ABSTRACT

of the dissertation for the scientific degree of Doctor of Philosophy (PhD) in specialty 6D070600 - "Geology and Exploration mineral deposits"

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STUDY OF THE PREVALENCE OF RARE-EARTH METALS IN COALS OF THE MAIN COAL BASINS OF CENTRAL KAZAKHSTAN

Relevance of the dissertation work.

The relevance of the work. Currently, in world practice, coal deposits are increasingly considered not only as fuel and energy raw materials, but also as a promising source of a large group of rare elements and precious metals (USA, China, Russia, etc.) In developed economies (USA, Europe, Australia, China), the rare metal composition in organic matter is partially evaluated and published in numerous publications, where it is shown that waste from the use of coal can also contain high, in some cases industrially significant concentrations of impurity elements (Yurovsky, 1968; Leonov et al., 1988; Zharov, 2004; Seredin, 2006; Yudovich, 2006, Arbuzov, 2006, 2008, 2014, 2019; Dai et al, 2010,2011,2019, etc.). In China, germanium and lithium are extracted from coal on an industrial scale. Attempts are being made to extract individual chemical elements (U, Au, Al, Ga, Sc) from coals and their waste (Dai et al, 2010,2011,2019, etc.). The effectiveness of extraction techniques can be enhanced by obtaining reliable. information about the distribution and mineral forms of elements in coals, as well as in their combustion products. It is shown that some coal-bearing strata or deposits in a number of cases can be considered as a potential integrated source of rare, rare earth and precious metals (Jurowski, 1968; Yudovich,1985-1989; Means, 1991-2003, Arbuzov S. I., 2008,2014,2019, etc.).

Coal basins of Central Kazakhstan are of great interest from the point of view of obtaining reliable geological information about the accumulation of rare earth metals in coal seams, the mechanisms of concentration of these elements in coal and mineral forms of their occurrence.

The proven coal reserves in Kazakhstan (according to the BP Statistical Review of World Energy, June 2020) amount to 34 billion tons— which is 4% of the total world reserves. More than 9/10 of all coal reserves are concentrated in the central and northern parts of the country. The main basins of Central Kazakhstan include the Karaganda, Ekibastuz and Maikuben coal basins and the Shubarkol deposit. The largest reserves and the largest coal basins and deposits belong to the deposits of carboniferous (Karaganda and Ekibastuz coal basins) and Jurassic.

In order to develop the coal industry, take systematic measures to support the industry, as well as implement new projects, the "Roadmap for the development of the coal industry of the Republic of Kazakhstan for 2019-2021" was developed and approved, which pays special attention to coals containing industrial concentrations of rare and dispersed elements such as germanium, gallium, yttrium

and lanthanides, tungsten and others. Some of them are toxic - mercury, arsenic, antimony, beryllium and others.

The purpose of the research is to study the regularities of the prevalence of rare earth elements in the coals of the main coal basins of Central Kazakhastan (Karaganda, Ekibastuz, Maykubensky coal basins, Shubarkol deposit).

The idea of the work is to determine the geochemical features of coal deposits in Central Kazakhstan, in order to identify anomalous, including industrially significant contents of rare and rare earth elements, mineral forms of finding elements to establish their genesis and the possibility of extraction.

Research objectives:

1. To conduct studies of the contents of rare earth elements in coals using a modern analytical base;

2. To establish the regularities of the prevalence of rare earth elements in the coal deposits of Central Kazakhstan

3. Identify the main factors affecting the accumulation of rare and rare earth elements in coals;

4. To establish the sources of admixture elements in the coal deposits of Central Kazakhstan;

5. To establish geochemical specialization of coals of the main coal basins (Karaganda, Ekibastuz, Maykubensky) and deposits (Shubarkol) of Central Kazakhstan on the basis of certain average contents of elements-impurities in coals.

6. To assess the prospects for the integrated use of coal from the Shubarkol deposit, including for the extraction of rare earth elements.

The object of the study is the coal deposits of Central Kazakhstan.

Scientific novelty:

1. The regularities of distribution and concentration of rare earth elements in the coals of the main coal basins (Karaganda, Ekibastuz, Maykubensky) and deposits (Shubarkol) of Central Kazakhstan have been established;

2. The geochemical specialization of the coals of the main coal basins of Central Kazakhstan in different epochs of coal formation was established, which were accompanied by the influence of various factors that determined the accumulation of impurity elements in the coals;

3. The possibility of integrated use of coals is shown on the example of oxidized coals of the Shubarkol deposit, which are characterized by increased concentrations of U, REE, which will reduce the degree of their impact on the environment;

Protected scientific provisions

1. The coals of the main coal basins (Karaganda, Ekibastuz, Maykubensky) and deposits (Shubarkol) of Central Kazakhstan are characterized by a complex geochemical specialization, which is determined by a combination of geotectonic factor, subsynchronous volcanism, petrofund features and epigenetic changes of coals that affect the accumulation of impurity elements in coals.

2. It has been established that one of the sources of rare-metal mineralization of coals in the Mesozoic and Cenozoic times were rock massifs that compose the

chain of the Kokchetav-North Tien Shan ancient folded structure and the Central Kazakhstan (Devonian) volcanic-plutonic belt in the east.

3. The possibility of integrated use of coals is shown on the example of oxidized coals of the Shubarkol deposit, which are characterized by increased concentrations of U, REE, which will reduce the degree of environmental hazard and obtain humates, uranium and associated REE using ammonium compounds and inorganic acids as reagents during heap leaching.

Practical significance. Knowledge of the REE distribution in coals will allow us to assess their rare metal potential. The study of background and anomalous contents of impurity elements and the assessment of the geochemical specialization of coal basins and deposits is the basis for the organization of predictive prospecting work both within coal-bearing deposits and in the framing structures, which will solve the tasks of reconstructing the paleostatement of the formation of coal-bearing formations and assess environmental safety.

The data obtained on the basis of modern research methods on the mineral forms of the presence of impurity elements in coals will allow us to assess the prospects for the integrated use of coals as a source of R and REE, to develop effective methods for extracting rare elements and to improve the methods of coal enrichment.

The results of the study were introduced into the practice of geological exploration organizations MD "Tsentrkaznedra" (Appendix 1) and LLP "Geotek" (Appendix 2), in the educational process during lectures and practical classes on the discipline "Geology and geochemistry of solid minerals" at the Department "Geology and Exploration of mineral deposits", NAO Map.

The final result of the research is the established patterns of distribution and features of geochemical specialization of coal in Central Kazakhstan; the main geological factors affecting the accumulation of impurity elements.

Personal contribution of the author. It consisted in collecting, processing, systematization, generalization and interpretation of factual material; in conducting field work with sampling for further analytical studies; in conducting laboratory studies on a scanning electron microscope; in substantiating the relevance of research work; in studying the geochemistry of rare elements; in establishing patterns of distribution of elements in coals and host rocks of the Shubarkol deposit. Based on the research results obtained by the author, the IRN 08052608 project is being conducted for the "Young Scientist" competition funded by the Ministry of Education and Science of the Republic of Kazakhstan for 2020-2022, where the author is the responsible performer.

Approbation. The main provisions of the dissertation work were reported at meetings and scientific and technical seminars of the Department "Geology and Exploration of Mineral Deposits" of Karaganda Technical University, at the technical council of Tau-Ken Temir LLP, MD "Tsentrkaznedra" (Appendix 3), at the international conference "Earth Sciences: yesterday, today, tomorrow". - St. Petersburg, 2017, at the XXIII International Scientific Symposium of Students and Young Scientists named after Academician M. A. Usov "Problems of geology and subsoil development", 2020; at the international scientific and practical conference

"Integration of science, education and production - the basis for the implementation of the National Plan" (Saginovsky Readings No. 11) (2019);

Scientific internships were completed in the periods 30.03.2019-14.04.2019 and 10.11.2019-16.11. on the basis of the Department of "Geoecology and Geochemistry", the Institute of Natural Resources, the National Research Tomsk Polytechnic University. During the scientific internship, leading TPU scientists took part in a scientific seminar. Consultations on the topic of the dissertation were received from Doctor of Medical Sciences, Professor Arbuzov S.I., Candidate of Medical Sciences, Associate Professor of the Department of GEGH Soktoev B.R., Candidate of Medical Sciences Ilyenok S.S.. Certificates of successful completion of scientific internships were obtained.

The main provisions of the dissertation work have been published in 20 scientific papers, 8 of which are in publications recommended by the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 6 - in the proceedings of Kazakhstani and foreign international conferences, and 6 articles in journals included in the Scopus Web of Sciences database, 1 patent and 3 intellectual property certificates. At the same time, the results of the work were used in the monograph "Coals of the Shubarkol deposit" and an intellectual property certificate was obtained on March 4, 2021.

The structure and scope of the dissertation. The dissertation is presented on 202 pages and consists of an introduction, five chapters, a conclusion and a list of sources used, including 363 titles. The dissertation is illustrated with 67 figures and 25 tables.

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