ABSTRACT

Of the thesis for the "Doctor of Philosophy degree by the specialty:
6D070600 - «Geology and mineral deposits exploration»

Frolova Olga Vyacheslavovna

The study of geological structure and material composition of ores from Verkhnee Espe rare earth deposit for the construction of the forecasting and prospecting model (East Kazakhstan)

The thesis is devoted to the study of the geological structure and material composition of rocks and ores of the Upper Espe deposit with the aim of developing criteria for forecasting and searching for rare earth deposits to increase the efficiency of geological exploration.

Relevance of the study. Rare earths are important strategic materials for various industries. According to the forecasts of the Australian consulting company Industrial Minerals Company of Australia (IMCOA), the prices of many rare earth elements and oxides can rise over the next 20 years two, or even three times. Moreover, according to analysts, this is a long-term trend. In the framework of the Industrial Innovative Development Program for 2015-2019, it was decided to adopt plans for the development of high-tech sectors of the mining sector: to step up the development of rare and rare earth metals. All this testifies to the fact that the huge rare-metal and rare-earth potential of Kazakhstan requires further study at the modern scientific level. It determines the relevance of this work.

The aim of research. The aim of the work is to develop an improved forecasting-exploratory model of rare-metal-rare-earth mineralization, on the example of the Verkhnee Espe deposit, as well as an assessment of the prospects of Eastern Kazakhstan for the discovery of rare earth deposits based on previous studies and new geological, geochemical, mineralogical, petrographic and geochronological data.

Objectives of the study:

1 Study of the geological structure and material composition of rocks and ores of the Verkhnee Espe deposit using modern methods of optical and electron microscopy.

2. Obtaining new data on geochronological U-Pb SHRIMP datings.

3. Identification of features of the formation and distribution of deposits of rare metals and rare earths.

4. Development of criteria for forecasting and prospecting RE deposits to improve the efficiency of geological exploration.

The object of the research is the rare-earth deposit Verkhnee Espe (Zharma-Saur zone, East Kazakhstan).

First protected position

The rare-earth deposit Verkhnee Espe is represented by an epimagmatic albitite-greisen niobium zirconium-rare earth formation, genetically associated with alkaline and sub-alkaline granites of the keregetas-Espina complex,

characterized by a complex ratio of the distribution of rare-metal and rare-earth elements; The age of granites according to SHRIMP definitions was 291.6 ± 2.4 Ma.

Second protected position

The main ore bodies have a stock lock morphology, Zr, Nb, Ta, TR mineralization, formed in the process of intense metasomatic changes of medium-grained ribekite granites (albitization, recybetization, silicification, etc.), are spatially confined to endo- and exocontact zones of the granitoid massif. localized in carbonic terrigenous sediments and controlled by zones of deep faults.

Third protected position

As a result of the studies, geological, structural, petrographic, mineralogical, geochemical, and geochronological criteria for forecasting and searching for the leading geological and industrial verkhne-espe type of rare-earth deposits have been developed, highlighting promising areas for further exploration and assessment.

Scientific novelty of the work. For the first time, previously inaccessible modern high-precision methods were applied to the study of the geochemistry of trace elements (ICP-MS / -AES) and the characteristics of magmatic and metasomatic processes. Trial U – Pb SHRIMP dating of zircons was carried out. Reassessment of the geological characteristics of the field was made, based on existing materials, its own new data, as well as foreign studies of alkaline complexes to improve the exploration model. Compiled GIS regional and local scales.

The practical significance of the work. An improved model of the field allowed us to formulate a number of criteria for further exploration and discovery of similar deposits at depth and on the flanks of the object in East Kazakhstan, as well as in other regions.

The main results of the study. Analytical studies of the rocks and ores of the rare-earth Verkhnee Espe deposit were carried out using modern methods of optical and electron microscopy. To determine the mineralogical, petrological and geochemical characteristics, an ICP-MS Agilent 7500cx inductively coupled plasma mass spectrometer was used, which determines 70 elements with high sensitivity (up to 1 ppb) and a scanning electron microscope.

A zircon uranium-lead dating was carried out using the local SIMS method (secondary ion mass spectrometry) using the SHRIMP-II instrument (a sensitive, high-resolution second-generation ion microprobe) at FSBI VSEGEI (St. Petersburg, Russia).

The chemical composition of minerals was clarified in the sector of mineralogy of the K.I. Satpayev Institute of Geological Sciences (analysts from candidate of medical sciences V.L. Levin and P.E. Kotelnikov) using an electron probe microanalyzer JCXA 733 using an energy dispersive spectrometer INCA ENERGY at an accelerating voltage of 25 kV, a probe current of 25 nA and focused (diameter 1-2 μm) or defocused (10 μm) probe. As reference samples used: CaF2 (F); albite (Na); adulyar (K); CaSiO3 (Ca); MgO (Mg); Al2O3 (Al);

SiO2 (Si); TiO2 (Ti); Fe2O3•MnO (Fe, Mn), metal Zn (Zn); BaSO4 (Ba), x(PO4) (x - РЗЭ).

All the data obtained were summarized into a single geographic information system (GIS).

As a result of the research, a number of basic search criteria for rare-metal mineralization of East Kazakhstan were developed, which can be used as a basis for forecasting and searching for new rare-metal-rare-earth objects.

The factual material and the personal contribution of the author. The dissertation is based on factual material collected by the author or with his participation during the period of study in the doctoral program of D. Serikbayev EKSTU, when performing state budget research work (from field work to writing a report) on budget program 055 “Scientific and / or scientific and technical activities” commissioned by the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan in topic No. 51-313-15 “Systemic metallogenic analysis of alkaline magmatism and rare-metal mineralization of the northern spurs of the Tarbagatai (Verkhnee Espe, Iysor, Sandyktas, Kyzylsai deposits, Severnoe, northern part of the Akzhailyutass massif and the nearest rare-metal manifestations)” (head Gavrilenko O.D.). And also extensive literary and stock materials of such scientists as Stepanov A.V., Belov V.A., Severov E.A., Mineev D.A., Kalachenko A.A., Narseev V.A., Bugayets N.A., Ermolov P.V., Scherba G.N. and many others, including foreign authors, which are listed in the list of references were used.

The author in 2013 and in 2014 passed foreign scientific internships (University of Uppsala, Sweden, Museum of Natural History, London, UK), which are of great importance in the implementation of scientific and analytical research.

The author personally:

- systematic and analyzed monographic, literary and reference data on the features of the formation of deposits of rare metals and rare earths;
- participation in field work was carried out with sampling for further analytical studies at the Verkhnee Espe deposit, as well as at other rare-metal objects within the Verkhneespinsky ore cluster;
- interpreted the results of analytical studies and compiled a GIS of regional and local scales;
- On the basis of the data obtained, forecasting and search criteria have been established to improve the efficiency of geological exploration.

Approbation of work. The results of research on the thesis were reported at the International Scientific and Practical Conference "Innovative technologies and projects in the mining and metallurgical complex, their scientific and personnel support" (Almaty, 2014), International Satpaev readings "Scientific heritage of Shakhmardan Yesenov" (Almaty, 2017 г.), IX International Conference "Efficient use of resources and environmental protection - the key issues of the mining and metallurgical complex" and the XII International Scientific Conference Perspective technologies, equipment and analytical systems for materials and nanomaterials" (Ust-Kamenogorsk, 2015), International scientific-practical conference "Green economy - the future of humanity" (Ust-Kamenogorsk, 2014), 37th Annual

Meeting Mineral Deposit Studies Group (Oxford, 2014), II International Scientific and Technical Conference of Students, Undergraduates and Young Scientists "Young Creativity for the Innovative Development of Kazakhstan" (Ust-Kmenogorsk, 2013), 17th International multidisciplinary scientific geoconference SGEM 2017 (Bulgaria , 2017), SEG 2017 Annual Meeting Meeting of Asia: China and B eyond (China, 2017).

The results of the work were introduced into the educational process for conducting lectures and practical classes on the discipline "Geoinformation technologies in geology", into the practice of JSC "National Geological Prospecting Company" KAZGEOLOGY ", TELLUR GOLD LLP.

According to the results of the dissertation, an application for the patent "Method of searching rare-metal-rare-earth mineralization" was filed and a notification was received on a positive result of formal examination. At the moment, undergoing substantive examination.

On the topic of the thesis, the monograph "System metallogenic analysis of alkaline magmatism and rare metal mineralization of the Tarbagatai northern spurs" was published in collaboration.

The results of the thesis are included in the Report on research work on the state budget theme No. 51-313-15 "System metallogenic analysis of alkaline magmatism and rare-metal mineralization of the northern spurs of Tarbagatai (Verkhnee Espe, Iysor, Sandyktas, Kyzylsai, Severnoe, northern part of Akzhaylautas massif and the nearest rare-metal manifestations)" (head Gavrilenko O.D.).

Publications. On the topic of the thesis 21 papers were published, of which 5 articles in journals recommended by the KKSON MES RK (EKSTU Bulletin, KazNTU Bulletin, Kazakhstan Mining Journal); 2 articles in the journal included in the Scopus database; 10 articles in materials of international scientific conferences of foreign and neighboring countries; 1 monograph in collaboration; 3 articles in the materials of the Republican Scientific and Technical Conference.