Available online at www.elixirpublishers.com (Elixir International Journal)

Pollution

Elixir Pollution 52 (2012) 11488-11489

ISSN: 2229-712X

Effective dose rate evaluation from radon in the air and water samples of neyshabur turquoise mine

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ARTICLE INFO

Article history:

Received: 18 May 2012;

Received in revised form:

11 November 2012;

Accepted: 15 November 2012;

Keywords

Radon effective dose rate,

Radon concentration,

Neyshabur Firoozeh mine.

ABSTRACT

In this work, radon concentration in the 22 air positions and 8 water samples of Neyshabur Turquoise (Firoozeh) mine has been measured with PRASSI system.

Turquoise is an opaque, blue-to-green mineral that is a hydrous phosphate of copper and aluminum, with the chemical formula $CuAl_6(PO_4)_4(OH)_8{+}4H_2O$. It is rare and valuable in finer grades and has been prized as a gem and ornamental stone for thousands of years because of its unique hue.

Radon is a radioactive gas with two radioisotopes- 220 and 222 mass number- has short decay half-life produced form ^{238}U natural series and ^{232}Th natural series. The radon gas can enter to the body via respiring, drinking and eating. The alpha emitted by this gas and other radiation emitted by its daughters increase the effective absorbed dose in respiratory and digestion systems.

We have measured and evaluated the effective radon dose rate from the air for the workers who cave in the mine effective dose per liter of drinking water samples. The result shows that the mean effective doses for air per hour and from water per liter are 1.2 μSv/h and 63 nSv/l, respectively.

Introduction

As it mentioned in the new world encyclopedia, at least two thousand years, Persia the old name of Iran the region once known as has remained the most important source of turquoise, for it is here that fine material is most consistently recovered. This "perfect color" deposit that is blue naturally and turns green when heated is limited to a mine in Neyshabur, Iran. This natural gem is rare and valuable in finer grades and has been prized as a gem and ornamental stone for thousands of years because of its unique hue. Workers cave the mine for finding the pieces of turquoise for some hours. Therefore, they get some effective dose form radon inside the mine.

Nearly 50% of annually radiation dose absorption of human is due to radon which is one of the main cancers cause at respiratory and digestion systems [1]. The ^{222}Rn radioisotope with 3.8 days decay half-life is produced form ^{238}U natural series and the ^{220}Rn radioisotope with 55 sec decay half-life form ^{232}Th natural series [1, 2]. The radon gas can enter to the body via respiring, drinking and eating. The alpha emitted by this gas and other radiation emitted by its daughters increase the absorbed dose in respiratory and digestion systems.

Some recent reports of large radon concentration in water supplies in different places [3-7] caused we concern to measure radon concentration in air and water samples of Neyshabur region. However, till date no study of radioactivity in the water has been carried out or reported for this region. The present research work is the first ever report of radon measurements the region by PRASSI system.

Indoor radon measurement and radon effective dose rate

Neyshabur Turquoise (Firoozeh) mine includes some tunnels which caved during more than seven thousands years in the past. We have measured radon concentration in the air of 22 positions inside the tunnels with PRASSI system. The PRASSI Model 5S is a suitable equipment for measuring radon in air samples. Its pumping circuit operates with constant fallow rate at 3 litters per minute and includes a ZnS(Ag) scintillation detector with 1830 cm^3 volume.

The indoor radon lever results are listed in the second column of table 1. The result demonstrate about 72% of the samples have radon level low than the normal level (48 Bq/m^3). Also the outdoor radon was 16.528 Bq/m^3 in that time. To evaluate the radon effective dose rate, we used the UNSCEAR suggestion for radon effective dose coefficient factor of 9 $nSv/(Bq\ h\ m^{-3})$ [1]. The results are listed in Table 1 as well as are shown in Figure 1.

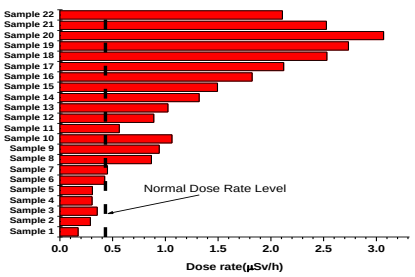

Figure 1: Table 1: The effective dose rate histogram in the air samples of the mine.

Radon Measurement in Water Sample

To measure radon gas in water, some care must be taken in sampling process. Usually, springs and deep wells waters are reach in radon, but after the water has been steered a little, it The system is particularly well suited for this type of

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PRASSI pumping circuit operates with constant fallow rate at 3 litters per minute in order to degassing the water sample properly.

Radon concentration in the 8 water samples of the mine region has been measured. The result of radon concentration in different the water samples are listed in Table 2 which show 6 samples have radon concentration gather than 10 Bq/l as the normal level. Some of the small springs in the main are drinkable, so, we have calculated the effective dose per liter of drinking water for ingestion according to parameters introduced by UNSCEAR report. In this report the effective dose coefficient from ingestion is equal to 3.5 nSv/(Bq l). The result shows that the mean effective doses for air per hour and from water per liter are 1.2 μSv/h and 63 nSv/l, respectively.

Table 1: Indoor radon level and corresponding effective dose rate in the air samples.

Samples.	Indoor Radon level (Bq/m^3)	Radon Effective dose rate (μSv/h)
Sample 1	19.113	0.172
Sample 2	32.074	0.289
Sample 3	39.250	0.353
Sample 4	33.832	0.304
Sample 5	34.271	0.308
Sample 6	47.156	0.424
Sample 7	50.045	0.450
Sample 8	96.460	0.868
Sample 9	104.584	0.941
Sample 10	117.922	1.061
Sample 11	62.588	0.563
Sample 12	98.918	0.890
Sample 13	113.794	1.024
Sample 14	146.664	1.320
Sample 15	165.974	1.494
Sample 16	202.442	1.822
Sample 17	235.725	2.122
Sample 18	281.201	2.531
Sample 19	303.930	2.735
Sample 20	340.956	3.069
Sample 21	280.741	2.527
Sample 22	234.345	2.109

Table 2: Radon concentration and the effective dose per liter in different water samples

Sample No.	Radon level (Bq/l)	The effective dose per liter (nSv/l)
Sample 1	7.54	26.39
Sample 2	9.37	32.795
Sample 3	15.03	52.605
Sample 4	15.42	53.97
Sample 5l	15.89	55.615
Sample 6	16.62	58.17
Sample 7	28.65	100.275
Sample 8	35.41	123.935

Conclusion

Main fraction of annually radiation dose absorption of human is due to radon (about 50%) which is one of the main cancers cause at respiratory and digestion systems. A section of radon come in body is due to drinking water and breathing process, so for improvement of the social health level, it would be better to reduce the radon level in the air of indoor places and water sources The result shows that the mean effective doses for air per hour and from water per liter are 1.2 μSv/h and 63 nSv/l, respectively.

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