ABSTRACT

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

DOCTORIAL CANDIDATE: RAGDANOVA ALTYNAY AIBEKOVNA

«CRITERIA FOR LOCALIZATION OF COPPER-PORPHYRY MINERALIZATION IN ORE-BEARING STRUCTURES OF EAST KAZAKHSTAN»

General characteristics of the research: The thesis examines the geological and structural features and patterns of localization of copper-porphyry mineralization within Eastern Kazakhstan. Based on the analysis of archival stock materials and modern publications, the systematization of data on the main structural and formation zones of the region, including a description of ore occurrences and deposits, was carried out.

Special attention is paid to the geological and genetic typification of ore objects, mineralogical, petrographic and geochemical criteria, as well as their comparison with world analogues. The analysis of sources, including archival reports of exploration parties and modern international studies, was carried out, which made it possible to clarify the age and structural positions of ore bodies, identify the controlling role of intrusive complexes and identify the search signs of promising sites.

The results of the study are of practical importance for forecasting new objects of copper-porphyry mineralization in East Kazakhstan.

Relevance of research. Porphyry copper deposits, characterized by large reserves with relatively low copper (0.3-1.0% Cu) and molybdenum, are becoming increasingly important in the raw material base of the world's copper deposits. These deposits are profitable for open-pit mining due to the high degree of extraction of copper and molybdenum, as well as the possibility of complex mining of ores containing valuable impurities such as rhenium, selenium, tellurium and bismuth. The low cost of mining and the complex nature of the ores determine their importance as the main source of copper and molybdenum. Porphyry copper deposits account for more than 50% of the world's copper production and more than 90% of molybdenum. In Eastern Kazakhstan, copper-porphyry deposits and ore occurrences are known in three metallogenic zones: Zharma-Saur (Shorskoye, Kishkine, Zhaksy Koytas, Kyzyl-Kain, Kensai), Chingiz-Tarbagatai (Bala-Urpek, Kanshoky, Karasu, Zapadnoye, Shunai, Argynbaisaz, Katayskoye, Belbastau,) and Dzungaro-Balkhash (Aktogay, Aydarly, Nurbai). The large industrial deposits of Aktogay and Aidarly are being successfully exploited, while the prospects of other facilities remain insufficiently studied.

Goal of research. Development of criteria for localization of copper-porphyry mineralization in Eastern Kazakhstan based on the analysis of structural-tectonic, magmatic, mineralogical, hydrothermal-metasomatic and geochemical and

geophysical features of ore-magmatic systems of structural-formation zones of Eastern Kazakhstan.

The objectives of research:

1. To determine the geodynamic and structural-tectonic conditions of the formation of the copper-porphyry mineralization of Eastern Kazakhstan.

2. Systematize copper-porphyry objects based on their geological, structural and geochronological features.

3. To clarify the mineralogical, hydrothermal-metasomatic, geochemical and geophysical criteria for localization of Cu mineralization.

Scientific novelty. Based on the information analysis, the geological and genetic systematization of known porphyry mineralization sites in Eastern Kazakhstan has been updated, specifying their structural and age position, their relationship to magmatism, the material composition of the mineralization, and its zonality. The data obtained made it possible to review and expand the set of prospecting and evaluation features of mineralization, to carry out its typological division based on international experience, to assess the degree of mineralization development and to identify areas potentially significant in industrial terms.

Practical value. The results obtained made it possible to revise the criteria for the spatial placement of porphyry ore systems in the ore-bearing structures of Eastern Kazakhstan, to forecast the prospects of the territory for copper-porphyry mineralization and to justify the allocation of priority sites for further study.

The use of the results of the work is focused on the development of the mineral resource base of copper production.

The main protected provisions:

1. It has been established that the copper-porphyry mineralization in Eastern Kazakhstan is localized mainly within the volcanoplutonic belts formed under the geodynamic conditions of an active continental margin with arc accretion. The main structural and tectonic control factor is a combination of first-order deep faults and transverse tectonic disturbances.

2. It has been established that porphyritic Cu–Mo systems of Eastern Kazakhstan form five types of porphyritic mineralization corresponding to five cycles of magmatism in Hercynian and Caledonian structures. Each type occupies a stable position within a specific structural and formation zone and is associated with a specific ore-bearing magmatic complex.

3. Using the data obtained, the criteria for localization of copper-porphyry mineralization in East Kazakhstan have been clarified, based on magmatic, mineralogical, hydrothermal-metasomatic, geochemical and geophysical features of ore-magmatic systems, providing effective forecasting of ore objects.

Research methodology. Review and analysis of research on copper-porphyry deposits and ore occurrences in East Kazakhstan and its global counterparts; field work with sampling; a set of analytical studies on a number of deposits. Study of the mineralogical features of the Zharma-Saur, Chingiz-Tarbagatai and Dzungara-Balkhash zones. Clarification of regional and local criteria for localization of copper-porphyry mineralization in East Kazakhstan.

Factual material and research methods.

The basis of this work consists of materials obtained by the author during the doctoral studies, as well as results from field expedition works carried out within the framework of project BR24992854 “Development and Implementation of Competitive Scientifically-Based Technologies to Ensure Sustainable Development of the Mining and Metallurgical Industry of the East Kazakhstan Region” at the JSC D. Serikbayev East Kazakhstan Technical University.

In preparation for the dissertation, the author completed international scientific internships at specialized scientific institutions - the Institute of Geology and Mineralogy of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk, Russia) and Karadeniz Technical University (Trabzon, Turkey).

The author analyzes monographic, reference and scientific publications on copper-porphyry deposits and ore occurrences in Eastern Kazakhstan within the Rudno-Altaisk, Zharma-Saur, Chingiz-Tarbagatai, Dzungaro-Balkhash structural and formation zones, as well as foreign analogues. The search criteria for the localization of an earthquake have been identified in order to assess the practical significance of known objects. Regional and local criteria for localization of copper-porphyry mineralization in Eastern Kazakhstan have been developed and an assessment of the prospects of the studied territory has been given.

Approbation of work and publications. The results of the research on the dissertation topic are presented in 7 publications, including 1 article in a peer-reviewed journal indexed in the Scopus database: Mining of Mineral Deposits, “Perspectivity of Eastern Kazakhstan for Cu-Au-Mo porphyry mineralization,” 2025, Volume 19, Issue 1, Pages 107–120, with a percentile of at least 35. In addition, 3 articles were published in journals recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan (CCES MES RK):“Cu-Porphyry Deposits of Eastern Kazakhstan,” University Proceedings, No. 2, 2022, pp. 137–143; “Geological Structure, Mineral Composition, and Prospective Assessment of the Sugatovskoye Deposit,” University Proceedings, No. 1 (98), 2025;“Clarification of Geological-Structural Features and Prospects for the Discovery of Cu-Mo Mineralization in the Southeastern Section of Kargoba,” Kazakhstan Mining Journal, No. 10, 2025, pp. 30–35. The results of the research were also presented at international scientific and practical conferences:International Scientific Conference “Research Reviews” (March 1, 2024), Prague, Czech Republic, 2024; International Scientific Conference “Foundations and Trends in Research” (May 23–24, 2024), Copenhagen, Denmark, 2024;X International Scientific and Technical Conference for students, master’s, doctoral students, and young scientists, dedicated to the 125th anniversary of Kanysh Satpayev (April 11–12, 2024), Ust-Kamenogorsk, Kazakhstan.

The structure and scope of the work. The dissertation consists of an introduction, six chapters and a conclusion, is presented on 189 pages, contains 50 figures, 7 tables and 5 appendices. The list of references includes 108 titles.

The first section examines the geological and structural prerequisites for the formation of copper-porphyry mineralization within Eastern Kazakhstan.

The second section is devoted to the research methodology, including the principles of stock analysis, geological-structural and mineralogical-petrographic studies.

The third section examines the geological characteristics of deposits and ore occurrences, their lithological and stratigraphic features, magmatism and structural control.

The fourth section contains a geological and genetic typification of copper-porphyry objects and their comparison with their global counterparts.

The fifth section presents the mineralogical, petrographic and geochemical characteristics of ore bodies and host rocks.

The sixth section examines the search features and criteria for forecasting objects of copper-porphyry mineralization, as well as the practical significance of the results obtained for geological exploration in the region.

The final section presents the main conclusions of the dissertation research.