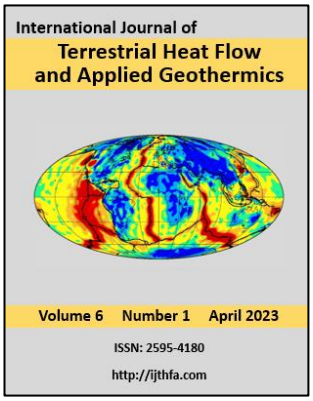
International Journal of Terrestrial Heat Flow and Applied Geothermics
VOL. 6, NO. 1 (2023); P. 25-28.
ISSN: 2595-4180
DOI: https://doi.org/10.31214/ijthfa.v6i1.95

IJTHFA
http://ijthfa.com/



Thermomineral Waters as Curative Properties in Yalama-Nabran Resort Zone of Azerbaijan

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Abstract

The article deals with the natural healing resources of the thermomineral waters of the Yalama-Nabran zone. The relevance of the work is determined by the presence of huge reserves of medicinal waters with a rich microelement composition for internal and external use. The characteristic of thermomineral waters of the studied region is given. The increased content of bromine, boron and other microcomponents in these waters, as well as the high temperature, make it possible for them to be widely and effectively used as a balneotherapeutic factor for therapeutic and prophylactic purposes.

Keywords
Thermomineral waters,
Temperature,
Composition,
Microcomponents.

Received: April 25, 2023

Accepted: May 11, 2023

Published: May 15, 2023

1. Introduction

The Yalama-Nabran resort area is located in the Republic of Azerbaijan, between the northeastern foothills of the Greater Caucasus and the coast of the Caspian Sea.

Administratively, the area covers the territory of the Khachmaz region of the republic. The largest settlements within the territory are the village. Yalama, Nabran, Ledzhet, Mukhtadyr, etc. The main routes of communication are the railway line and the paved highway Baku-Rostov-Moscow.

All settlements are interconnected by paved roads and telephones.

The population is mainly engaged in agriculture: gardening, vegetable growing and animal husbandry. The industry of the region specializes in the processing of agricultural raw materials.

Industrial enterprises and accompanying mechanical workshops, car depots and other enterprises are located in the district center Khachmaz and the village. Hudat. There are also large canning factories for processing vegetables, fruits and berries.

2. Results

The Kusar foothill plain is orographically subdivided into 3 zones, elongated parallel to the Main Caucasian Range:

Figure 1 – Nabran resort area.

1) The zone of foothills and low mountains with absolute elevations of 850-220 m is located to the west of the Samur-Absheron Canal. It is characterized by a strongly rugged relief, dissected by numerous gullies, ravines and a number of hilly hills and ridges.
2) Sloping plain with absolute elevations of 250-40 m, located between the Samur-Absheron canal and the railway. The surface is characterized by a slightly undulating relief, dissected by riverbeds and small channels.
3) The seaside lowland with absolute elevations from 40 to -27 m is located between the railway line and the coast of the Caspian Sea. This is an almost flat plain, with weakly dissected valleys of streams and rivers, to the beach area it breaks off with a steep ledge 6-8 m high, covered with dense forest. The beach stretches in a

narrow strip along the seashore. A significant part of it is swamped, wedged groundwater, and overgrown with moisture-loving vegetation.

According to E.M. Shikhlinsky, a large amplitude of absolute terrain marks causes the presence of three types of climate in the area, territorially almost coinciding with orographic zones:

a) cold, with dry winters (Piedmont zone);
b) moderately warm, with an almost uniform distribution of precipitation over time (Sloping Plain);
c) climate of semi-deserts and dry steppes, with an almost uniform distribution of precipitation (Primorskaya lowland).

Average long-term air temperatures in the Piedmont zone are 9.50-10^{0}C and below, with maximum temperatures up to 20^{0}C below zero. The amount of atmospheric precipitation is from 430 mm to 615 mm. They fall in the form of snow and rain. Precipitation intensity is average, with occasional showers.

Within the Oblique Plain and the Primorskaya Lowland, the average annual air temperature is 12.5^{0}C, with one-time maximum values up to 40^{0}C. The amount of precipitation ranges from 300 mm to 450 mm. The value of relative humidity is 70-81%. Atmospheric precipitation, as a rule, of low intensity, falls in the form of rain, occasionally snow. The snow cover is unstable in time and is small in thickness (3-6 cm). In severe winters, repeating in 5-10 years, its thickness increases to 0.3-0.5 m. Evaporation ranges from 750 to 1100 and is approximately 2-2.5 times higher than the amount of atmospheric precipitation, which determines a very low humidity coefficient of the territory (0.44-0.4%). The freezing of the soil is insignificant - the zero temperature of the soil does not exceed 40 cm of depth.

In the coastal part of the territory, the winds of the western and northwestern rhumbs dominate, there are breezes blowing from the sea during the day, and at night and in the morning from the land, in the cool seasons of the year, foehns blow from the mountains - warm and dry winds. In the summer, sometimes there are dry winds.

Below is a description of the main climate elements that are important for the formation of groundwater resources, conditions for work and development of the territory.

All rivers of the plain belong to the basin of the Caspian Sea. The average density coefficient of the river network for the territory of the Kusar foothill plain is 0.54 km/km^2, but its value increases towards the foothills (up to 0.6-0.8) and decreases towards the sea (up to 0.4), due to the confluence of small rivers and streams to transit rivers. The main rivers of the region are: Small Samur, Big Samur (both on the territory of the Dagestan Autonomous Republic), and within the Kusar foothill plain - Kusarchay, Kuruchay, Kudialchay, Akhchay, Karachay, Velvelichai.

In the mountain zone, they are characterized as typical mountain rivers. They flow in canyon-like rapids valleys of erosion-tectonic genesis and have huge flow velocities; within the inclined plain and lowland, their valleys expand, flatten and in places form swamps. The main sources of river nutrition are melt water (70%), rainwater (7-15%) and groundwater (20-40%). Directly on the territory of the work carried out, along the southern border of the region, one river flows - Kusarchay. The hydrogeological regime of the rivers is characterized by the presence of one flood in the warm season (March-August), caused by the melting of snow, glaciers, spring rains and several smaller floods in autumn-winter, caused by rains, because almost all rivers, with the exception of the river. Samur flow in deep incised valleys. During floods, they do not flood the surrounding areas. The turbidity of water varies greatly with time and along the course of rivers. In the flat parts it is equal to 250-500 g/m^3, in the mouth parts it increases up to 1000 g/m^3. Only in the middle and lower reaches of the rivers Kusarchay, Kudialchay, Velvelichai, the turbidity of the water during heavy rains increases to 2000-4000 g/m^3.

River waters are fresh (0.3-1.0 g/l), bicarbonate, calcium, soft, with a total hardness of 3-6 mg-eq/l.

The hydrochemical characteristics of groundwater in the Yalama-Nabran resort area are given on the basis of the results of chemical analyzes.

Within the limits of the Kusaro-Shabran artesian basin, where the area of prospecting is located, several aquifers have been identified, confined to the stratigraphic units of the same name.

Below, we consider the hydrochemical characteristics of formation waters for individual aquifers discovered by exploratory wells.

Underground waters of the Sarmatian stage were exposed and studied in well No. 9 in the interval of 1810-1735 m. The deposits of the Sarmatian stage contain highly mineralized formation waters of chloride-sulfate sodium composition, with a mineralization of 16.5 g/l. The content of microcomponents is iodine 8.66-12.2 mg/l, bromine 29.07-35.2 mg/l and boron 42.1-54.37 mg/l.

The chemical composition of water according to the Kurlov formula is expressed as follows:

$$J^{9,5}\ Br^{32,7}\ B_2O_3{}^{49,6}\ M^{16,5}\ \frac{Cl^{70,7}\ SO_4{}^{24,6}}{(Na+K)^{94,4}}\ T^{34oC} \qquad (1)$$

According to the criteria for assessing thermomineral waters, the groundwaters of the Sarmatian stage are highly mineral, iodine, low thermal.

According to the Azerbaijan Scientific Research Institute of Balneology and Physiotherapy named after CM. Kirov, thermomineral water in the range of 1810-1735 m, discovered by well No. 9, belongs to the V group of conditioned therapeutic iodine suitable for use in the form of baths, for chronic diseases of the musculoskeletal system, peripheral nervous system, cardiovascular system, gynecological and skin diseases, and atherosclerosis.

The complex geological structure of the region, the paleohydrogeological conditions for the formation of formation waters, as well as the lithofacies variability of the water-bearing rocks of the deposits of the productive stratum, led to the formation of diverse aquifers in the section of these deposits, which differ sharply from each other in their unique hydrochemical features (Minchuk, et al. 1986).

As a result of a detailed study of the chemical composition of the formation waters of the productive stratum, it turned out to be possible to clearly distinguish between them. The boundary of distribution of two different types of water passes almost in the middle part of the section.

Based on the foregoing, two water-bearing complexes are distinguished in the deposits of the productive stratum: lower and upper.

Groundwater of the aquifer complex of the lower productive stratum (PTI) was studied in all exploratory wells drilled in the Yalama-Nabran zone.

The main component of the salt composition of PTI formation waters are sodium chlorides, the content of which usually exceeds half the amount of dissolved salts (Salakov, 2011). An additional component of the salt composition are calcium and magnesium chlorides and bicarbonates, as well as a small amount of sulfates. A characteristic part of the salt composition of the waters of the aquifer complex of the lower productive strata are bromine, iodine, boron, the accumulation of which occurs with an increase in water salinity (Salakov, 2022).

In addition to thermomineral substances, PTI waters include gaseous and organic substances, free carbon dioxide (CO_2), nitrates (NO_2) and silicic acid (SiO_2). Naphthenic acids and their salts are absent.

In well No. 6, the aquifer complex of the lower section of the productive stratum was tested in the interval of 1609-1485 m. The chemical composition of water according to the Kurlov formula is expressed by the following formula:

$$J^{25,97}\ Br^{108,76}\ B_2O_3{}^{117,2}\ M^{44,5}\ \frac{Cl^{98,0}}{(Na+K)^{94,9}}\ pH^{7,6\text{-}8,0}\ T^{42oC} \quad (2)$$

The mineralization of these waters is 41.2-46.6 g/l. The content of micro-components is as follows:

NO_2 - 0.01-0.03
SO_2w – 30.0 mg/l
SiO_2 - 8.40 mg/l
LiO_2 - 2.9-3.2 mg / l
Rb_2O - 0.0-0.2
CsO - 0.2
SrO - 60
Alkalinity 415-580, pH - 7.6-8.0.

According to the main criteria for evaluating thermomineral waters, the water belongs to the sodium chloride type, brine, carbonic, bromine (high concentration), iodine (high concentration), siliceous, slightly alkaline, thermal (4.5). Genetic coefficients:

$$\frac{rNa}{rCl}=0,95; \quad \frac{rCl}{rBr}=243$$

According to the Azerbaijan Scientific Research Institute of Balneology and Physiology named after CM. Kirov formation water, obtained in well No. 6 from a depth of 1609-1485 m, is suitable for external use, in the form of baths for chronic diseases of the musculoskeletal system, cardiovascular system, peripheral nervous system, gynecological, skin diseases and atherosclerosis.

In well No. 7, the PT was studied in the interval of 1845-1516 m. The chemical composition of water according to the Kurlov formula is expressed as follows:

$$J^{17,23}\ Br1^{84,7}\ B_2O_3{}^{128}\ M^{57,1}\ \frac{Cl^{99,2}}{(Na+K)^{88,3}}\ T^{54oC} \quad (3)$$

The content of microcomponents is as follows:

NO_2 - 1.5 mg/l
SiO_2 - 15 mg/l
pH - 7.6

According to the main criteria, the water is carbonic, sodium chloride type, brine, high concentration bromine, high concentration iodine, siliceous, slightly alkaline, high-thermal. Genetic coefficients:

$$\frac{rNa}{rCl}=0,89; \quad \frac{rCl}{rBr}=265$$

According to the Institute of Balneology and Physiotherapy. CM. Kirov reservoir water, tapped by well No. 7 in the interval of 1845-1516 m, is classified as therapeutic bromine, suitable for external use in the form of general and local baths for chronic diseases of the musculoskeletal system, cardiovascular and peripheral nervous systems, some skin and gynecological diseases, as well as atherosclerosis.

In well No. 9, the PT was studied at a depth of 1676-1480 m. The chemical composition of water is expressed by the Kurlov formula:

$$J^{7,40}\ Br^{24,40}\ B_2O_3{}^{8,2}\ M^{12,2}\ \frac{Cl^{75,6}\ SO_4{}^{22,8}}{(Na+K)^{69,4}Ca^{23,3}}T^{31oC} \quad (4)$$

Mineralization of water 12.2-18.9 g/l. The content of microcomponents in water is as follows:

NO_2 - 0.01 mg/l
CO_2well – 64 mg/l
SiO_2 - 20 mg/l
Alkalinity 140-188
pH - 7.6.

Genetic coefficients:

$$\frac{rNa}{rCl}=0,92; \quad \frac{rCl}{rBr}=205$$

The main criteria for water: chloride-sulfate, sodium-calcium, highly mineralized, bromine, iodine, siliceous, slightly alkaline, low thermal (warm).

In well No. 9, the aquifer of the Apsheron stage was exposed and tested in the interval of 1006-808 m. The chemical composition of water is expressed by the Kurlov formula:

$$J^{1,32}\ Br^{17,33}\ B_2O_3{}^{6,64}\ M^{4,51}\ \frac{Cl^{16,31}\ SO_4{}^{68,49}HCO_3{}^{15,19}}{(Na+K)^{90,10}} \quad (4)$$

According to the main criteria, the water is sulfate, sodium, low-mineralized, low-thermal. Genetic coefficients:

$$\frac{rNa}{rCl}=5,06 \qquad \frac{rCl}{rBr}=232$$

In well No. 10, formation water of the Apsheron aquifer complex was studied in the interval of 962-842 m. The chemical composition of water according to Kurlov:

$$J^{1,32}\ Br^{16,52}\ B_2O_3{}^{18,21}\ M^{4,1}\ \frac{Cl^{63,83}\ SO_4{}^{24,10}HCO_3{}^{12,05}}{(Na+K)^{91,25}}\ T^{32oC} \quad (5)$$

According to the main criteria, the water is chloride-sulfate-sodium type, low-mineralized, low-thermal. Genetic coefficients:

$$\frac{rNa}{rCl}=1,04; \qquad \frac{rCl}{rBr}=237$$

According to the balneological qualification, the water of the Apsheron stage, obtained from the interval of 962-842 m, from well No. 10 belongs to the I group. According to the general chemical composition, it is similar to the Chartak (Dagestan Autonomous Republic) medicinal table water obtained from well No. 82. Water should be used for medicinal purposes in chronic gastritis with preserved and insufficient secretory function of the stomach, chronic diseases of the liver and biliary tract, chronic pancreatitis (Salakhov, 2013).

Summarizing the hydrochemical characteristics of groundwater in the deposits of the Sarmatian stage, productive stratum, Akchagyl and Apsheron stages of groundwater in the Yalama-Nabran zone, it should be noted that sodium chlorides predominate in the chemical composition, the content of which exceeds half the amount of dissolved salts. There are also

sulfates and bicarbonates from anions, and calcium and magnesium from cations. The presence of free carbon dioxide was noted. Common to all aquifers is the content of such microcomponents as iodine, bromine and boron, the amount of which sharply decreases from bottom to top along the section. The studied waters do not contain naphthenic acids and their salts. All formation waters in the region are characterized by an increase in the mineralization of formation waters with stratigraphic depth, which, apparently, is associated with the difficult conditions of their formation and sedimentation processes.

In the aquifers of the Sarmatian stage and the lower part of the productive stratum, brine chloride-sodium waters are common, in which iodine, bromine and boron are also present in significant quantities. The value of genetic coefficients is respectively:

$$\frac{rNa}{rCl} = 0{,}89\text{-}0{,}97; \quad \frac{rCl}{rBr} = 176\text{-}271$$

The distribution of sodium chloride waters in the deposits of the Sarmatian stage and the lower productive strata is of a local nature. So, if in the northwestern section of the territory under consideration in wells 111, 1180, 6, 7, 10 brine sodium chloride waters with a mineral content of up to 57 g/l are common, then in the southeastern section in wells 9, 12, 18 medium - and highly mineralized waters of the chloride-sulfate-sodium type with a mineralization of 12-20 g / l.

In the southeastern section, in the area of well No. 115 (Nizovaya village), brine, sodium chloride waters were again encountered. A decrease in the salinity of formation waters over the area probably occurs as a result of their dilution, due to overflow, with less mineralized waters of the upper aquifers. The pH value is 7.6-8.4.

In the aquifers of the upper part of the productive strata and the Akchagyl stage, there are mainly low- and medium-mineralized waters of the chloride-sulfate sodium type. Genetic coefficients:

$$\frac{rNa}{rCl}=1{,}00\text{-}1{,}04; \quad \frac{rCl}{rBr}=171\text{-}270$$

The value of the concentration of hydrogen ions pH - 7.0-8.4. In the aquifer of the Apsheron stage, low-mineralized formation waters of chloride-hydrocarbonate sodium composition are common. The value of genetic coefficients:

$$\frac{rNa}{rCl}=1{,}02\text{-}2{,}05; \quad \frac{rCl}{rBr}=110\text{-}237$$

3. Conclusions

So, groundwater, common in the aquifers of the Apsheron, Akchagyl stages and deposits of the productive stratum, is diverse in the quantitative content of individual chemical components, but at the same time they are homogeneous in salt composition.

The decrease in water salinity from bottom to top and the change in the chemical composition of waters in the same direction confirm that the waters formed in the upper horizons were associated with the influence of surface waters during formation and were in the conditions of a hydrogeological zone of active water exchange.

The distribution of sodium chloride and other types of water in deep aquifers is typical for the entire region under consideration.

References

Minchuk, M.A., Zakharova V.A., Guseynov, R.I. and others. 1986. Report on the results of prospecting and evaluation work for hydromineral raw materials and soda waters of the Azerbaijan SSR. Baku. p. 92

Salakhov, S.Sh. 2011. Inhibitory protection against corrosion of equipment using thermal waters of Azerbaijan. Moscow, Actual problems of the humanities and natural sciences. No. 2. p. 268-270.

Salakhov, S.Sh. 2022. The importance of Sanatorium-resort complexes for medical treatments in Azerbaijan. Rio deJaneiro, İnternational Journal of Terrestrial Heat Flow and Applied Geothermics. Volume 5. P. 51-54.

Salakhov, S.Sh. 2011. Water content of the rocks of the Meso-Cenozoic deposits of the Alazan-Agrichay valley of the Azerbaijan Republic. Materials of the International Scientific and Practical Conference "Modern problems of the oil and gas complex of Kazakhstan". Volume I. - Kazakhstan: Aktau. p. 138-140.

Salakhov, S.Sh. 2011. Corrosion protection of equipment operating in the thermal waters of Azerbaijan. III International Scientific Correspondence Conference "Actual Issues of Modern Engineering and Technology": a collection of reports. Part II. - RF, Lipetsk: Gravis. p. 81-82.

Salakhov, S.Sh. 2013. Hydrogeochemical conditions of the interfluve of the Kura and Iori of the Republic of Azerbaijan. - St. Petersburg: Scientific Opinion. No. 4. p. 249-252.