ABSTRACT

Dissertation for the degree of Doctor of Philosophy (PhD) in the specialty 6D075500 - "Hydrogeology and engineering geology" by Ainur Baikadamova

Topic: "Assessment of thermal energy resources of thermal waters of the Zharkent Depression"

The dissertation research "Assessment of the thermal energy potential of thermal waters of the Zharkent Depression" is based on the analytical analysis of the geothermal resources of Kazakhstan for the purpose of their use in thermal power engineering, which is relevant in many cases of climate change and the country's transition to sustainable development. Kazakhstan, like many other countries, seeks to reduce emissions of harmful substances and reduce dependence on carbon energy. The transition to the "green resources" requires the introduction of alternative solutions. Geothermal energy, located in the bowels of the Earth, ranks second among renewable resources and is becoming one of the most important strategies for Kazakhstan, where a lot of work is required for alternative developing of natural sources. In this matter, it is important to assess the prospects of the Zharkent Depression, which is capable of providing reserves of thermal waters that have not yet found active use.

The main objective of the study is to assess the thermal energy potential of the thermal waters of the Zharkent Depression and to develop proposals for their integrated development. The objectives of the work include:

1. Analysis of world experience in the use of hydrogeothermal resources in order to understand the key aspects of application and opportunities for the region.
2. Assessment of the geological structure and hydrogeological conditions of the Zharkent Depression in order to identify the features of the occurrence and characteristics of thermal waters.
3. Conducting a hydrogeochemical analysis to determine the genesis and qualitative characteristics of thermal waters, including gas-chemical composition.
4. Assessment of the thermal potential of thermal waters for heat supply and the possibility of their use for recreational and balneological purposes.

5. Development of a feasibility study for the use of geothermal resources and recommendations for the implementation of technologies aimed at the efficient and sustainable use of resources.

The scientific novelty of the work is as follows:

- the influence of geological and lithological factors and the depth of circulation of thermal waters on their chemical and gas compositions, their genesis based on isotope studies has been clarified;
- both natural and predicted resources of formation thermal waters of the Cretaceous deposits of the Zharkent Depression, as well as their heat and energy potential have been assessed;
- a feasibility study has been carried out for the integrated development of the water-energy potential of formation thermal waters of the Cretaceous deposits of the Zharkent Depression;
- recommendations and process flow charts have been developed for the practical use of thermal waters of the Zharkent Depression using the example of a pilot section of well 3T.

The following main provisions are substantiated and defended in the work:

1. High-pressure formation waters of the Cretaceous deposits of the central part of the Zharkent depression represent a unique hydrogeological object, characterized by specific geological-structural and hydrogeological conditions for the formation of nitrogenous, weakly mineralized, weakly alkaline formation thermal waters, which have high potential for use in thermal energy and medical and health purposes, which emphasizes their high practical significance.

2. The data of isotope studies of thermal waters of the chalk deposits of the Zharkent depression confirms that formation waters are the result of interaction of ancient infiltration waters with host rocks. The feeding area is a watershed with an altitude of 3300 m, located in the south of the territory (Ketmen ridge). Hydrogeochemical indicators of thermal waters are determined mainly by the dissolution of easily mobilized salts during the movement of water from the feeding area to the central part of the depression. 3. Analysis of technical and economic indicators of the integrated development of thermal waters of the chalk deposits of the central part of the Zharkent depression shows that the production of thermal energy is a more profitable option, while the return on investment increases with the subsequent use of thermal fresh water for therapeutic and recreational purposes

(mineral baths, saunas, swimming pools, showers), bottling as therapeutic table water and pond farms.

Materials and methods of research.

The dissertation is based on the results of the author's research during the implementation of targeted and grant scientific projects during his work at the U.M. Akhmedsafin Institute of Hydrogeology and Geoecology. Previously conducted targeted hydrogeological studies showed the prospects of using thermal waters in the Zharkent Depression. Complex research methods were used, including modern methods and methodologies of hydrogeology, geology and geothermy. Modern methods of hydrogeochemistry were used, which served to assess the chemical composition of thermal waters, including ion-salt, microcomponent, isotopic and gas compositions. The methods and approaches used, especially in the analysis of the genesis of thermal waters, were a key part of the research. In the course of the work, an extensive database of chemical analyses of water over a long period of time was collected, including also modern analyses carried out using modern analytical equipment. At the global level, there is a certain positive experience in the integrated development of geothermal groundwater. These waters are widely used for heating, balneology and recreation in many countries. The exploitation of thermal waters is becoming important in the context of the growth of alternative energy production and the transition to a "green economy".

The first section of the paper examines international experience in the use of geothermal sources, which demonstrates successful examples of the use of these resources in such countries as Iceland, the USA, the Philippines and China. Iceland, for example, actively uses geothermal resources to heat more than 90% of residential buildings and generate electricity. This practice has allowed the country to significantly reduce carbon emissions and improve the environmental situation. In the USA, in particular in California, Nevada and Utah, geothermal energy is an important part of the energy balance, providing reliable electricity supply for large regions. The Philippines occupies one of the leading places in the world in the use of geothermal energy, due to its location on the Pacific Ring of Fire, which allows the country to actively develop this resource for energy supply. China also actively uses geothermal energy for heating and cooling buildings, especially in large cities, which improves the environment and reduces energy costs. The next section of the paper pays attention to the description of the geological and hydrogeological features

of the Zharkent Depression, which is bounded by the Zhetysu Alatau and Ketmen mountain ranges. The geological and structural features of the depression provide unique conditions for the circulation and heating of formation groundwater. A productive thermo-water-bearing complex is confined to the geological layers of the Cretaceous period, the temperature of formation waters in the central part of which reaches 70-100 ° C, which is promising for their use in thermal power engineering.

In addition, the thermal waters of the Zharkent Depression are characterized by a diverse content of minerals, which makes them suitable for therapeutic and balneological purposes. In this context, the author studied the gas-chemical composition of the waters and identified the main factors influencing its formation. The studies included an analysis of the stratigraphy and tectonics of the region, which allowed for a better understanding of the mechanisms of circulation of thermal waters and their relationship with adjacent rocks. The study was carried out on the basis of field and laboratory methods, including analysis of thermal water samples. In the process of work, modern methods of hydrogeochemistry and analytical techniques were used to identify the features of the chemical composition, including ionic and salt composition, as well as the presence of trace elements. Measurements of the temperature and flow rate of aquifers were carried out, which made it possible to assess the current operational reserves of thermal waters and determine their suitability for various purposes, such as heating and recreational use. The author conducted a detailed analysis of the data obtained, which made it possible to identify the most promising areas for further development. Particular attention was paid to the choice of analysis methods, which made it possible to take into account the specific conditions of the region, as well as to determine the composition of mineral components and its impact on the further use of thermal waters.

The main section of the dissertation is devoted to the assessment of the thermal potential of the thermal waters of the Zharkent Depression. The author analyzed field research data and laboratory test results to determine the operational reserves and volumes of thermal water production. The study includes an analysis of the depth of aquifers, their temperature regime and chemical composition. The thermal potential was assessed using thermodynamic models, which made it possible to calculate the volume of heat available for use in heat supply. As a result, it was revealed that the thermal waters of the Zharkent Depression can be effective for supporting heating systems in adjacent settlements and for use in the production of thermal energy using binary technologies. The next section of the work is devoted to the feasibility study

of the use of thermal waters for heat supply and other purposes. Here the author considers the profitability of various schemes for the use of geothermal resources, as well as the economic feasibility of their use. In particular, a binary cycle was considered, which allows the use of thermal waters with a temperature of 70-100 ° C for the production of electricity. The author proposed specific recommendations for the implementation of the binary cycle and other technologies that will be effective in the conditions of the region. The study showed that the cost of extraction and exploitation of thermal waters in the Zharkent Depression can be economically justified provided that modern technologies and environmentally friendly methods are used.

Environmental and social significance

Geothermal energy has significant environmental benefits. Unlike carbon sources such as oil and coal, geothermal sources do not emit carbon dioxide and other pollutants, which helps improve the environmental situation in the region. The use of geothermal energy also helps reduce dependence on fossil fuels, which is especially important for Kazakhstan, where a significant portion of electricity is produced by coal. The author emphasizes the importance of sustainable use of thermal waters, which requires the use of modern technologies and regular research to minimize environmental impacts.

The social significance of the work is that the use of geothermal resources can contribute to the development of the region and improve the quality of life of the local population. The introduction of new technologies will ensure a more stable energy and heat supply and reduce heating costs. In addition, thermal waters can be used to create recreational facilities, which will contribute to the development of tourism and the creation of new jobs. The author also considers the possibility of using thermal waters in agriculture for heating greenhouses, which will allow the development of agricultural production in the winter.

Conclusions and recommendations

The dissertation concludes with conclusions on the prospects for using the thermal waters of the Zharkent Depression and the development of recommendations for their comprehensive development. The author emphasizes that geothermal resources represent a significant potential for Kazakhstan, which requires further research and use. Within the framework of the work, specific

measures were proposed for the development of geothermal sources, including the introduction of binary cycles and other technologies that allow the efficient use of the heat of thermal waters. Recommendations include additional research into deep heat.

Personal contribution of the author consists of setting up and conducting experiments and research, generalization and interpretation of the results, writing articles.

Publications. Based on the results of the completed research work, 8 articles were published and 3 reports were made, of which 1 work was presented in international publications included in the Scopus and Thomson Reuters databases, and 3 articles in scientific publications recommended by the KOKSNVO RK.

Structure and volume of the dissertation. The dissertation work consists of an introduction, literature review, description of objects, research methods, results of research experiments and discussions, conclusions and a list of references from 105 titles.

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