalies ΔTa up to -100 ÷ -300 nT (Fig 1).

The areas in the north of the Karaganda depression draw special attention, where an increase in the intensity of anomalies Δ Ta up to +500 nT and more is observed over non-magnetic rocks of the Carboniferous and Jurassic, interpreted by the relatively shallow occurrence of post-Carboniferous intrusions, which can be represented by granodiorite outcrops 60 km northwest of the village of Shakhtinsk.

The earthquake sources recorded in the depth interval of 14–22 km in some areas located in the junction zone of the Karaganda depression with the Tekturmas anticlinorium, within the swathe of the Spassk fault (Mikailova et al., 2018).

Our studies made it possible to determine the nature of this fault using the method of A.V. Vvedenskaya, which is by northwest-trending strike-slip fault with a large amplitude, that is consistent with the dynamics of regional faults in this direction.

Standard method of A.V. Vvedenskaya, based on the signs of the first arrivals of the P-wave to construct a stereogram of the earthquake source mechanism, determine the orientation of the three main stress axes and the position of two equiprobable nodal planes (Vvedenskaya, 1969).

Isometric and oval anomalies. Isometric, ring and oval anomalies of different sizes match to the subjacent intrusive, batholiths, eruptive vents and other local geological formations. Above these bodies observed local isometric negative anomalies with intensity from a few hundred to a thousand nT amid of indifferent negative or weakly positive magnetic field.

Anomalous geomagnetic fields with intensity from -200 to -650 nT and more are represented by local isometric (including ring) anomalies ΔTa confined to the mapped subjacent intrusive and massifs of Lower Permian syenodiorites (easterly the Torgai, Eremtau and Arshaly settlements), alaskites (for example, near the settlements Kokdombak and Bayanaul), granodiorites (40 km west of the Akadyr railway station) within the structural elements of the Boshchekul anticlinorium and the Shiderty depression.

In the structural elements of the Teniz depression and the Sarysu-Teniz zone of block folds, composed by Paleozoic formations, are formed by isometric or polygonal positive anomalies with increased intensity (from +100 to +500 nT and more). In some areas, the intensity of anomalies here increases up to +600÷+700 nT, less often more (Litvinova et al., 2002).

The genesis of ΔTa anomalies is associated with subjacent intrusive, massifs of Lower Permian syenodiorites. The orientation of anomalies or anomalous zones can be grouped into northeast, northwest and meridional directions, which are not consistent with the general orientation of the Teniz depression and Sarysu-Teniz zone of block folds (Daukeev et al., 2002).

The Uspensky anticlinorium in the anomalous geomagnetic field is a zone of sublatitudinal orientation with anomaly intensity from -200÷-600 to +100÷+550 nT. It is isolated by the coincidence of the orientation of magnetic anomalies and tectonic elements (Litvinova et al., 2002).

Mosaic systems of anomalies of alternating-sing geomagnetic field. They are isolated by small isometric and irregularly shaped anomalous areas, representing by a set of chaotically located positive and negative anomalies of varying intensity.

The complex nature of the anomalous geomagnetic field practically does not change at the North Balkhash anticlinorium. Intense geomagnetic anomalies of variable values (from -200÷-500 nT to +500 nT and more) of both signs form anomalous fields of complex configuration here, which are associated with the intrusions of the North-Balkhash (Kounrad) and Sayak metallogenic regions.

To the east and northeast of the Central Kazakhstan and Chingiz regional faults in the anomalous geomagnetic field, the area of sharply differentiated ("variegated") anomalies is isolated with a clear tendency to northwest strike. According to magnetic data, this territory entire can already be attributed to the Irtysh-Altai folded belt.

In the anomalous geomagnetic field of the Zhezkazgan depression, it seems possible to trace a clearly defined contact (and partly a deep continuation) of large geological structures in Kazakhstan. In its northwestern part, outcrops of the Ulutau (Karsakpaya) crystalline basement are mapped; in the southwestern part - the northern end of the Big Karatau ridge; and to the northeast and east, segments of the Atasu, Chu-Ili and Zhalair-Naiman folding zones are marked.

In the anomalous geomagnetic field of the central part of the Zhezkazgan depression, a clearly pronounced anomaly ΔTa is observed, elongated in the northwest direction and consisting of three maxima with values of +200÷+400 nT (20 km southwest of the cities of Zhezkazgan and Satbaev). This anomaly is probably caused by a latent (non-eroded) mafic-intermediate intrusive, which played an important role in metamorphogenic processes.

Earthquake sources were recorded in separate areas confined to fault zones and located in the joint zone of the Dzhezkazgan depression with the Ulutau metamorphic basement high in the depth range of 14-16 km.

The Dzhungaro-Balkhash region is isolated by the complex nature of the anomalies of geomagnetic fields with the intensity of anomalies of both signs from -200÷-500 to +50÷+400 nT and more. The strike of these anomalies here is weakly correlated with the orientation of tectonic elements. Earthquake sources were recorded with a depth of 15–22 km in the fault zones of this region (Nusipov et al., 2007).

Result and discussion

The vertical components of the Bz magnetic field were studied in order to obtain a complete picture of the nature of magnetically disturbing objects (Nusipov et al., 2007).

A fragment of the scheme of the vertical component Bz of the Kazakh shield (for the epoch 1900 and 2004) was used to study its tectonic structure and is a system of isolines with negative and positive values, forming extensive maxima and minima (Fig 2).

The Zhalair-Naiman synclinorium, the Devonian marginal volcanic-plutanic belt and the Aktau-Mointy anticlinorium form a large subisometric anomalous region of negative values of the vertical component Bz from -10 up to -30 nT or more, which, apparently, will approaches to more heated rocks of the consolidated crust (Nusipov et al., 2007).

From the west (Ulutau metamorphic ledge, Zhezkazgan depression, the southern part of the Devonian marginal volcano-plutonic belt), from the north (Tenizkaya depression, Maikainsky anticlinorium) and from the east (Uspensky and Zhaman-Sarysu syncolinories, Dzungar-Balkhash region), this anomalous area is adjacent to vast the range of positive values of the vertical component Bz (from +10 to +40 nT and more) (Fig 2).

The nature of these positive values can be explained by the presence here of more heated rocks of the consolidated crust in the field of the dipole current component of the Earth's main planetary field (Nusipov et al., 2007).

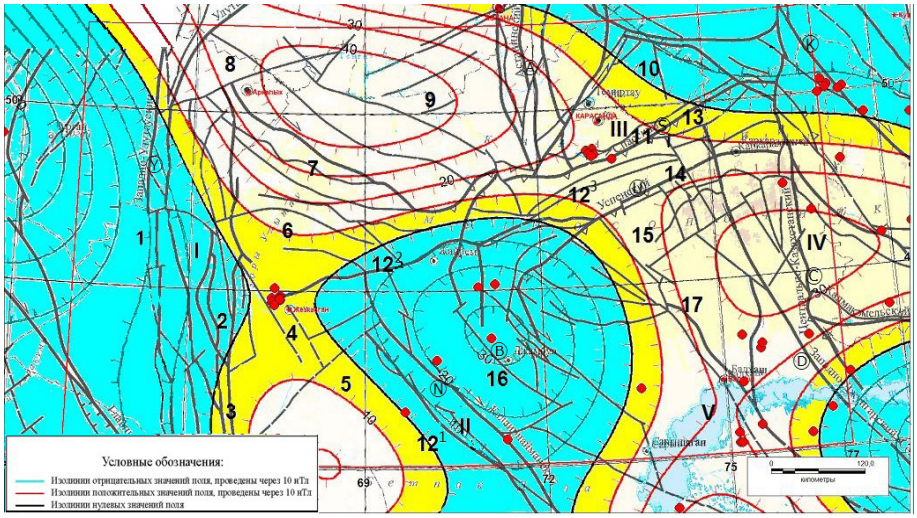

Fig 2. The fragment of the scheme of the vertical component Bz of the magnetic field of the Kazakhstan's lithosphere, according to the MF POMME model for the 2001 epoch. Scale 1:5,000,000 with highlighted contour under study and earthquake sources.

In general, a fragment of the scheme of the vertical component Bz of the magnetic field of the Kazakh shield is interesting in that the nature of the isolines coincides with the nature of the isolines of the amplitudes of modern earth crust movements according to ground leveling data (Abetov et al., 2020) obtained as a result of many years of ground leveling work.

This fact means with a high probability the relationship between the state of magnetization of the deep layers of the earth's crust and the fields of modern motions. Since the basicity of rocks increases with depth, there is an obvious connection between the geothermal field and magnetic susceptibility (Abetov et al., 2020).

It is known that the Curie point for rocks is several hundred degrees. Therefore, weak and negative fields can correspond to heated rocks of the crust, while less heated ones form positive fields, being magnetized in the field of the dipole current component of the main planetary field of the Earth.

It should be added to this that on slices of the consolidated crust at depths of 10 and 30 km there is a trend of increasing the value of geothermal anomalies in the western direction, which is a criterion for changing the thermal conductivity of the rocks. Geothermal anomalies are confined to active tectonic faults and have direct correlations with the morphology, orientation, and intensity of magnetic and gravity anomalies (Abetov et al., 2019).

Areas with increased values of geothermal anomalies are characterized by linearly elongated anomalies of the geomagnetic field of both signs and submeridional orientation, while areas with decreased values of geothermal anomalies on slices of the consolidated crust of 10 and 30 km have mosaic, oval and ring anomalies of the geomagnetic field (Nusipov et al., 2007).

Areas with minimum temperatures in the consolidated crust correspond to a wide

range of changes in anomalies and the sign of the geomagnetic field. Here it is unstable and variable (Abetov et al., 2019).

The Central Kazakhstan Gravity Minimum and adjacent areas are distinguished by low values of thermal fields on slices of the consolidated crust of 10 and 30 km (Abetov et al., 2019). From here, to the west, towards the Ulutau high of the metamorphic basement, the density of the consolidated crust and the values of geothermal anomalies increase (Abetov et al., 2019), which is directly related to the different thermal conductivity of the rocks that make up the consolidated crust.

Earthquake sources are concentrated along the periphery of the Central Kazakhstan Gravitational Minimum (Abetov et al., 2020; Mikailova et al., 2018; (Abetov et al., 2019) and at the junction of areas with different ages of basement consolidation (Abdullabekov et al., 1975; Abetov et al., 2020), most of which are concentrated in gradient zones of changes in the values of geothermal, geomagnetic and density anomalies of the consolidated crust.

Conclusions

The anomalous geomagnetic field of Central Kazakhstan reflects the different degree of magnetization of rocks, as well as their relative position, structure and depth. In addition, through changes in magnetic properties caused by contact-metasomatic, metamorphic and hydrothermal processes, the anomalies of this field to some extent include the consequences of ore-forming, magmatic and lithological processes of formation of areas and regions of Central Kazakhstan;

The anomalous geomagnetic field (AGMF) of Central Kazakhstan is caused by heterogeneous - magnetized rocks occurring at different depths in the earth's crust;

The high differentiation of anomalous geomagnetic field reflects the geological structure of Central Kazakhstan and induces genetic and tectonic-magmatic aspects of its geological structure and evolution;

The morphology, intensity and size of geomagnetic anomalies provide an opportunity for identification and geological forecasting, while the differentiation of these anomalies, the gradient of their changes characterizes the qualitative (structural) features of magnetically disturbing bodies;

Within Central Kazakhstan, magnetic anomalies of various parameters are observed: linearly elongated and arcuate, winding with a clearly pronounced predominance of the major axis, polygonal, subisometric, oval, ring, mosaic, and etc.; intensive and low-intensity; low- and high-gradient (contrast); finally, large and very small in area;

Above the outcrops on the daytime surface of the pre-Mesozoic basement, the highest contrast of anomalies ΔTa is observed, where elements of the geological structure appear in the structure of the anomalous geomagnetic field: deep faults, blocks of sedimentary-volcanogenic formations, places of display of secondary changes in rocks, as well as some mineral deposits associated with them;

The relations between the magnetization of rocks and the vertical component of the Bz magnetic field with anomalies of the latest and modern movements of the Earth's crust, geophysical potential fields, including thermal fields, is traced;

The anomalous geomagnetic field of Central Kazakhstan correlates with seismic

activity. Earthquake sources are confined to deep faults or fault nodes and are characterized by a sharp change in the sign of tension and orientation of magnetic anomalies. The greatest number of seismic events is confined to faults that delimit tectonic blocks with geomagnetic field anomalies of different intensity and sign.

REFERENCES

Abdullabekov K.N., Maksudov S.H. (1975). Variations of the geomagnetic field in seismically active areas-Tashkent, FAN. – 1975.

Abetov A.E., Uzbekov A.N. (2019). Anomalies of the gravitational field of Central Kazakhstan. Geology and conservation of mineral resources. Almaty. –2019. – Vol. 2(71). – Pp. 47–53.

Abetov, A.E., *Uzbekov, A.N.*, *Grib, N.N.*, *Imayev, V.I.* (2020). Newest Tectonics and Modern Geodynamics of Mining Industrial Areas of Central Kazakhstan - *IOP Conference Series: Earth and Environmental Science. –2020.* – 459(4), 042011. doi:10.1088/1755–1315/459/4/042011.

Belkin V.A., Mironenko Yu.A., Odintsov S.D. (1983). Anomalous magnetic field (AMF) at altitudes of 30 km // In the collection: Investigation of the structure of the geomagnetic field. Moscow. IZMIRAN, –1983. – Pp. 178–184.

Daukeev S.Zh., Uzhkenov B.S., Lyubetsky V.N., Miroshnichenko L.A. (2002). Deep structure and mineral resources of Kazakhstan. Almaty. – 2002. –Vol. 1.

Litvinova T.P., Makarova Z.A., Shmiyarova N.P. (2002). Map anomalous magnetic field (ΔTA) Kazakhstan. Scale 1:1000000. Explanatory note. Almaty. –2002.

Lugovenko V.N. (1974). Statistical analysis of the anomalous field of the USSR. Moscow. Nauka, – 1974.

Lugovenko V.N., Odintsov S.D. (1984). On the question of the spatial structure of the anomalous magnetic field of continents // In the collection: Experimental studies of the geomagnetic field. Moscow. IZMIRAN, – 1984. – Pp. 65–72.

Mikhailova N.N., Uzbekov A.N. (2018). Tectonic and technogenic earthquakes in Central Kazakhstan – News of the national academy of sciences of the Republic of Kazakhstan. Series of Geology and technical sciences. –2018. – Vol. 3, Number 429, – Pp. 146–155.

Nusipov E.N., Shatsilov V. I., Uzbekov N.B. (2007). Geodynamics and seismicity of the lithosphere of Kazakhstan. – Almaty. –2007.

Vvedenskaya A.V. (1969). Investigation of stresses and ruptures in earthquake sources using dislocation theory. Moscow. – 1969.

CONTENT

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.geolog-technical.kz/index.php/en/
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Подписано в печать 10.09.2023.
Формат 70x90$^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
19,0 п.л. Тираж 300. Заказ 5.

РОО «Национальная академия наук РК»
050010, Алматы, ул. Шевченко, 28, т. 272-13-19