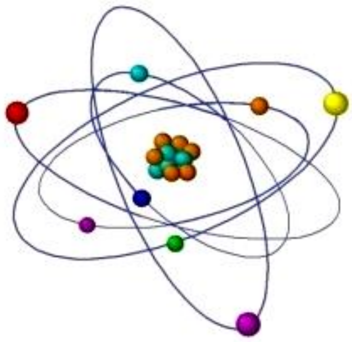
INVESTIGATION OF RADON RADIOACTIVE EMISSION IN NATURAL WATERS OF VILLAGE KVEMO KHVITI (GEORGIA)



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ABSTRACT: *In the present work it was studied the content of radioactive gas radon - Rn-222 in the number of sources of surface water located nearby to village Kvemo Khviti, (Gori Municipality) in the territory of so-called Kartli artesian basins. Research was carried out during a year once a quarter. Radon detector RAD7 was used for determining radon content. It was established, that radon content in water considerably changes depending on the source location as well as on water type too. So, for example, radon content in various sources of water was within the limits from several units of Bq/L up to 10 Bq/L. A comparison with literary data has been carried out.*

Key words: Radon, surface water, activity concentration, village Kvemo Khviti

INTRODUCTION

Radioactivity is not created by human, it is a part of the environment and is everywhere - in rocks, the surface of the earth, the atmosphere, etc. Since the 50-60s of the last century, the problem of radioactive radiation on the environment and living organisms (including humans) has been the subject of numerous studies. Scientists have determined that radioactivity affecting human health is caused by three families of natural radionuclides - Th-232, U-238 and U-235, as well as K-40. Among these radionuclides, special attention is paid to radioactive gas - radon (Rn-222), whose contribution to natural radioactivity is up to 50%.

Radon (Rn) is an element of the Mendeleev's periodic system, with atomic number 86. Radon is a colorless, odorless, tasteless, and well soluble in water, radioactive gas. It is the heaviest gas at room temperature. The most stable isotope (Rn-222) has a half-life of 3.8 days.

In nature, nuclei of radon are constantly produced during the radioactive decay of primary parent nuclei. By mass, its balanced content in the Earth's crust is 7×10^{-16}%. Due to its chemical inertness, radon relatively easily leaves the crystalline matrix of the "parent" mineral and gets into groundwater, natural gases and air. Since Rn-222 is the longest-lived isotope among the four natural isotopes of radon, its content in the environment is the maximum. The content of radon in the air depends, first of all, on the geological structure (for example, granites, which contain a lot of uranium, are an active source of radon, while the radon content on the surface of the seas is very small), as well as on the weather (during rains, microcracks through which radon enters the soil are filled with water; snow cover also prevents radon from entering the air). An increase in radon concentration in air is observed before earthquakes, probably due to higher active exchange of air due to microseismic activity in the ground. The solubility of radon in water is 460 ml/l; the solubility in organic solvents and in human adipose tissues is tens of times higher than the solubility in water [1].

Radon is a naturally occurring, radioactive, noble gas that is ubiquitous in soil, air, and water. Radon continuously flows from the Earth's rocks as a result of the fission of the uranium (U-238) nucleus. The amount of uranium in the earth's core is low (for example granite, phosphates), so the loss of radon is constantly compensated and there is always a certain equilibrium concentration of it in the atmosphere. The released radon dissolves in the groundwater and rises with it to the earth's surface [2]. If radon-containing water is used for domestic use (shower, dishwashing, etc.), radon released from the water accumulates in living spaces. Radon accumulated in the indoor air of buildings can pose a health risk [3, 4].

If the groundwater is used for drinking purposes, the radon content of the water must be taken into account. According to the USA Environmental Protection Agency (EPA), radon dissolved in drinking water causes an average of 168 cancer deaths each year, 89% of which are lung cancer (caused by radon released from water) and 11% stomach cancer (caused by radon content in drinking water) [5]. Since drinking water is a necessary element for life, relevant institutions have developed recommendations on the content of radon in drinking water. According to the recommendation of the European Commission, the level of radon in drinking water is 100 Bq/L, and if the activity exceeds 1000 Bq/L, then safety measures should be taken [6], and the level suggested by EPA is 11.1 Bq/L [5].

Systematic studies of the state of radon distribution in water resources of Georgia is an actual problem. The work presents the results of the research of radon activity in the surface waters of the village of Kvemo Khviti (Gori municipality, Georgia), together with the students of the public school.

PROBLEM STATEMENT

There are several artesian basins in East Georgia some of which are used for reception and supply of the population by drinking water. These artesian basins feed the numerous springs located on the whole territory of the region. Research of their natural radioactive activity represents doubtless interest from the scientific point of view as well as from the practical point of view.

The objective of the work was studying of features of radon content distribution depending on geographical factors in surface sources of water, located in Kartli artesian basin. In the present publication, there are given and generalized all results of the carried out researches for the period of winter and spring.

RESEARCH OBJECTS

The object of the study was the surface and drinking water of the territory of village Kvemo Khviti and the surrounding areas (Gori municipality, Georgia), where the radioactive gas radon research was planned. For the research, there were selected 10 control points, located in Kvemo Khviti village and surrounding areas. The list of control points is given in Table 1.

Table 1. List of control points selected for radon research

№	Control point	Characteristics of the sample	Location of the control point
1	WT-1	Central tap water	v. Kvemo Khviti
2	WT-2	Drinking water from the reservoir	“--------“
3	WR-1	River (Liakhvi) water 1	v. Pkhvenisi
4	WW-1	Drinking water from the well	v. Variani
5	WSp-1	Drinking water from the spring	“--------“
6	WR-2	River (Liakhvi) water 2	v. Pkhvenisi
7	WT-3	Central tap water	v. Kvemo Khviti
8	WT-4	“--------“	v. Kvemo Khviti
9	WW-2	Drinking water from the well	v. Variani
10	WSp-2	Drinking water from the spring	v. Variani

Notes: WSp – spring water; WW – well water, WR – river water, WT – Tap water.

METHODOLOGY

Sampling - Sampling was carried out in special glass containers; the volume of the container is 250 mL. Containers were filled with water up to the top and densely closed by a cover. Then the selected water samples were transported to the laboratory for analysis.

Of the three isotopes of radon, the subject of research is Rn-222, because the half-lives of Rn-220 and Rn-219 are much shorter, and they decompose before migrating into soil and rocks, and their amount in the air is insignificant. Electronic radon detector RAD7 was used for the determination of radon content in water. The RAD7 device uses a method for the registration of radon decay products, namely alpha particles Po-218, Po-2014 and Po-210 (which are formed as a result of decay), based on the use of a solid semiconductor sensor.

Detailed information on measurements and processing of results can be found in the literature [7].

RESULTS

Four expeditions were carried out, during which a total of 40 water samples were taken based on the instructions given in advance to the students. Results of carried measurements are given in Table 2.

Table 2. Average minimum and maximum values of radon activity in different types of water samples taken from Kvemo Khviti village and surrounding areas

value	Water type											
	WSp			WW			WT			WR		
	aver	min	max	aver	min	max	aver	min	max	aver	min	max
A_{av}, Bq/L	4.9	2.9	6.2	5.8	4.6	7.3	4.7	3.7	6.0	0.1	0.03	0.3

Apparently from the received results, it is possible to note that the highest content of radon was observed in artesian well water with an average of 5.8 Bq/L, and the lowest with an average of 0.10 Bq/L in river water.

Table 3 shows a comparison of the received results with some literary data. Apparently from the data, the results received in the present work lay within the values received in other publications.

Table 3. Radon content in surface water in different countries

№	Country (region)	Water type	A, Bq/L			Lit.
			ave.	min.	max.	
1	Lebanon (Beirut, Mount Lebanon, Beqaa, etc)	WSp WW	29.0 7.3	9.8 0.9	49.6 19.9	[8]
2	India (Rajasthan)	WUn	3.3	1.6	5.4	[9]
3	Iran (Mashhad)	WSp	16.1	12.6	20.6	[10]
4	Turkey (Tokat city)	WSp	-	0.13	1.20	[11]
5	Georgia (village Kvemo Khviti)	WSp	4.9	2.9	6.2	Present work
		WW	5.8	4.6	7.3	
		WT	4.7	3.7	6.0	
		WR	0.1	0.03	0.3	

ANALYSIS

Relatively high values of radon concentration in groundwater (artesian, well, spring waters) are due to the fact that these waters are saturated with radon, which is formed in the deep layers of the soil, rises up and dissolves in the groundwater.

Relatively low concentration of radon in surface waters (the water of the Liakhvi River) is related to the process of radon degassing, i.e. the process of passing from water to the atmosphere.

In the drinking water, collected by the students, the obtained values of radon concentration do not exceed the threshold level recommended by the US Environmental Protection Agency (US EPA) for drinking water (11 Bq/L) [12].

Thus, the conducted studies have shown that the radon content in the tested drinking water samples is not extreme, and from the point of view of radiological safety, consumption of these waters does not represent a health hazard.

CONCLUSIONS

According to the radon activity in the surface water samples, most of the the examined control points belong to the groups of low (0.3 - 1.0 Bq/L) or higher than typical (3 - 10 Bq/L) radon activity groups.

The obtained results were compared with the literature data. The average values are significantly lower compared to the data of other countries.

Acknowledgement

*This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG) [grant number SCR-22-178]***.**

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