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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
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«ХАЛЫҚ» ЖҚ

# Х А Б А Р Л А Р Ы

## ИЗВЕСТИЯ

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

## N E W S

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

*Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. 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.*



## ЧФ «ХАЛЫҚ»

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

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

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

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

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

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

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

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

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

**С уважением,  
Благотворительный Фонд «Халык»!**

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R.M. Sadirov, 2023**

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## **FUNDAMENTAL PROBLEMS RELATED TO GOLD-ORE PROCESS IN THE CENTRAL KYZYLKUM, PROSPECTS FOR THEIR SOLUTIONS**

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**Abstract.** The reason for the formulation of this work is the unsatisfactory level of the development on the issues about the formation of gold-ore process in the Central Kyzylkum. Recently, paradigms about metamorphogenic or polygenic-polychronic models of the formation of deposits in the region have again prevailed in the scientific community. The testing ground for these hypotheses was mainly the Muruntau deposit, a gold mining giant of world significance, on the issues of the conditions of its formation, controversy has been conducted on the pages of native and foreign literature for many years. Regarding the method and time of formation of its ores, there are dozens of different, sometimes contradictory views and constructions. Unfortunately, it should be noted that similar “pseudo-scientific” approaches to the genesis of Central Kyzylkum deposits entail great danger in terms of the practical application of the results of fundamental research, since genetic models are the basis for geological exploration work. As a result of studies conducted over the past decades to study the mineralogical and geochemical characteristics of ores, the conditions for the formation of metasomatic



and intrusive formations, their temporal relationships and other issues, new data have been established that served as the basis for the formulation of new approaches and views on the features of the formation of gold and gold- rare metal mineralization of the Central Kyzylykum. In contrast to the established ideas about the polygenic and multi-stage nature of ores, it is indicated about the formation of the gold mineralization of the Central Kyzylykums as a result of the formation of a single ore-magmatic system, which develops uniformly regardless of the composition and age of the host rocks. Important problematic issues on the geology of the ore deposits of the region are noted.

**Keywords:** Central Kyzylykum, gold mineralization, ore formation models, formation factors, magmatism, metasomatism, mineral parageneses, productive associations, geochemical features, prospecting value

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## ОРТАЛЫҚ ҚЫЗЫЛҚҰМДЫҢ АЛТЫН МИНЕРАЛДАНУЫ: НЕГІЗГІ МӘСЕЛЕЛЕР МЕН ОЛАРДЫҢ ДАМУ БОЛАШАҒЫ.

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**Аннотация.** Бұл жұмыстың жолға қойылуына Орталық Қызылқұмда алтынның минералдануын қалыптастыру мәселелерінің қанағаттанарлықсыз дамуы себеп болды. Соңғы уақытта ғылыми ортасында аймақтағы кен орындарының пайда болуының метаморфогендік немесе полигенді-полихронды үлгілері туралы парадигмалар қайтадан басым алған. Бұл гипотезаларды сынау үшін сынақ алаңы негізінен әлемдік маңызы бар алтын кенінің алыбы Мұрынтау кен орны болды, оның қалыптасу шарттары туралы отандық және шетелдік әдебиеттер беттерінде көптеген жылдар бойы даулар туындады. Оның кендерінің қалыптасу әдісі мен уақытына қатысты ондаған әртүрлі, кейде бір-біріне қайшы келетін көзқарастар мен құрылмалар бар. Өкінішке орай, Орталық Қызылқұм кен орындарының

генезисі мәселелеріне ұқсас «жалған ғылыми» тәсілдер іргелі зерттеулердің нәтижелерін тәжірибеде қолдану тұрғысынан үлкен қауіп төндіретінін атап өткен жөн, өйткені генетикалық модельдер геологиялық барлаудың негізі бөлатын. Соңғы онжылдықтарда Орталық Қызылқұмның алтын және алтын-сирек металл кендердің минералогиялық және геохимиялық сипаттамаларын, метасоматикалық және интрузиялық түзілістердің қалыптасу жағдайларын, олардың уақыт байланыстарын және басқа да мәселелерді уйренуы бойынша жүргізілген зерттеулердің нәтижесінде жаңа деректер анықталды, олар маңызды рөл атқарды, және кен орындарының қалыптасу ерекшеліктеріне жаңа көзқарастар мен көріністерді тұжырымдауға негіз болды. Рудалардың полигенді және көп сатылы табиғаты туралы қалыптасқан пікірлерден айырмашылығы Орталық Қызылқұмның алтын минералдануы біртұтас кен-магмалық жүйенің генезисы нәтижесінде қалыптасқаны, негізгі жыныстардың құрамы мен жасына қарамастан ол дәл осылай дамитындығы көрсетілген. Аумақ кен орындарының геологиясы бойынша маңызды проблемалық мәселелер атап өтілді.

**Түйін сөздер:** Орталық Қызылқұм, алтынның минералдануы, түзілу факторлары, негізгі мәселелері, практикалық салдары

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## **ЗОЛОТОЕ ОРУДЕНЕНИЕ ЦЕНТРАЛЬНЫХ КЫЗЫЛКУМОВ: ФУНДАМЕНТАЛЬНЫЕ ВОПРОСЫ, ПЕРСПЕКТИВЫ ИХ РАЗВИТИЯ**

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**Аннотация.** Причиной постановки данной проблемы является неудовлетворительный уровень разработки вопросов формирования золотого оруденения Центральных Кызылкумов. В последнее время в научной среде довлеют парадигмы о метаморфогенном или полигенно-полихронном характере

моделей образования месторождений региона. Полигоном для отработки этих гипотез, в основном служил месторождение Мурунтау — золоторудный гигант мирового значения, по вопросам условий образования которого в течение многих лет ведется полемика на страницах отечественной и зарубежной литературы. Касательно способа и времени образования его руд имеются десятки различных, иногда противоречивых взглядов и построений. К сожалению, следует отметить, что аналогичные «псевдонаучные» подходы к вопросам генезиса месторождений Центральных Кызылкумов влекут за собой большую опасность в плане практического применения результатов фундаментальных исследований, так как генетические модели являются основой для проведения геолого-разведочных работ. В результате проведенных в последние десятилетия исследований по изучению минералого-геохимических характеристик руд, условий формирования метасоматических и интрузивных образований, их временных взаимоотношений и другим вопросам, установлены новые данные, которые послужили основой формулировки новых подходов и взглядов на особенности формирования золотого и золото-редкометалльного оруденения Центральных Кызылкумов. В противовес устоявшимся представлениям о полигенном и полиэтапном характере руд, указано о формировании золотого оруденения Центральных Кызылкумов в результате становления единой рудно-магматической системы, которое развивается однотипно вне зависимости от состава и возраста вмещающих пород. Отмечены важные проблемные вопросы по геологии рудных месторождений региона.

**Ключевые слова:** Центральные Кызылкумы, золотое оруденение, факторы формирования, основные проблемы, практические последствия

## Introduction

The reasoning for the choice of topic, the relevance of the problem and, the purpose of the study. In the course of describing the experience, which is the basis for the study, it is reported that there is a problematic situation in justifying the choice of topic. Central Kyzylkum is one of the largest gold mining regions not only in Central Asia, but throughout the world. Despite more than half a century of researches of large deposits in the region (Muruntau, Kokpatas, Daugyztau, etc.), there is no appropriate consensus on the formation of the gold-ore process until now, as well as the features of the localization of ore bodies, the material characteristics and conditions for the formation of metasomatic and formations and ore associations, their age and other aspects of the formation of the object.

It is identified that the genetic characteristics of industrial concentrations of useful components are not only theoretical, but also of great practical importance in terms of developing predictive and prospecting criteria and identifying the areas, which are expected to have profit, and positions for hidden the process of becoming ores. Therefore, it is the ideas about the features of the formation and localization of the ore process that determines the strategy of prospecting.

In this regard, the Muruntau deposit, a world-class gold ore giant, is of great interest, on the issues of the formation conditions of which there has been controversy in the

pages of local and foreign literature for many years (Berger et al., 1994; Drew et al., 1996; Kempe et al., 2001). Regarding the method and time of formation of its ores, there are dozens of different, sometimes conflicting views and worldviews, which are reflected in separate works (Muruntau gold field 1998; Savchuk et al., 2018).

As a result, in recent years, an alternative model for the formation of the gold-ore process has been developed, which is followed by a significant part of researchers, combining the “features” of both sedimentary-epigenetic and postmagmatic-hydrothermal views, and attributing polychronic and polygenic nature to the mineralization of the Muruntau deposit.

The essence of this model is the idea that the process of becoming ores was originally present in ancient specialized strata, which was redeposited in the Hercynian era of tectonic-magmatic activation and formed deposits. The authors note that “...the ever more widespread recognition of the polychronicity and polygenicity of gold-bearing associations has brought together the competing genetic concepts for a long time...”.

It is confirmed as a valid concept, for example, adhering to the hypothesis of the syngenetic-epigenetic nature of the Kyzylkum gold-ore process or the “black shale” model of its formation, in fact, exploration work should be focused on finding and identifying areas of distribution, supposed to, “particularly favorable motley besapan” or, even worse — carbonaceous formats, which are distributed almost throughout the Kyzylkum. Thus, the meaning and logical basis of prospecting work get lost in its validity, and the statements of purely ephemeral assumptions and constructions mislead practical geology. But the nature of ore-forming systems is complex and its identification requires deep scientific research with a comprehensive, methodologically sound analysis of the research results, based on modern fundamental theoretical constructions.

### **Materials and methods**

This work is based on a critical analysis of the results of previous studies and data obtained by the authors in recent years (Karabayev, 2019), as well as modern theoretical premises for the patterns of formation of ore concentrations in natural systems, views are presented according to facts on the genesis of gold-ore process in the Central Kyzylkum, in particular the Muruntau deposits.

At the same time, the question was proposed - what is the reason for the emergence of ore (as a concept of an industrial category; “ore is a formation with an industrial content of a useful component (Geological dictionary, 2010)”, in connection with which the paper will focus on the processes that form industrial mineralization, and not small concentrations of a useful component of purely geochemical or mineralogical interest.

### **Results**

Nevertheless, regional features, the geotectonic position of the Southern Tian Shan and Central Kyzylkum, in its composition, (Goldfarb et al., 2013; Yakubchuk et al., 2002) geological characteristics of large deposits of the region are reflected in many works (Ecomomos et al., 1688., Kempe et al., 2001; Natal'in et al., 2005; Wall et al., 2004; Wilde et al., 2001) and they are not affected here.

Let us consider a little, in our opinion, fundamental problems in the field of the geology of ore deposits, regarding the formation and placement of the gold-ore process

in the Central Kyzylkum, which are waiting for their solution. It should be noted that some of the issues under the consideration are being studied and solved by various specialists (Seltmann et al., 2014; Savchuk et al., 2018). Instead, over the past decades, as a result of precision research methods to identify the material composition of ores, metasomatic formations, to establish the absolute age of ore-magmatic formations and on various aspects of these issues, new data have been obtained, on the basis of which genetic models of deposit formation processes are presented (Morelli et al., 2007; Seltmann et al., 2003; Wall et al., 2004.).

The most common assumption was that the gold ore objects of the Central Kyzylkum and Muruntau belong to deposits with sedimentary-epigenetic, in some models marked as metamorphogenic or metasomatic-metamorphogenic nature of mineralization, as well as hydrothermal associated with magmatic sources (Kostitsin, 1996; Morelli et al., 2007).

Finally, in recent years, an alternative model has been born, which is followed by a significant part of researchers, combining the “signs” of both sedimentary-epigenetic and postmagmatic-hydrothermal ore genesis, and attributing the multi-stage, polychronic and polygenic nature to the mineralization of the Muruntau deposit (Graupner et al., 2006; Muruntau gold field 1998). According to some authors (Muruntau gold field 1998), the increasingly widespread recognition of the polychronicity and polygenicity of gold-bearing associations has brought together the long-standing competing genetic concepts, the alternativeness of which is important only in solving the (hypothetical) question about the sources of gold.

Unfortunately, it should be noted that similar “scientific” approaches to the issues of the genesis of deposits entail some danger in terms of the practical application of the results of fundamental research, since genetic models are the basis for identifying predictive and prospecting criteria and determining the strategy and direction of geological exploration and ultimately - the allocation of promising areas and the discovery of new deposits. Statements of purely ephemeral assumptions and constructions mislead practical geology. These include the identification of “geochemical specialization of strata”, “elevated geochemical background” of rocks, or even “ore-bearing (!) strata”, which, in fact, indicate that prospecting should be focused on identifying precisely these rocks. But the nature of ore-forming systems is different and its identification requires deep scientific research with a comprehensive, methodically sound analysis of research results based on fundamental theoretical constructions on the issues are have been taking into consideration.

There are some of the research results which were obtained in recent years:

1) *On the importance of the role of carbonaceous metasomatism in the formation of ores.* In the ore-bearing strata of the Central Kyzylkum, carburized rocks are found everywhere. Researchers consider the sources and significance of the carbonaceous matter in the rocks and ores of the Central Kyzylkum in different ways (Graupner et al., 2005; Seltmann et al., 2003; Kostitsin, 1996), some explain it by bringing it from the mantle. Meanwhile, there is no explanation of the reason for the most intense “carburization” of the finest-grained (pelitic) and least permeable rocks over vast areas. The basis for judgments about the hypogene carburization of rocks in this region is

sometimes observed sharp blackening of them in the structures of sliding faults, which is the result of mylonitization.

The development of carbon compositions in the host rocks of the Central Kyzylykum has a regional character, which is clearly observed in weakly metamorphosed siliceous rocks extending over vast areas. The carbon composition is distributed in the form of cryptogranular grains in them, evenly distributed over the mass of the rock, with a content of up to a few %, without any connection with the zones of “mantle metasomatism and deep faults”. Most researchers consider the composition of carbons of the host rocks of the Central Kyzylykum to be a product of metamorphism of the bioorganic matter of primary sediments.

The collected data show that the content of the carbon composition decreases as the intensity of metamorphic and, especially sharply, metasomatic processes intensify - the rocks are intensively lightened. During hydrothermal transformation, hydrocarbons are removed.

The above facts make it possible to cast doubt on the dominant importance and (or) the presence of carbonaceous metasomatism in the formation of gold mineralization in the Central Kyzylykum.

2) *Regarding black shale strata “specialized” for gold, up to “... ancient placers” in the Central Kyzylykum.* In order to identify the relationship between the contents of elements and the conditions of rock formation, statistical processing of geochemical data was carried out for individual samples, reflecting rocks of various genesis (regional metamorphosed, contact metamorphic and metasomatic) and composition. At the same time, the contents of ore elements in the host rocks were determined by their unchanged differences, which can be used to determine their geochemical background. Furthermore, it has been established that the content of gold and other elements in sedimentary rocks is lower or clarkite, which is confirmed by numerous data; their significant contents are associated only with metasomatically altered rock varieties (Wall et al., 2004; Wilde et al., 2001), the formation of which is associated with postmagmatic hydrothermal processes. In theoretical terms, this means that the gold ore mineralization of the Central Kyzylykum is genetically related to the processes (derivatives) of the formation of granitoid intrusions, and in practical terms, similar (gold-rare metal) ores can be predicted in connection with the aureoles of post-magmatic processes in favorable geological and structural positions. We also note the presence in the region of gold deposits (with rare metals), where mineralization is localized in intrusive rocks (Zarmitan, Sarytau, etc.).

3) On the confinement of the gold-ore process to certain, on the example of Muruntau - to the “variegated Besapan”, suites and stratigraphic levels of metamorphic rocks and their prospects. To date, there is no consensus on the age of gold mineralization in Central Kyzylykum and its deposits (Morelli et al., 2007; Wilde et al., 2001).

Isotope-geochronological studies (Rb-Sr-method) of metamorphic and igneous rocks of the Muruntau ore field made it possible to establish the chronology of the formation of the deposit (Drew et al., 1996; Kempe et al., 2001). It has been established that “... the age of the greenschist metamorphism of the ore-bearing Besapan suite was  $401 \pm 11$  million years, and the main stage of hydrothermal ore formation coincides in time with the formation of igneous rocks of the second stage (quartz syenite-porphyries and kersantites) -  $273.1 \pm 1.6$  million years. years and is separated from the time of intrusion of granitoids of the first stage (Murun alaskite granite) -  $286.1 \pm 1.2$  million years”. The formation of subsequent stages of ore formation “...occurred in separate pulses, 257.6



$\pm 2.2$  Ma,  $230.2 \pm 3.5$  Ma, and  $219.4 \pm 4.2$  million years, which were caused by pulses of tectonic activity in the region at that time”.

The data indicate that the regional metamorphism of the Besapan Formation is confined to the Silurian-Devonian boundary and is separated from ore-metasomatic processes in the Muruntau ore field and belongs to different geotectonic epochs (Wilde et al., 2001; Kostitsin, 1996), and exclude the metamorphogenic model of ore formation in the rocks of individual suites. or thick. Here we briefly dwell on the isolation of hydrothermal ore formation from the time of intrusion of granitoids of the first stage. In recent years, the polystage formation of igneous formations and the multistage nature of associated mineralization have been noted (Karabayev, 2019; Natal'in et al., 2005; Wilde et al., 2001) and it has been indicated that the formation of rare-metal or gold-rare-metal ores lags slightly behind the time of intrusion of granitoid massifs - mineralization is associated with the subsequent, postmagmatic stage of mineral formation. For example, the gold-rare metal mineralization of the Sautbay and Sarytau deposits (Eastern Bukantau) was formed after the intrusion of dike formations (diorite porphyrites, etc.), which intruded after the consolidated granitoid massifs. Then, dikes of the next stage (lamprophyres, etc.) are emplaced, and gold mineralization proper (Karabayev, 2019) is superimposed on them, consisting of several stages, which also fall on different time intervals according to ( $257.6 \pm 2.2$ ,  $230.2 \pm 3.5$ , and  $219.4 \pm 4.2$  million years. But, in fact, all these formations are derivatives of a single evolving ore-magmatic system.

Therefore, in the Central Kyzylkum, the gold-ore process coincides in age with Permian granitoids (Karabayev, 2019; Morelli et al., 2007; Wilde et al., 2001; Kostitsin, 1996); is located in rocks of different composition and a wide age interval, i.e. superimposed on sedimentary-terrigenous (“black-shale”) deposits, as well as on granitoid rocks from the Precambrian to the Lower Permian (Goldfarb et al., 2013; Seltnann et al., 2014); the formation of ore process is genetically related to the formation and derivatives of granitoid magmatism. At the same time, the formation of intrusive formations may consist of several phases, but heterogeneous (rare-metal, gold-rare-metal, gold-silver, etc.) mineralization will be associated with separate stages of a single stage of the postmagmatic process.

4) *The relationship of igneous formations with the process of becoming ores* : a conclusion was made about the pregranitoid age of the mineralization of the Muruntau deposit based on the intersection of the most productive mineral complexes with granodiorite-porphyry dikes, (Drew et al., 1996; Muruntau gold field 1998; Kostitsin, 1996), as well as the conclusion about their separation in time and the absence of a connection between ore process and magmatism was considered as an “essential”, due to the basis of the superimposition of ore-metasomatic associations on dikes.

Some researchers explained the presence of two stages of mineral formation of different ages according to the presence of ore dikes, the combination of metasomatic formations and various mineral associations of the Muruntau megastockwork (Muruntau gold field 1998). It has been established that the formation of igneous formations and various types of gold mineralization, even within the same tectonic-magmatic cycle, is a multi-stage process that is most fully manifested in large deposits, reflecting the duration and multi-stage nature of magmatic, postmagmatic activity and the long-lived nature of ore-localizing structures (Karabayev, 2019; Muruntau gold field 1998.). Therefore, the conclusions about the pre-ore and post-ore nature of dikes and, the absence of a



relationship between magmatism and the process of becoming ores, are not entirely appropriate; some dikes can be post-ore in relation to the rare metal process of becoming ores, but on the same object - pre-ore in relation to gold or gold-silver.

The data which were shown above indicate that intraore dikes of various compositions are often observed, especially at large deposits. Thus, the intersection of scheelite-gold-feldspar associations by granodiorite-porphyry dikes at the Muruntau deposit is not a basis for attributing mineralization to pre-granitoid (metamorphogenic) formations.

The comparison of the results (Karabayev, 2019) shows the similarity of the sequence of formation of vein-magmatic and ore paragenetic mineral associations of deposits of rare-metal and gold-rare-metal deposits in Western Uzbekistan.

The relationships under consideration can be reflected, to some extent, an integral model of the formation of endogenous process of becoming ores, where material formations are formed in the following age sequence: intrusion of the main phase of the granitoid intrusive → magnesian skarns → second phase of intrusion, pre-ore dikes of diorite-porphyrates, syenite-porphyrates → calcareous skarns, quartz-K-feldspar metasomatites (mainly areal) of the early alkaline stage of post-magmatic processes → quartz-pyroxene-scheelite, quartz-K-feldspar-gold-scheelite, amphibole-biotite-quartz (with scheelite and gold) productive associations with a high content of bismuth in ores → intrusion intraore dikes (lamprophyres, diorite-porphyrates) → veined beresite, eisite, argillite metasomatites, in association with gold-arsenic, gold-polysulfide and gold-silver ore associations → barren quartz-carbonate, zeolite veinlets.

All these processes occur under conditions of changing geodynamic conditions, leading to the repeated emergence (or renewal) of fault structures that supply, distribute, and localize the process of becoming ores of various types.

An analysis of the available and newly obtained data made it possible to state some problems in the geology of ore deposits, which are as follows:

1. The process of becoming ores is associated with magmatic processes in deposits of noble and rare metals, (Karabayev, 2019; Morelli et al., 2007; Wilde et al., 2001), including dike formations of various age and composition. What are the relationships of these formations — in spatial, genetic, age terms, How are dikes of different composition related to granitoid intrusions and the process of becoming ores, and where are the centers of their formation? These questions are waiting to be resolved. Since, in recent years, a multi-stage nature of the formation of various igneous formations and heterogeneous process of becoming ores have been established.

2. To develop theoretical foundations for the regularities of the formation and distribution of mineral deposits in natural systems and to create their basis of integral models that reflect the parameters of the formation of deposits and the search and forecast base. In this regard, it should be noted that unreliable approaches and ideas on the formation of mineral deposits create a certain danger in the practical application to the results of fundamental research in applied geology, since genetic models of the process of becoming ores should determine the basis of exploration and strategic directions of geological exploration and, ultimately, serve as an important theoretical basis leading to the discovery of new deposits.

3. To create the determination of the material composition of gold ore process, mainly micromineral complexes, distribution features of various paragenesis of ore minerals and ore-accompanying elements in space and time, based on modern worldviews, reflecting the patterns of formation, as well as, localization of deposits in natural

systems, moreover, a new science-based material forecast complexes. At present, it is problematic to achieve significant progress in the field of complex deep processing of minerals, without the widespread use of precision research methods that provide the instrumental basis for the implementation of these important scientific and practical developments and technological solutions.

4. One of the important scientific directions of ore geology is the study of metasomatic processes and associated process of becoming ores. The materials obtained in recent years on the formation of metasomatic formations and their relationship with mineralization (Karabayev, 2019) and the results of experimental studies indicate the need to revise the existing scientific views in this area. In particular, it is important to establish the relationship of various metasomatites with heterogeneous process of becoming ores, in particular skarns with tungsten ores, the significance and sequence of the formation of various near-ore changes during the formation of gold-ore process, their formational subdivision, and other issues.

5. The importance of fault tectonics in the location of various igneous formations and ore deposits in the region has been established (Drew et al., 1996; Savchuk et al., 2018). Recent studies have obtained preliminary data on the relationship of various intrusive formations, metasomatic and ore formations formed at separate stages of a single ore-magmatic stage, with fault structures of various directions. The study of the regularities of the stage-by-stage formation of tectonic structures of individual mining regions, depending on the features of their geodynamic development, serves to identify the nature of the location of various mineral deposits and acquires important prognostic significance.

### **Conclusion**

1. The gold-ore process coincides in age with Permian granitoid magmatism in the region; it is located in rocks of different composition and a wide age interval, superimposed on carbonaceous sedimentary-terrigenous deposits, as well as on granitoid rocks from the Precambrian to the Lower Permian; the formation of ore process is genetically related to the formation and derivatives (postmagmatic solutions) of granitoid magmatism - the presence of a process that contributed to ore formation is most important in the formation of deposits; fault tectonics is fundamental in the localization of mineralization; these features should serve as the basis for judgments in matters of genesis, location and forecasting of industrial facilities.

2. The formation of gold-ore process is a long process (but one stage process!) in that area, and it is associated with various mineral and geochemical parageneses. Gold-rare-metal deposits located in near-intrusive spaces, gold is associated with the manifestation of rare-metal, bismuthine-telluride (main productive), gold-arsenic and silver-gold-sulfosalt stages of ore formation. Gold-ore process is composed of a combination of gold-arsenopyrite (the main productive) along with the gold-polysulfide-telluride and silver-gold-sulfosalt associations were observed in gold-silver objects which is localized on remote parts of igneous bodies.

These conclusions are quite justified and are consistent with the fundamental regularity of the evolution of ore-forming systems, according to which all endogenous gold deposits, regardless of age, geological and tectonic position, composition of the deep substrate and host rocks, are characterized by a standard set of several productive gold-bearing mineral associations, and the process ore deposition is controlled by the laws of thermodynamics - mainly by changing the temperature and acid-base of the

solution. The solution to these issues contributes to the development of geological science in general, moreover, it is a great practical importance in the field of predictive and prospecting basis for geological exploration, in particular.

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**CONTENT**

<b>A.E. Abetov, N.B. Uzbekov, A.N. Uzbekov</b> STRUCTURE AND INTERPRETATION OF THE ANOMALOUS GEOMAGNETIC FIELD OF CENTRAL KAZAKHSTAN.....	8
<b>I.O. Aimbetova, O.S. Baigenzhenov, A.V. Kuzmin, E.O. Aimbetova, B.S. Abzhalov, A.T. Dagubayeva</b> DEVELOPMENT OF A NEW ENERGY-INTENSIVE COMPOSITION VANADIUM ELECTROLYTE AND INVESTIGATION REVERSIBLE CHARGE TRANSFER MECHANISMS FOR USE HIGH-EFFICIENCY ENERGY STORAGE DEVICES.....	22
<b>M.R. Aktayev, T.SH. Toktaganov, L.Kh. Akbayeva, O.N. Lyakhova</b> RESEARCH OF THE CONDITIONS OF WATER FORMATION IN RADIATION-HAZARDOUS SITES OF THE SEMIPALATINSKY TEST POINT.....	35
<b>Sh.S. Amanova, A.Z. Hajiyeva, F.M. Jafarova</b> ECO-GEOGRAPHICAL ASSESSMENT OF URBAN LANDSCAPE DEVELOPMENT DYNAMICS ON THE BASIS OF GIS.....	45
<b>B.K. Assilbekov, D.A. Bolysbek, N.E. Kalzhanov, K.Sh. Uzbekaliyev</b> STUDY OF THE EFFICIENCY OF MACHINE LEARNING ALGORITHMS BASED ON DATA OF VARIOUS ROCKS.....	58
<b>I. Bekbasarov, N. Shanshabayev</b> UPLIFT BEHAVIOR OF PYRAMIDAL-PRISMATIC PILES IN CLAY SOIL.....	76
<b>D.A. Bolysbek, A.B. Kuljabekov, G.I. Issayev, K.Sh. Uzbekaliyev</b> EXPERIMENTAL STUDY OF DISSOLUTION OF CARBONATE SAMPLES USING X-RAY MICROCOMPUTED TOMOGRAPHY.....	89
<b>N.A. Vysotskaya, B.N. Kabylbekova, R. Spabekova, A.A. Anarbaev, K.T. Kurbanbekov, E.G. Lukin</b> REMOVAL OF SCALES FROM THE SURFACE OF PIPES WITH CHEMICAL SOLUTIONS IN HEAT SUPPLY SYSTEMS.....	100
<b>I.R. Kudaibergenova, N.V. Gritsenko, M.B. Tskhay, N.N. Balgabayev, B.Sh. Amanbayeva</b> FEATURES OF TECHNOLOGY FOR CULTIVATING CORN FOR GRAIN UNDER DRIP IRRIGATION ON SEREOZEM SOILS.....	109
<b>R.Yu. Zaripov, P. Gavrilovs, B.D. Kabbasov</b> ON THE DEVELOPMENT OF TANKS FOR PETROLEUM PRODUCTS MADE OF COMPOSITE MATERIAL.....	121
<b>I.G. Ikramov, G.I. Issayev, Z.M. Kerimbekova, G.K. Ivakhnyuk</b> DETERMINING THE IMPACT OF GRANULATED SLAG ON PUBLIC HEALTH.....	132
<b>A. Sh. Kanbetov, M.Z. Muldakhmetov, D.K. Kulbatyrov, R.G. Duisekenova, G.S. Dyussengaliyeva, G.R. Zhaksiyeva</b> SOIL CONDITION STUDIES IN THE AREA OF THE TENGIZ DEPOSIT.....	145

<b>M.S. Karabayev, M.Sh. Moyliev, E.M. Amirov, A.B. Yusupov, R.M. Sadirov</b> FUNDAMENTAL PROBLEMS RELATED TO GOLD-ORE PROCESS IN THE CENTRAL KYZYLKUM, PROSPECTS FOR THEIR SOLUTIONS.....	156
<b>A.Zh. Kassenov, K.K. Abishev, A.S. Yanyushkin, B.N. Absadykov, D.A. Iskakova</b> RESEARCH OF THE STRESS-STRAIN STATE OF THE BUCKET ELEVATOR NODE CHAIN.....	167
<b>M. Nurpeissova, B. Mingzhasarov, B. Burkhanov, D. Kyrgyzbaeva, Zh. Nukarbekova</b> INFLUENCE OF METEOROLOGICAL FACTORS ON THE ACCURACY OF MONITORING RESULTS.....	179
<b>A.R. Omarov, A.Zh. Zhussupbekov, A.S. Sarsembayeva, A.B. Issakulov, A.M. Buranbayeva</b> NUMERICAL MODELLING MICRO PILES AND EVALUATION OF THE O-CELL TEST RESULTS.....	190
<b>V. Povetkin, A. Bukayeva, A. Nurmukhanova, A. Seitkhanov, M. Kerimzhanova</b> IMPROVING THE DESIGN OF A CENTRIFUGAL GROUND PUMP IN ENRICHMENT PRODUCTION.....	202
<b>T.S. Salikhova, S.A. Glazyrin, T.K. Salikhov, A.Sh. <u>Alimgazin</u>, Z.A. Bimurzina</b> DEVELOPMENT OF A TECHNOLOGICAL SCHEME OF A WASTE-FREE BIOENERGY PLANT FOR THE DISPOSAL OF WASTE.....	217
<b>B.T. Uakhitova, R.A. Zhokanov, Z.S. Sarkulova, M.M. Taizhigitova, N.B. Kurbangaliyeva</b> STATISTICAL ANALYSIS AND QUANTIFICATION OF RISK DANGERS OF INJURIES.....	230
<b>A.G. Fremd, A.J. Bibosinov, B.A. Iskakov</b> DISTRIBUTION OF ZONES OF DECOMPRESSION OF THE EARTH'S CRUST AS AN INDICATOR OF THE OIL PROSPECTS OF THE TERRITORY OF THE CASPIAN REGION.....	242

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