

## ABSTRACT

for the

**Tleuova Zhanna Tursynkyzy's thesis**

«Environmental problems and pollution of drinking groundwater in Southern Kazakhstan» submitted for the degree of Doctor of Philosophy (PhD) in the major 6D075500 – «Hydrogeologists and engineering geology»

**Relevance of the research:** The relevance of the work lies in the problems of the demand for fresh water and the prevention of their pollution, the rationale for the rational development of fresh groundwater resources of drinking quality for the territory of Southern Kazakhstan.

In the modern period, groundwater pollution is gaining increasing proportions. Pollutants enter aquifers through the aeration zone together with atmospheric precipitation, which wash out substances from the upper layers of the soil. Many pollutants, including those contained in dust, car exhaust fumes, emissions from heating systems of residential buildings and industrial enterprises, settle on the surface of the earth. In agricultural regions where pesticides and fertilizers are actively used, these substances penetrate into groundwater and surface watercourses with surface runoff, gradually increasing their concentration and leading to a change in the chemical composition of the upper, least protected aquifers.

Analysis of groundwater monitoring data in any territory shows that over time, components of pollutants are included in their natural composition, the concentration of which continues to increase. As a result, areas are formed where the quality of groundwater no longer meets the sanitary standards applicable to centralized water supply sources intended for drinking needs.

Thus, studies of environmental problems and pollution of drinking-quality groundwater in the territory of Southern Kazakhstan seem to be very relevant.

**The object of research** is fresh groundwater and water intakes of drinking water supply in the administrative regions of Southern Kazakhstan.

**The subject of research** includes regional distribution features, quantitative and qualitative indicators, forecast resources, proven operational reserves of fresh groundwater in the region, as well as their potential sources of pollution and the state of contamination.

**The main purpose of the research** is to study geocology and the quality of drinking groundwater in the territory of Southern Kazakhstan.

**To achieve this goal, the following tasks have been solved:**

- 1) the foreign and domestic scientific and applied published materials on ecological hydrogeology and the qualitative composition of drinking-quality groundwater are summarized and analyzed;
- 2) the main patterns of resource allocation and the characteristics of the qualitative composition of drinking groundwater in the region, potential sources of pollution have been clarified, taking into account the natural protection of the former from the surface of aquifer;



3) the analysis was carried out using modern chemical analytical equipment and software components of the chemical composition of fresh groundwater in the region, which determine its choice for domestic drinking water supply and the state of its contamination;

4) the current state of groundwater use for domestic drinking water supply and prospects for sustainable drinking water supply to the population of the region are analyzed;

5) measures are recommended which can help in solving the problems of pollution and reduction of subsurface water resources, negative anthropogenic impact on groundwater and water supply of water-deficient areas of the territory.

**Research methods.** The author of the dissertation has implemented complex research methods, including modern methods and methodologies of hydrogeology and hydrogeochemistry using modern software tools for processing and analyzing the physico-chemical composition of groundwater. Field research, which included conducting land routes, was carried out with water sampling. Chemical and analytical laboratory studies of the selected samples were carried out to study the hydrogeochemical parameters of the fresh groundwater of the exploited deposits. The processing of the obtained laboratory analysis results was performed using the AquaChem 11 software package, calculations of paired correlations of components were performed in the Statistika software package.

The complexity of the research allowed the author to substantiate the main defended provisions of the dissertation and the novelty of the research.

**The scientific novelty of the work is as follows:**

- based on a comparative analysis of the physico-chemical composition of fresh groundwater in Southern Kazakhstan with world standards for assessing their drinking quality, it was found that the concentrations of individual hydrogeochemical indicators of groundwater in exploited deposits in the region do not correspond to world standards for drinking water quality;

- comparative analysis of methods for processing the results of laboratory studies of groundwater analyzed using the AquaChem 11 software package presented in the form of Piper diagrams; and the classical method of paired correlations is applicable for the development of detailed methods for improving the quality of groundwater;

- based on an assessment of the current state of groundwater pollution in the administrative regions of Southern Kazakhstan, no reliable evidence of the impact of climate change on groundwater resources has been identified, however, the direction of anthropogenic changes in the underground hydrosphere has been established;

- measures are proposed aimed at improving the situation with drinking water supply in water-scarce areas of the region and at reducing the negative anthropogenic impact on groundwater, which manifests itself in the form of pollution and a decrease in the volume of water resources.

**The main provisions submitted for protection:**

1. Concentrations of individual hydrogeochemical indicators of groundwater from exploited deposits in Southern Kazakhstan do not meet international drinking



water quality standards. Exceedances were recorded in the following indicators: sodium – by 1.5% (Karachik groundwater deposit), sulfates – by 3% (Mirgalimsay groundwater deposit), total iron – by 1.2% (Mirgalimsay groundwater deposit), nitrates – by 1.9% (Shengeldi), lead – by 1.8% (Mikhailov groundwater deposit), cadmium – by 1.4% (Karachik groundwater deposit),) and ammonia – by 3.3% (Shengeldi); in 46% of the samples, the fluoride content exceeded the WHO recommended levels for oral administration.

2. Analysis of paired correlations for key hydrogeochemical indicators confirmed the conclusions about the conditions for the formation of groundwater deposits established earlier, which is an additional basis for the possibility of using the calculation of their reserves.

3. Anthropogenic impacts on groundwater in the modern period have practically not been identified: water withdrawal at a level of no more than 30-40% of the total volume of approved reserves has not caused resource depletion; and the choice of water intake sites ensured the supply of drinking quality water to the consumer.

**The field of application** is hydrogeology, geocology and hydrogeochemistry.

**The practical significance** of the research carried out is associated with an increase in water abstraction for a number of groundwater deposits that supply water to such megacities and large cities of Southern Kazakhstan as Almaty, Shymkent, Taldykorgan and Taraz; both actual and potential pollution sites have been identified on the area of 5 previously listed regions of Southern Kazakhstan.

In order to protect the environment and water resources in the territory of Southern Kazakhstan, measures have been developed and recommended which can help in solving the problems of water supply in water-deficient areas of the territory, reduce pollution processes and reduce subsurface water resources, negative anthropogenic impact on groundwater.

Further research should be aimed at developing an automated monitoring system for exploited freshwater deposits to promptly assess the state of their operation and prevent depletion and pollution, as well as to create information and analytical models to substantiate and make effective management decisions.

**The author's personal contribution** consists in setting the purpose and objectives of the dissertation; collecting and summarizing research materials; conducting ground route work; creating thematic maps; interpreting the results; formulating conclusions and main provisions submitted for thesis defense; writing scientific articles and reports on the topic of the thesis

The author participated as an executor in the implementation of the grant project «Assessment of changes in hydrogeochemical conditions of groundwater deposits in Kazakhstan under climatic and anthropogenic influences», as well as the scientific and technical program «Assessment of freshwater resources as the main source and long-term reserve of sustainable drinking water supply to the population of the Republic of Kazakhstan».

**Publications.** The main results of the dissertation were discussed and tested at international and national scientific conferences, published in 8 articles, including 2

articles in an international journal included in the Scopus database ("News of the national academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences" and "Water MDPI"); 1 article in the republican specialized publication recommended by the Committee for Control in the field of Education and Science of the Ministry of Internal Affairs of the Republic of Kazakhstan ("Mining Journal of Kazakhstan"); 2 articles in other scientific journals and publications ("Geology and protection of the subsoil" and "Bulletin of KazNITU"); 2 reports and 1 thesis published in the materials of international and regional conferences.

**The structure and scope of the thesis** The dissertation work consists of an introduction, six chapters, a conclusion and a list of references. The work is presented on 135 pages of typewritten text, contains 14 tables, 31 figures, a list of used sources from 80 titles and 3 appendices.

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