Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-29 April 2010

Geothermal Water Resources of the Republic of Tajikistan and a Perspective on Their Use

Inom Normatov

Institute of Water problems, Hydropower and Ecology Academy of Sciences Republic of Tajikistan, 12, Parvin street, Dushanbe, 734002, Tajikistan,

E-mail:owp@tojikiston.com

Keywords: hydrogen sulphide, iodine-bromine, Hoja Obi-Garm, Pamir Mountain, Mineralization

ABSTRACT

Economic and cultural activities of the modern society are intimately connected with the usage of natural waters. A modern foresight of all changes in the regime of water reserves became a prime necessity. It raises the need for the reliable protection of natural waters because in modern world the resource of water is one of the main economic factors determining the advance of a national economy.

The concept of Central Asia (the former name is Middle Asia and Kazakhstan) that is used nowadays includes the republics of CIS: Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan, Afghanistan. Hydrographically, the region of Central Asia (CA) is distinguished as the Aral Sea basin, which in turn consists of two basins – the Syrdarya and the Amudarya Rivers. Total water resources of the Aral Sea basin surface waters make 115.6km^3/year (Table 1).

Table 1.Surface water resources of the Aral Sea basin

Country	*A* (km^3/year)	*B* (km^3/year)	The Aral Sea basin	
			km^3/year	%
Kazakhstan	—	4.50	4.50	3.9
Kyrgyzstan	1.90	27.4	29.30	25.3
Tajikistan	62.9	1.1	64.00	55.4
Turkmenistan	2.78	—	2.78	2.4
Uzbekistan	4.70	4.14	8.84	7.6
Afghanistan	6.18	—	6.18	5.4
CA	78.46	37.14	115.6	100.0

A: The Amudarya River basin; *B*: The Syrdarya River basin

According to approximate evaluation, underground water resources in the Aral Sea basin make 43.7 km^3/year of which 36.2% are approved exploitation reserves. Moreover, a large quantity of return waters is formed in the Aral Sea basin – 45.8 km^3/year, a small part of which is only repeatedly used for irrigation – 6.0 km^3/year, and a great part of the waters is led to rivers (23.5 km^3/year) and natural reduction (16.3 km^3/year).

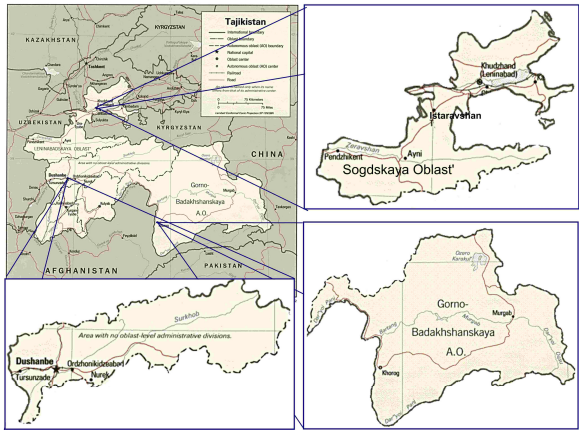
Tajikistan is rich in water resources, within the territory of the country all kinds of water bodies are represented practically. In the mountains numerous glaciers are amassed. Based on information that is available at the present time, in Tajikistan there are about 8492 glaciers occupying 6 % of all territory of the country. The total area of glaciations reaches 8476.2 km^2.

An abundance of feeding sources, the large absolute altitudes and mountain relief have resulted in development of a dense fluvial network. The total number of the rivers, streams and temporary water flows in Tajikistan is more than 25000, and by total length about 90000 km. The number of rivers with lengths of more than 10 km is 947, with a total length of more than 28500 km.

The territory of Tajikistan is part of the Tyan - Shyan Djungar - Pamirian hydrogeological folded area within the system of intermountain artesian basins. Classification of Tajikistan by water mineralization is as follows (in g/dm^3): very fresh waters is less than 0.1; fresh - from 0.1 up to 1.0 (among them 0.1-0.3; 0.3-0.5; 0.5-0.1); salty - 0.1-35.0 (light salted 1-3; medium salted 3-5; salty 5-10; over salted 10-35);bracken - more than 35 (among them 35-75; 75-150; 150-200. etc.)

The chemical composition of the water of Tajikistan is varied but the basic types are: carbonated (hydro carbonated, calcium, sodium); sulfated and chlorides (chloride calcium).

The republic is subdivided by geological structures and hydrogeological conditions. The divisions are: North-Tajik, Central-Tajik, Northeast, Southwest and Southeast.



North-Tajik. Within the region the Mesozoic-Cenozoic and Paleozoic develop cracking-earth, cracking-lode, pore-primordial and pore-cracking; in hollows (quaternary deposit) - pore-primordial in river valleys and the pile-dwellings. Water-carrier horizons are classified as without self outpouring and self outpouring. In unusual circumstances springs are permanent but typically seasonal with the production rate from 0.1-0.5 up to 1.0-5.0 l/s, and rarely up to 10 1/s or more. Quaternary deposit underground waters are found at depths from 15.5 up to 100 m or more. The production rate rises to 20 1/s. Waters

hydrocarbonate and contains sulfate calcium - magnesium and sulfate sodium-calcium with a mineralization 0.5-0.8 up to 7.5 g/dm^3.

The following types of waters are developed in the region:

The pore primordial of the quaternary deposit is 500 m or more. The depth of deposits are from 0.5-3.0 m (is flooded the part of the bottom of the river Sirdarya) to 10-30 m, and on inter-cone watersheds up to 80-90 m. Waters without self outpouring and self outpouring have the production rate of 0.1-0.5 up to 15.0 1/s or more. Mineralization goes up to 1.0 g/dm^3 as hydro carbonated-sulfate calcium-magnesium.

Central-Tajik. The underground water's Mesozoic-Cenozoic deposits are used as water supplies for settlements and irrigation. Springs have a production rate from 0.1-0.2 1/s to 10.0-20.0 1/s and are often outputs of the group character. The structure of the water is hydro carbonated-sulfate calcium-sodium with a mineralization up to 1.0 g/dm^3 and only on occasions up to 1.2-1.3 g/dm^3, leaving springs from the Jurassic period carboniferous thickness - up to 2.0 g/dm^3 and the structure of the water is sulfate-chloride calcium. Waters of Paleozoic deposit and intrusion formations have a wide development and flow as descending and weak rising single and group springs with the production rate from 0.5-1.5 1/s up to 5.0-10.0 1/s.

The springs from tectonic zones sometimes have flows of 20-25 1/s and even up to 40.0-50.0 1/s. The structure of hydro carbonated -sulfate calcium-chloride (magnesium) waters with a mineralization are 0.2-0.3 g/dm^3, and waters dated for Silurian sandstones are up to 1.0 g/dm^3.

Mineral water output coincides with a Silurian deposit (sources Anzob and Khoja-Sang-Khok) which creates numerous jets from zones of small breaks surrounding the Main Gisar's deep break. The production rate of the separate jets are 0.01-0.03 1/s. Parts where it is capped by springs, natural outputs have run low. The production rate of the springs (with a self outpouring) are 0.2-0.3 1/s, the temperature of the water is 60-80 ^{o}C and mineralization (Anzob) is of 1.5 g/dm^3 and (Khoja-Sang-Khok) is 1.97 - 2.0 g/dm^3. The dissolved gas carbonic acid is (1.7-2.5 g/1). It also contains silicon acidity – 8.0 mg/1; radon – 1.9 unit Mahe. The structure of the water is hydrocarbonate calcium - sodium – magnesium. Cracking-lode waters of the intrusive complex have a mineral water output, that coincide with young breaks, surrounding numerous ancient deep deposit breaks.

Mineral waters have high-temperatures (26-75^{oC}) and nitric terms with miscellaneous chemical compound and a mineralization (0.4-1.0 up to 2.5 g/dm^3).

Well-known sources Yavroz (a valley of the river Kafernigan); Khoja - Obi - Garm (a valley of the river Varzob) and Obi - Garm (a valley of the river Obi - Garm) are commonly utilized. Water is released by a spring at the depth of 128 - 275 m. The spring itself gives vent to the production rate 0.6-0.9 l/s. The mineralization of the water changes from 0.3 g/dm^3 (in spring) up to 3.1 g/dm^3 (in winter) and contains the following components: silicon acidity – 7.3 –28.0 mg/1, bromine up to 10.0 mg/1 and radon of - 5 - 8 units Mahe. The dissolved gas is nitrogen, with trace amounts of hydrogen sulfate. The water is used by the bathhouse "Yavroz".

Mineral Sources of Obi-Garm are connected to breaks, in surrounding Vakhsh a deep break that is shipped under quaternary deposit (capacity in the center of a hollow up to 300 m).

Mineral water is capped by springs at the depth of 100-200 m. A total production rate at the self-outpouring up to 60-65 1/s. Temperature on the self- outpouring is 42-53 ^{oC}. A structured of sulfate-chloride, sodium-calcium with a mineralization of 0.9 g/dm^3. Water contains silicon acid (25.7-31.4 mg /1) and the dissolved gas - nitrogen. The waters are being utilized by the Obi - Garn health resort.

Mineral waters of Khoja - Obi – Garm are in the regional zone of the Gushary thrust which is complicated because it has broken breeds (granitites) that have formed into shallow blocks. Water flows from cracks and spreads on a slope. Where water outputs "it boils" due to the difference of temperatures and forms high-temperature steam (96-98 ºC) which is used in the steam emanatory. The water temperature on the self outpouring is from 60-680 C up to 82-96ºC, the mineralization is 0.4 g/dm^3. The presence of radon in the water is 5-40 units Mahe, silicate -140 mg /1, hydrogen sulfate -3.0 of mg /1, fluorine – 20.0 of mg / 1, the free dissolved gas - nitrogen As the temperature lowers the mineral contents of the components also decrease. The structure of water is hydro carbonate (35 %), chloride (33 %), sulfate (32 %) and sodium (70 %).The health resort Khoja - Obi - Garm exists because of the abundance of mineral water.

Special attention to Chilu - Chor - Chashma (a central part of the Beshkent valley) is deserved because it has numerous jets in cracked (gaping cracks) limestones with a total production rate of about 1500 1/s. Fresh water is (0.3-0.4 g/dm^3). Formation of underground water, with partial unloading - like the spring of Chilu -Chor - Chashma, occurs due to a superficial water river of Kafernigan which circulates on a tectonic break in paleogen limestones. Spring water is valuable to the waterless valley and is used for economic drinking water supplying settlements, as irrigation, a watering place, and flooding.

Waters of the Jurassic deposits are widespread. Springs are usually (70 %) grouped with the production rate from 2.0-3.0 1/s to 10.0-20.0 1/s. Mineralization is 0.1-0.3 g/dm^3. The water contains hydro carbonate-sulfate calcium and is not used. Output of mineral water is connected to Jurassic breeds: the pool river Aksu, sources Kazil-Rabat, Khan - Yuli, Shainak with production rate of separate jets up to 1.0 1/s and total production rate is 5.0 1/s. Fresh waters nitrogen-carbonic warm (up to 40 ºC) it is strongly aerated.

Waters of the Precambrian Metamorphisation Intrusive Formation. The Pre-Cambrian metamorphic widths are distributed in the Northern and in the Central zones of Pamir in narrow strips. They compose almost all of Southwest Pamir and are submitted by strongly cracked gneisses, magmatics and crystal slates with interlayer and lenses of marble which are broken by numerous intrusive formations among which the largest are granitites of the Pamir-Shugnanian complex. Underground waters have universal distribution and unload as springs with the production rates 1.0-3.0 1/s, are dated to wash off loops or taken out of a deposit of the pile-dwellings and to the cones carrying out the draining of these types. The structure of the water is hydro-carbonate sulfate calcium-magnesium (sodium) with a mineralization of 0.1-0.3 g/dm^3. A number of mineral sources are dated with Pre-Cambrian breeds on the Southwest Pamir are more likely to occur in the zones of tectonic breaks. Based on features of chemical

and gas properties and temperature, the following groups are allocated:

1. Salted carbonic comes from very hot sources in Lyangar (a valley of the river Pamir) and Garm-Chashma (a valley of the river Garm-Chashma) are dated to a sublatitude break in widths of gneisses and marble. There are plenty of griffons, where the total of the production rates are more than 6.0 1/s. Waters are hydro-carbonate-chloride, sodium-calcium with a mineralization of 3.4 g/dm^3 with silicate -150 mg/dm^3. The temperature of the water is 62ºC. A balneary of Garm - Chashma come from this source. Lyangar has water containing hydro-carbonate-chloride and sodium with a mineralization of 2.3 g/dm^3. The production rate is 0.20 1/s with a temperature of 45ºC. The water is used by the local population for medical purposes.

2. Water sources Darshai, Shirgin, Avdj (a valley of the rivers Pyanj, Pamir), Hoz - Guni (a valley of the river Garm- Chashma) have salted carbonic hot and warm waters.

   Source Shirgin. The temperature is 35ºC. The production rates are -3.5-4.0 1/s, mineralization is 1.22 g/dm^3. The structure of water is hydro-carbonate-sulfate calcium-sodium-magnesium.

   Source Darshai. The temperature is 38ºC, the production rates are 8.0 1/s and mineralization is 2.6 g/dm^3. The structure of the water is hydro-carbonate-chloride sodium-calcium.

   Source Avdj. The temperature is 32-35ºC, the production rates are 1.5 1/s and mineralization is 2.0 g/dm^3. The structure of the water is hydro-carbonate-chloride sodium-calcium.

3. Iniv, Vrang, Borshor, Junt and Churj are salted carbonic sodium sources. Water seeps from cracks in breeds of Pre-Cambrian. The temperature of water is 13-20ºC the production rates are 0.5-2.0 1/s with mineralization 1.5-2.5 g/dm^3. The structure of the water is hydro-carbonate sulfate calcium-sodium-magnesium. There is no absorption and the water is used by the local population.

There are also more mineral sources in valleys of the rivers Vanch, Gunt, Pyanj and its inflows.

In the neogen deposit of Northern periphery of Dushanbe basin lie self -outpouring thermal slightly hydrogen sulfate midmineralized (3.0-12.0 g/1) waters of sulfate-chloride sodium structure aerated by nitrogen. They are used for medical purposes by the balneary Shaambari. Waters of such type are opened by springs in the valleys of the Hanaka and Luchob rivers. They are distinguished as having favorable climatic conditions and can provide for the expansion of health resorts and sanatoriums. From 750 m^3 / revealed part of water, in quantity of 250 m^3 / day can be used for table water (spring № 60 - Hingou-Tavildarinsky horizon), the other part – 500 m^3 /day will be a reserve for their external applications after additional preheating (spring № 6, 82 and 84 of the Boldjuanskii horizons). For additional resources of such waters in a case of an emergency it is necessary to bore the special springs in accordance with their technical equipment.

The best places to open the waters: on the Northern board of the pool is between the cities Dushanbe and Vahdat, on the Southern board area are Sardarov (Northwest slope storage Rangon). The incoming water will find balneological applications to the ambulance station in the regional centers Rohati and Sardarov.

Self-outpouring, warm and hot, high outflow, strong hydrogensulphite medium-and high-mineralized waters such as Sochi - Matsesta, a different chemical compound, aerated by nitrogen and methane are circulated in the deposits of paleogene. These waters are not used yet, but have balneological value. Around sources these waters in the valley of Luchob there can be created the long time balneological resort. Only one spring (№ 81) gives every day 700 m^3 of strong hydrogensulphite water, which will provide for a large health resort with 1500 - 2000 places, providing a structure of treatment like the well-known health resort of Sochi - Matsesta. The construction of a health resort in the Tajik republic will relieve workers not only in Tajikistan, but also the other areas of Central Asian republics, of long and expensive trips to the Sochi - Matsesta resort.

A similar resort could be opened on the Southern board of a pool near the center of Sardarov and Vahdat. It is a water of paleogene complex opened on Luchob structure and can be considered simultaneously as hydro mineral industrial raw material - for extraction from these strong sulfate waters of native sulfur. Water outflows of only one spring will provide the daily reception from 0.3 up to 0.6 t pure sulfur that in one year makes above 100 - 200 t.

The self outpouring, warm and hot iodine - bromine - boric hydrogen sulphite are highly mineralized chloride - sodium and chloride, sodium - calcium waters, aerated by methane, less often nitrogen (extreme east part of pool) lie in thick deposits. The mineralization of water grows from the East to the West, and the quantitative maintenance of biologically active components increases. These waters are not used yet, but there is a balneological value in the diluted type. There are favorable conditions for using these waters in the valley of river Luchob, where they lie at an accessible depth (1200 - 1500 m). One spring (№ 81) can produce about 700 m^3/day bracken iodine - bromine - boric - water. It can provide for 600 - 700 baths under condition that the water is diluted. These waters can be an additional reserve for a potential balneological resort in the valley of Luchob.

There are self outpouring high outflow hot bromine and bore containing hydrogensulphite high mineralized waters chloride - sodium structure, aerated by methane in the deposits of high denseness in the Chalk period. There are more full investigated waters in the East part of Dushanbe basin (Andigen spring № 92, 100) in the deposits of low thickness in the Chalk period. These waters are recommended by us for balneological use (bath) without additional heating and can provide for the needs of a big resort. Only from one spring (№ 92) water gives vent a day 500 m^3 at temperature 45 - 50ºC. This water can also be used for industrial heating purposes in Vahdat for heating hotbeds and hothouses for the cultivation of citrus. Similar waters could be opened near the Northern suburb of Dushanbe and in area of the region center Sardar accessible depth (1300-1400 m). Low outflow, warm and hot lie on the bromine and bore vent containing hydrogen sulphite high mineralized chloride - sodium or chloride sodium - calcium waters, aerated by methane in the deposits of Jurassic age. It is possible that the mineralization of the waters will grow from the boards of the pool to its center and from the East by the West up to the concentration of strong brines. The water is not used at this time but an opening of a high

outflow of water will create balneological interest, and may be an industrial heating value. The most favorable areas for a conclusion of Jurassic waters on a surface are areas of Andigen and Luchob anticline folds where Jurassic breeds lay at a depth of 1000 m.

In Paleozoic breeds the bases can be opened cracking hot, and it is possible that when superheated, high outflow waters of different structure will be formed. The most probable place for an opening is an area Fayzabad (Andigen folds and to the East from it), Northern suburb of city Dushanbe (Luchob folds) and area Karateginskaya of a ledge (a prospective underground shaft). Cracking waters of the Paleozoic base will have broad applications: a) medical waters as a basis for balneological sanatoria and hospitals; 6) as a source of thermal energy for central heating; b) as economic waters (depending on a mineralization) - for creation of douches, baths and laundries.

Table 2.Thermal waters of Pamir Mountains

№	Source. well	*A* (m)	*Y*	*T* (ºC)	*M* (g/l)	pH	*D* (l/s)	Utilization
1	Kauk	4200	1965	76	0.7	7.1	4	
2	Issikbulac	3900	1965	71	0.6	7.4	1.5	
3	Dzhilandi	3500	1965	67.5	0.3	7.8	5.6	
4	Tokuzbulak	3500	1965	66	0.3	7.4	2	
5	Elisu	3700	1965	63.5	0.97	7.7	1.5	
6	Dzharti-gymbez	4180	1965	62.5	1.6	17	3.5	
7	Garm-chashma	2770	1965	60	3.1	6.9	1.5	remedial
8	Langar	2840	1965	49	2.6	7.2	1.5	
9	Yamchin	3300	1965	43	0.7	7.3	3	
10	Kokbai	3920	1962	40	0.1	6.8	4	
11	Bakhmir	4060	1965	38	3.7	6.9	0.4	
12	Kizilrabat	3880	1965	38	1.3	6.7	1.6	
13	Dzhaus-hangoz	3360	1965	36	0.5	7	10	

A: Absolute mark; *Y:* Year of examine; *T:* Temperature of water; *M:* Mineralization; *D:* Discharge.

Result of studying of the hydrogeological conditions of the Gissar valley show that the artesian pool of Dushanbe is a great thermal mineral water resource. This remarkable gift of nature in the picturesque Gissar valley is a treasure to the Tajik republic. It could become in due course a valley of health resorts. Further investigations by deep drilling are needed not only on anticlines, but, primarily in local synclinal folds for potentially wide economic and balneological use. In the territory of the Republic of Tajikistan more than 200 mineral sources were detected. They differ in physical-chemical composition and geographic situation. In the northern zone of Tajikistan (Sogd area) the mineral sources are placed, basically, on plains and in foothills. In the central and southern zones they are located in valleys, foothills and middle mountains. In the Gorno-Badakhshan autonomous region, they are located in the Alpine mountains.

Thermal source of health resort "Garm Chashma". Pamir.

In the territory of Tajikistan in the lower hydrodynamic zone of basins of fissure waters and artesian basins, the thermal and subthermal waters enriched by balneological valuable components (of hydrogen sulphite, carbon dioxide, iodine, bromine, silicon acid etc.) and introduced by two groups are widespread and are the following: water of a particular composition (hydrogen sulphite and iodine-bromine) of artesian basins; carbon and siliceous thermal waters of Central Tajikistan and Pamir; radon waters of Northern Tajikistan; water of a nonspecific composition (thermal waters of neogene of the South-Tajik depression and Silurian formations of Turkistan mountain range).

Table 3.Thermal waters of Central of Tajikistan

№	Source. well	*A* (m)	*Y*	*T* (ºC)	*M* (g/l)	pH	*D* (l/s)	Utilization
1	Hodzha-Obigarm	1835	1957	98	0.4	8.5	1.5	remedial
2	Tamdikul	2199	1975	88	0.7	8.8	0.65	remedial
3	Hovatag	634	1972	55	401	7.3	11.7	remedial
4	Obi-Garm	1333	1957	53	0.8	7.3	14.8	remedial
5	Obisafet	2600	1976	51	0.5	7.1	12	
6	Garmova	1520	1967	42	0.5	6.8	1.3	
7	Yavroz	1129	1972	41.5	2.5	7.8	9	remedial
8	Yaman kirchin	2900	1976	33	0.6	7.3	3	

A: Absolute mark; *Y:* Year of examine; *T:* Temperature of water; *M:* Mineralization; *D:* Discharge.

The hydrogen-sulphide waters such as at Matsesta are advanced within the West-Fergana and South-Tajik regions. In Western Fergana at the depth of 250-300 m (chalkstones of paleogene, Alay suite) with temperature 27.5ºC and by pressure (without the pouring out) water with salinity of 16-17 g/dm^3 and hydrogen sulphite of 290 mg/1 well production was 0.6-0.8 1/s.

Building a health resort in the Isfara river valley is possible.

In South-west Tajikistan such waters are available in Dushanbe and Vakhsh basins. In Luchob structure (depth 490-660 m) warm waters (35.5ºC) were pouring out (production rates of 1-16 l/s) with the contents of hydrogen sulphite ranging from 500 to 3000 mg/1 and salinity ranging from 4-40 g/dm^3, which allows the creation of a health resort with 1500-2000 places since one well gives up to 700 m^3/per day of a very strong sulphide water. The waters are dated to paleogenic chalkstones.

In Vakhsh basin (Kiziltumshuk structure), at depth of 400-610 m in clay layers (sandstones, the chalkstones) pouring out (production rate 0.75 l/s) warm (31.5°C) waters were opened with hydrogen sulphite of up to 150 mg/1 and salinity of 28 g/dm^3 and were used by hydropath.

The carbonic waters (cold and hot) are known in Gissar mountain range and in Pamir and are the concern to crack-vein waters of fractures zone. On the southern slope of Gissar mountain range, the water of a type Darasun-source Hojasangkhok (Ziddi) with salinity of 1.9-3.5 mg/dm^3 contains 1700-2500 mg/dm^3 of carbon dioxide. The mineral water "Anzob" was partially bottled. The cold carbon dioxide Pamir waters (13 sources) are situated in the valley of the rivers Pyanj and Aksu (altitude of 2100-4000 m) with quantities of carbon dioxide of 400-1400 mg/1 and salinity of 0.4-3.9 g/dm^3.

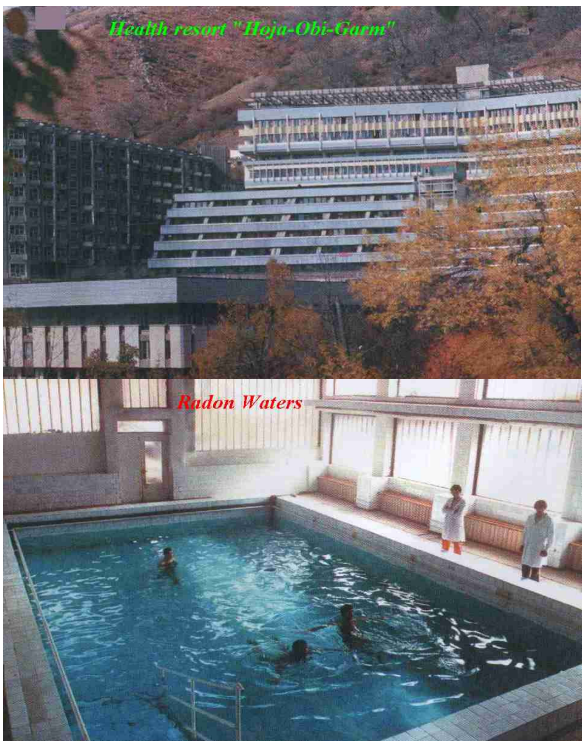
In sources such as Darasun and Narzan, particular components are hydrogen sulphite of 12-51 mg/1 and silicon acid of up to 82 mg/1. Production rates of sources range from 0.2 to 8 l/s.

The thermal carbon dioxide Pamir waters such as Borzhomi and Vishi have temperature ranging from 22-25°C to 67-77°C. The majority of sources are used only by local population, except for the Garm-Chashma source, where the hydropathical (treatment of cardiovascular and nervous systems, locomotorium and other diseases) operates. Total quantity of water is 600 m^3/per day, but only a minor part is used.

The siliceous thermal waters are widely advanced in Gissar mountain range and in Pamir on the composition of spontaneous gases such as nitrogen. The hydrocarbonate-chloride of a sodium composition of a source Hoja-Obi-Garm (temperature of 64-98ºC with salinity of water 0.4 g/dm^3 and of 140 mg/l silicon acid and of up to 20 mg/1 of fluorine) is a major concern. It is used in health resort Hoja-Obi-Garm.

A great quantity of a siliceous nitrogen thermal water (temperature of 45-77°C) is available in Pamir (Yashilkul, Jilandi, Jartigumbez etc.). Production rates of sources are 4-10 1/s with quantity of a silicon acid of 10-100 mg/1. It is used by a local population.

Iodine-bromine waters are connected with meso-cainozoic depositions of the Fergana and South-Tajik artesian basins, where at depths of 720-870 m (structure Aktash) and 2500-2670 m (structure Kara-Tura) water with salinity 45 g/dm^3 and 236 g/dm^3 were opened inclusive of up to 10.4 mg/1 of iodine and with a great quantity of bromine. These waters are not used.

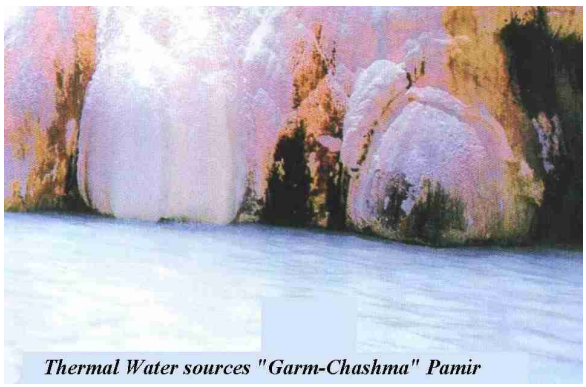


Medical waters are located in neogene depositions of Dushanbe basin and Silurian depositions of Turkestan mountain range. These waters are used in the health resort.

Waters of Silurian depositions (Havatag) opened at depth of 1182 m (pouring out at 10 1/s, temperature of 54-56ºC, salinity is 4.1 g/dm^3 and nitrous chloride-sodium thermal water). Health resort "Havatag" uses these waters. The waters of a hydropathical "Havatag" (with altitude of 600 m above sea level) consist of strong mineral sources of a chloride-sodium type with salinity of 4.1 g/1. Except of basic elements in the water there are also biologically active microelements: bromine of 1.25 mg/1, iodine of 1.9 mg/1, iron, boron as a metaboric acid, molybdenum and fluorine. From gases, there are: methane, ozone, hydrogen sulphite and etc. In this hydropathical, the treatment of eczema, neurodermite and psoriasis is conducted.

The water of the source "Hoja-Obi-Garm"- (altitude 1790-1960 m) is alkaline, weak mineralized, rich in silicon acid, contains a little hydrogen sulphite and has a moderate radioactivity. Temperature of water is in the limits of 45-96°C. In the health resort "Hoja-Obi-Garm", because of curative waters, fine climate, and the natural medical factor, the strong radioactive vapor consists of radon, moderate quantity of carbon dioxide and nitrogen.

Physicochemical properties of the sources at health resort "Obi-Garm" (altitude 1200-1380 m) differ from the sources at “Hoja-Obi-Garm”. The water is mineralized by alkaline and siliceous. The hydrogen sulphite is two times larger, and the radioactivity, on average, is four times less. Together with water, nitrogen is discharged. The major medical factor of the health resort is the terminal water with temperature at the exit being 37-40°C. The climatic conditions here are favorable and promote the strengthening of the health.



Thermal Water sources "Garm-Chashma" Pamir

The large popularity of "Garm-Chashma" is in its treatment of dermatoses (altitude 2800 m). The source water by the physical-chemical properties consists of hydrogen sulphide-carbon, chloride-hydrocarbonate and sodium-siliceous thermal waters. The content of hydrogen sulphide in water is 170 mg/1. The temperature of the water is not subject to particular oscillations and is on average about 59ºC. Its salinity reaches 3.0-3.3 g/l. The source belongs to alkaline waters of the maiden class. The water roughly bubbles up producing CO_2 in the outlet. Besides that, in the water there are iron, aluminum, magnesium, strontium and fluorine which increase its medical properties. The valuable medical factor of the region, where the source is situated, is due exclusively to the purity of mountain air. The mineral water such as "Narzan" is unique, and is used by the patients during the stay, and positively influences the outcomes of treatment.

CONCLUSION

In the territory of the Republic of Tajikistan more than 200 mineral sources have been detected. They differ in physicochemical composition and geographic situation. In the northern zone of Tajikistan (Sogd area) the mineral sources are placed, basically, on plains and in foothills, in central and southern zones they are in valleys, foothills and middle mountains, in Gorno-Badakhshan autonomous region they are in Alpine mountains.

REFERENCES

Baratov R.B. Undergrounds and Mineral waters of the Tajikistan. 2003. Dushanbe. Donish. 30 p.

Churshina N. M. Mineral waters of the Tajikistan. 1982. Dushanbe. Donish, 218 p.

Krat B.N. Minerals medical, thermal and industrial undergrounds waters of Tajikistan. 1985. Dushanbe. Donish, 144p.Water resources of the Tajikistan (Ed.: Inom Normatov). 2003. Dushanbe.OMU, 112 p.