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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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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.

НАНПК сообщает, что научный журнал «Известия НАНПК. 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 НАНПК. 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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ZELTMAN Reyman, Ph.D, head of research department in petrology and mineral deposits in the Earth sciences section of the museum of natural history (London, England) **H = 37**

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

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

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

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

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

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

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

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

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NPJSC «Abylkas Saginov Karaganda Technical University»,
Kazakhstan, Karaganda.
E-mail: kikina_ev@mail.ru

STUDYING THE STRATIGRAPHY OF PORPHYROIDAL STRATA OF THE ZHOLSHOKY MOUNTAINS AREA IN THE ATASSU-MOIYNTY WATERSHED

Kikina Yevgeniya — PhD doctoral student of the 3rd year of the educational program 8D07201-”Geology and exploration of mineral deposits”, NPJSC «Abylkas Saginov Karaganda Technical University», Karaganda, Republic of Kazakhstan

E-mail: kikina_ev@mail.ru, <https://orcid.org/0000-0002-1441-455X>;

Sadchikov Alexander — Candidate of Technical Sciences, senior Lecturer of the Department of Geology and Exploration of Mineral Deposits, NPJSC «Abylkas Saginov Karaganda Technical University», Karaganda, Republic of Kazakhstan

E-mail: a.sadchikov@mail.ru, <https://orcid.org/0000-0002-6022-2073>;

Amangeldikyzy Altynai — Doctor of Philosophy PhD, Associate Professor of the Department of Geology and Exploration of Mineral Deposits, NPJSC «Abylkas Saginov Karaganda Technical University», Karaganda, Republic of Kazakhstan

E-mail: amangeldikyzy@inbox.ru, <https://orcid.org/0000-0002-6665-8804>.

Abstract. The article developed a new stratigraphic scheme of metamorphosed Pre-Cambrian deposits of the Zholshoky area in the Atassu-Moiynty watershed. Particular attention was paid to the porphyroid strata, which were previously included on geological maps as part of the Upper Riphean Altynsyngan Formation, were we included in the Kabantau Formation. Also noticed the relationship of the Kabantau Formation with the underlying porphyroids of the Urkendeu Formation, where the quartzites and shales included in these formations are generally similar, and the porphyroids in these formations are distinguishable in color and structural-textural characteristics and the petrochemical features of porphyroids of these two formations are given. The conducted studies have made significant adjustments to the schemes for stratigraphic dissection of the Pre-Cambrian in Zholshoky, and these data will be applied throughout the Atassu-Moiynty watershed and other regions with Pre-Cambrian metamorphic outcrops.

Keywords: stratigraphy, Pre-Cambrian deposits, porphyroid, metamorphic rocks, proterozoic

© **Е.В. Кикина***, **А.В. Садчиков**, **А. Амангелдіқызы**, 2024
«Әбілқас Сағынов атындағы Қарағанды техникалық университеті»
коммерциялық емес акционерлік қоғамы, Қазақстан, Қарағанды.
E-mail: kikina_ev@mail.ru

АТАСУ-МОЙЫНТЫ СУАЙРЫҒЫНДАҒЫ ЖОЛШОҚЫ ТАУЛАРЫ АУДАНЫНЫҢ ПОРФИРОИДТЫ ҚАБАТЫНЫҢ СТРАТИГРАФИЯСЫН ЗЕРТТЕУ

Кикина Евгения Вячеславовна — Докторант PhD «Геология және пайдалы қазбалар кен орындарын барлау», «Әбілқас Сағынов атындағы Қарағанды техникалық университеті» коммерциялық емес акционерлік қоғамы, Қазақстан Республикасы, Қарағанды қ.
E-mail: kikina_ev@mail.ru, <https://orcid.org/0000-0002-1441-455X>;

Садчиков Александр Викторович — т.ғ.к., аға оқытушы кафедралардың «Геология және пайдалы қазбалар кен орындарын барлау», «Әбілқас Сағынов атындағы Қарағанды техникалық университеті» коммерциялық емес акционерлік қоғамы, Қазақстан Республикасы, Қарағанды қ.
E-mail: a.sadchikov@mail.ru, <https://orcid.org/0000-0002-6022-2073>;

Алтынай Амангелдіқызы — Доктор PhD, доцентінің м. а. кафедралардың «Геология және пайдалы қазбалар кен орындарын барлау», «Әбілқас Сағынов атындағы Қарағанды техникалық университеті» коммерциялық емес акционерлік қоғамы, Қазақстан Республикасы, Қарағанды қ.
E-mail: amangeldykyzy@inbox.ru, <https://orcid.org/0000-0002-6665-8804>.

Аннотация. Мақалада Атасу-Мойынты су алабындағы Жолшоқы таулары ауданының метаморфизацияланған кембрий алдындағы шөгінділерінің жаңа стратиграфиялық схемасы әзірленді. Бұған дейін геологиялық карталарда жоғарғы рифейлік алтынсыңған свитсының құрамына енген порфиرويدты қабаттарға ерекше назар аударылды, біз оларды қабантау свитасына еңгізген едік. Сондай-ақ, қабантау свитасының уркендеу свитасының төмендейі орналасқан порфиرويدтарымен қарым-қатынасының ерекшеліктері байқалады, мұнда осы свиталардың құрамына кіретін кварциттер мен тактатастар жалпы ұқсас, ал бұл свиталардағы порфиرويدтар түсі мен құрылымдық-текстуралық сипаттамалары бойынша ерекшеленеді және осы екі свитаның порфиرويدтарының петрохимиялық ерекшеліктері келтірілген. Жүргізілген зерттеулер Жолшоқы тауларындағы кембрийге дейінгі стратиграфиялық бөлшектеу схемаларына елеулі түзетулер енгізді және бұл деректер Атасу-Мойынты су алабының бүкіл аумағында және Кембрий алдындағы метаморфтық шығулары бар басқа өңірлерде қолданылатын болады.

Түйін сөздер: стратиграфия, кембрий алдындағы шөгінділер, порфиرويدтар, метаморфты жыныстар, протерозой, қышқыл вулканиттер, Орталық Қазақстан

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НАО «Карагандинский технический университет имени Абылкаса Сагинова», Казахстан, Караганда.

E-mail: kikina_ev@mail.ru

ИЗУЧЕНИЕ СТРАТИГРАФИИ ПОРФИРОИДНЫХ ТОЛЩ РАЙОНА ГОР ЖОЛШОКЫ В АТАСУ-МОИНТИНСКОМ ВОДОРАЗДЕЛЕ

Кикина Евгения Вячеславовна — Докторант PhD «Геология и разведка месторождений полезных ископаемых», НАО КарТУ имени Абылкаса Сагинова, Республика Казахстан, г. Караганда

E-mail: kikina_ev@mail.ru, <https://orcid.org/0000-0002-1441-455X>;

Садчиков Александр Викторович — Старший преподаватель кафедры «Геология и разведка месторождений полезных ископаемых», НАО КарТУ имени Абылкаса Сагинова, Республика Казахстан, г. Караганда

E-mail: a.sadchikov@mail.ru, <https://orcid.org/0000-0002-6022-2073>;

Алтынай Амангелдіқызы — Доктор PhD, и.о. доцента кафедры «Геология и разведка месторождений полезных ископаемых», НАО КарТУ имени Абылкаса Сагинова, Республика Казахстан, г. Караганда

E-mail: amangeldykyzy@inbox.ru, <https://orcid.org/0000-0002-6665-8804>.

Аннотация. В статье была разработана новая стратиграфическая схема метаморфизованных докембрийских отложений района гор Жолшоки в Атасу-Моинтинском водоразделе. Особое внимание было уделено порфиroidным толщам, которые ранее на геологических картах включали в состав верхнерифейской алтынсынганской свиты, были нами включены в кабантаускую свиту. Также замечены особенности взаимоотношения кабантауской свиты с подстилающими порфиroidами уркендеуской свитой, где входящие в состав этих свит кварциты и сланцы в целом аналогичны, а порфиroidы в этих свитах различимы по цвету и структурно-текстурным характеристикам и приведены петрохимические особенности порфиroidов этих двух свит. Проведенные исследования внесли существенные корректировки в схемы по стратиграфическому расчленению докембрия в горах Жолшоки и эти данные будут применяться на всей территории Атасу-Моинтинского водораздела и на других регионах с докембрийскими метаморфическими выходами.

Ключевые слова: стратиграфия, докембрийские отложения, порфиroidы, метаморфические породы, протерозой

Introduction

The Zholshoky Mountains area is located in the western part of the Atasu-Mointin watershed, which in turn is part of the Aktau-Moiynty SFZ (structural-formational zone). The Aktau-Moiynty SFZ is one of the largest Pre-Cambrian massifs in Central Kazakhstan. The stratigraphy of this area has been studied since the 1950s, especially actively in the 70s–90s (Avdeev, 1965; Alperovich, 1971;

German, 1979; Zaitsev, 1980; Filatova, 1986), and more recently from the early 2000's to the present (Degtyarev, 2008, 2015; Tretyakov, 2010–2016) but some questions remain debatable until now, up to different understanding of the total volume and age range of the thickness.

Carried out modern work on the site within the framework of GMC-200, allowed the authors to perform the following tasks: to make significant adjustments to the schemes of stratigraphic dissection of the Pre-Cambrian in the Zholshoky mountains, in particular porphyroids - volcanites of acidic composition, to identify patterns of structure of their sections, the features of metamorphism, structural position and geodynamic conditions of formation.

Below is a map of the facts (Figure 1) of the area where the geological survey and collection of necessary materials were carried out.

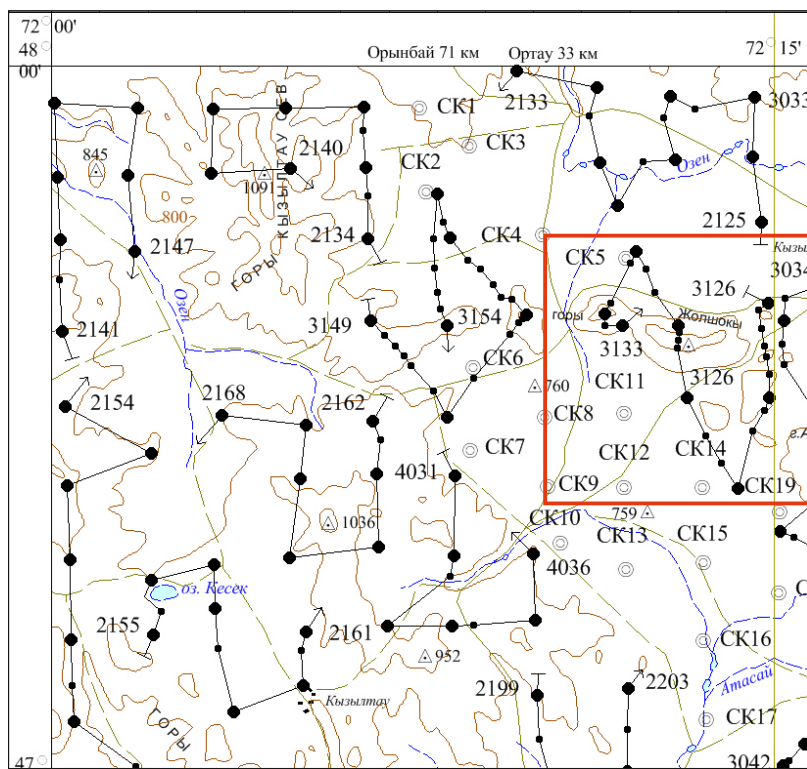


Figure 1 - Map of the actual material of sheet L-43-A.

- (3133) – sampling point. ● – intermediate sampling point. SK10 - wells. The section of the Zholshoky Mountains is highlighted in red.

Materials and basic methods

In developing the scheme of stratigraphic breakdown of the Pre-Cambrian deposits of Zholshoky were used geochronological, historical and geological, based on geodynamic events.

Laboratory work on the study area included:

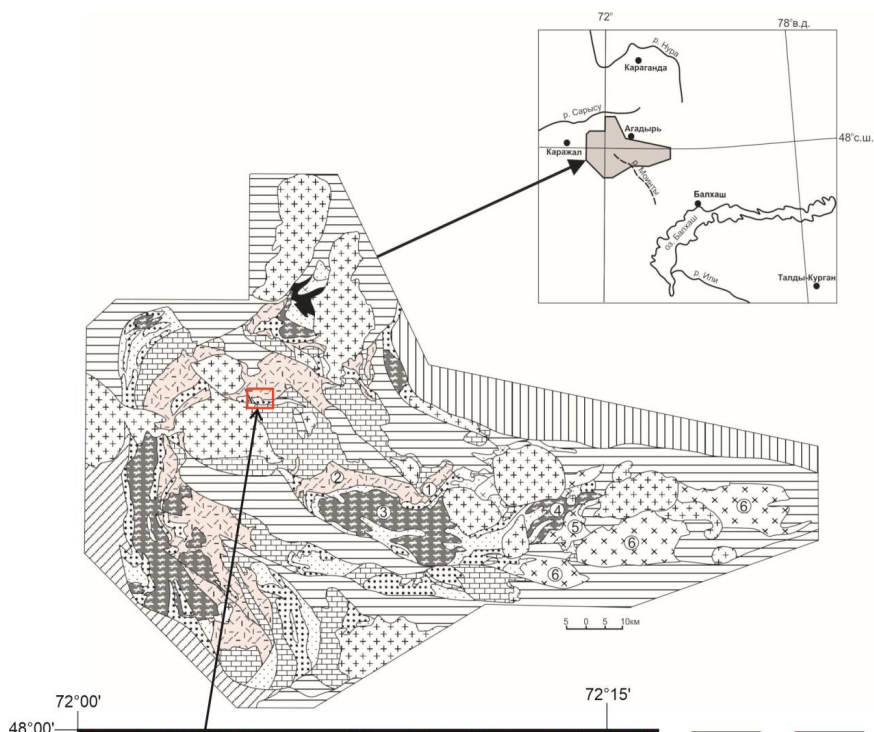
- Semi-quantitative spectral analysis for Ag, As, B, Ba, Be, Bi, Ce, Co, Cu, La, Mn, Mo, Ni, P, Pb, Sb, Sn, U, V, W, Y, Zn;
- silicate analysis;
- making transparent grinds;

All types of laboratory work were performed in the specialized chemical-analytical laboratory of Azimut Geology LLP.

As a result, the authors propose the following stratigraphic scheme of the Pre-Cambrian breakdown for the Zholshoky Mountains area, which is described in the chapter results.

Results

Stratigraphy. According to the adopted scheme (taking into account the correction), the section of the Pre-Cambrian strata of the area are stratified formations of the Lower Proterozoic and Upper Riphean. Only the Lower Proterozoic strata of the Kabantau Formation of quartz-sericite and mica schists, quartzites and porphyroids (PR_{1kb}) were included by the authors in the area of the Zholshoky mountains; the Aidakharly Formation of quartz-sericite schists and quartzites (PR_{1ad}) and at the foot of the mountains in the western and southwestern part of the Lower Devonian deposits of the Pragian and Emsian stage of green sandy-aleuritic marine sediments with horizons of polymictic gravelites, conglomerates and lenses of limestone (D_{1p-e}) (Figure 2).



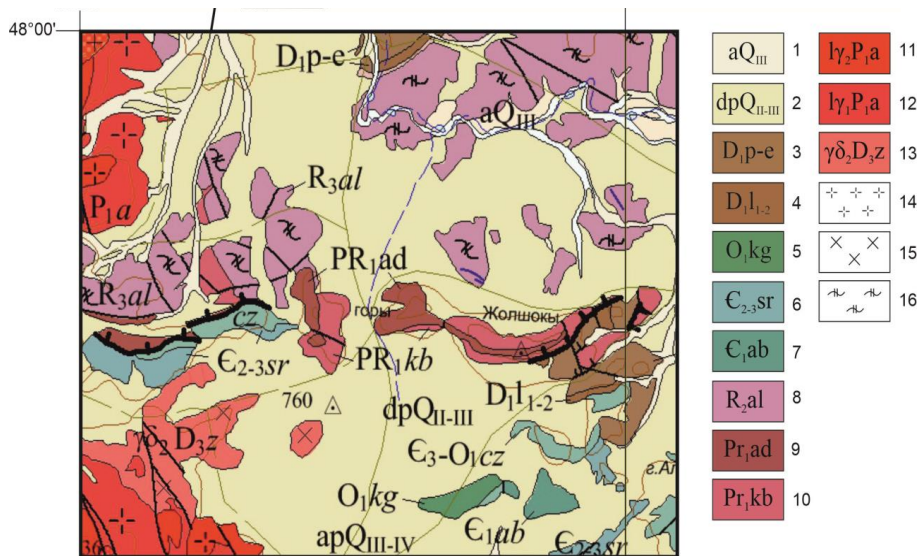


Figure 2 - Geological map of the Zholshoky Mountains area (L-43-A).

- 1 – Upper link. Alluvial deposits of the first terrace above the floodplain. Sands, pebbles, loams, sandy loam.
 - 2 – Upper link holocene. Deluvial-proluvial loam, sandy loam, rubble; alluvial-proluvial loam, sand, pebbles.
 - 3 – Gray-colored sandstones, gravelites, lenses of conglomerates, siltstones, organogenic limestones.
 - 4 – Boulder and pebble conglomerates "limestone" and polymictic, gravelites, sandstones. At the bottom of the undisturbed horizon of red "garbage" siltstones with gravelly admixture.
 - 5 – Kogeday Formation. Conglomerates, gravelites, sandstones, siltstones, tuffs.
 - 6 – Sarykum Formation. Light gray, thinly layered limestones, dolomites, marls, siliceous siltstones.
 - 7 – Abylhayr Formation. Gray, light gray massive coarse-layered calcareous dolomites; stromatolites.
 - 8 – Altynsyngan Series. Porphyroids in lavas and tuffs of dacite, rhyolite, and rhyodacite composition. At the bottom the pack of different quartzite conglomerates.
 - 9 – Aidakharly Formation. Quartz-sericite shales, white quartzites.
 - 10 – Kabantau Formation. Quartz-sericite and mica schists, quartzites, porphyroids.
 - 11 – II phase. Medium-fine-grained leucocratic granites.
 - 12 – I phase. Strong medium-grained leucocratic granites.
 - 13 – II phase. Medium-grained granodiorites, quartz diorites.
 - 14 – Leucocratic granites.
 - 15 – Granodiorites.
 - 16 – Porphyroids.
- Kabantau Formation (PR₁kb)

The Kabantau Formation was isolated and first described in the areas adjacent to the territory of sheet L-43-1 to the west in the process of work of GDP-50 (German, 1979). Previously, on the geological maps of GDP-50 sheet L-43-I, quartzites and shale strata, the authors compared with the Kabantau Formation, belonged to the Taskoraly and Sulumanak formations of the Upper Riphean, and porphyroids were part of the Upper Riphean Altynsyngan Formation.

The outcrops of the Kabantau Formation are confined to the slopes and tops of the dominant ridges in the terrain, which determines the degree of exposure of the rocks of the Formation.

In the studied area, the Kabantau Formation overlaps the porphyroids of the Urkendeu Formation without visible inconsistency. This bedding is mapped in the Kushoky Mountains, along the northeastern slope of which is traced a marker

horizon of mottled quartzite 5 meters thick, which in the stratotypic section of the Kabantau mountains is confined to the roof of the Urkendeu Formation.

Overlapped by the Kabantau Formation, also without apparent inconsistency, by shales and quartzites of the Aydakharly Formation of the Lower Proterozoic. These relationships were observed by the authors on the southern slope of Mount Zholshoky, but given the complexity of the tectonic structure of this area, its isolation from the main distribution fields of Proterozoic formations, and the similarity of the structure of sections of the Kabantau and Adakharli formations, it is difficult to make unequivocal conclusions.

The section of the Kabantau Formation, most fully described outside of the GMC-200 area, has a two-member structure. Its lower part (pack) is composed of metamorphosed sedimentary rocks - shales, quartzites and quartzite-schists.

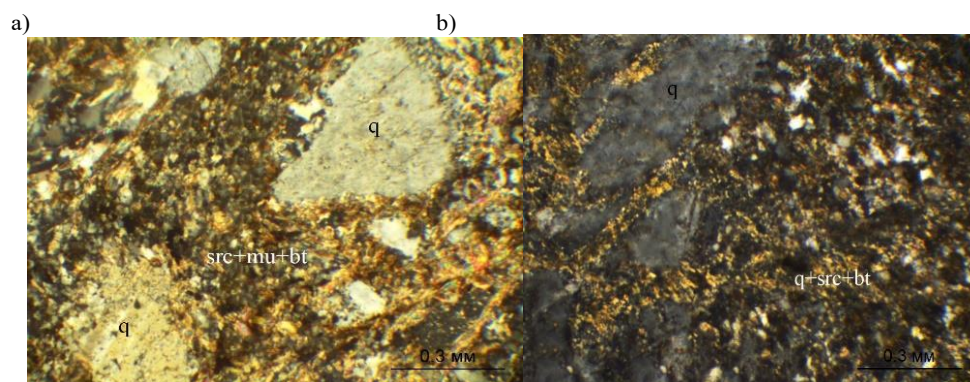


Figure 3 - Microstructure of porphyroids of the Kabantau Formation in thin sections.
a) – Sample 3079, with analyzer; b) – Sample 3082, without analyzer

The upper pack of the Kabantau Formation is a lamination of porphyroids, shales with interlayers of quartzites. Meta-sedimentary varieties are generally similar to shales and quartzites of the lower unit; porphyroids are more varied in color and texture-structural features than rocks of the Urkendeu Formation; fluidal varieties and varieties with relict gradational stratification (metatuffites) are common in them. The microstructures of the described porphyroids are shown below (Figure 3). These features we represent the outcrops of porphyroids in the foothills of the Zholshoky Mountains.

The metamorphism of the rocks of the suite corresponds to the greenschist facies (Kovach, 2011). The thickness of the Kabantau Formation in the area of the Zholshoky Mountains can reach 700 meters, and to the west of the study area, in full sections of the formation its thickness is estimated at least 1200m.

Petrographic features of porphyroids of the Kabantau Formation in the Zholshoky Mountains can be judged, based on two, available to the authors of the article, silicate analyses, as well as 12 samples of previous researchers (Filatova, 1986) (Table 1).

Table 1 - Content of petrogenic elements (wt%) in representative analyses of porphyroids of the Kabantau Formation.

No.	sample No.	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅
1	3133	76,74	0,18	13,65	2,46	-	<0,01	0,63	0,15	0,19	4,00	0,12
2	3153/4	71,50	0,36	15,30	2,94	-	0,05	0,59	0,13	1,65	5,97	0,07
3	2866	72,82	0,18	13,02	1,52	1,4	сл.	0,87	1,89	1,96	6	0,18
4	2866/5	72,09	0,23	14,13	0,66	2,13	0,04	1,07	1,15	2,21	4,65	0,21
5	2867/6	70,39	0,23	14,86	1,47	1,71	0,06	1,8	1,15	3,48	2,71	0,16
6	2868	68,43	0,41	15,58	1,25	2,78	0,06	1,66	1,15	3,66	3,27	0,14
7	2868/2	70,88	0,23	14,68	1,12	2,24	0,05	0,95	1,48	2,2	5,72	0,14
8	2868 11	70,72	0,4	14,04	2,95	1,03	0,08	0,88	1,23	1,3	5,84	0,1
9	2869 31	71,6	0,33	13,65	1,39	1,35	0,08	0,89	1,48	2,12	5,72	0,23
10	2576	73,67	0,12	14,6	0,48	1,35	0,03	0,97	0,6	7,12	1,2	0,2
11	2581	72,42	0,26	14,28	1,65	0,93	-	1,62	0,45	3,26	2,62	-
12	473 2	75,82	0,09	12,95	0,68	0,63	0,94	0,65	0,6	2,82	4,56	0,28
13	473 3	74,19	0,08	13,68	1,02	0,95	0,03	0,75	0,6	2,42	4,5	0,28
14	475 1	69,96	0,27	14,96	2,45	1,26	0,04	1,08	0,75	2,3	5,2	0,28

According to the ratio of silica and alkali sum, most of the samples of the Kabantau Formation fall into the rhyodacite field, and less frequently into the low-alkaline rhyolite field (Figure 4). All breeds belong to the potassium series (Figure 5) and are characterized by high potassium (Figure 5). In terms of the relative aluminum oxide content, the porphyroids of the Kabantau series belong to the group of very high alumina, wt %: SiO₂–72,23, TiO₂–0.24, Al₂O₃–14.24, Fe₂O₃–1.57, FeO*–1,27 MnO–0.10, MgO–1.03, CaO–0.92, Na₂O–2.62, K₂O–4.43, P₂O₅–0.17.

Also, a comparative characterization was made with porphyroids of the Urkendeu Formation, which are found in nearby areas and which are similar in composition to porphyroids of the Kabantau Formation (Figure 4)

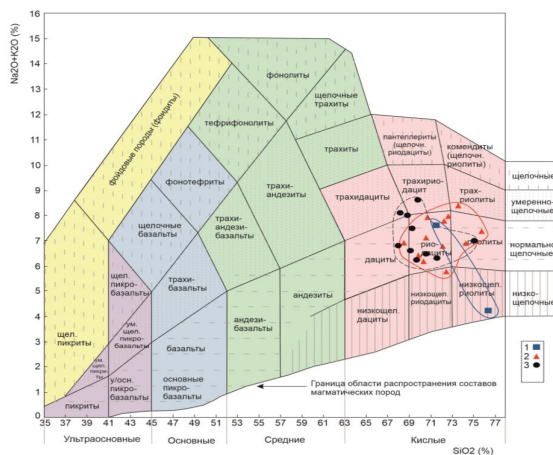


Figure 4 - Petrochemical diagram of SiO₂-(K₂O+Na₂O) for rocks: Kabantau Formation and Urkendeu Porphyroids Kabantau Formation.

1 – porphyroids of the Kabantau Formation (PR1kb); 2 – porphyroids of the Kabantau Formation (PR1kb) (German, 1975); 3 – porphyroids of the Kabantau Formation (PR1ur) (German, 1975)

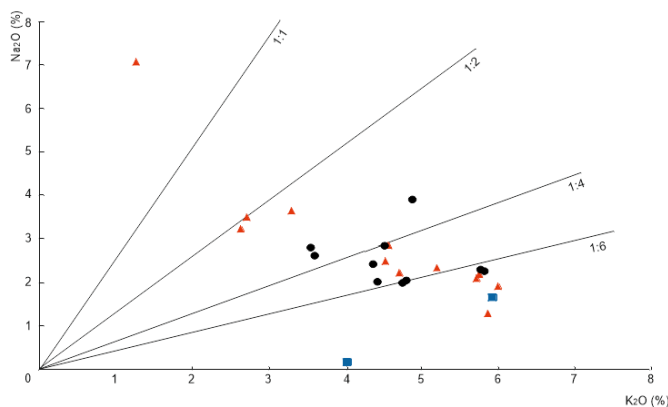


Figure 5 - Petrochemical diagram of $\text{Na}_2\text{O} - \text{K}_2\text{O}$ for rocks: Urkendeu and Kabantau formations
 1 – porphyroids of the Kabantau Formation (PR1kb); 2 – porphyroids of the Kabantau Formation (PR1kb) (German, 1975); 3 – porphyroids of the Urkendeu Formation (PR1ur) (German, 1975)

According to L.I. Filatova (Filatova, 1986), the porphyroids of the described sequence differ from similar rocks of the Urkendeu Formation in their composition by higher silicic content and lower alkalinity (Figure 4), with a more prominent role of sodium in the alkali balance (Figure 5). In addition, she noted a two- to threefold decrease in the lithium content in the Kabantau porphyroids compared to the Urkendeu.

The Kabantau Formation together with the overlying Aidakharly Formation are included by the authors of the article in a single metavolcanogenic-terigenous formation (PR1_{vt}); therefore, the geochemical characteristics of the formation, as well as the characteristics of the physical properties of its rocks, are given below, after the description of the Aidakharly Formation (Fig. 7).

The Early Proterozoic age of the Kabantau Formation is accepted in accordance with the Regional Stratigraphic Scheme, which is also confirmed by its consistent occurrence on the porphyroids of the Urkendeu Formation of the Lower Proterozoic.

Aidakharly Formation (PR_{ad})

The distribution area of the described formation is very small; it is located at the top of the Zholschoky Mountains and their western continuation near the frame of sheet L-43-I. Here, the rocks of the formation form a narrow synclinal structure, extending sublatitudinally, apparently tilted to the south. Farther westward, beyond L-43-10, this band of outcrops is spatially contiguous with the Akmaya and Aidakharly ridges, where the described formation receives its maximum distribution.

At the GDP-50 stage, the quartzites and shales that we isolated in the Aidakharly Formation belonged to the Taskoralin Formation of the Upper Riphean (Kroner, 2008). Yu.A. Zaitsev and his colleagues attributed these outcrops to the lower part of the Kabantau Formation (Zaitsev, 1980), which was largely based on the erroneous idea that all the porphyroids surrounding the Zholshoky Mountains belong to the Urkendeu Formation. According to our field observations, firstly, porphyroids of two stratigraphic levels are distributed in the described area: Lower Proterozoic and Upper Riphean (the age of the latter, which will be discussed below, is confirmed by modern isotopic determinations). Second, the shale and quartzite package, according to the superstructure of the first of these levels (obviously, the Kabantau level), by the nature of the section completely corresponds to the lower part of the Aidakharly Formation of the Akmai Mountains on sheet L-42-VI.

The section of the Aidakharly Formation in the Zholshoky Mountains has a two-member structure. The porphyroids of the Kabantau Formation are obviously overlain by greenish-gray mica, chlorite-mica, and quartz-mica schists, in which brown quartzite interlayers appear higher on the slope. The section is crowned by massive white and spotted quartzites that form the ridge crest. The thickness of the formation is up to 100 meters. The degree of metamorphic changes in the rocks of the formation, as well as previously described divisions, corresponds to the greenschist facies.

The Early Proterozoic age of the Aidakharly Formation is accepted in accordance with the Regional Stratigraphic Scheme.

The similarity of the structure of the sections and the material composition of their constituent rocks allow the Kabantau and Aidakharli formations to be combined into a single metavolcanogenic-terrigenous formation (PR_{1vt}).

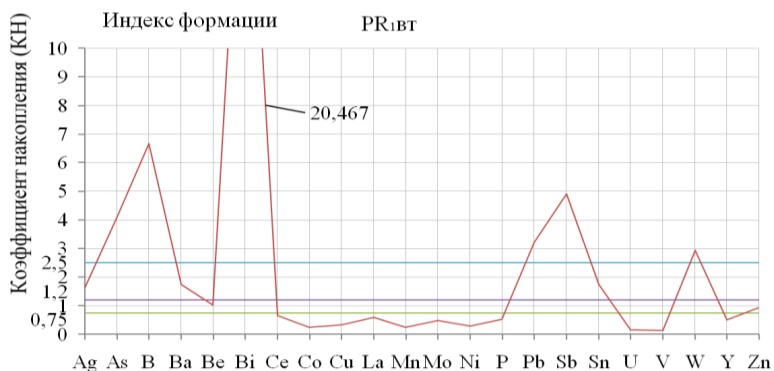


Figure 6 - Elemental concentration diagram for the rocks of the metavolcanogenic-terrigenous (quartzitic-shale with porphyroids) formation

The rocks of this formation are characterized by litho-chalcophylic association of dispersed elements with significant accumulation of arsenic, boron, bismuth, lead, antimony, and tungsten (accumulation coefficient over 2.5), moderate accumulation of barium and tin (accumulation coefficient within 1.2–2.5) and removal of cobalt,

copper, lanthanum, manganese, molybdenum, nickel, phosphorus, uranium, vanadium, yttrium (accumulation coefficient less than 0.75) (Figure 6).

Upper Riphean. Altynsyngan Series (R_3al)

This formation is traced by the authors to the north of the Zholshoky Mountains. While in the predecessors (Alperovich), the outcrops at the foot of the Zholshoky Mountains were included in the Altynsyngan Formation, which is not confirmed by the authors of this article.

The outcrop of volcanites of the Altynsyngan series is good. They consist of numerous small mountain massifs with elevations up to 1000 meters and more, within which rocks of the series give rocky outcrops. The lower, terrigenous part of the series is very poorly exposed, in fact, in 2–3 small areas.

In the described territory, the deposits of the Altynsyngan series unconformably overlap the rocks of the Aikarly, Taskoraly, and Kabantau series with erosion. The Altynsyngan series is overlapped, uncoordinated with erosion, by coarse-clastic rocks of the Baiepshin Formation of the Upper Riphean and "limestone" conglomerates of the Lockhovian stage of the Lower Devonian.

Active intrusive contacts of the described series are established with granites of the second allochthonous phase of the Upper Triassic Uzunzhals complex along the northern contact of the Uzunzhals massif, and the first phase of the Akchatau complex of the Lower Permian in the eastern contact of the Akchatau massif.

The main rocks composing the Altynsyngan series are porphyroids – volcanites of acidic composition, irregularly, but usually very weakly metamorphosed. According to the authors of this report, based on their own field observations and review of a significant number of thin sections, the Altynsyngan series contains both virtually unmetamorphosed and varieties with typical metamorphic structures and associations of newly formed minerals, especially in the main mass of rocks (Figure 7).

Macroscopically porphyroids of the series, these are rocks of different shades of gray, pinkish, greenish-gray, tobacco colors. Textures from massive to distinctly schistose; structure, usually porphyritic. Porphyritic (blastoporphyritic) secretions, ranging in size from a fraction of a millimeter to the first millimeter and, in some cases, over a centimeter, are represented by quartz and, in subordinate quantity, feldspars, mainly calanitic.

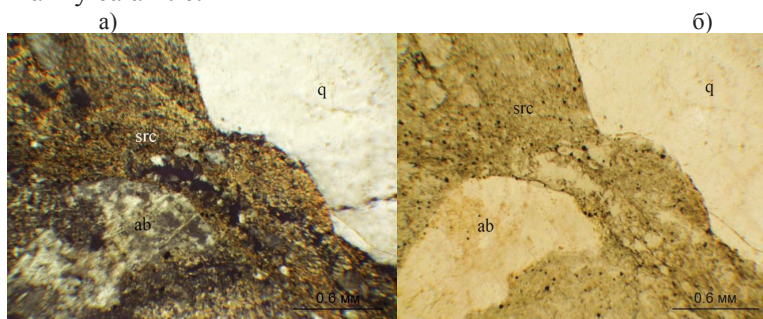


Figure 7 Porphyroid of the central block with a lepidoblastic base mass. Porphyry quartz excretions bear traces of melting (section 4006) a) – with analyzer; b) – without analyzer

Analysis of the cited generalized section of the Altynsyngan series allowed L.I. Filatova to conclude that this sequence belongs to "a typical lava explosion formation with a significant role of ignimbrites proper" (Degtyarev, 2015).

The petrochemical composition of the volcanites of the Altynsynganskaya series was studied on the basis of 21 silicate analyses of samples taken, mainly within the GMK-200. As can be seen in the classification diagram (Figure 8), the composition of the rocks of the series varies over a wide range, from normally alkaline dacites, rhyodacites, and rhyolites to their moderately alkaline analogs, which clearly distinguishes this sequence from the Urkendeus Formation of the Lower Proterozoic. According to the $N_2O/K_2O - SiO_2$ ratio, the rocks belong mainly to the potassium-sodium series and, to a lesser extent, to the potassium series (Figure 9). In terms of the relative potassium content, the described volcanics belong to the high-potassium group. The aluminosilicate coefficient a' , which varies from 2.73 to 4.86, indicates a very high aluminosilicity of rocks.

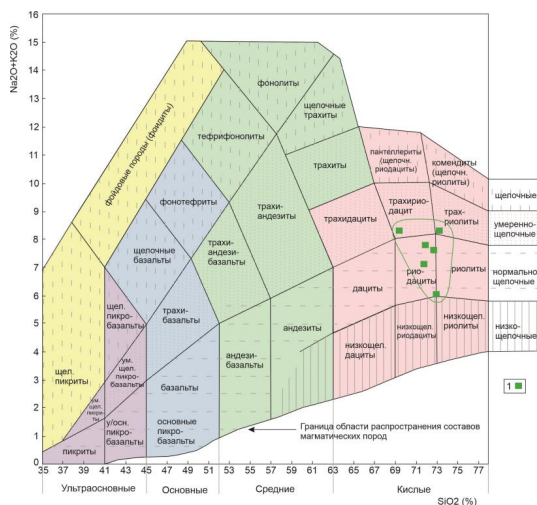


Figure 8 - Petrochemical diagram $Na_2O - K_2O$ for porphyroids of the Altynsyngan Formation

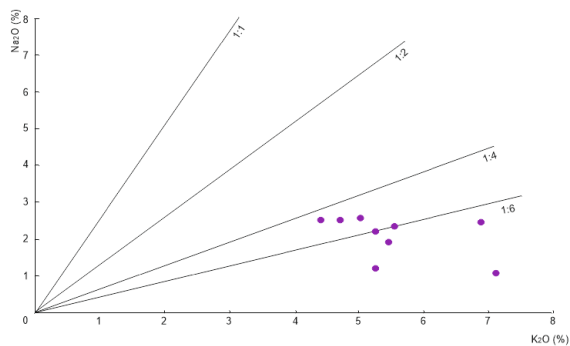


Figure 9 - Petrochemical diagram $Na_2O - K_2O$ for rocks of the Altynsyngan Formation (R_{3al})

The Altynsyngan series is characterized by a litho-chalcophilic association of scattered elements. Significant accumulation of boron and lead (accumulation coefficient over 2.5) is noted in the rocks of the formation. Arsenic, antimony, tin, and tungsten accumulate in moderate concentrations (accumulation factor in the range 1.2–2.5). Silver, beryllium, cerium, cobalt, copper, lanthanum, manganese, molybdenum, nickel, phosphorus, uranium, vanadium, yttrium, zinc (accumulation factor less than 0.75) (Figure 10).

To substantiate the age of the Altynsyngan series, we have repeatedly used isotopic-geochemical data on zircon monomineral fractions from the constituent volcanics. The results presented by different authors showed a wide range of values, which was the cause of many years of debate. The current stratigraphic scheme is based on the 1540 ± 45 Ma figure obtained from 5 samples taken by L.I. Filatova in the Kotyrtas (Keregetas) area; the exact location of the sampling points could not be established (German, 1979).

The most "recent" results of isotope-chemical studies are given in the dissertation of A.A. Tretiakov (Tretiyakov, 2010). These analyses were performed using modern ID TIMS and SHRIMP II techniques with appropriate preparation of analytical material and are considered by the authors of this report as the most reliable at this stage of research. Two samples were taken, the first AM-046 in the area of Kotyrtas mountains, the second north of Zholshoky mountains (the number and exact place of sampling is unknown). The age values of the first sample correspond to 925 ± 9 Ma, the second to 921 ± 5 Ma, which also corresponds to the Late Riphean.

The described sequence is attributed by the authors to the metaryolite-dacite (porphyroidal) formation (R_{3p}). L.I. Filatova (1991) associated the accumulation of these deposits with an isolated meridional volcanotectonic depression deposited on the consolidated Early Proterozoic basement. According to the assumptions of some researchers, the volcanites of the Altynsyngan series are comagmatic to granitoids of the Uzunzhals complex of the Lower Riphean. Isotopic-geochemical and geochemical studies in recent years confirm this assumption, which will be discussed below in the description of intrusive formations.

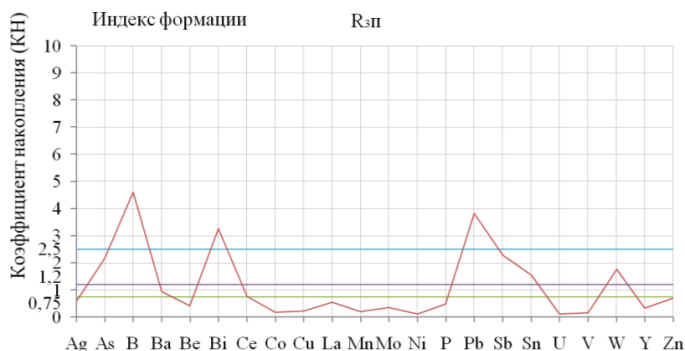


Figure 10 - Diagram of the concentration of elements of metaryolite-dacite (porphyroidal) formation rocks

Conclusion

In this article, the relationship of stratigraphic strata of the Zholshoky Mountains area was studied. The surveys made it possible to make some changes in the distribution of these stratigraphic strata. Earlier, the Zholshoky Mountains were completely included in the Altynsyngan Formation. But according to the work done, the slopes of the Zholshoky mountains are included in the Kabantau formation of quartz-sericite and mica schists, quartzites and porphyroids, and the mountain top in the Aidakharly formation of quartz-sericite schists, white quartzites. And the Altynsyngan Formation was recorded north of the Zholshoky Mountains. All this makes it possible to more accurately understand the stratigraphy of the area and neighboring areas and further identify deposits for exploration and development of this area. And also provides an opportunity for scientific research into the formation of deposits.

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