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

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
КАЗАХСТАН
Satbayev University

N E W S

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

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

3 (459)

MAY – JUNE 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.

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

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

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

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

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

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

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

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

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

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

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

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

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/

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

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/

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

NEWS of the National Academy of Sciences of the Republic of Kazakhstan
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 3, Number 459 (2023), 262–281
https://doi.org/10.32014/2023.2518-170X.441

IRSTI: 553.078+553.041+553.061

© E.Yu. Seitmuratova[1*], R.T. Baratov[1], F.F. Saidasheva[1], V.S. Goryaeva[1], M.A. Mashrapova[1], Ya.K. Arshamov[2], 2023
[1]"K.I. Satbayev Institute of Geological Sciences", Almaty, Kazakhstan;
[2]Satbayev University, Almaty, Kazakhstan.
E-mail: seimuratova@mail.ru

TO STUDY THE RING STRUCTURES OF CENTRAL AND SOUTHERN KAZAKHSTAN AND THEIR ORE CONTENT

Seitmuratova Eleonora Y. — Doctor of geological and mineralogical sciences, professor, chief scientific employee, Head of the Laboratory of geological and ore formations K.I. Satbayev Institute of Geological Sciences
E-mail: seimuratova@mail.ru, https://orcid.org/0000-0001-8403-4635;
Baratov Refat T. — PhD, senior researcher employee, K.I. Satbayev Institute of Geological Sciences
E-mail: refa_88@mail.ru, https://orcid.org/0000-0002-0627-1536;
Saidasheva Farida F. — Candidate of geological and mineralogical sciences, senior researcher employee, K.I. Satbayev Institute of Geological Sciences
E-mail: faridasaidasheva@mail.ru, https://orcid.org/0000-0002-5817-1158;
Mashrapova Moldir A. — PhD, junior researcher, K.I. Satbayev Institute of Geological Sciences,
E-mail: moldir_m_@mail.ru, https://orcid.org/0000-0002-6009-9730;
Arshamov Yalkunzhan K. — Candidate of geological and mineralogical sciences, associate professor, Deputy Director of the Department of Geological Survey, Prospecting and Exploration of Mineral Deposits of the Institute of Geology and Oil and Gas Business K. Turysova, Satbayev University
E-mail: y.arshamov@satbayev.university, https://orcid.org/0000-0003-0527-6797.

Abstract. The article presents the results of visual interpretation of satellite images of 30 1:500000 scale tablets of Central and Southern Kazakhstan, carried out during the work on the grant project of the Ministry of Education and Science of the Republic of Kazakhstan “Studying the ore content of ring structures in Central and Southern Kazakhstan with identifying the most promising of them for setting prospecting works” (2018–2020). An analysis of the newly compiled "Map of Ring Structures of Central and Southern Kazakhstan" at a scale of 1:1,000,000 clearly shows their very wide manifestation. So, on the sheets of the studied region, 6783 ring structures (CS) of different sizes and genesis were deciphered. According to geological publications of the last 40-50 years, it is noted, on the example of various regions of the world, that many types of minerals are confined to the CS. Analysis of the distribution of ore mineralization in the region relative to the CS shows that in Central and Southern Kazakhstan from 54–70 % to 90–100 % of ore mineralization is localized in the CS. Based on this search criterion, the authors recommend setting up prospecting and appraisal work at eight priority ore-bearing CSs in order to identify new deposits.

Keywords: space images, interpretation, mineral deposits, ring structures of different genesis, ore-localizing structures

© Э.Ю. Сейтмұратова[1*], Р.Т. Баратов[1], Ф.Ф. Сайдашева[1], В.Я. Горяева[1], М.А. Машрапова[1], Я.К. Аршамов[2], 2023

[1]Қ.И. Сәтбаев атындағы геологиялық ғылымдар институты, Алматы, Қазақстан;
[2]Сәтбаев Университеті, Алматы, Қазақстан.
E-mail: seimuratova@mail.ru

ОРТАЛЫҚ ЖӘНЕ ОҢТҮСТІК ҚАЗАҚСТАННЫҢ САҚИНАЛЫ ҚҰРЫЛЫМДАРЫН ЖӘНЕ ОЛАРДЫҢ КЕНДЕНУІН ЗЕРТТЕУ

Сейтмұратова Э.Ю. — Геология және минералогия ғылымдарының докторы, профессор, бас ғылыми қызметкер, геологиялық және кен формациясы лабораториясының жетекшісі, Қ.И. Сәтбаев атындағы геологиялық ғылымдар институты
E-mail: seimuratova@mail.ru, https://orcid.org/0000-0001-8403-4635;
Баратов Р.Т. — PhD, аға ғылыми қызметкер, Қ.И. Сәтбаев атындағы геологиялық ғылымдар институты
E-mail: refa_88@mail.ru, https://orcid.org/0000-0002-0627-1536;
Сайдашева Ф.Ф. — Геология және минералогия ғылымдарының кандидаты, аға ғылыми қызметкер, Қ.И. Сәтбаев атындағы геологиялық ғылымдар институты
E-mail: faridasaidasheva@mail.ru, https://orcid.org/0000-0002-5817-1158;
Машрапова М.А. — PhD, кіші ғылыми қызметкер, Қ.И. Сәтбаев атындағы геологиялық ғылымдар институты
E-mail: moldir_m_@mail.ru, https://orcid.org/0000-0002-6009-9730;
Аршамов Я.К. — Геология және минералогия ғылымдарының кандидаты, қауымдастырылған профессор, Пайдалы қазбалар кенорындарын геологиялық түсіру, іздеу және барлау» кафедрасы, Қ. Тұрысов атындағы Геология және мұнай-газ ісі институты, Сәтбаев Университеті
E-mail: y.arshamov@satbayev.university, https://orcid.org/0000-0003-0527-6797.

Аннотация. Мақалада Қазақстан Республикасы Білім және Ғылым министрлігінің«ОрталықжәнеОңтүстікҚазақстанныңсақиналықұрылымдарының кенділігін зерттеу және іздеу жұмыстарын жүргізу үшін олардың ең болашағы бар учаскелерін анықтау» (2018–2020) тақырыбындағы гранттық жоба бойынша орындалған Орталық және Оңтүстік Қазақстанның 1:500000 масштабтағы 30 планшетті ғарыштық суреттерін визуалды дешифрлеудің нәтижесі келтірілген. Жаңадан құрастырылған 1:1000000 масштабтағы «Орталық және Оңтүстік Қазақстанның сақина құрылымдарының картасын» талдау олардың өте кең көрінісін айқын көрсетеді. Сонымен, зерттелген аймақтың парақтарында әртүрлі өлшемдер мен генезистік 6783 сақина құрылымы (КС) дешифрленген.

Соңғы 40–50 жылдағы геологиялық басылымдарға сәйкес, әлемнің әртүрлі аймақтарының мысалында пайдалы қазбалардың көптеген түрлері КС-мен шектелгені атап өтіледі. Өңірдегі кенді минералданудың КС-ке қатысты таралуын талдау Орталық және Оңтүстік Қазақстанда 54–70 %-дан 90–100 %-ға дейінгі кен минералдануының КС-да локализацияланғанын көрсетеді. Осы іздестіру критерийіне сүйене отырып, авторлар жаңа кен орындарын анықтау үшін сегіз басым кенді кен орындарында іздеу-бағалау жұмыстарын жүргізуді ұсынады.

Түйін сөздер: ғарыштық суреттер, дешифрлеу, пайдалы қазбалар кен орындары, әртүрлі генезистегі сақиналы құрылымдар, кенді локализациялаушы құрылымдар

© Э.Ю. Сейтмуратова[1*], Р.Т. Баратов[1], Ф.Ф. Сайдашева[1], В.С. Горяева[1], М.А. Машрапова[1], Я.К. Аршамов[2], 2023

[1]ТОО «Институт геологических наук им. К.И. Сатпаева», Алматы, Казахстан;
[2]Сатпаев Университет, Алматы, Казахстан.
E-mail: seimuratova@mail.ru

К ИЗУЧЕНИЮ КОЛЬЦЕВЫХ СТРУКТУР ЦЕНТРАЛЬНОГО И ЮЖНОГО КАЗАХСТАНА И ИХ РУДОНОСНОСТИ

Сейтмуратова Э.Ю. — доктор геолого-минералогических наук, профессор, главный научный сотрудник, руководитель лабораторией геологических и рудных формации, Институт геологических наук им. К.И. Сатпаева
E-mail: seimuratova@mail.ru, https://orcid.org/0000-0001-8403-4635;
Баратов Р.Т. — PhD, старший научный сотрудник, Институт геологических наук им. К.И. Сатпаева
E-mail: refa_88@mail.ru, https://orcid.org/0000-0002-0627-1536;
Сайдашева Ф.Ф. — кандидат геолого-минералогических наук, старший научный сотрудник, Институт геологических наук им. К.И. Сатпаева
E-mail: faridasaidasheva@mail.ru, https://orcid.org/0000-0002-5817-1158;
Машрапова М.А. — PhD, младший научный сотрудник, Институт геологических наук им. К.И. Сатпаева
E-mail: moldir_m_@mail.ru, https://orcid.org/0000-0002-6009-9730;
Аршамов Я.К. — кандидат геолого-минералогических наук, ассоц. профессор, кафедра геологической съемки, поиска и разведки месторождений полезных ископаемых, Институт геологии и нефтегазового дела им. К. Турысова, Сатпаев Университет
E-mail: y.arshamov@satbayev.university, https://orcid.org/0000-0003-0527-6797.

Аннотация. В статье приведены результаты визуального дешифрирования космических снимков 30 планшетов масштаба 1:500000 Центрального и Южного Казахстана, выполненных при работе над грантовым проектом МОН РК «Изучение рудоносности кольцевых структур Центрального и Южного Казахстана с выявлением наиболее перспективных из них для постановки поисковых работ» (2018–2020 гг.). Анализ вновь составленной «Карты кольцевых структур Центрального и Южного Казахстана» масштаба 1:1000000 однозначно показывает их очень широкое проявление. Так, на листах исследованного региона отдешифрировано 6783 кольцевых структур (КС) разного размера и генезиса. Согласно геологическим публикациям последних 40–50 лет на примере различных регионов мира отмечается приуроченность многих видов полезных ископаемых к КС. Анализ размещения рудной минерализации региона относительно КС показывает, что в Центральном и Южном Казахстане от 54–70 % до 90–100 % рудной минерализации локализуется в КС. На базе этого поискового критерия авторы рекомендуют постановку поисково-оценочных работ на восьми первоочередных рудоносных КС с целью выявления новых месторождений.

Ключевые слова: космические снимки, дешифрирование, месторождения полезных ископаемых, кольцевые структуры разного генезиса, рудолокализующие структуры

Introduction

Space exploration started with invention of space crafts, permitting systematic remote sensing of the surface of the Solar system planets and their satellites, showed their morphological and structural shape in a totally new way, revealing the widest development on their surfaces of circular structures (CS) of different design and size, which vary from dozens and hundreds to two-three thousands of kilometres (Bazilevsky et al., 1983: 200; Bryukhanov et al., 1987: 184; French, 2010; Masaitis, 1979: 20; Adam et al., 2012: 14). According to reviewed publications on circular structures, they are encountered in different tectonic structures of the Earth, on platforms and in folded areas (Bevan et al., 2018); Reimold, 2014; Zeylik, 1987: 37). They have different genesis, size and morphology (Katz et al., 1980: 5; Veselova et al., 2019; Bazilevsky et al., 1983: 200; Bryukhanov et al., 1987: 184; Dietz, 1968: 21; Kenkmann, 2014; Masaitis, 1979: 20) (Fig. 1, 2).

Circular structures on the Moon's surface	Circular structures on the Mars's surface	Circular structures on the Mercury's surface

Fig. 1. Circular structures on surface of the solar system planets and their satellites

Noteworthy, majority of researchers involved in the study of circular structures note their connection with deposits of various minerals (Bazilevsky et al.,1983; Laverov, 2007: 198; Katz Ya.G. 1980; Kleyner, 2010; Masaitis, 1979: 124; Smirnov, 1973: 10; Sokolov et al., 1977: 173; Solovyov, 1978; Struzhkov et al., 2005: 320; Stuart, 2011; Zeylik et al., 1982: 90; Zeylik et al., 1987) (Fig. 3). Therefore, the need in full use of space survey materials looks to be highly topical.

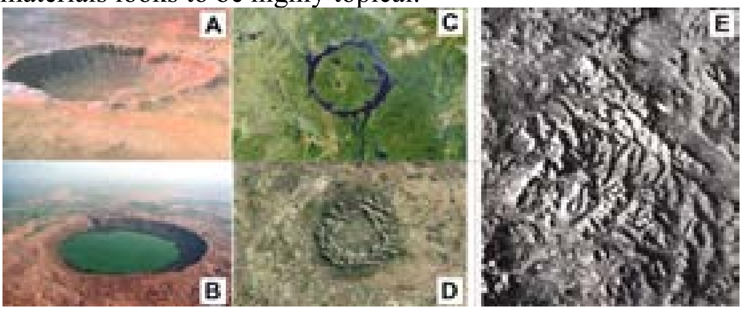


Fig. 2. The Earth circular structures: A - Arizona Meteor Crater (USA), B - Crater Lonar (India), C - Crater Manicouagan (Canada), D - Crater Gosses Bluff (Autralia), E - TasKora Mountain area (Central Kazakhstan)

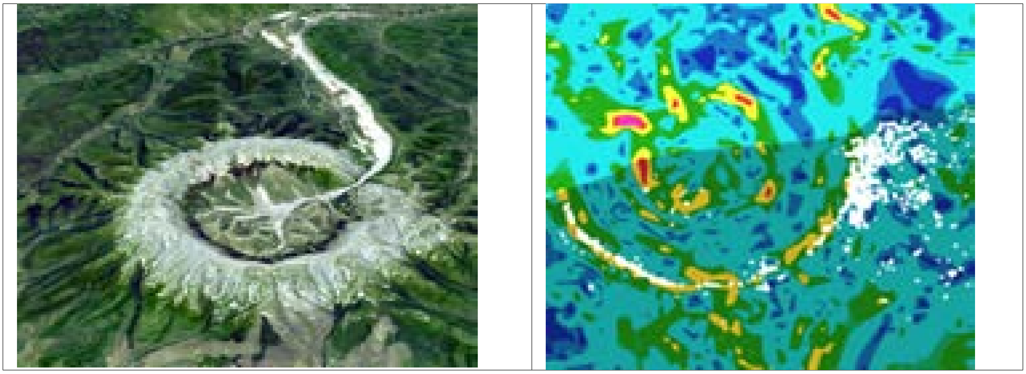


Fig.3: left - a satellite image of the Kondyor meteorite crater, East Siberia, platinum deposit; right - a map of gravity anomalies of the Chicxulub crater, Yucotan Peninsula, Mexico, Campeche oil field (2/3 of Mexico's oil production)

However, in spite of the established ore-controlling role of circular structures, this prospecting criterion is still underutilised in geological practice. At present, the fund of easily discoverable deposits is completely exhausted, and it poses a challenge for prospecting geology to attract new methods. In this regard, the limited use of remote sensing materials for geological tasks is not to be encouraged.

This was the reason to apply for a grant to fund the work on the theme "Study of ore bearing capacity of circular structures of Central and Southern Kazakhstan with identification of the most promising ones for prospecting".

Materials and main methods

The study of circular structures was implemented during the period of 2018–2020 in an area reflected in 28 sheets scaled 1:500,000 (fig. 4).

Fig. 4. The localisation chart of satellite image sheets of Central and Southern Kazakhstan

In order to identify the intensity of occurrence of circular structures in the territory of Central and South Kazakhstan, the interpretation of satellite images of all the chart sheets was carried out (fig. 4) (Seitmuratova et al., 2022), resulting in compilation of the first time 1:1,000,000 scale map of circular structures of Central and Southern Kazakhstan (fig. 5) (Seitmuratova et al., 2022: 53). The Map indicates a huge number of circular structures and their extremely uneven occurrence similar to those found in other regions of the Earth (Bryukhanov et al., 1987: 184, Stuart, 2011: 5; Hergarten, 2015: 6).

There are three distinguished size groups of circular structures: the first contains large circular structures with diameters of 30–50 and >50 km; the second, medium size of 10–29 km; the third, small CS with diameters of 0.5 to <10 km.

Numbers of circular structures counted according to indicated dimensions are given in Tables 1 and 2 compiled using the Map of circular structures of Central and Southern Kazakhstan at a scale of 1:1,000,000. The conducted statistical analysis (fig. 5) shows that small circular structures are unambiguously predominant in the studied area, as it can be seen from Tables 1 and 2.

Fig. 5. The 1:1,000,000 scale map of circular structures of Central and Southern Kazakhstan"

Table 1. Intensity of occurrence of circular structures of different dimensions in the territory of Central Kazakhstan

List of sheets		N-42-B	N-42-G	N-43-B	M-42-A	M-42-B	M-42-B	M-42-G	M-43-A	M-43-B	M-43-B	M-43-G	L-42-A	L-42-B	L-43-A	**Total**
RS quantity by dimension	large 30-50 km and >50	1	2	4	8	2	0	3	7	6	10	5	3	8	4	63
	Medium 8-29 km	15	29	30	45	58	97	69	66	37	89	758	45	51	31	1420
	small 0.5-8 km	277	112	18	271	476	224	117	74	126	102	119	94	293	145	2448
General quantity of CS		293	143	42	324	536	321	189	147	169	201	202	142	352	180	3931

Table 2. Intensity of occurrence of circular structures of different dimensions in the territory of South Kazakhstan

List of sheets		L-41-G	L-42-B	L-42-G	L-43-B	L-43-B	L-43-G	L-44-A	L-44-B	L-44-B	L-44-G	K-42-A	K-42-B	K-43-A	K-43-B	K-44-A	Total
R S quantity by dimension	large 30-50 km and >50	4	9	6	4	11	4	5	5	7	4	8	27	17	14	10	135
	Medium 8-29 km	9	18	40	29	15	37	31	17	18	11	23	38	24	16	25	351
	small 0.5-8 km	239	170	358	182	82	205	69	54	142	36	189	149	132	102	257	2366
General quantity of CS		252	197	404	215	108	246	105	76	167	51	220	214	173	132	292	2852

A total of 6,783 circular structures were identified on sheets of Central and Southern Kazakhstan. The figure can be considered quite reliable as we compare it with more than 5,000 circular structures shown in the 1982 "Cosmogeological map of the USSR" of scale 1:2,500,000 (Cosmogeological map, 1984), which does not permit viewing the class of small circular structures, most widespread in the region.

Further, the "Map of the circular Structures of Central and Southern Kazakhstan" shows a highly uneven manifestation of circular structures in the region.

Thus, in Central Kazakhstan their greatest number of 536 CS was identified on the sheet M-42-B, in the territory more than 60 % of which is covered with loose sediments. Accordingly, it is very difficult to speak about the nature of the CS. Less but sufficiently large amount of CS is registered on sheets M-42-A (324 CS), M-42-B (321 CS), L-42-B (352 CS) (Table 1). All listed sheets show extensive fields of outcrops of Devonian volcanogenic and plutonogenic formations of Devonian (Central Kazakhstan) volcano-plutonic belt (VPB) which in many respects explains great number of CS. Also striking is the high number of CS on the sheets M-43-B and -G (201 and 202 CS), the most area of which contains volcanogenic and intrusive formations of the Carboniferous-Permian intracontinental Balkhash-Ili VPB. This geological factor allows referring most of them to endogenous CS.

The large number of circular structures in the different-age VPBs can be explained by a single mechanism of volcanic structure formation. The extensive development of shallow (0.5–5 km) CS within them is determined by endogenous domes and parasitic vents, which correspond in composition to the strata of acid, intermediate or basic volcanics. They are often surrounded by arched semicircular and circular-shaped faults because they are "squeezed out" along fractures through overlapping strata. All other sheets also show a predominance of shallow structures. Circular structures include medium- and small-size structures, which overlap to form a complex surface pattern. Small structures on the sheets are always distributed unevenly, and are gathered in clusters in different parts of the sheets. They are often confined to circular fractures of larger CSs, as well as grouped within them, overlapping each other. In the background of medium-sized CS, the distribution of linear structures is clearly visible, rather they create a surface pattern. In general, more large and medium-sized structures are conspicuous, although their number is much less than that of small ones. Very often CSs in diameter of 70 km and more are systems of magmatic structures (Kyzyltas, Kargaly, Kyzylrai and others), which developed in the superstructure zone outlined by this circular fracture. The other big CSs fix intrusive domes or simple circular structures. There are also extended lineaments stringing the CSs. Not all of the CSs are clearly expressed, often only their fragments can be fixed or overlapping of one structure with another, which affects their counting. The most massive CS are encountered at conjunction of the Devonian and Late Paleozoic structural-formation zones of the Balkhash-Ili VPB. Noteworthy is the fact that a uniform distribution of CSs of different diameters while being formed under sharply different geological situations. This is particularly prominent in the sheet L-42-A.

The CS occurrence intensity analysis shows that, according to the genesis, undoubtedly, magmatic CS are dominant in the CK territory (Zeylik, 1987: 37; Laverov, 2007: 198). Apart from endogenous, there are 34 proven and supposed impact CSs in the territory. These are meteorite craters: Shunak, Kumdykol, Intaly, BayanAul, Karkaraly, Kent, Ejebai, BesShoky South and the verified Ishim (Teniz) astroblem described earlier by B.S. Zeilik (Zeylik, 1987: 37), which was later included into the "Catalogue of impact structures" by A.V. Mikheevskaya. (Mikheeva, http://labmpg.sscc.ru/Impact/). A their detailed study of a number of CSs can transfer them to another group of genotypes (Baynazar, Big Konyrat, oth.). With such huge number of CSs identified in the CK, it is impossible to solve the ranking task within a single project. This area of research remains promising for the coming years.

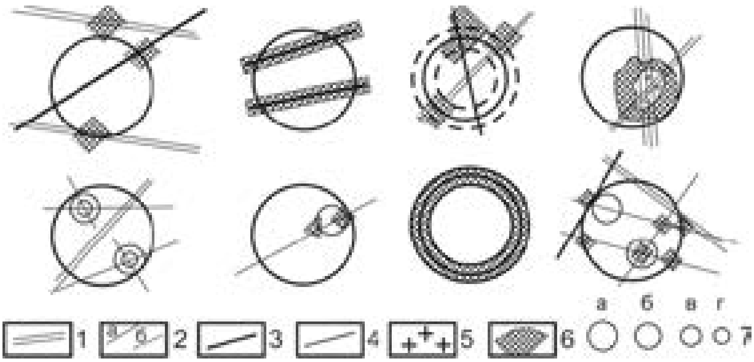
The CS occurrences in South Kazakhstan, according to Table 2, is also highly intense: **2,852** CSs have been delineated in the sheets. In general, the intensity of occurrence of CS in the territory of Southern Kazakhstan reveals approximately the same distribution pattern as in Central Kazakhstan. Thus, large circular structures also include medium- and small-sized CSs. Small-sized CSs are often grouped into separate areas. A large number of faults of different direction and extent, arched and radial, crossing the CSs are observed. Very often, the circular structures overlap each other. Quite often CSs are localised along large linear faults. In the whole, not all CSs, identified in the SK, are ranked according to their genesis. The two astroblems, Zhezkazgan and Arganaty, (Zeylik, 1987: 37) are attributed to cosmogenic CS in the SK. The major part of the Zhongar Alatau CSs is attributed to magmatic ones. Whereas, the CS of the western sheets L-41-G, L-42-B, K-42-A,B of South Kazakhstan, poorly studied, are not ranked genetically.

The statistical analysis of the CS dimensions intensity in CK and SK showed an undoubted dominance of cosmogenic and endogenic CS.

Identification of ore bearing capacity of CS in the Central and Southern Kazakhstan is one of the primary study tasks of a practical significance for prospecting. The role of CS in localization of many types of minerals (fig. 3) is highlighted in publications in various case studies in the world (Laverov, 2007: 18; Smirnov, 1973: 10; Solovyov, 1978: 111; Struzhkov et al., 2005: 320; Zeylik et al, 1982; Neville et al., 2014).

In accordance with the fluid dynamic concept of mineral deposit formation put forward by B.A. Sokolov and V.I. Starostin (Sokolov et al., 1977: 49), it is obvious that structural control in the spatial distribution of various mineral deposits associated with fluid dynamic processes is exercised by permeability zones formed by endogenous or cosmogenic processes (Laverov, 2007: 198; Smirnov, 1973: 10; Sokolov et al, 1977: 49).

The studies in this direction revealed typical positions of structural element relationship, whereby arise the most favourable conditions for localization of a mineralization. Thus, according to V.V. Solovyov (Solovyov, 1978: 111), deposits can be confined to the outer or peripheral CS contours; be located behind the CS contours in areas of CS intersection with crossing or associated faults of different ranks and sizes; in areas of interference (thickening) of different size CSs and of different genesis; in apical parts of plutons reflected as CS (fig. 6).



1 - regional faults; 2 - circular faults of volcano-plutonic structures (o), their outer and inner zones (b); 3 - local faults; 4 - feathering faults; 5 - central-type granite plutons; 6 - areas favourable for mineral deposits; 7 - inducing circular structures: a - local structures, b - blind intrusions, c - necks, subvolcanic intrusions, *d* - apical protrusions of ledges, bosses

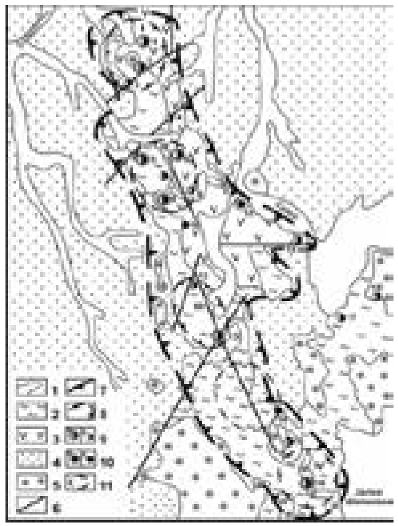
Fig.6. Models of structural-tectonic control of mineralisation in volcanogenic belts of Central Kazakhstan (Skublova, 1979)

In the above cases, the list of which can be extended further, the determining factor is a degree of permeability of the Earth's crust, due to its fragmentation. Considering only one of the listed conditions, namely, the possibility of crossing the CS in the zone of their interference with lineaments, V.V. Solovyov has recommended a number of promising areas in the territory of the former CIS countries (Solovyov, 1978: 111). In opinion of many researchers, modern metallogenic studies, especially of continental VPBs, are impossible without a detailed analysis of CS.

The CS study became particularly important in predicting and searching for epithermal mineralization associated with volcano-tectonic structures (VTS) in VPB. Deposits of Au, Ag, Sn, Cu, W and other metals are known in volcanic belts. In search of these deposits, CS are especially crucial for fixing the position of central volcanoes (fig. 7, 8) and underlying peripheral magmatic sources, location of arc and radial faults.

Results

Proceeding from the above, there was a task to analyse the ore-bearing capacity of CS of the region in question. For this purpose, the first 1:1,000,000 "Map of circular structures of Central and Southern Kazakhstan" (fig. 5) was juxtaposed against a number of metallogenic profile materials, namely: the 1:1,000,000 map of minerals of Kazakhstan (Uzhkenov, Nikitchenko, 2003), the 1:500,000 Prognostic and metallogenic map of the Kazakh SSR in the Central-Kazakhstan series (Dumler et al., 1986), the 1:500,000 map of gold-bearing capacity of the Zhongar-Balkhash folding system (Seitmuratova, Zhukov, 1995), the 1:1,500,000 copper-bearing capacity map of the RK territory (Tyugai, et al, 1999), the Catalogues of occurrences, and mineralisation points in GDP-50 and GDP-200 reports. The maps were georeferenced (ArgGIS), and ore loadings were removed to the attributed tables.



The Dukat ore district

The Karamken ore district

Fig.7. Confinement of gold-silver epithermal occurrences to circular and oval structures of the Okhotsk-Chukotka VPB (Struzhkov et al., 2005: 320).

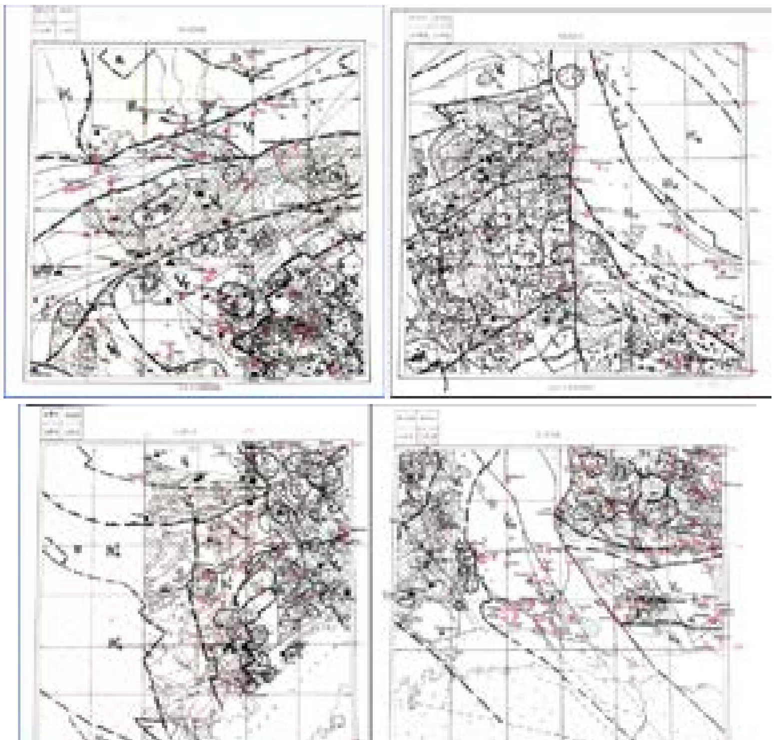


Fig.8. The chart of confinement of epithermal copper-porphyry and gold-silver occurrences to circular magmatic structures of NW sector of ZhBFS (Central Kazakhstan) (Seitmuratova, Zhukov, 1977).

Further, the ore bearing capacity data were consolidated into a single ArcGIS Database with categorisation of mineralisation types and scale (large, medium, small deposits, ore occurrences and mineralisation points). Reliable base material on ore bearing capacity of the studied area made it possible to compile very informative tables of ore bearing capacity of Central and South Kazakhstan (Tables 3,4), which show the intensity of manifestation of ore mineralization in structural-formation zones of Central and South Kazakhstan and its quantity in spatial relationship with CSs.

Table 3. Intensity of occurrence of ore mineralisation in structural-formation zones of Central Kazakhstan and its quantity in spatial connection with circular structures

Title of SFZ	Quantity of CSs	Huge/ large deposits	Medium deposits	Small deposits	Mineralisation points and ore occurrences	General quantity of manifestations and CS-associated manifestations	
Marjevskaya	51			3 Cu, U, Pb	no data	3	2 Cu/
IV 2 Kalmakkul	66	6 U		8–7 U, 1 Al	2 Cu	10	80 %
IV 3 ZharKainAgash	56	1 Al	1 Fe	6–3 Fe, 1 Au, 2 U	no data	8	4
IV 4 Kokchetau	76	8	2	8	No data	18	11\61 %
IV 5 Stepniak	71	2 U	1 Au	18–8 Au, 3 Fe, 6U, 1 Al	24–12Al, 5Au, 1Cu, 6 Fe	45	40\88 %
IV 5/1 Shatsk subzone	14	2 U	1 Zr	2 - 1Au, 1U	no data	5	3\60 %
IV 6 YeshkiOlmes	54	2 U	3 Au	10–2Au, 1Cu, 7U	15–7Cu, 8Au	30	26\86 %
IV 7 Selety	54	1 Au	10 - 2Al, 4Au, 2Cu, 2Sb	13–4Al, 8Au, 1Cu	42–12Al, 22Au, 7Cu, 1Fe	66	52\78 %
IV 8/1 Agdym	35		1 Fe	4–2Fe, 1U, 1Au	15–1Ti,Zr, 2Al, 2Fe, 3Au, 2Pt, 1PbZn, 4 Cu	20	9\45 %
IV 8/2 Yerementau	8			1Fe	10 - 6Cu, 1Mo, 1W, 2au	11	6\54 %
IV9/1 North Karaganda	33	1Cu	1Au	1Cu	37–17Cu, 8Au, 7Pb,Zn, 1Fe,Mn, 4 Al	40	35\87.5%
IV9/2 Central Karaganda	18		1Cu	2Cu	14–9Cu, 1Ba, 1Al, 1Fe, 1Mn,Zn 1Zn,Mn	17	10\58 %
IV 10 Spassk	31		2 / 1Cu, 1Au	2 / 1Cu, 1Au	109–97Cu, 4Ba,Pb,Zn, 1Mn,Pb,Zn, 4Au, 3Al	113	87\76 %

IV 11/2 East Sarysu-Teniz	81		1Au	5–3Au, 1Cu, 1Sn	44Pb,Zn,Ba, 28 Au, 18 Mo,W,Bi,Sn, 13 Al, 13 Fe,Mn, 5 Cu	127	107\84
IV 11/1 West Sarysu-Teniz	51	2Al	3/2Al, 1Mn	1Cu	39–6Au, 17Pb,Zn,Ba, 2W,Mo, 11Fe,Mn, 2Cu, 1Al	47	42\89 %
IV 11/3 Zhailma	15	4–3Ba, Pb,Zn 1 Fe,Mn	6–3Ba,Pb,Zn, 3 Fe,Mn	7–3Fe,Mn, 4 Ba,Pb,Zn	29–19Fe,Mn, 10Ba,Pb,Zn	46	26\56 %
IV 12 Atasu	17	1Pb,Zn,Ba		4–3Pb, Zn,Ba, 1Mn,Fe	46–5Ni,Co, 11Mn,Fe, 18Au, 6Pb,Zn, 6W,Mo	51	42\82 %
IV 20 Near-Atasu	38	3 W,Mo, Bi,Sn		6 / 2Pb,Zn, 3U, 1Cu	11Au,8Cu,36Pb,Zn,Ba,7Ni,Co,7Fe,Mn,54W,Mo,Bi,Sn	133	103\77 %
IV 13 Ulutau-Karsakbai	78	2 Tr-It	2 / 1Pb,Zn, 1Fe	15/10Fe, 1Al, 4Au, 4Cu	99–3Al,6W,Bi,Mo,13Au,27Cu,22Fe,Mn,15Pb,Zn,Ba,13Ni,Co	118	102\86 %
IV 31 Zhezkazgan	22	1 Cu	4Cu	9–7Cu, 2 Mn	21 - 13Cu, 8 Fe,Mn	35	28\80 %
IV 22 Mointy	55		2Cu	4–1Fe,Mn, 3W,Mo, Sn,Bi	61 - 11Au,7W,Mo,Be,19Pb,Zn,5Fe,Mn,19Cu	67	47\68 %
IV 21 Bullatau-Buruntau	41		3–1Sn, 1Au, 1Pb,Zn	9–5W,Mo, 2Pb,Zn,Sn, 2Au	42 / 13Au, 5Ni,Co, 1Cr, 2Ti,Zr, 12Pb,Zn, 9W,Mo,Sn	55	46\83 %
IV 19 Zhalair-Naiman	6	1Au	7–5Au, 1Pb,Zn, 1Fe,Ti	11–7Au, 1Cu, 3U	8 - 1Cu, 2Au, 4Ni,Co, 1Cr	28	18\64 %
IV 17 Shu	13		2–1Sn, 1Fe	5/3U, 2Au	11–4Fe, 4Au, 1V,Mo, 1Sn, 1Pb,Zn	18	13\72 %
V 1 Bozshakol	26	1Cu	1Au	4/3Au, 1Al	20/2Co,Ni, 5Al, 2Ti,Zr, 6Cu, 5 Au	26	17\65 %
V 2 Kendykty	29			2/1Cu, 1Au	88–7Au, 74Cu,1 Mo,W, 4Ni,Co, 2Pb,Zn	90	76\84 %

V 3 MaiKain	52	2–1Ni,Co, 1Mo,W	4–3Au, 1Cu	8–3Ni,Co, 5Au	128–57Cu, 20Ni,Co, 38Au, 2Fe, 3Al, 7Zn,Pb, 1Bi	141	123\87 %
V 4 Ekibaztuz-Shiderty	63		1Au	3–1Au, 1Pb,Zn, 1Fe	149–111Cu, 19Au, 8Pb,Zn,Ba, 4W,Mo,Be, 6Fe, 1Ni	153	145\95 %
V 9 Near-Chingiz	20		1Au	2Cu	46–5Au, 27Cu, 4Fe, 1Nb,TR, 6Pb,Zn, 1Ni,Co, 2Hg	49	35\72 %
II 1 Karasor-Nura	29		1Cu	1Cu	66–55Cu, 2Au, 8Pb,Zn, 1Fe	68	57\84 %

II 2 Sarysu	39			3Au	25–12Au, 8Cu, 2Mn,Fe, 2Pb,Zn, 1Mo	28	19\68 %
II 3 Tekturmas	5			2–1Au, 1Cu	8–2Fe,Mn, 2Cr, 2Au, 2Ni,Co	10	4\40 %
II 4 Uspen	82	3 W,Mo	2–1W,Mo, 1Pb,Zn	8–3Cu, 2Fe,Mn, 2W,Mo, 1U	154–29Au,43Cu,38W,Mo,Be,Sn,30Pb,Zn,10Fe,Mn,2Cr,2Ni,co	167	140\84%
II 5 Zhaman-Sarysu	47	5–1Cu, 3W, Mo	3–1Cu, 2W,Mo	7–3Pb,Zn, 2W,Mo, 1Cu, 1Au	140–62Au,33Cu,28W,Mo,2Fe,Mn,13Pb, Zn,2Al	155	141\91%
II 6 Aktau-Tasaral-KyzylEspe	60	1Cu	5–2Pb, Zn,Ba, 1Cu, 2Mo,W	15–1Cu, 6Pb,Zn, 2Fe,Mn, 4Mo, W,2Au	184–65Pb,Zn, 49Au, 30Cu, 27W,Mo, 7Fe,Mn, 6Al	205	183\90%
II 9 South Tokrau	40		2–1Pb,Zn, 1Mo	1Au	65–17Au,10Cu,4W,Mo,16Al,10Pb,Zn,8Fe	68	61\90 %
II 8 West Tokrau	77		1W,Mo	9–4Au, 3Pb, Zn,1Cu, 1Mo,W	182–70Au, 29Cu, 23W,Mo, 38Pb,Zn 22Al	192	180\94 %
II 10 Zhantau	24		1Cu	1Pb,Zn	39–14Au, 10Cu, 8Pb,Zn, 7Mo,W	41	33\80 %
II 11 East Tokrau	50	2–1Pb, Ba, 1Al	6–4Cu, 1Pb,Zn, 1Fe	8–2Cu, 4Pb,Zn, 1Bi, 1Fe	116–24Au,19Cu,13W, Mo,4Fe,9Nb,TR,24Pb,Zn,23Al	132	121\92 %
II 12 KotanEmel-KalmakEmel	79		2 Au	2/1Au, 1Fe	116–54Au, 41Cu, 3Fe, 9Pb,Zn, 2W,Mo, 7Al	120	92\77 %
II 13/1 West Bakanas	11			1Cu	11–9Au, 2Cu	12	10\83 %
II 13/2 Bakanas	54			5–3Cu, 4Au	75–62Cu, 12Au, 1Pb	84	71\85 %
II 14/1 Tasty	26	2Cu	2Cu		11 Au, 13Cu	26	17\65 %
II 14/2 Kosak	20		1W,Mo		17–10Au, 5Cu, 1Fe, 1Pb,Zn	18	15\83 %

II 14/3 KotyrAsan	47	1Cu	5–2Cu, 3Mo,W	2–1Cu, 1Mo	60–12Au, 2Fe,3Pb,Zn, 18Al, 19Cu,6 W,Mo	67	62\92 %
II 15 North Balkhash	28		3Au	2Au, 1Cu	20–17Au,1W,Mo, 2Fe,Ti	25	19\76 %
II 17 Itmurundy-Kazyk-Tulkulam	5ф				4Au,4Ni,Co,2Fe,Ti	10	7\ 70 %
II 16 Sayak	35		4–1Mo,W, 2Cu, 1Au	5–4Cu, 1Au	42–20Au, 11Cu, 7Fe,Ti, 4Au	51	43\84 %

The Table 3 show highly uneven distribution of ore mineralisation in the study area.

The generalized data on ore content of SFZ of Central Kazakhstan (Table 3) once again showed the polymetallic nature of mineralization in the most part of the study area. Only three zones are marked as having 1-3 types of mineralization: three Cu-U-Pb small deposits in Marievka SFZ, 9 Au and 3 Cu small deposits and ore occurrences in West Bakanas, and 17 Cu and 11 Au in Tasty. In all other SFZs, the mineralisation is more diverse, ranging from 3 to 7-9 types. The greatest number of mineralization types is observed in the Akdym SFZ: 8Cu, 5Fe; 4Au; 4Cu; 2Al; 2Pt; 1Ti-Zr;1U;1Pb-7W; NearAtasu (7): 57W, Mo, Bi, Sn; 38Pb, Zn; 11Au; 9Cu; 7Fe, Mn; 7Ni, Co; 3U; Karsakbai (9): 32Cu; 22Fe, Mn; 17Fu; 11Fe; 13Ni, Co; 15Pb, Zn, Da; 6W, Bi, Mo; 2TR, It; 3Al; MaiKain (7): 55Cu; 26 Ni, Co; 41Au; 4Pb, Zn; 3Al; 2Fe; 1W, Mo; NearChingiz (7): 29Cu; 6Au; 6Pb, Zn; 2Hg; 1Ni, Co; 4 Fe; 1Nb, TR; Uspen (7): 46Cu; 44W, Mo; 31Pb, Zn; 29Au; 10Fe, Mn; 2Ni, Co; 2Cr; East-Tokrau (7): 30Pb, Zn; 25Cu; 24Au; 23Al; 13W, Mo; 9Nb, Ta; 6Fe.

In general, the metallogenic specialization of the SFZ of Central Kazakhstan is polymetallic. If to focus only on the dominant type of mineralization, most of the SFZ of Central Kazakhstan have *copper, copper-gold or gold specialization.*

The SFZs of the northwestern part of the region sharply differ from other SFZs of the region. These are the KalmakKol SFZ with its specialization in uranium with single occurrences of copper; the ZharKainAgash SFZ with iron ore; the Kokshetau SFZ with uranium-gold ore; the Stepniak SFZ with gold ore and single occurrences of iron, copper and aluminum; the uranium-bearing Shatsk subzone; the YeskiOlmes SFZ with gold ore and uranium (9) and copper (8) occurrences; the Selety SFZ with gold ore and noticeable occurrences of copper (10) and aluminium (18).

The Table 3 also shows that, with the exception of Marjevskaya, KalmakKol, Central Karaganda and Zhezkazgan SFZs, all other 44 have gold ore occurrences. Interestingly, despite of wide manifestation of gold mineralization, there are few known large gold deposits in Central Kazakhstan: Vasilkovskoye stockwork gold-quartz-sulphide geological-industrial type (GIT), Bestobe and Akbakai quartz-vein GITs. In traditional gold mining SFZs of Stepniak, EshkiOlmes, Selety, several medium-range gold deposits are known (Zholymbet, Aksu, Kvartsite hills, oth.), about 20 small deposits of artisanal level and dozens of occurrences and mineralization points are revealed. The main stage determining their high gold-bearing capacity in the above SFZs is the island-arc stage, which is in full conformity with the ore-bearing capacity of modern ensialic island arcs. These SFZs are noted to have their gold-ore occurrences closely connected with the copper ones. A wide occurrence of CSs in these SFZs allows us to evaluate them as promising in detecting copper-porphyry deposits with gold and epithermal gold-silver deposits proper.

As a result of the data generalization on ore content in Central Kazakhstan SFZ (table 3), another very important aspect of metallogeny of the region was marked: a distinct copper specialization of the following SFZs: Yerementau – 6Cu from 11 occurrences; North Karaganda - 19Cu from 40; Central-Karaganda – 12Cu from 17; Spassk - 99Cu from 113; Ulutau-Karsakbai – 32Cu from 118; Zhezkazgan – 25Cu from 118; Mointy – 21Cu from 67; Kendykty – 75Cu from 90; MaiKain – 55Cu of 141; Ekibastuz-Shiderty – 111Cu of 153; NearChyngyz – 2Cu of 49; Karasor-Nuran – 57Cu of 68; Uspen – 46Cu of 167; East Bakanas – 65Cu of 82; Tasty subzone – 17Cu of 28; KotyrAsan – 23Cu of 68; Sayak – 17Cu of 51. In this list of SFZs with domination of copper mineralization and manifestation of various geodynamic settings, we should focus on identification of copper deposits of different GIT. The noted diversity of geodynamic settings in SFZ with copper specialization allows predicting GIT deposits of cuprous sandstones in Karsakbai, Zhezkazgan and Karasor-Nuria SFZs. The SFZ with ensimatic island arcs - Marievskaya, Yerementau, Bozshakol, MaiKain, Kendykty, Ekibastuz-Shiderty - can promise discovery of new copper-porphyry with gold and copper-chalcopyrite deposits.

Table 4 "Intensity of ore mineralization occurrence in structural-formation zones of South Kazakhstan and its quantity in spatial relationship with circular structures" was compiled to solve the problem of spatial relationship with CSs of ore mineralization in the South Kazakhstan SFZ.

Table 4. Intensity of occurrence of ore mineralisation in structural-formation zones of South Kazakhstan and its quantity in spatial relationship with CSs

Title of SFZ	Quantity of CSs	Huge/large deposits	Medium deposits	Small deposits	Points of miner-alisation and ore occurrence	Total quantity of manifes-tations	Quantity of minera-lisations in spatial connection to CSs
IV 15 Great Karatau	126	7/3V(Mo), 2Pb,Zn, 2U	6–1Fe, 1Au, 3Pb,Zn, 1Cu	36–19Au, 3V(Mo,W), 1Fe, 13Pb,Zn	No data	49	38 / 72 %
IV 16 Small Karatau	53			1Mo,1Pb,Zn	No data	2	2 / 100 %
IV 30 Karzhantau-Ugam	22			4–2Pb,Zn, 1Hg(Mo), 1Fe	No data	4	2 / 50 %
IV 29 Kyrgyz	24		1Au	8–6Au, 1Cu, 1Pb,Zn	No data	9	5 / 55.5 %

Table 4 continue

SyrDarya Depression	~320	5 - 1NGC, 4U	4–1NGC, 3U	9–2HN, 1U, 1Fe, 5Al	No data	18	13 / 72.2 %
Shu-Sarysu depression	~ 270	3U	7–4U, 1GC, 2Cu	12–5G, 2W,Mo, 1Sn, 3U, 1Pb,Zn	No data	22	17 / 78 %
IV 17/1Near-Shu subzone	45	1Cu	1Pb,Zn	3 - 1Cu, 1Au, 1U	3–2Pb,Zn, 1Cu	8	5 / 62.5 %
IV 23 Zheltau	56		3–2Pb,Zn, 1U	14 - 7Au, 4U, 3Mo,W	No data	17	13 / 76.5 %
IV 19/1 Sarytum subzone	21			2–1Mo(U), 1Au	No data	2	2 / 100 %
Ili depression	87		6–4Cu, 2U(Re)	7–3Au, 2U, 1Cu	No data	13	11 / 84.6 %
IV 18 Kendyktas	62		6–2Cu, 3Au, 1U(Mo)	15–7Au, 4Cu, 4Pb,Zn	No data	21	14 / 66.6 %
IV 24 Trans-Ili	31			3–1W,Mo, 2Pb,Zn	No data	3	2 / 66.6 %
IV 25 Kastek	25			2Au, 2P,Zn	No data	4	4
IV 25 /1 Boguty subzone	11	1W(Mo)		4–1W, 1Pb,Zn, 2Au	No data	5	5 / 100 %
IV 26 Shili-Kemin	22			1Au	No data	1	0
IV 26 / 1 North Kemin subzone	48			4–2Au, 1W, 1Pb,Zn	No data	4	4 / 100 %
IV 27/1 North Ketpen	23		1U(Mo)	1Au	No data	2	0
IV 27/2 South Ketpen	30			4Au	No data	4	2 / 50 %
IV 28 Teriskey	31			3Sn	No data	3	3 / 100 %
II 23 Ili	~150		1Au	17–11Au, 3Pb,Zn, 1Cu, 2Al	26Au	44	34 / 77.2 %
II 14/4 AltynEmel	68	1Cu	2Pb,Zn	7–4Pb,Zn,3Au	6Au	16	13 / 81.2 %
II 22 Tekeli	43	1Pb,Zn	1Pb,Zn	6–3Pb,Zn, 2Au, 1U	1Au	9	6 / 66.6 %
II 21 Borataly	57			2W,Mo		2	1 / 50 %
II 20 Central-Zhongar	114		1Sn,W	9–1Cu, 7Au, 1Hg,Sn	24	34	26 / 76.5 %
II 19 Sarkand	91			1W	3Au	4	4 / 100 %
II 18 Tastau (North Jongar)	84			2Au	17Au	19	15 / 78.9 %

The Table 4 reveals many distinctive features of ore-bearing capacity of the South Kazakhstan SFZ differing it from the Central Kazakhstan SFZ in terms of intensity of occurrence of ore mineralization, metallogenic specialization of SFZ, and the number of identified CSs.

The Table 4 shows that in most part of the SFZ between 60 % and 100% of the ore mineralisation occurrences are spatially related to CS. In Small Karatau, Karzhantau-

Ugam, Kirgiz, Shilik-Ketpen, North-Ketpen, South-Ketpen and Borataly SFZs only about 50 % of ore mineralisation is associated with CS. In the Terskei SFZ, none of the 9 ore occurrences is confined to CS.

The ore content of the South Kazakhstan SFZ differs from the Central Kazakhstan SFZ not only quantitatively. Polymetallic mineralization, predominant in this area, is undoubtedly dominant in Great Karatau (77), Karzhantai-Ugam (12), Sarytum (15), Tekeli (5) SFZ. In the structural-formational zones of Trans-Ili, Kastek, North Ketpen, Ili and AltynEmel, polymetallic mineralization is closely associated with copper, rare-metal (V, Mo, W) and gold mineralization. The last association occurs mainly in the southeast of South Kazakhstan, within the Zhongar-Balkhash folding system (ZhBFS). It should be noted that the ZhBFS SFZ has a clear gold specialization, which is linked to a similar specialization of SFZ of the northern segment of the ZhBFS.

The next broadly manifested type of mineralization in the SFZ of SK is copper, which dominates in Karzhantas-Ugam (10); Kendyktas (52); North-Kemin (10) and Terskei (4) SFZ, and in Trans-Ili (4); Near-Shu (9); Kastek (2); North Ketpen (2) and Ili (15) SFZs, copper mineralization is associated with the dominant rare metal, polymetallic and gold mineralizations.

This type of mineralisation is associated with polymetallic and copper mineralisation in a number of SFZs: Great Karatau, Near-Shu subzone, Zheltau and Trans-Ili SFZs.

Like the Central Kazakhstan SFZs, the South Kazakhstan SFZs, with exception of Borataly and Tastau (North Zhongar), are characterised by polymetallic specialisation.

The final results of the study include scientifically substantiated recommendations for prospecting in newly identified prospective structures: prospective circular structures Shoimbai (M-42-G), Shoptybai (M-43-XVI), Kosmurun system of circular structures, volcano-tectonic structure Big Zhaur (L-43-G) and ore-bearing volcano-tectonic structure Eastern Kyzyltas.

Conclusion

The factual material allowed us to characterize the ore-bearing capacity of Central and Southern Kazakhstan and to identify 8 promising ones to recommend them for prospecting and appraisal work. The scientific novelty of the study is determined by the fact that on the basis of remote sensing data and previously identified characteristic features of CSs of different genesis, the ranking of such structures in Central and Southern Kazakhstan was carried out for the first time. The wide development of endogenous and cosmogenic structures among CSs was proved and their ore-controlling role for a number of geological-industrial types of mineral deposits was shown.

The practical significance of the study lies in the fact that identification of genetic type of ore-bearing CS, given the differences in their internal structure, determines a fundamentally different prospecting strategy.

The research was carried out with financial support of the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan under Contract No. 147 of 14.03.2018.

REFERENCES

Adam A. Garde, Iain McDonald, Bredan Dyck, Nynke Keulen, 2012 — *Adam A. Garde, Iain McDonald, Bredan Dyck, Nynke Keulen. Searching* for giant, ancient impact structures on Earth: The Mesoarchaean Maniitsoq structure, West Greenland. Earth and Planetary Science Lettes. Pp. 197–210, https://doi.org/10.1016/j.epsl.2012.04.026.

Bazilevsky A.T. and others., 1983 — *Bazilevsky A.T. and others.* Rep. ed. Academician Sadovsky M.A. Impact craters on the Moon and planets [Udarnye kratery na Lune i planetah]. M. Science. 200 p. (in Russ.).

Bevan M. French, Robert M. McKay, Huaibao P. Liu, Derek E.G. Briggs, and Brian J. Witzke, 2018 — *Bevan M. French1, Robert M. McKay, Huaibao P. Liu, Derek E.G. Briggs, and Brian J. Witzke.* The Decorah structure, northeastern Iowa: Geology and evidence for formation by meteorite impact. Geological Society of America Bulletin. V. 130, № 11/12. Pp. 2062–2086.

Bryukhanov V.N., Bush V.A., Glukhovsky M.Z. and other, 1987 — *Bryukhanov V.N., Bush V.A., Glukhovsky M.Z. and other.* Ring structures of the Earth's continents. M. 184 p.

Cosmogeological map of the USSR scale 1:2 500 000. (1984) Ed. E.A. Kozlovsky M. Mingeo USSR.

Dietz R.S., 1968 — *Dietz R.S.* Astroblems: Ancient structures on Earth formed by meteor impacts. Explosive craters on Earth and planets. M. 20. Pp. 153–173.

French B.M., Koeberl C., 2010 — *French B.M., Koeberl C.* The convincing identification of terrestrial meteorite impact structures: What works, what doesn't, and why. Earth-Science Reviews 98. Pp. 123–170.

Hergarten S., Kenkmann T., 2015 — *Hergarten S., Kenkmann T.* The number of impact craters on Earth: Any room for further discoveries? Earth and Planetary Science Letters, 425. Pp. 187–192, https://doi.org/10.1016/j.epsl.2015.06.009

Katz Ya.G. Avdeev V.L. Belov V.P., 1980 — *Katz Ya.G. Avdeev V.L. Belov V.P.* On the classification of the ring structures of the Earth [O klassifikacii kol'cevyh struktur Zemli. Kosmogennye kol'cevye struktury Zemli]. Cosmogenic ring structures of the Earth. M. MOIP. 4. Pp. 22–26. (in Russ.)

Kenkmann T., Poelchau M.H., Wulf G., 2014 — *Kenkmann T., Poelchau M.H., Wulf G.* Structural geology of impact craters. Journal of Structural Geology 62. Pp. 156–182.

Kleyner Yu.M., Levintov M.Ye., Khasin R.A., 2010 — *Kleyner Yu.M., Levintov M.Ye., Khasin R.A.* Role of ring structures in morphostructure of Hentiy and their metallogenic significance/ International Geology Review. Pp. 655–658p

Laverov N.P. (2007) — *Laverov N.P.* Environmental and climate change [Izmenenie okruzhayushchej sredy i klimata]. Program №16 of the Presidium of the Russian Academy of Sciences. Moscow. IGEM RAS. 198 p. (in Russ.) ISBN 978-5-88918-034-0p

Masaitis V.L., 1979 — *Masaitis V.L.* The main features of the geology of astroblems of the USSR [Osnovnye cherty geologii astroblem SSSR]. Meteoritic structures on the surface of planets. Collection of reports. M. Science. 19. Pp. 173–192 (in Russ.).

Mikheeva A.V. — Catalog of impact structures. Electronic version at http://labmpg.sscc.ru/Impact/

Neville A.S., Cook D.J., Afifi A.M., Stewart S.A., 2014 — *Neville A.S., Cook D.J., Afifi A.M., Stewart S.A.* Five buried crater structures imaged on reflection seismic data in Saudi Arabia. GeoArabia 19. Pp. 17–44.

Reimold W.U., and Koeberl C., 2014) — *Reimold W.U., and Koeberl C.* Impact structures in Africa: A review: Journal of African Earth Sciences, v. 93. Pp. 57–175.

Seitmuratova E.Yu., Baratov R.T., Saidasheva F.F., Goryaeva V.S., Mashrapova M.A., Arshamov Ya.K., 2022 — *Seitmuratova E.Yu., Baratov R.T., Saidasheva F F., Goryaeva V.S., Mashrapova M.A., Arshamov Ya.K.* Patterns of manifestation of ring structures of Kazakhstan and their ore content [Zakonomernosti proyavleniya kol'cevyh struktur Kazahstana i ih rudonosnost'] Geology and bowels of the earth. Pp. 50–64 (in Russ.).

Smirnov V.I., 1973 — *Smirnov V.I.* Meteoritic hypothesis of the origin of Sudbury [Meteoritnaya gipoteza proiskhozhdeniya Sadberi]. Geology of ore deposits. V. 15 № 2. 8. Pp. 3–12. (in Russ.).

Sokolov V.A., Starostin V.I., 1977 — *Sokolov V.A., Starostin V.I.* Fluid-dynamic concept of formation of mineral deposits (hydrocarbons, metallic and non-metallic) [Flyuidodinamicheskaya koncepciya obrazovaniya mestorozhdenij poleznyh iskopaemyh (uglevodorody, metallicheskie i nemetallicheskie)]. Smirnovsky collection-97. Fund them. Academician V.I. Smirnova. M. 48. Pp. 99–147 (in Russ.).

Solovyov V.V., 1978 — *Solovyov V.V.* Structures of the central type of the territory of the USSR according to the data of geological and morphological analysis [Struktury central'nogo tipa territorii SSSR po dannym geologo-morfologicheskogo analiza]. L. VSEGEI. (in Russ.).

Struzhkov S.F. Konstantinov M.M., 2005 — *Struzhkov S.F. Konstantinov M.M.* Metallogeny of gold and silver in the Okhotsk-Chukotka volcanogenic belt [Metallogeniya zolota i serebra Ohotsko-Chukotskogo vulkanogennogo poyasa]. M. Scientific world. 320 p. (in Russ.).

Stuart S.A., 2011 — *Stuart S.A.* Estimates of the abundance of yet undiscovered impact craters on Earth: Journal of the Geological Society. T.168. Pp.1–4. https://doi.org/10.1144/0016-76492010-006.

Veselova L.K., Kasymkhanova Kh., Kozhakhmetova U., Bekseitova R., Shmarova I., 2019 — *Veselova L.K., Kasymkhanova Kh., Kozhakhmetova U., Bekseitova R., Shmarova I.* Exomorphogenesis of Cosmogenic Ring Structures of Kazakhstan. Pp. 49–58 https://doi.org/10.2478/jlecol-2019-0004.

Zeylik B.S., 1987 — *Zeylik B.S.* Ring structures of Kazakhstan [Kol'cevye struktury Kazahstana]. Abstract for the degree of Doctor of Geological and Mineralogical Sciences. M. 37 p. (in Russ.).

Zeylik B.S., Seitmuratova E.Yu., 1982 — *Zeylik B.S., Seitmuratova E.Yu.* Ring structures of the Northern Balkhash region and assessment of their prospects for certain types of minerals [Kol'cevye struktury Severnogo Pribalhash'ya i ocenka ih perspektiv na otdel'nye vidy pol. Iskopaemyh]. Report on the economic contract topic. 1979-1982 Alma-Ata (in Russ.).

CONTENTS

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)

Заместитель директор отдела издания научных журналов НАН РК *Р. Жәлиқызы*
Редакторы: *М.С. Ахметова, Д.С. Аленов*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 14.06.2023.
Формат 70х90$^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
20,0 п.л. Тираж 300. Заказ 3.

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