

ANNOTATION
dissertations for the degree of Doctor of Philosophy PhD
in the specialty 6D070600 - "Geology and exploration of mineral deposits"

Li Elena Sergeevna

STUDY OF THE FORMS OF FINDING PLATINOIDS AND REES IN CU-NI AND CU ORES OF PICRITES AND CARBONATITES OF NORTHERN ULYTAU WITH AN ASSESSMENT OF PROSPECTS FOR THEIR EXTRACTION

The dissertation was devoted to the study of the patterns of formation, features of the material composition and genetic features of noble and rare elements in microminerals-inclusions in the sulfides of the Northern Ulytau ores.

Relevance of research

From the point of view of the development of breakthrough technologies, there is no more widely discussed topic in the world today than the production and consumption of rare earth elements (REE) and platinum group elements (PGE) and nickel. They find application in various fields of production.

REEs are a unique group of chemical elements whose properties change smoothly with increasing atomic number of the element. This feature allows using REE as geochemical indicators of the sources of matter and the mechanism of processes occurring in the entire range of temperatures and pressures that exist in nature, from the differentiation of mantle matter to the processes of weathering, the formation of the composition of the hydrosphere and modern sedimentary deposits.

The REE compositions in ancient sulfide ore occurrences will make it possible to judge the genetic relationship of ancient pyrite ores with modern ore deposits and the possible nature of transformations occurring with ore matter during the formation of deposits on the continents.

The relevance of this work is determined by the need to form a holistic view of the patterns of distribution, occurrence forms, composition and genetic features of noble and rare elements in micromineral inclusions in sulfides of ores of picrites and carbonatites of Northern Ulytau.

Given that knowledge of the composition of ores and the forms of occurrence of noble metals (metals of the platinum group), rare and rare earth elements can significantly affect the economic value of PGE-Cu-Ni and PGE-Cu ores of Northern Ulytau.

The purpose of the study is to study the patterns of accumulation, distribution and form of occurrence of REE and PGE in Cu-Ni and Cu ores of Ulytau picrites and carbonatites, respectively.

The main objectives of the study:

1. To study patterns of distribution and occurrence of REE in Ni-Cu and Cu ores of Ulytau picrites and carbonatites, respectively.

2. Determine the degree of influence of geological-tectonic, magmatic, mineralogical and other factors on the formation of geochemical features of picrites and carbonatites of Northern Ulytau.

3. To determine the genesis and stages of ore formation of PGE-Cu-Ni and PGE-Cu ores of Northern Ulytau and associated noble and rare earth elements.

The object of study is PGE-Cu-Ni and PGE-Cu ores of picrites and carbonatites of Northern Ulytau.

Scientific novelty

1. As a result of the research, it was found that in the picrites of the Karaturgai complex, along with previously known sulfides (pyrrhotite, pentlandite and chalcopyrite), zigenite $(\text{Co,Ni})_3\text{S}_4$, platinum telluride (moncheite) $(\text{Pt,Pd})(\text{Te,Bi})_2$, silver telluride Ag_2Te , lead telluride (altaite) PbTe , lead selenide PbSe , solid solutions of iridium group metals (Ir, Os, Ru), rare earth elements (Dy, Er, Y, Ce).

2. Violarite $(\text{Fe,Ni})_3\text{S}_4+\text{Er, Co}$, pyrite (FeS_2) , sphalerite (ZnS) , pyrrhotite (FeS) , microinclusions of cobaltite (CoAsS) , nickel cobaltite $(\text{NiCoAsS}(\text{Ru, Rb, Pt, Ir, Os}))$, ferrocobaltine (FeCoAsS) , gersdorffite (NiAsS) , silver telluride ($\beta\text{-Ag}_2\text{Te}$, $\gamma\text{-Ag}_2\text{Te}$), acanthite (Ag_2S) , lead telluride (PbTe) , galena, testibiopalladite $\text{Pd}(\text{Sb,Bi})\text{Te}$, bismuth testibiopalladite, melonite (NiTe_2) , vavrinite $(\text{Ni}_2\text{SbTe}_2)$.

The main protected provisions:

1. The pattern of distribution and occurrence of elements of the platinum group (Pt, Ir, Ru, Rh, Os) and rare earth elements (Dy, Er, Y, Ce) in copper-nickel ores of the Karaturgai ultramafic complex within the Ulytau anticlinorium was determined based on the study mineral associations of sulfides interspersed in karaturgai picrites.

2. The pattern of distribution and occurrence of platinoids (Pt, Ir, Ru, Rh, Os), rare earth elements (Er, Y, La, Ce, Pr, Nd, Sm) and rhenium in linear-fractured carbonatites and genetically related to copper pyrite ores within the Mayatas ore region.

3. The intrusion of the hypabyssal dolerite-picrite Karaturgai complex (825 Ma), which is a derivative of the melting of spinel peridotite, occurred against the background of collision of folded structures of the Ulytau megaterrane.

The end result of the work is the established patterns of distribution and occurrence patterns of REE and platinoids in PGE-Cu-Ni and PGE-Cu ores of picrites and carbonatites of Northern Ulytau, respectively; the genesis and stages of ore formation of hypabyssal rocks of the dolerite-picrite complex and linear-fractured carbonatites of the Ulytau folded region have been established.

Practical significance

1. Establishing the spatial and temporal position of sulfide PGE-Cu-Ni u deposits in dolerite-picrite and carbonatite rocks is important for the basic prospecting characteristics associated with the features of ore-magmatic systems within the Precambrian folded complexes.

2. The obtained geochemical data make it possible to determine the composition of the main useful components (Pd, Pt, Cu, Ni, etc.) in the main mineral sulfide phases, to get an idea of the thermodynamic conditions of ore

formation, which is important for choosing the most optimal processing scheme for enrichment.

3. The results of studies of the ore genesis of the Karaturgai sulfide ores with REE and PGE indicate favorable conditions for the formation of high concentrations of sulfides in the bottom and root parts of the picrite-dolerite complex, which makes it possible to recommend drilling to search for REE and PGE in higher concentrations.

The personal contribution of the author consisted in the collection, processing, systematization, generalization and interpretation of factual material; in carrying out field work with sampling for further analytical studies; in conducting laboratory research, in substantiating the relevance of research work; in the study of geochemistry and the establishment of the forms of occurrence of REE and elements of the platinum group in sulfide ores of picrites and carbonatites of Northern Ulytau.

Approbation

The main provisions of the dissertation work were reported at meetings and scientific and technical seminars of the Department of Geology and Exploration of Mineral Deposits of the Karaganda Technical University, at the XVII International Forum-Competition of Students and Young Scientists "Actual Problems of Subsoil Use" - St. Petersburg, 2021, at the International Scientific Symposium of students and young scientists named after academician M. A. Usov "Problems of geology and subsoil development", 2019; at the international scientific and practical conference "Integration of science, education and production - the basis for the implementation of the Plan of the Nation" (Saginovsky readings) (2019,2020,2021);

Scientific internships were completed in the periods 10/06/2019-10/14/2019 on the basis of the Institute of Geological Sciences named after A.I. K. Satpaev, Almaty and from April 18 to May 1, 2021 at the Belarusian State University (Minsk, Republic of Belarus) at the Department of Regional Geology.

During the passage of scientific internships, consultations were received on the topic of the dissertation from the Doctor of Geology and Mathematics, Head of the Laboratory of Mineralogy at the IGN. K. Satpaeva, Bekenova G.K., Ph.D. Senior Research Fellow, Laboratory of Mineralogy, IGN named after K. Satpaeva Levina V.L., Head of the Department of Regional Geology, Belarusian State University (Minsk), Candidate of Geological and Mathematical Sciences, Associate Professor Lukashova O.V., Ph.D. Samodurova V.P., Doctor of G-M.S., Professor Zuy V.I.

Received certificates of successful completion of scientific internships.

The main provisions of the dissertation work were published in 14 scientific papers, 1 of which, in publications recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 8 in the proceedings of Kazakhstani and foreign international conferences, and 5 articles in journals included in the Scopus database, 1 patent.

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