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Research Article

FEATURES OF CHANGE OF HELIUM CONCENTRATION IN UNDERGROUND WATER (ON THE EXAMPLE OF THE SOUTHERN TIEN SHAN AND THE PAMIRS)

***M. M. Zakirov, R.S. Ziyavuddinov**
**Tashkent State Technical University, Universitet Street 2, Uzbekistan, Tashkent*
**Author for Correspondence: mzakirov1957@mail.ru*

ABSTRACT
The article discusses a more in-depth study of the distribution of dissolved helium in groundwater and hot water sources of the southern Tien Shan and Pamir regions. Studies were conducted on Gulcha - lake Zorkul and Ishkashim - Jirgatal. Helium anomalies in groundwater and hot water sources are associated with factors like, relief, water exchange conditions, drainage of groundwater, geological structure, tectonic movements, magmatism, etc. that determine the formation of helium in groundwater.

Keywords*: Helium, Mineral, Hydrosphere, Groundwater, Springs, Hydrogeochemistry, Faults Tectonics, Migration*

INTRODUCTION
Helium is one of the six noble gases (ne-Ne, argon Ar, krypton-Kr, xenon-Xe and radioactive radon-Rn) in the periodic system of elements. All these gases were discovered at the end of the nineteenth century, and helium was discovered by Ramzai in 1894 in the spectrum of the gas extracted from the mineral – leveite. But, long before that, in 1868-1871, the yellow spectral line was seen in the spectrum of the solar corona and called it helium. In 1895 helium was detected in gases of natural sources and in the atmosphere of the Earth. Now we know that the nature of the above helium is different. Radiogenic helium, a product of α-decay, is present in uranium minerals, while the helium of the Sun is due to its origin of thermonuclear reactions, and this helium is called primary. This was followed by a systematic study of helium in various areas of nature [Verkhovsky (No date)]. In all these areas of research, the role of dissolved helium in groundwater is particularly large. This is the main subject of the scientific research of the authors in this article, and they will mainly be discussed.
The southern Tien Shan and Pamir region of the research in the present time attracts special attention to itself by the abundance of mineral sources and geodynamic processes like mountain building. It has been established that the mountains of the Southern Tien Shan and the Pamirs are large blocks (blocks) raised by the internal forces of the Earth to the maximum height on our planet. Rock, semi-rock and glacial deposits formed the basis of water sources that are diverse in their genesis and structure of water-bearing rocks. They were formed under conditions of active tectonic processes, high seismicity, cryogenesis, with the participation of various faults in permeability, in various paleogeographic settings and determined the heterogeneity of the water-bearing medium (Khambrabaev 1980; Matyukov *et al.,* 2014; and Barkhatov, 1971).
These conditions contributed to the local distribution of cold and hot sources of groundwater containing helium, hydrogen sulfide and other gases. These sources are currently used for medicinal purposes. The wide distribution of mineral springs, especially hot, is associated with the activity of deep tectonic faults (Khambrabaev, 1980), intensive modern movements and high seismicity of this region (Matyukov *et al.,* 2014). The presence of dissolved helium in these waters is of great interest for the study of both the fundamental and applied features of the underground hydrosphere. In this regard, a more in-depth study of the distribution of dissolved helium in groundwater, including the identification of factors determining the formation of helium in groundwater, is highly relevant. Here, the influencing factors are: relief, water exchange conditions, drainage of groundwater, geological structure, tectonic movements and magmatism.

The purpose of this article is to evaluate the peculiarities of changes in the concentration of helium in the groundwater of the southern Tien Shan and the Pamirs.

MATERIALS AND METHODS

In the process of accomplishing this goal, this paper analyzes a large amount of factual material on special hydrogeochemical studies conducted by staff of the Institute of Seismology at the Academy of Sciences of Uzb in 1977-78years and 1988-89 years. in the underground waters of the southern Tien Shan and the Pamirs. Determination of the absolute content of helium in groundwater on the device INGEM-1 (magnetic discharge indicator of helium).

In the complex of hydrogeochemical studies we have a special place given to the geological and tectonic conditions that affect the hydrogeological conditions of both deep aquifers and near-surface sources.

DISCUSSION

Within the Pamir and the southern Tien Shan, hydrogeochemical studies were conducted on the profiles of Gulcha - lake Zorkul and Ishkashim - Dgirgatal. The areas of these profiles differ in relief, water exchange conditions, drainage of groundwater, tectonic faults, chemical composition of water-bearing rocks (Fig. 1).

From the literature it is known that in the area of research according to the tectonic zoning scheme (Barkhatov, 1971) four tectonic zones of the Pamirs are distinguished. These are the northern, central, southeastern, and southwestern Pamir. All zones of the study area are separated from each other by marginal deep faults of sub latitudinal strike. The faults, folded structures, and shapes of most igneous rocks are arcuate to the north (Khambrabaev 1980; Matyukov *et al.*, 2014).

Based on the above tectonic zones of the southern Tien Shan and the Pamirs, we will describe below the sources of groundwater with different concentrations of dissolved helium and temperatures in these zones.

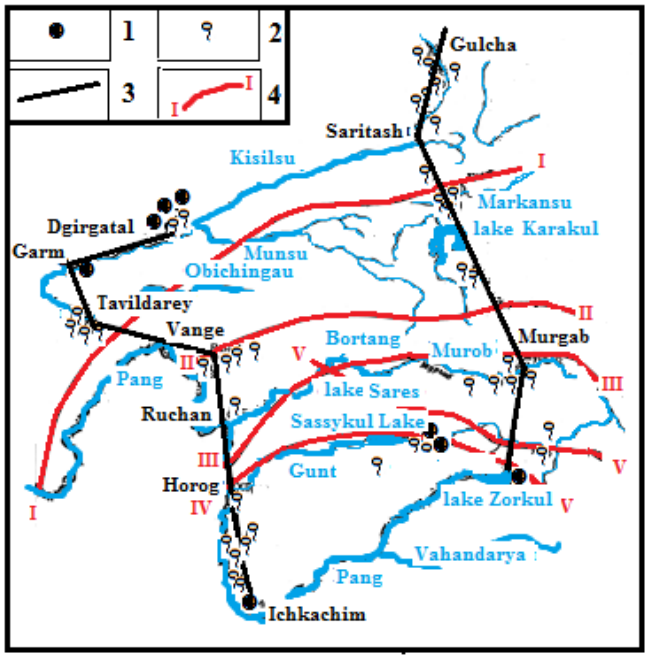

Figure 1. Location of tested water points and deep faults of the Southern Tien Shan and Pamir (Barkhatov, 1971).

1- wells; 2- tested springs; 3- profiles; 4- deep faults: I –North Pamir, II –Vanch-Akbaital, III –Rushano-Pshart, IV –Alichur-Gurumdin, V –Gunt-Alichur

The groundwater of the southern Tien Shan, mainly confined to the rocks. They form typical water pressure systems with infiltration and sedimentation waters of different composition and salinity. Crack-karst waters are found in carbonate rocks. Unloading of groundwater in general is due to their pinching out in inter-basin depressions, valleys and due to underground outflow into the central submerged part - the Alai Valley, where the drainage element of the relief is the modern channel of the Kyzylsu river. The springs and ground waters of the Alai Valley are mainly associated with glaciers. The temperature measurements carried out range from 70°C (spring In the village of Sufikurgan) to 28°C (spring In the village of Gulcha). Dissolved helium is absent, and only in some sources is the concentration of dissolved helium in the range from 0.00008 to 0.0007 ml /l. At the tested wells in the districts of the Tomdy river, the village of Garm, Sarytash, Sufikurgan and others. The concentration of dissolved helium in underground waters is from 0.00002 to 0.01 ml/l with a temperature from 11^0C to 75^0C (Ziyavuddinov, 2011).

Hydrogeological conditions of the Pamirs differ from the hydrogeological conditions of the southern Tien Shan by a significant variety of topography, water exchange conditions, drainage of groundwater, geological structure, tectonic movements, and the material composition of water-bearing rocks. In these zones, mainly fractured, fractured-karst waters and waters of tectonic fault zones are developed. Numerous mineral sources of both thermal and cold waters are widely developed. As in the conditions of the southern Tien Shan and the Pamirs, groundwater is fed mainly by the infiltration of precipitation and meltwater of glaciers. Groundwater comes to the surface in the form of marginal sources, confined to local erosional incisions, to the upper reaches of the sides and the bottoms of valleys and gorges.

The zone of the northern Pamirs is included in the Kunlun system (Barkhatov, 1971). From the north it is separated from the Alay valley by the North-Pamir fault, and from the south by the Akbaitalsky fault zone. Precambrian sedimentary-metamorphic and magmatic formations participate in the structure of the zone. In the northern Pamir, mineral water outlets are very rare. Outlets of thermal spring waters in this area are not known. The springs of Kyzyl-Art, Muzkol, Meteorological Station are mostly cold, with temperatures ranging from 1°C (Kyzyl-Art) to 11°C (Tavildara village). The concentration of dissolved helium from the trace to 0,0015 ml/l (Ziyavuddinov, 2011).

The zone of the central Pamir from the north is limited by the Akbaitaly fault zone, and from the south by the Rushan-Pshart deep fault [4]. The fissure waters of Mesozoic, Paleozoic and Precambrian sediments are widely developed in this zone, presented in the form of springs with a flow rate from 10 to 30 m3 / day. and mineralization up to 1 g / l. Water temperature varies widely from 2°C to 27°C. The concentration of dissolved helium in the springs of the Muskol valley, Vanch village varies from 0.0001 to 0.0015 ml / l (Ziyavuddinov, 2011; Chernov *et al.*, 1990).

On the territory of the southwestern Pamir in the districts of the cities of Rushan, Khorog and Ishkashim, the outlets of the springs are confined mainly to the valley of the Pyanj River. And in the lower reaches of its large tributaries, such as Gunt, Bortang, and others, where the highly dissected relief favors the conditions of water exchange and drainage of groundwater, the concentration of dissolved helium ranges from 0.0004 to 0.0015 ml / l. The temperature varies from 2°C to 15°C and the sources belong to cold waters. The originality of the southwestern Pamir, the northern part of Khorog and southeast of Ishkashim is that from north to south there is a change in both the concentration of dissolved helium (from 0.0015 to 0.05 ml / l) and the temperature of the underground waters (from 27^0C to 60^0C). Here there are open structures with fairly fresh water with low helium values. In closed structures, sedimentary waters are encountered, i.e. waters formed in the process of formation of water-bearing rocks. They have a salinity of 2.2 g / l to 8.8 g / l, with a concentration of dissolved helium from 0.0015 to 0.05 ml / l and temperatures up to 60°C (Ziyavuddinov, 2011). On the territory of the southeastern Pamir, groundwater is confined to the bottoms of broad glacial valleys and to metamorphic rocks of the Precambrian, Lower and Middle Paleozoic, broken by deep tectonic faults (Fig. 1), such as Rushano-Pshart, Alichur-Gulumdinsky and Gunt-Alychursky Multinationals. , 3,4]. Where there are many exits in the form of springs are cold from 7^0 C to 16^0C and hot springs from 40 to 63^0C, and in the waters of these sources the concentration of

helium is within 0.0001–0.08 ml / l. Sources of pinch out at heights with an absolute mark of 3700-4200 m.

It is known that the permafrost thickness available in the study area is waterproof. In these sediments there are so-called permafrost waters of cryogenic pressure. One of many such sources is a spring on the Ak-Arkhar area, Avni, which functions in the thickness of permafrost with a temperature of 34-77^{0}C, with a concentration of dissolved helium of 0.02-0.04 ml / l.

In general, the groundwater of the study area is formed completely within hydrogeological massifs and travels all the way from the feed area to the surface only in rock and semi-rock.

The results of the studies carried out in the southern Tien Shan and the highlands of the Pamir include the fact that the concentration of dissolved helium in groundwater varies depending on geological and tectonic conditions. On the basis of hydrogeological conditions and the quantitative content of dissolved helium in groundwater, the study area can be divided into areas with low and high helium values.

Low values (0.0001-0.0015ml / l) of helium have cold (1-16^{0}C) springs located in the Alay valley within the southern Tien Shan, northern and central Pamirs, which are located in the zone of active water exchange, drainage of groundwater . Considering the lightness and mobility of an inert gas such as helium, in fissure sediments groundwater is a transport for its migration into the atmosphere (Zakirov, 2015; Ziyavuddinov, 2011).

Elevated values (0.0015-0.05 ml / l) of helium contain warm and hot springs (24-75^{0}C) in various zones of tectonic faults. In the area of the Alay valley, where the South Tien-Shan and the North-Pamir rifts

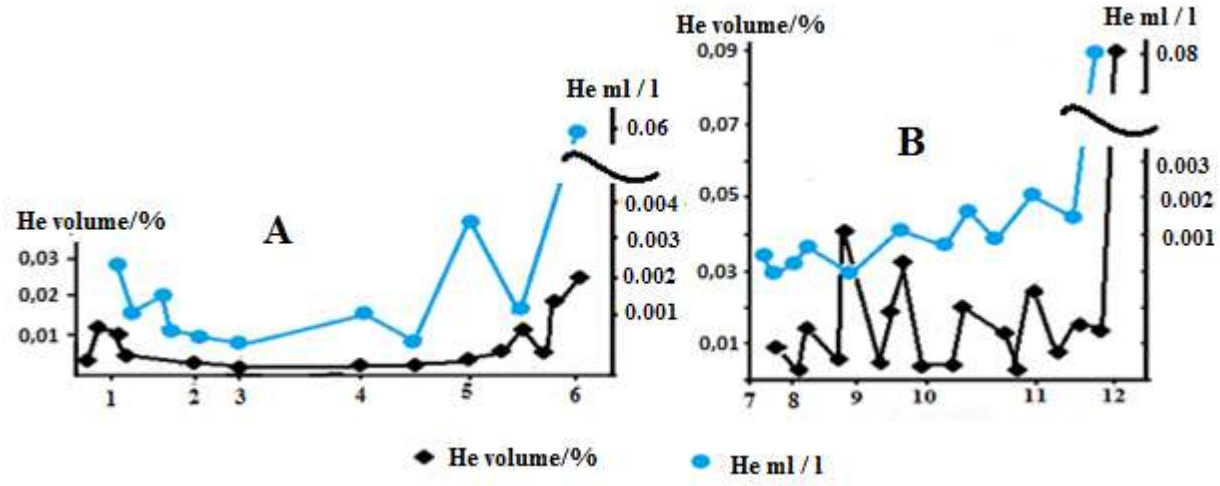

Fig. 2. Schematic graph of the change in helium along the Dzirgatal-Ishkashim profile (A) and Gulcha-oz. Zorkul (B).

Water points: 1-Jirgatal; 2-Garm; 3-Vanch; 4-Rushan; 5-Bashor; 6-Ishkashim; 7-Gulcha; 8-Kizilart; 9-meteorological station; 10-Saritash; 11-Alichur; 12-oz. Zorkul.

there are springs in Dzhirgatal, SLE. in p.Yavruz and p.Vanch with helium content from 0.0001 to 0.01 ml / l (Ziyavuddinov, 2011). The same values are found in groundwater in the areas of nos. Khorog, Garm Chashma, Dzharty – Gumbaz, Ishkashim, Barshor, Alichur, Ak-Arkhar, in the area of Sassykul, Zorkul lakes located in the zones of deep faults of Akbaitalsky, Rushano-Pshart, Alichur-Gulumda and Gunt-Alichur (Barkhatov, 1971; and Ziyavuddinov, 2011). The above-mentioned deep faults are mainly confined to the southwestern and southeastern Pamir (Fig. 1). In addition, in the area of these water points, according to a schematic graph (Fig. 2), high concentrations of helium are noted on the profile from Gulcha to Zorkul lake.

In the Pamir study area from north to south, helium changes from 0.0004 to 0.08 ml/l (Ziyavuddinov, 2011). The confirmation of this (the conditions for the preservation of dissolved helium in groundwater depends on the water exchange of the horizon and geological and tectonic conditions) is the schedule of helium changes along the profile from Dzhirgatal to Ishshim. It runs mainly along the valley of the Pyanj river and in the lower reaches of its large tributaries having deep erosion inflows and open geological structures. These zones of active water exchange are characterized by low helium concentrations.

CONCLUSION

Unlike the western part, in the eastern part of the Pamir groundwater and springs are characterized by high helium concentrations, and are confined to the wide bottoms of glacial valleys, to zones of deep faults, closed geological structures, where there are favorable conditions for enriching helium with groundwater. In addition, the increased content of helium indicates the connection of aquifers with the deep layers of the earth's crust.

Thus, in conclusion, it can be noted that groundwater and water sources are an object for studying and manifesting the nature of fluid-dynamic processes to substantiate the peculiarities of changes in the concentration of helium in groundwater. Geological and tectonic conditions have a significant influence on the characteristics of the change and quantitative content of helium in the groundwater of the studied area. The geological and tectonic conditions of the research area determine the energy potential of the helium flow, and the tectonic conditions determine the filtration routes for helium, along which it migrates through various structural and lithological disturbances (faults and weakened zones of the earth's crust).

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