SEASONAL DETERMINATION OF RADON CONCENTRATION IN SOIL SAMPLES FROM KALAIN GOLD MINE AT BAGO REGION

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Abstract

Soil gas Radon, ^{222}Rn, concentration was measured in kalian gold mine of Shwe Kyin Township at Bago Region. Seasonal determination of radon concentration in soil samples were tested by using RAD 7 radon technique detector. Three different seasons (summer, rainy and cold) in each level of five different depths (2.5 ft, 5 ft, 7.5 ft, 10 ft and 12.5 ft) in the same place were taken for soil gas measurement, starting from the ground surface. Based up on results, the cold season has the most radon contents in three seasons. The measured results were accepted by International Commission on Radiological Protection (ICRP) standard. The results obtained from this study are not dangerous for workers in that area.

Keywords- gold mine, soil, Radon concentrations, cold season and RAD 7

Introduction

Radon is formed in the ground from the radioactive decay of uranium-238, which is present in small quantities in all rocks and soils. Radon is a naturally occurring radioactive noble gas. The soil and rocks feature also control the prevalence of radon [K.B.A. Ahmad, 2010]. In an outdoor, air flow is reducing its stronger quickly dissipate radon. It can move freely through cracks or gaps in soils and bedrock. Radon which reaches the open air is rapidly diluted to harmless concentrations [O.O. Joshau, L. Macheka, 2013]. Radon -222 gas, commonly called radon is colourless, odourless and tasteless and therefore undetectable by human senses. Radon can only be detected or measured with special detectors. Two methods can be used for measuring of radon concentrations as short-term (Active) and long-term (Passive) methods [P.A.a.M. Colgan, A.T, 2009]. In this research, RAD 7 radon detector short-term (Active) method was used to determine the radon concentrations of soil samples from Kalain Gold Mine, Shwe Kyin Township and Bago Region.

Material and Methods

Radon

Radon (^{222} Rn) is a chemically noble gas. The atomic number of radons is 86. Although it is a colourless gas, the half-life of ^{222}Rn is 3.82 days [Benter & Yinon, 2005]. Basic information of radon is shown in table 1. Radon (^{211} Rn) to (^{222}Rn) isotopes and their half-life were listed in table 2. The atomic structure of radon is shown in table 3 and radon electron configuration (Bohr Model) as shown in figure 1 [Brill A.B, 1994].

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Table 1. Basic information's of radon

Symbol	Rn
Atomic number	86
Atomic mass	222.0 amu
Melting point	- 71.0 °C (202.15 K, -95 °F)
Boiling point	- 61.8 °C (211.35 K, -79.24 °F)
Number of protons/ electrons	86
Number of neutrons	136
Classification	Noble gas
Crystal structure	Cubic
Density at 293K	9.73 g/cm^3
Colour	colourless

Table 2. Isotopes

Isotopes	Half-life
Rn-211	14.6 hours
Rn-212	24.0 minutes
Rn-217	0.6 milliseconds
Rn-218	35.5 milliseconds
Rn-219	3.96 seconds
Rn-220	55.61 seconds
Rn-222	3.82 days

Table 3. Atomic structure of radon

Number of energy levels	6
First energy level	2
Second energy level	8
Third energy level	18
Fourth energy level	32
Fifth energy level	18
Sixth energy level	8

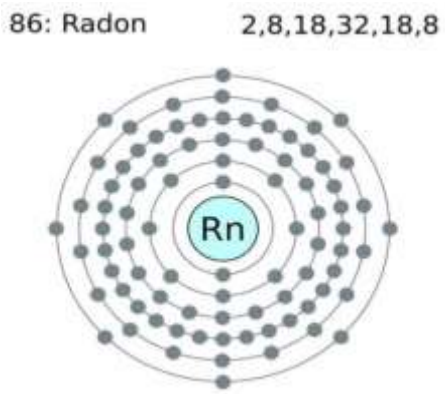

Figure 1. Radon Electron Configuration (Bohr Model)

Table 4. Unit of Measuring Radon Level

Type of Device	Units Used	Conversion
Devices that measure concentrations of radon gas	Becquerel's per cubic metre (Bq/m^3) (Canada)	1Bq = 1 dis / s
	picocuries per litre (pCi/L) (United States)	$1pCiL^{-1} = 37\ Bqm^{-3}$ $200\ Bqm^{-3} = 5.4\ pCiL^{-1}$

A Safe Level of Radon Gas

Guideline values of action levels of radon concentration in different countries as shown in table 5. Action levels of radon concentration in different countries were generally mentioned as four circumstances by ICRP's record [(ICRP) in USA]. There is no action required for the concentration volume which was lower than $200Bqm^{-3}$ as shown in table 5 [ICRP 46(3-4)].

Table 5. Action levels of radon concentration in different countries

Country	**Action Level (Bqm^{-3})**
United Kingdom	200
Ireland	200
Israel	200
Norway	200

Sample Collection

The RAD 7 detection was performed in soil samples at Kalain gold mine at 284 ft above sea level. The samples are collected at 17° 50' 46.08″ north latitude, 96° 57' 46.80″ east longitude and Kalian gold mine with GPSMAP 62 S as shown in figure 2. Soil samples were collected from various depths, recoding their depths with long tape measurement as shown in figure 3.

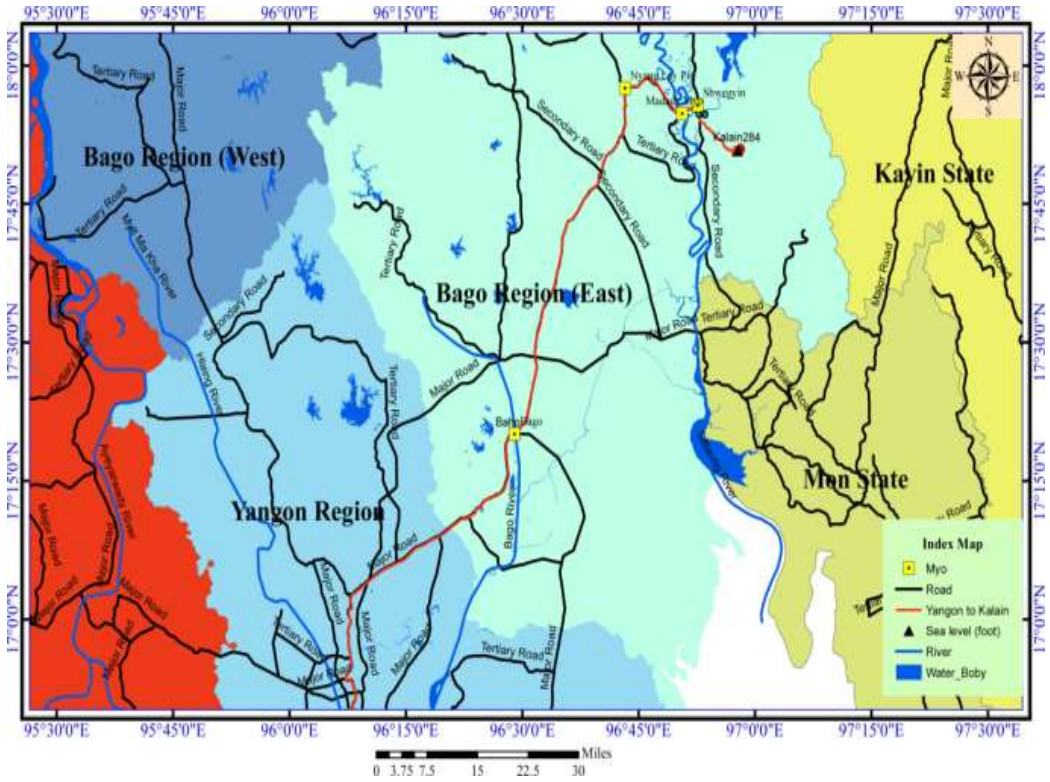

Figure 2 Location map of Kalain Gold Mine from Yangon Region

Figure 3 Kalain gold mine at Shwe Kyin Township

Measurement Procedure

Radon Soil gas measurement

After taking arrangement consists of RAD 7(Active Method) professional Durridge and small drying tube filled with fresh (blue) descendant ($CaSO_4$) positioned vertically, soil gas sample plastic can was filled through sampling point. The soil gas probe should be inserted into the soil sample up to depth about 15cm. Make sure that there is a reasonable seal between the probe shaft and the lid of can, so that ambient air does not descend around the probe and dilute the soil gas sample. Soil gas is normally so high in radon that it is not necessary to use long cycle

times to gain precision. Five minutes' cycle times (purge 5 minutes, pumping 5 minutes, waiting 5 minutes and counting 5 minutes) are sufficient. In total, each set of readings included four 5-minute cycles that took half hour. Running the test and interpretation of the data were also taken out [Ali K. Hasan, Ahmed R. Shaltakh, 2011]. Soil samples were placed into the small tube inlet, and passed through the inlet filter after small drying tube and then took out the results from its clear wide monitor as shown in figure 4.

Figure 4 Durridge RAD 7 Radon Monitor

The RAD 7 detector (Active Method) converts alpha radiation directly to an electric signal and has the possibility of determining electronically the energy of each particle, which allows the identification of the isotopes (^{218}Po, ^{214}Po) produced by radiation, so it possible to instantaneously distinguish between old and new radon, radon from thorn and signal from noise. The schematic diagram of the radioactive natural decay series of Uranium- 238 is shown in figure 5 [S. Girigisu, 2012].

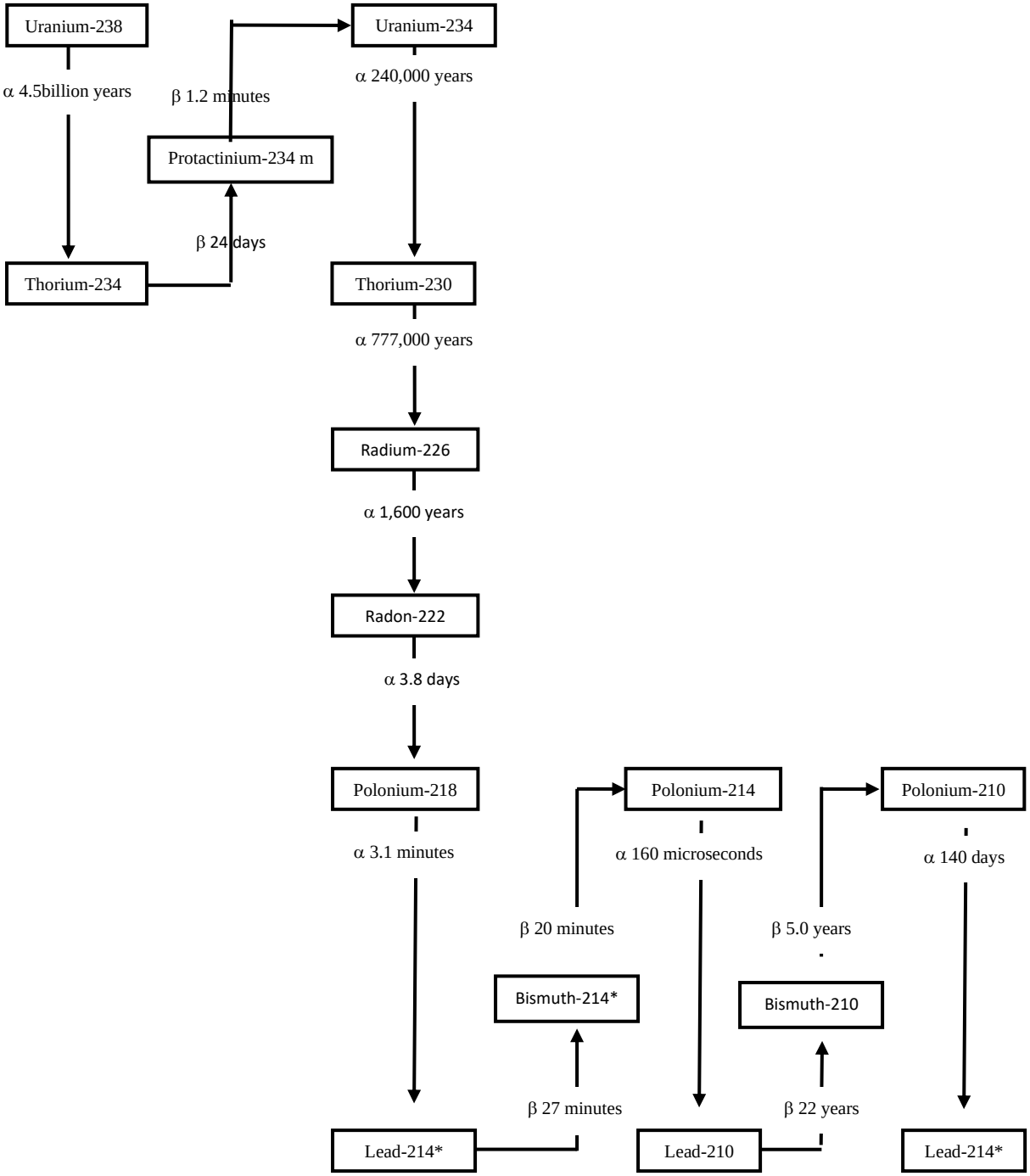

Figure 5 Radioactive Natural Decay Series of Uranium- 238

Results and Discussion

For radon concentration measurement, passive method does not require external power to operate and active method requires power to function (i.e., batteries, DC adaptors or electricity from outlet). In active method, RAD7 radon gas detector will measure the radon concentrations in soil samples at the end of the half hour period. After the determination of the soil sample was used RAD7 detector, coming out five different results for three seasons. It could be easily note that radon concentration was showing maximum at 5ft depth and minimum at 12.5ft depth. These different results data were also described with (chart) in figure 7 and below table 6, table 7 and table 8. As shown in table 6, the radon concentrations of Kalain gold mine in Summer Season

higher than that of Kalain gold mine in Rainy Season as shown in table 7. Among the three seasons, the Cold Season has the most radon concentration of Kalain gold mine than the others as shown in table 8. No action is required for the concentration volume which was lower than 200 Bqm^{-3} that had been defined by International Commission on Radiological Protection (ICRP) standard.

Table 6 Specific activity of Soil samples different depths in Summer Season at Kalain Gold Mine by RAD 7

Samples No:	Depth	Specific Activity (Bqm^{-3})
1	76.2 cm (2.5 ft)	24.60 ± 2.70
2	152.4 cm (5 ft)	36.51 ± 2.90
3	228.6 cm (7.5 ft)	16.40 ± 1.04
4	304.8 cm (10 ft)	10.90 ± 0.57
5	381 cm (12.5 ft)	8.20 ± 2.00

Table 7 Specific activity of Soil samples different depths in Rainy Season at Kalain Gold Mine by RAD 7

Samples No:	Depth	Specific Activity (Bqm^{-3})
1	76.2 cm (2.5 ft)	16.40 ± 2.44
2	152.4 cm (5 ft)	24.60 ± 2.68
3	228.6 cm (7.5 ft)	15.30 ± 0.54
4	304.8 cm (10 ft)	8.84 ± 0.75
5	381 cm (12.5 ft)	8.16 ± 1.98

Table 8 Specific activity of Soil samples different depths in Cold Season at Kalain Gold Mine by RAD 7

Samples No:	Depth	Specific Activity (Bqm^{-3})
1	76.2 cm (2.5 ft)	25.70 ± 1.49
2	152.4 cm (5 ft)	49.20 ± 3.19
3	228.6 cm (7.5 ft)	16.40 ± 1.41
4	304.8 cm (10 ft)	13.10 ± 0.68
5	381 cm (12.5 ft)	12.30 ± 1.33

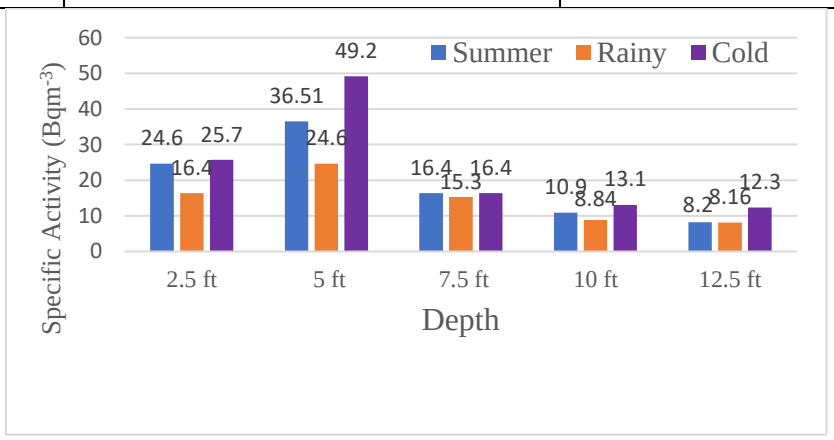

Figure 7 The radon concentrations of soil samples three season at kalain gold mine by RAD 7

Conclusion

The purpose of this research is focused on the public health point of view why radon is believed to be the second largest cause of lung cancer, after that of smoking. According to the results, it was evidently shown that maximum and minimum concentration of radon in soil samples is found in depths of 5ft and 12.5ft respectively. The maximum radon concentration obtained at 5 ft by all seasons. For the depths less than 5 ft the recoil radon prevalence moves more easily to the air, so the activity should be less. In the depths more than 5 ft the rocks soil grains constituted more compact with small or without pore space. The recoil radon at those depths should be embedded in the grains, and then the radon activity may decrease. In order to agree with results acquired at larger depths by actual practice methods, the radon emanation coefficients for different soil samples should be modified. No action may be required for maximum concentration in 5 ft depth by three seasons was less than 200 Bqm^{-3} that had been defined by International Commission on Radiological Protection (ICRP) standard. So, it did not seriously effect on people at Kalain gold mine. However, we have to continuously and widely study on radon concentration and it is very important in future for human health dealing with unseen-able radioactive leaking such as radon.

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