

A Study of ^{222}Rn Concentration in Jeju Spring Water (Yongcheonsoo)

Chung-Hun Han^{1),*} and Seong-Pil Ryu²⁾

¹⁾ Jeju National University, 102, Jejudaehak-ro, Jeju-si, Jeju-do, Republic of Korea

²⁾ Jeju Special Self-Governing Provincial Council, 13, Munyeon-ro, Jeju-si, Jeju-do, Republic of Korea

*tang007@jejunu.ac.kr

1. Introduction

Yongcheonsoo is the spring water that flows through the ground after the precipitation and flows naturally through the cracks and open gaps in the ground layer. These spring water is distributed over 900 from Mt. Halla to the coast in Jeju Island. Yongcheonsoo has been used not only as a drinking water source but also as a living and agricultural water source until the 1980s when waterworks were not available. Environmental radiation studies of characterization of these spring water are not enough.

Radon originates from the radioactive decay of naturally occurring uranium and thorium deposits. The radon can be found, in trace amounts, in almost all soils and rocks. Being a gas, radon can escape from mineral surfaces and dissolve in ground water, which can carry it away from its point of origin. Typical groundwater sources average between 200 and 600 pCi/L of radon [1].

Since radon occurs naturally in soil and rocks, it is virtually omnipresent on earth. It accounts for more than 50% of the total dose from all sources of ionizing radiation absorbed by the population [2].

In this paper, we present the first measurement of radon concentrations in spring water (Yongcheonsoo) in Jeju Island.

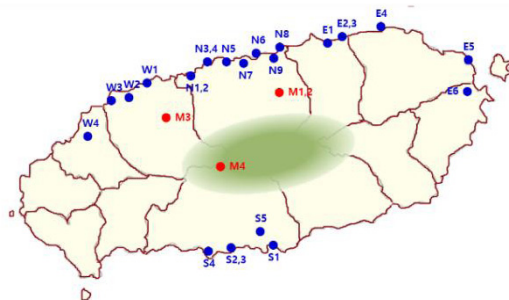


Fig. 1. Sampling sites of spring water.

2. Materials and methods

2.1 Sampling locations

Spring water (Yongcheonsoo) 28 samples were

collected from 9 Northern (JN), 6 East (JE), 4 West (JW), 5 South (JS), and 4 Mountain (JM) of Jeju in April to May 2018 (Fig. 1). We have sampled them from 1 to 6 p.m.

2.2 Sample Analysis

The measurements were carried out on samples by using RAD H₂O of RAD7 (DurrIDGE Co.). The decomposition products ^{218}Po and ^{214}Po of ^{222}Rn are in ionic state and adsorbed to other materials easily. Therefore, the instrument was purged for about 10 minutes before the sample was measured, and then the moisture in the chamber was dropped to 6% or less. When samples were taken, spring water was poured for more than 5 minutes, and bubbles were collected so as not to generate as much as possible. Measurements were taken within 30 minutes after sampling. The sample measurement vessel was sampled at a predetermined capacity (250 mL) in the "wat250" mode, and then measured 4 times for 5 minutes.

3. Results and discussion

We have measured, using the RAD H₂O of RAD7, ^{222}Rn concentrations in spring water (Yongcheonsoo) in Jeju Island.

The concentration of radon was found to be 17.60~558.00 pCi/L (mean 152.33 pCi/L, median value 131.50 pCi/L (Table 1). The radon content of S3 ("Seogaleummul" Yongcheonsoo) was the highest at 558.00 pCi/L. The spring water of the lowest radon concentration was M3 ("ongseongmul" Yongcheonsoo) at 17.60 pCi/L.

The radon content of Jeju Yongcheonsoo was 32 times lower than the average concentration (4,946pCi/L) of radon in the global groundwater by NCRP report. There was no spring water exceeding the range of 4,000 pCi/L proposed by the US Environmental Protection Agency (EPA). But the three spring waters of S3 (558.00 pCi/L), N6 (333.00 pCi/L) and N7 (300.00 pCi/L) were higher than Maximum Contamination Level (MCL) by the USEPA. However, it was much lower than the radon

standard or recommended value for drinking water of the world.

Table 1. ^{222}Rn concentrations in spring water (Yongcheonsoo) in Jeju Island

Sample	Low (pCi/L)	High (pCi/L)	Mean (pCi/L)	
JN	N1	121±51.7	140±55.0	131 ±7.99
	N2	106±49.2	133±54.0	119 ±12.00
	N3	131±53.5	211±65.8	160 ±36.50
	N4	159±58.1	207±65.2	186 ±20.00
	N5	169±60.1	218±67.1	201 ±22.00
	N6	284±75.8	320±79.4	300 ±15.80
	N7	273±74.5	383±86.6	333 ±50.20
	N8	137±54.7	176±60.8	161 ±16.90
	N9	109±49.9	188±62.5	147 ±32.00
Mean			193.11 ±74.76	
JE	E1	43.1±35.0	90.5±46.4	65.8 ±20.00
	E2	27.1±29.6	46.4±35.6	37.6 ±8.59
	E3	66.5±41.0	94.5±47.2	82.6 ±11.80
	E4	42.7±34.7	81.6±44.2	58.2 ±17.60
	E5	19.3±26.7	34.8±32.2	26.1 ±6.60
	E6	31.3±31.3	70.8±42.2	48 ±17.20
Mean			53.05 ±20.26	
JW	W1	62.2±39.8	97.1±47.4	85.4 ±16.50
	W2	162±59.2	243±70.6	208 ±33.70
	W3	69.6±41.4	89.4±45.8	77.6 ±8.51
	W4	119±52.0	158±58.6	132 ±18.00
Mean			125.75 ±59.86	
JS	S1	194±63.9	259±72.6	234 ±28.80
	S2	258±71.8	318±79.0	280 ±26.70
	S3	488±96.7	614±108	558 ±52.10
	S4	236±69.2	261±72.6	249 ±10.50
	S5	191±63.7	272±74.5	235 ±41.60
Mean			311.2 ±139.21	
JM	M1	34.8±32.2	54.1±37.7	41.6 ±9.13
	M2	27.1±29.6	50.5±36.9	36.8 ±9.84
	M3	15.7±25.3	19.6±27.0	17.6 ±2.24
	M4	47.2±36.3	63.0±40.3	54 ±6.71
Mean			37.5 ±15.12	
Total Mean			152.33 ±120.43	

The radon concentrations in Jeju Island were in the order of South (311.20 pCi/L) > North (193.11 pCi/L) > Western (125.75 pCi/L) > East (53.05 pCi/L) > Mountain (37.50 pCi/L).

Overall, the higher the altitude, the lower the concentration of radon. It shows that radon has some relation with altitude. Spring water located in high altitude areas show water quality close to that of rainfall. This phenomenon is due to the fact that the circulation rate of groundwater is very fast and water-rock reaction is hardly occurred in the stratum, so radon is less dissolved in rock.

4. Conclusions

We have measured, using the RAD H₂O of RAD7, ^{222}Rn concentrations in spring water (Yongcheonsoo) 28 samples in Jeju Island. The mean concentration of radon was 152.33 pCi/L. The radon content of S3 was the highest at 558.00 pCi/L. The spring water of the lowest radon concentration was M3 at 17.60 pCi/L. The radon content of Jeju Yongcheonsoo was 32 times lower than the average concentration of radon in the global groundwater by NCRP report. There was no spring water exceeding the range of 4,000 pCi/L proposed by the US Environmental Protection Agency (EPA). But the three spring waters of S3, N6 and N7 were higher than Maximum Contamination Level (MCL) by the USEPA. However, it was much lower than the radon standard or recommended value for drinking water of the world. The radon concentrations in Jeju Island were in the order of South > North > Western > East > Mountain. Overall, the higher the altitude, the lower the concentration of radon. It shows that radon has some relation with altitude.

ACKNOWLEDGEMENT

This research was supported by Science Research Program through the Jeju Green Environment Center (JGEC, No. 18-18-02-15-36-03).

REFERENCES

- [1] Milvy, P. and Cothorn C.R., Scientific Background for the Development of Regulations for Radionuclides in Drinking Water, Chapter 1 in Cothorn and Rebers (1990).
- [2] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), Sources and Effects of Ionizing Radiation. United Nations, New York (1995).