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Assessment of Spring Water on Geological Characteristics (Springs in Murmansk Are Taken As an Example)

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Abstract

The article deals with the relevance of the spring waters study and presents the results of the springs' classification in Murmansk and outskirts of the town on geological and ecological characteristics. Spring Water is the main source of water for drinking, agricultural and industrial needs. The availability of water determines the location and activities of people in the area. Our growing population experiences great demands on natural freshwater resources. However they are under various forms of pollution such as agricultural, industrial and domestic. In this research spring water samples were taken from the springs of Murmansk and outskirts of the town. Physical and chemical parameters were analyzed. The characteristics of each parameter were compared with the standard data established in the Russian Federation for this indicator. The characteristics of each parameter were within safe limits.

Keywords: spring water, physical and chemical parameters, water quality, geo-ecological classification.

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1. Introduction

According to the world health organization (WHO), currently about 2.4 billion people worldwide live in conditions of extremely poor hygiene and have such poor hygiene practices, exposure to risks of incidence and spread of infectious diseases is tremendous.

Murmansk region is part of the Arctic region of Russia, here, as in other countries and areas belonging to the Arctic zone, you need to constantly monitor the state of the natural environment and especially water resources, as water is fundamental to life and health.

The Murmansk region is quite specific area according to its geographical location and climatic conditions. Climate of the Murmansk region is peculiar and differs from the climate of other polar areas of Russia. Winter, the longest season, lasting more than six months, approximately from October to April and summer is approximately two to two and a half months, from mid-June until mid (late) August. Such specificity of climatic conditions should be considered when forming conclusions about the change in the quality of spring water depending on the season.

The study of springs (groundwater supply to the surface of the earth) and the protection of water resources from anthropogenic pollution is a complex task of high importance and negatively affects the quality of underground sources water.

Analysis and systematization of published scientific materials on the assessment of groundwater quality in the Arctic basin allows drawing conclusions about the low degree of study of this issue. Monitoring researches of water quality in the Arctic, as a rule, are carried out on water bodies -- wastewater receivers (in local pollution zones) and concentrate on measuring the content of individual components of pollution without taking into account the entire complex of physical, chemical and biological processes occurring in water bodies.

However, a prominent place is given to water protection and depletion of groundwater as one of the types of natural resources that are a source of drinking water supply for the population. Groundwater pollution could be an important indicator of the ecological status of the Arctic basin.

In order to improve the efficiency of measures for studying and protecting Spring Waters from pollution, a comprehensive classification of springs is necessary to work out. On its basis it is possible to model the processes occurring in water sources further as well as the implementation of environmental activities aimed at improving the environmental situation in the catchment areas of groundwater sources [1].

2. Methods and Equipment

2.1. Methods

2.1.1. Sampling and sampling methods

Spring water samples were taken from four springs located in Murmansk and outskirts of the town (Figure 1). Water samples were taken in two-liter polyethylene bottles separately, filled to the top without any air bubbles. Before sampling, the bottles were

thoroughly washed with samples in order to avoid possible contamination during bottling all precautions were taken. The selected samples were stored in a refrigerator (4°C) during transportation to the Murmansk State Technical University (MSTU) laboratory for analysis.

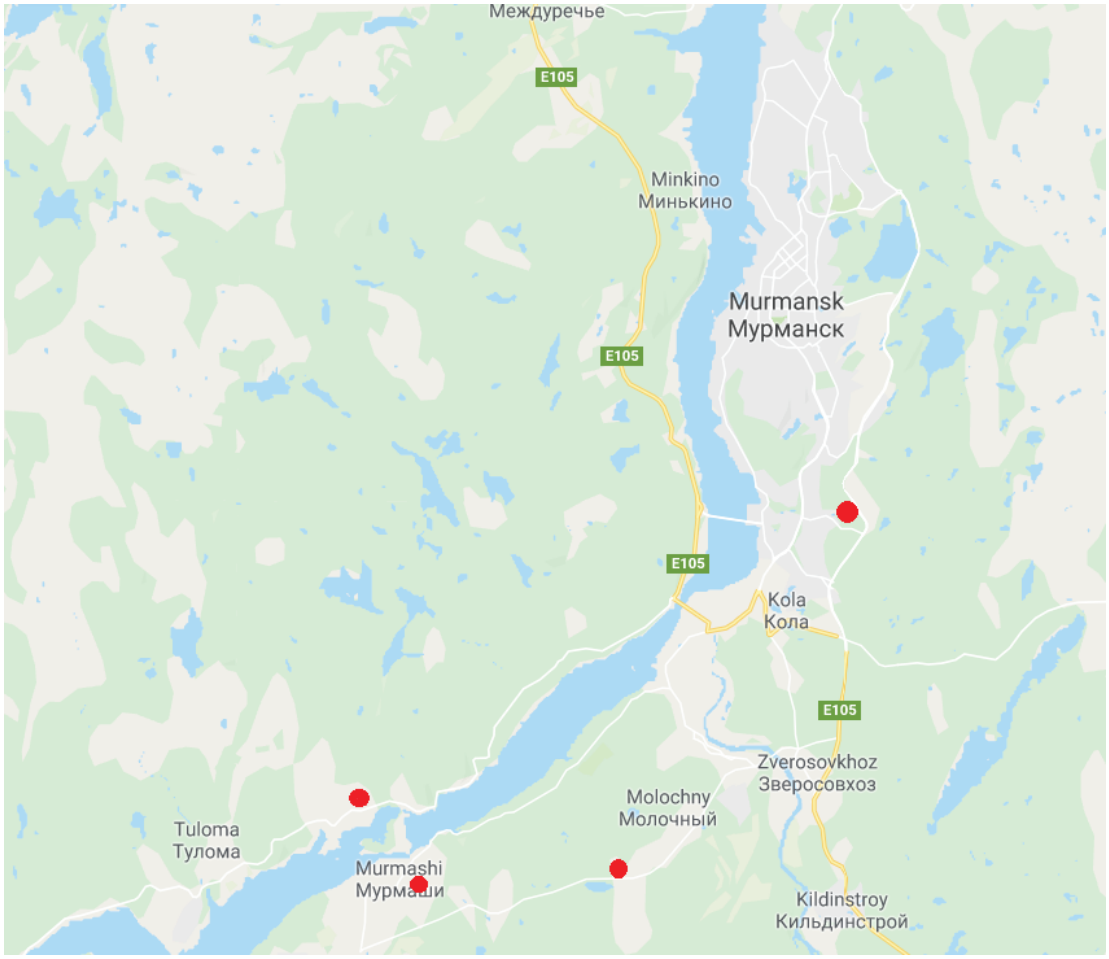

Figure 1: Map-scheme of the spring water location.

2.1.2. Physical and chemical analysis

The analysis of various physical and chemical parameters has been carried out. Temperature, hydrogen index (pH) were measured in the selected samples. Permanganate oxidizability, total hardness, total alkalinity, calcium (Ca^{2+}) and chlorides (CL–) were determined by titrimetric method. Nitrates (NO3-), nitrites (NO2-), sulfates ($SO4^{2-}$), phosphates (PO4), total iron and chromaticity were determined photometrically using the KFK-2 photocolorimeter.

Water quality was assessed in accordance with the sanitary rules and norms SanPiN 2.1.4.1175-02 "Hygienic requirements to water quality of centralized water supply. Sanitary protection of sources".

2.1.3. Classification

In order to study and classify springs by geo-ecological features we used the method of studying previously published materials and the method of descriptive survey to obtain data on the location, landscape conditions and the state of the spring captage.

3. Results

Based on the physical and chemical studies of spring waters samples of Murmansk and outskirts of the town, the chemical composition of the water can be classified as ultra-fresh, very soft and sulfate-bicarbonate.

Environmental monitoring of water quality of the studied springs, conducted from March 2014 to July 2019, allowed giving an objective hydrochemical assessment of water.

During a long-term study a comprehensive classification of springs in Murmansk and its suburbs was compiled according to the main geo-ecological features.

4. Discussion

Almost all springs by the type of power supply belong to the sources of pore groundwater except the spring on the way to Murmansk Airport (Archeiskiy) has a mixed type of power supply.

According to the debit and the nature of the schedule- all the springs of the territory belong to the class of low-debit permanent and active depending on season. All springs are characterized by seasonal fluctuations in flow rates throughout the year. The lowest characteristics of the flow rate are observed in the autumn-winter period-from November to March. Since April an increase in the characteristics of spring water has been recorded which is associated with an active infiltration during snowmelt and precipitation.

According to the temperature characteristics the waters of the springs are cold. Their temperature varies slightly during the year.

Table 1: Classification of springs by geo-ecological features.

The main geo-ecological characteristics	The spring in Prichalnoye (Domashniy)	The spring is on the way to Murmansk Airport (Archeiskiy)	Murmashi Spring	The spring on Fadeev stream street
in connection with non-pressure and pressure water spring	The spring relates to the descending	The spring relates to the ascending	The spring relates to the descending	a downward fissure
according to the type of supply	ground sources, supply is due to infiltration of atmospheric precipitation	a mixed type (pressure crack horizon archaea and infiltration of precipitation)	groundwater sources (supply occurs due to infiltration of precipitation	groundwater sources (infiltration of precipitation in the catchment area of the stream)
on a debit and character of a mode the spring belongs to	the spring belongs to low-rate seasonal (flow rate varies from 0.17 to 0.6 l/s)	low-rate seasonal (flow rate varies from 0.02 to 0.69 l/s)	low-rate seasonal (flow rate varies from 0.01 to 0.80 l/s)	low-debit permanent (flow rate from 0.16 l / s to 1.25 l / s)
according to the temperature	cold (water temperature varies from +2.5°C to + 3.8°C)	cold (water temperature varies from +2.2°C to + 3.7°C)	cold (water temperature varies from +2.7°C to + 4.0°C)	cold (water temperature varies from + 2.2°C to + 5.0°C)
on landscape conditions	residential area	agricultural areas	residential area	residential area
on sanitary and technical condition of a spring captage	well-equipped springs with convenient approach to the place of water	well-equipped springs with convenient approach to the place of water	well-equipped springs with convenient approach to the place of water	a satisfactory condition of the structure
chemical composition	bicarbonate calcium, ultrapure	sulphate, ultra pure sulfate,	sulfate-, chloride hydrocarbonate calcium-sodium, ultrapure	sulfate-, chloride chloride, calcium, ultrapure
safety in bacteriological quality	safe (total microbial number is good, coliform organisms (-), thermotolerant organisms (-)	safe (total microbial number is good, coliform organisms (-), thermotolerant organisms (-)	dangerous (total microbial number is good, coliform organisms (+), thermotolerant organisms (-)	dangerous (total microbial number is good, coliform organisms (+), thermotolerant organisms (+)

According to the landscape conditions the areas of the spring's location were related to residential areas, near agricultural lands, transport infrastructure, garage cooperative societies.

According to the sanitary and technical condition of the spring and the approach the following groups of springs were identified:

- springs related to the spring well-equipped with convenient approach to water;
- springs with satisfactory condition of the structure. Two groups of springs have been identified for bacteriological safety:

- safe (springs in Prichalnoye, on the way to Murmansk Airport);
- dangerous (the springs in Murmashi, Fadeev stream street)

This classification which takes into account not only the physical and chemical characteristics of springs, but also the geo-ecological conditions of the formation supply waters allows adjusting the tasks for the study and protection of springs in the framework of environmental measures, to simulate the processes and to map the anthropogenic load.

5. Conclusion

Groundwater, including spring water, is in constant contact with various components of the environment and its quality depends on the complex physical and chemical processes resulting from these contacts. The change in groundwater quality as a result of pollution is especially obvious in industrial zones and in areas of increased anthropogenic load [2].

The water quality of the spring generally meets the established standards for non-centralized sources of drinking water supply, but there is an increase in color and total iron content in water samples in spring and autumn, which can be associated with natural factors (floods, intense precipitation).

First of all, this may be due to the infiltration nature of spring water, and secondly, the fact that soil composition affects the chemical composition of spring water, since groundwater is in direct contact with the underlying rocks. As well as one of the factors that determine the quality of the spring water can be attributed to the low protection of the aquifer from pollution from surface areas.

With the help of geo-ecological classification of springs in Murmansk and its suburbs the experience has shown that the majority of the springs belong to groundwater sources (supply is due to infiltration of precipitation), therefore, they can be a kind of indicators of anthropogenic pollution in the Arctic region. In such conditions the problem of timeous detection and groundwater protection from pollution is very urgent.

Further research and monitoring of the studied wells and springs are advised to investigate trends of water quality and possible seasonal changes [7].

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Conflict of Interest

The authors have no conflict of interest to declare.

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