# ABSTRACT

PhD Thesis, Degree in Geology and Mineral Exploration (Code 8D07201)

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"STUDYING OF THE DISTRIBUTION OF RARE ELEMENTS IN RARE LAKES AS A SCIENTIFIC BASIS FOR FORECASTING AND PROSPECTING WORK (EAST KAZAKHSTAN)"

**Relevance of the work.** The use of lake waters as mineral raw materials is determined by several factors. First, lakes contain large renewable deposits within large hydrogeological systems. This means that water can be extracted from lakes for long periods of time without fear of running out of resources. Secondly, the extraction and production of products from lake waters are relatively environmentally friendly processes. Thirdly, the use of evaporative concentration makes it possible to isolate valuable components from lake waters. This process allows you to obtain concentrated products with a high content of useful elements.

Finally, the production of products from lake waters has a low cost due to the integrated use of hydromineral raw materials. This means that the same water can be used to produce different products, increasing resource efficiency.

Thus, research on rare elements in natural waters and the use of lake waters as mineral raw materials have great potential for scientific and industrial applications.

**Goal of the work.** The purpose of the research is to study the chemical composition of lake waters, salt brines, brine and bottom sediments from small lakes in Eastern Kazakhstan to identify the mineralization of rare metals and other types of minerals.

**Research objectives:**

1. Collection and synthesis of literary, archival and stock materials on the research topic.
2. Conducting chemical analysis, studying the mineral composition of samples using high-resolution and highly sensitive research methods.
3. Study of patterns of distribution of valuable components in the composition of lake waters.
4. Development of recommendations on the possibility of developing and using lake waters and salt brines for the production of alkali metals.

**Research methodology:** consisted of collecting, analyzing and systematizing literary, archival and stock materials on the features of occurrence and material composition of intrusive complexes in Eastern Kazakhstan. In the geochemical study of the water of salt lakes in order to assess the content in them

primarily of rare alkaline elements (Li, Rb, Cs), as well as other elements using the ICP-MS method, in conducting aerial photography to link sampling points and establish the localization of the objects under study.

**Scientific novelty of the work.**

For the first time, for areas of Eastern Kazakhstan characterized by the development of different types of sedimentary formations and igneous complexes, the chemical and rare element composition of waters was determined, the main sources and factors influencing the composition of lake waters and bottom sediments were determined. The prospects for rare metal mineralization in the waters of small lakes in the Burabay and Delbegetey areas, located in the zone of weathering and surface washout of bedrock of granitic composition, have been established.

An analysis of digital relief models and lake bottom hypsometry was carried out to determine the areas of maximum concentrations of bottom-forming material.

In the study areas, the concentrations of microelements of industrial importance (Li, Sr, Rb, B, U) in water and bottom sediment of lakes were studied. For the first time, a comparison of the concentrations of microcomponents in the bedrock of the studied massifs, in water and bottom sediment of lakes was carried out.

**Practical significance of the work.**

For the first time, based on modern methods of studying the material composition, the prospects of selected areas for the development of hydromineral raw materials and the extraction of rare metals and rare elements have been assessed

The main source of rare-alkaline elements are rare-metal and rare-earth mineral occurrences, which in the East Kazakhstan region are associated with Permian granites.

The following areas of research are distinguished:

1) Burabaysky section of lakes (Burabaysky granite massif, south of the Kurchum river).

2) Delbegeteysky area (lakes in the north-west of the Delbegeteysky granite massif).

3) Shagan-Charsky section (Between the Shagan and Char rivers).

4) Kaskabulaksky area (area of the Maksut deposit, here is a fault zone in which an intrusion and the Suurly tungsten deposit are known to the south of the lakes).

Considering the high geochemical migration ability of rare alkaline elements in the thickness of loose sediments as a result of intense geodynamic processes in the East Kazakhstan region. We can assume the possibility of their migration to the upper horizons and accumulation in salt lakes localized within the area of development of Permian granite intrusions and associated deep tectonic faults. Within the granite complexes under consideration, we have identified about 95

water basins. There is a prospect of discovering sedimentary deposits of lithium, which may be concentrated in the brine of salt lakes.

**Main protected provisions:**

1. The accumulation of rare and alkaline elements occurred in small salt lakes localized within the area of development of granite intrusions of predominantly Permian age and associated deep tectonic faults. The maximum concentrations of bottom-forming material are observed at the minimum elevations of the catchment area.

2. Based on the type of mineralization, the studied lakes are classified as hydrocarbonate-sulfate, sulfate, and hydrocarbonate. The predominant type of lakes in terms of ionic composition in all areas is the hydrocarbonate type.

3. Rare metal mineralization is most clearly manifested in the Burabay and Delbegetey areas, it is subject to the water-rock interaction, the leading process of formation of the macro- and microcomponent composition of the water of the studied lakes is the areal washout of granite weathering products. The content of rare elements in the drainage reservoirs of the Burabay and Delbegetey areas is determined by the composition of the feeding ground and underground waters, the climatic regime, which could lead to the precipitation of easily soluble salts.

**Factual material and personal contribution of the author.**

The dissertation is based on factual material collected by the author or with his participation in the period from 2020 to 2023 at the VKTU named after D. Serikbayev when carrying out state budget research work (from field work to writing a report) according to the budget program commissioned by the science committee of the Ministry of Education and Science of the Republic of Kazakhstan in the topic AR 08052707- “Conducting geochemical studies of lakes in East Kazakhstan in order to identify the mineralization of rare metals in them” (supervisor Amralinova B .B.). We also used extensive literary and stock materials from such scientists as Stepanov A.V., Belov V.A., Severov E.A., Mineev D.A., Kalachenko A.A., Narseev V.A., Bugaets A. O.N., Ermolov P.V., Shcherba G.N. and many others, including foreign authors, who are given in the list of sources used. The author completed foreign scientific internships in 2022 and 2023 (Novosibirsk State University, Novosibirsk, Russia, Karadeniz Technical University, Trabzon, Turkey), which are of great importance in carrying out scientific and analytical research.

By the author personally:

- monographic, literary and reference data on the peculiarities of the formation of deposits of rare metals and rare earths were systematized and analyzed;
- took part in field work with the selection of samples for further analytical studies in the areas of Burabay, Delbegetey, Chagan-Char, Kaskabulak;
- field surveys on geometrization and alignment of lakes were carried out. Sampling of water, bottom sediments, brine and salt brines from lakes.

- chemical analysis was carried out, the mineral composition of samples was studied using high-resolution and highly sensitive research methods.

**Approbation of work.**

The author's personal contribution lies in carrying out the bulk of theoretical and experimental research outlined in the dissertation work.

On the topic of the dissertation work, 14 scientific works were published, including: 3 (three) articles in foreign peer-reviewed journals, 5 (five) in publications recommended by KOKNVO RK, 6 (six) theses in the collections of the International Scientific and Practical Conference.

In the journal indexed in the Web of Science Core Collection database:

Rare-Metal Mineralization in Salt Lakes and the Linkage with Composition of Granites: Evidence from Burabay Rock Mass (Eastern Kazakhstan), Water 2023, 15(7), 1386; https://doi.org/10.3390/w15071386

Article in recommended journals from the Scopus list

“Rare-Metal Pegmatite Deposits of the Kalba Region, Eastern Kazakhstan: Age, Composition and Petrogenetic Implications Minerals 2020, 10(11), 1017; https://doi.org/10.3390/min10111017

“Mineralization of rare metals in the lakes of East Kazakhstan” Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetuthis link is disabled, 2021, 2021(5), pp. 16–21, https://doi.org/10.33271/nvngu/2021-5/016

In journals included in the list of recommended publications of the KOKNVO RK:

Bulletin of EKSTU named after. D. Serikbaeva. No. 3. 2020 - Ust-Kamenogorsk P.36-43.

Bulletin of EKSTU named after. D. Serikbaeva. No. 4. 2020 - Ust-Kamenogorsk P.15-18.

Bulletin of Eurasian Science. Geosciences, No. 5 (September - October), 2021. Volume 13, https://esj.today/19nzvn521.html

KARTU, Proceedings of the University, 1(86)2022. P.127-233. DOI 10.52209/1609-1825_2022_1_127

Mining magazine of Kazakhstan No. 10, 2022. P.26-31.

Information about the documents of protection for the intellectual property object:

Patent No. 35251, RSE “National Institute of Intellectual Property” Ministry of Justice of the Republic of Kazakhstan. 08/20/2021