J. Myanmar Acad. Arts Sci. 2020 **Vol. XVIII.No.2B**

RADON MEASUREMENTS IN AND AROUND SOME GOLD MINES IN SHWE KYIN

Hein Nay Zar Wann[1], Tin Tin Phyo Lwin[2], Yin Maung Maung[3], Kyi Thar Myint[4]

Abstract

The aim of this paper is to carry out the radon concentration. In this research, radon concentration in five soil samples collected from different depths at Kalain Ravine are recorded by RAD 7 radon detector as 415, 8.20, 16.4, 13.1 and10.9Bq/m^3 respectively. At5 ft depth, the recommended remedial action has to perform in less than 3 years and underneath this depth, there is no action required. Collected soil samples were also examined with energy dispersive X-ray fluorescent spectrometer. In addition to the standard feature of identification of all elements sodium (Na) to Uranium in a sample, quantitative information is provided. In these samples, it was observed that the main constituents in all samples Si, Al, Fe, K and S. Potassium was detected in all samples which can contribute to K^{40} activity. The pore space in soil grains might contain water and if the radon atom terminates its recoil in the water, the radon might be transported to water around mining sites (mine dump, mine tailings or ravine). Water samples were collected and analysed in laboratory to record radon concentration also with RAD7 detector. It was found that the radon concentration in water samples from Kanni tailing dam and Kyet Khat Kali spring were 4.84 pCi/L and 2.68 pCi/L respectively. The water samples were analysed with Atomic Absorption Spectrometer (AAS) to be see the concentration of particular hazardous elements (Pb and K). It has been obtained that in water samples from both sites no trace of lead was found. Potassium contents in water samples from KyetKhatKali site is 1.53 mg/L and that from Kannitwin is 0.99 mg/L.

Keywords : Radon Concentration; RAD 7; EDXRF; AAS

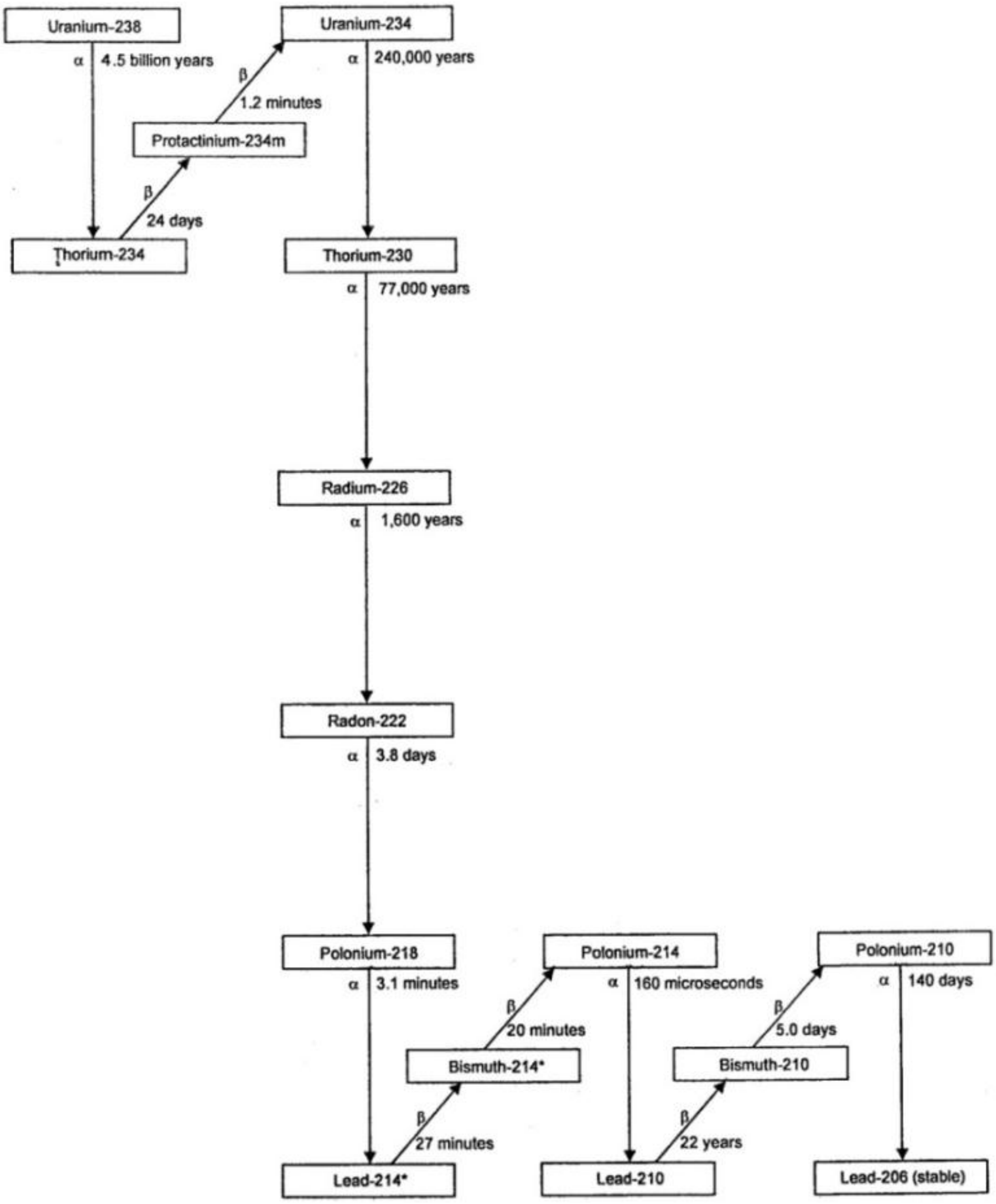
Introduction

Radon is a radioactive gas that is formed naturally by the radioactive breakdown of uranium in soil, rock and water. It cannot be detected by the senses, i.e, it is colour less and odourless however, it can be detected with special instruments. Radon usually escapes from the ground into outdoor air where it mixes with fresh air resulting in concentration too low to be of concern. Radon gas breaks down or decays to form radioactive elements that can be inhaled into the lungs. In the lungs, decay continues, creating radioactive particles that release small bursts of energy. Radon is a inert, water soluble gas produced by the decay series of radium (^{226}Ra) which is also a decay product of uranium (^{238}U) decay series. Radon further decays into Polonium (^{218}Po) which emits an alpha particle of energy 5.5 MeV. Radon is present in trace amount almost everywhere on earth being distributed in the soil, groundwater and in the lower levels of the atmosphere. Radon which is present everywhere on the earth surface reaches by different processes and accumulates in the houses and underground mine. In order to measure the radon concentration which would not exceed the safe level, the investigation can be taken out by appropriate instruments. In this research work, RAD 7 solid state detector was used to determine the radon concentration in soil samples and water samples from Shwe Kyin Gold mines, Bago Region.

[1] U, Assistant Lecturer, Department of Physics, Hpa-An University
[2] Dr, Assistant Lecturer, Department of Physics, University of Yangon
[3] Dr, Professor, Department of Physics, University of Yangon
[4] Dr, Professor (Retd:), Department of Physics, West Yangon University

Natural Decay Series

Radioactive decay occurs when an unstable (radioactive) isotope transforms to a more stable isotope, generally by emitting a subatomic particle such as an alpha or beta particle. Radionuclides that give rise to alpha and beta particles are shown in this figure.



Natural Decay Series: Uranium – 238

A Safe Level of Radon Gas

Radon gas braks down or decays to form radioactive elements that can be inhaled into the lungs. In the lungs, decay continues, creating radioactive particles that release small bursts of energy. This energy is absorbed by nearby lung tissue, damaging the lung cells. When cells are damaged, they have the potential to result in cancer when they reproduce.

The construction of new dwellings should employ techniques that will minimize radon entry and will facilitate post-construction radon removal, should this subsequently prove necessary.

Radon concentration	Recommended Remedial Action Time
Greater than 600 Bq/m^3	In less than 1 year
Between 200 Bq/m^3 and 600 Bq/m^3	In less than 3 years
Less than 200 Bq/m^3	No action required

ICRP recognizes that an action level can have two distinct purposes:

(a) to define workplaces either in which intervention should be undertaken, or

(b) to identify where the system of protection for practice should be applied.

Radon concentrations in water samples are below the WHO recommended permissible level (100 pCi/L) and much lower than WHO action level (300 pCi/L) [ICRP, 2007].

Material and Methods

Sample collection

The RAD 7 detector was performed on soil samples at ByutMyaung Site on the mine dump of ShweKyin gold mines at 284 ft above sea level.

The samples are collected the location at 17° 50' 46.08' north latitude, 96° 57' 46.80' east longitude and Kalain, Byut Myaung site with GPSMAP 62 S.

The collected soil samples at depths with five feet and two feet variations are shown in figures1, 2 and tables 1, 2.

Water samples were collected from two different sites with clean litre polythene bottles. One of the samples was collected from Kanni tailing dam and another from the Kyet Khut Kali spring as show in figure 3 and table 3.

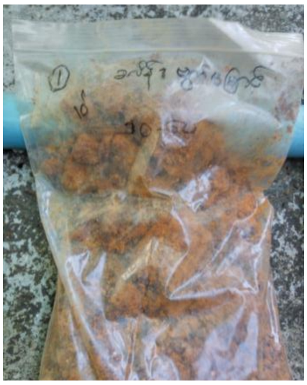


Figure 1 Soil samples at depths with five feet variations

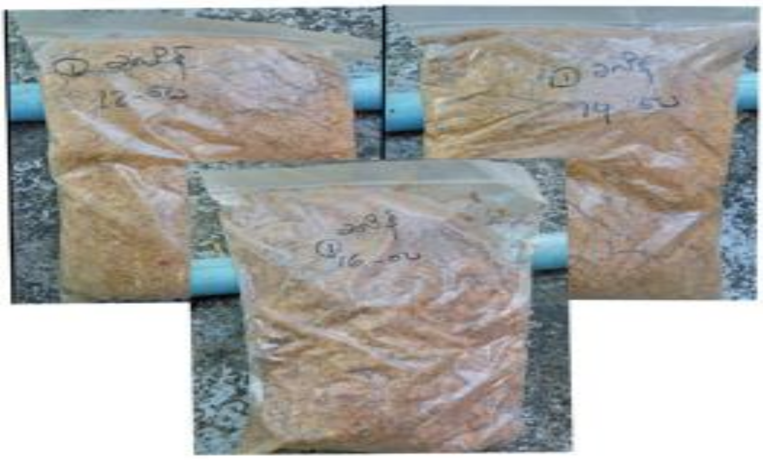


Figure 2 Soil samples at depths with two feet variations

Table 1 Collected soil samples from different depths with five feet variations

Samples No:	Location	Depth
1	Kalain Ravine ByutMyaung gully	1.524 m (5 ft)
2		3.048 m (10 ft)

Table 2 Collected Soil sample from different depths with two feet variations

Sample	Location	Depths
1	Kalain Ravine ByutMyaung gully	3.6576m (12ft)
2		4.2672m (14ft)
3		4.8768 m (16ft)

Ravine – Deep narrow valley groge, mountain cleft.
Gully – A channel worn by running water deep artificial channel.

Figure 3 Water samples from Kanni tailing dam and Kyet Khat Kali spring

Table 3 Collected water samples from different depths and locations

Sample No	Location	Depth
1	KyetKhat Kali	0.9144 m (3ft)
2	Kannitwin	5.7912 m (19 ft)

Figure 4 Photo graph of taking the sample of the soil and water on various depths

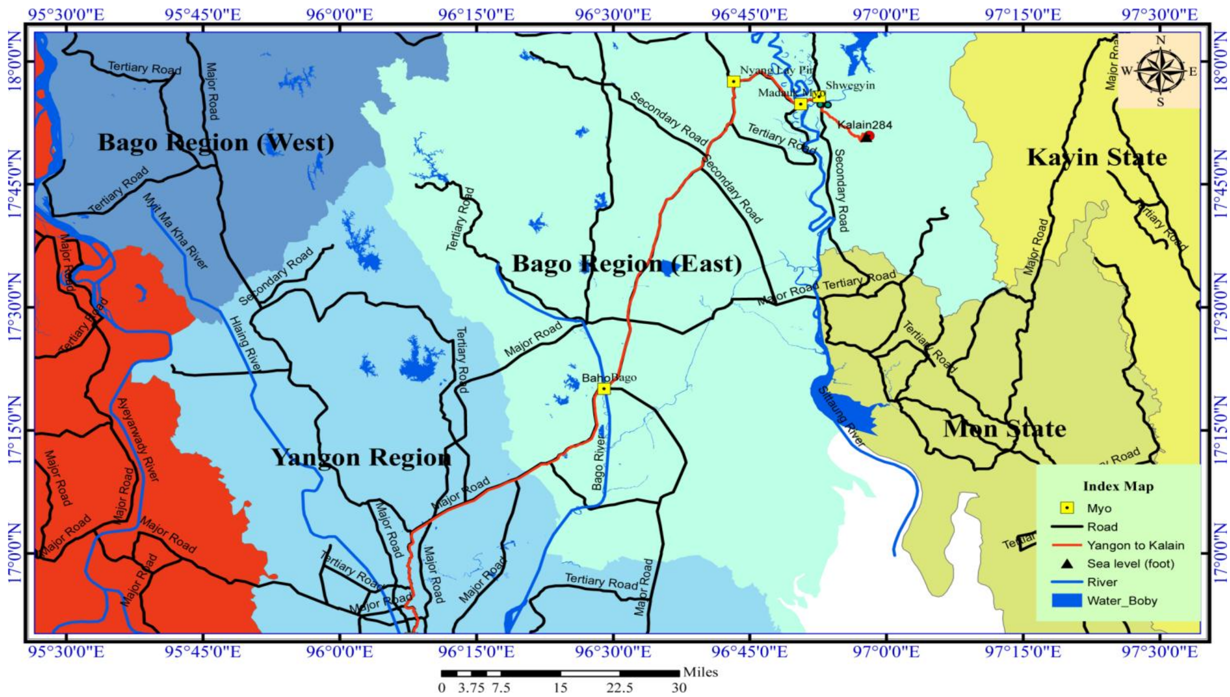


Figure 5 Location Map of Shwe Kyin Goldmine from Yangon Region

Measurement Procedure

After taking arrangement consists of RAD professional 7 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 minute cycle times (pumping 5 minutes, waiting 5 minutes, counting 5 minutes) are sufficient. In total, each set of readings included four 5 minute cycles that took 1 half hour. Running the test and interpretation of the data were also taken out.

The Water Probe is used to collect radon samples from large bodies of water. The probe consists of a semi-permeable membrane tube mounted on an open wire frame. The tube is placed in a closed loop with the RAD 7.

When the probe is lowered into water, radon passes through the membrane until the radon concentration of the air in the loop is in equilibrium with that of the water. As with the RAD AQUR, the RAD7 data and water temperature data are collected simultaneously and accessed by CAPTURE Software of RAD 7 to determine the final result.

The study on soil samples are conducted at Universities' Research Centre (URC) Monywa University. A Shimadzu Co. X-ray fluorescence spectrometer, model EDX-700, was used, following the operating condition; X-ray tube; Rh (3.0 KW); Excitation; 50 KV for NaKα and 50 KV for ULα; Current: 1-50 μA, maximum; Collimator; 10 mm; Detector: Si (Li) cooled with LN_2 (liquid nitrogen); Measurement time: Live-60 s.

Atomic absorption spectrometry (AAS) is an analytical technique that measures the concentrations of elements. Atomic absorption is so sensitive that it can measure down to parts per billion of a gram (μgdm^{-3}) in a sample. The technique make use of the wavelengths of light specifically absorbed by an element. They correspond to the energies needed to promote electrons from one energy level to another, higher, energy level. The concentrations to toxic elements such as Pb and K in two water samples from mining sites were analyzed by AA-6300 SHIMADZU at AMTT analytical laboratory.

Results

Table 4 Specific activity of soil samples with five feet variations

Samples No:	Depth	Specific Activity (Bqm^{-3})
1	1.524 m (5 ft)	415
2	3.048 m (10 ft)	8.20

Table 5 Specific activity of soil samples with two feet variations

Samples No:	Depth	Specific Activity (Bqm^{-3})
1	3.6576 m (12 ft)	16.4
2	4.2672 m (14 ft)	13.1
3	4.8768 m (16 ft)	10.9

Table 6 Concentration of elements contained in soil samples from different depths

Elements	% Concentration of Elements at the depth(ft)				
	5ft	10ft	12ft	14ft	16ft
AL	27.879	19.814	22.377	18.689	26.946
Si	**41.537**	**33.895**	**65.831**	**60.005**	**48.139**
S	0.576	0	0	0.705	0.739
K	5.161	2.306	3.671	2.695	0.301
Ti	4.154	5.118	0.635	0.735	6.968
V	0.144	0.135	0.038	0	0
Cr	0.087	0.110	0	0.019	0.100
Mn	0.061	0.097	0.022	0.047	0.035
Fe	20.080	38.106	7.284	16.987	16.293
Ni	0.037	0.066	0.020	0	0.067
Cu	0.063	0.080	0.052	0.055	0.053
Zn	0.029	0.077	0.040	0.048	0.060
Ga	0	0	0	0	0.024
Rb	0	0	0.006	0	0
Sr	0.025	0.035	0.025	0.016	0.063
Y	0.013	0	0	0	0
Zr	0.099	0.137	0	0	0.180
Nb	0.016	0.023	0	0	0.031
Ir	0.040	0	0	0	0

Table 7. Specific activity of water samples from different locations

Samples No:	Location	Specific Activity (pCi/L)
1	KyetKhat Kali	2.68
2	Kannitwin	4.84

Table 8 Atomic Absorption Spectroscopy data for water samples from different locations.

Samples No:	Name	Lead (mg/L)	Potassium (mg/L)
1	KyetKhat Kali	ND	1.53
2	Kannitwin	ND	0.99

ND = not detected (< LOD), Pb< 0.006 mg/L , LOD = limit of detection

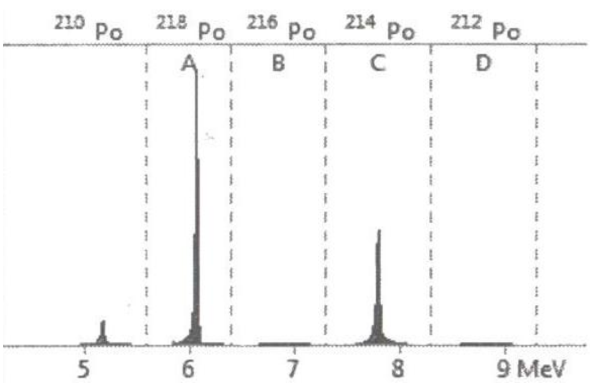


Figure 6 5 ft depth Spectrum for soil sample

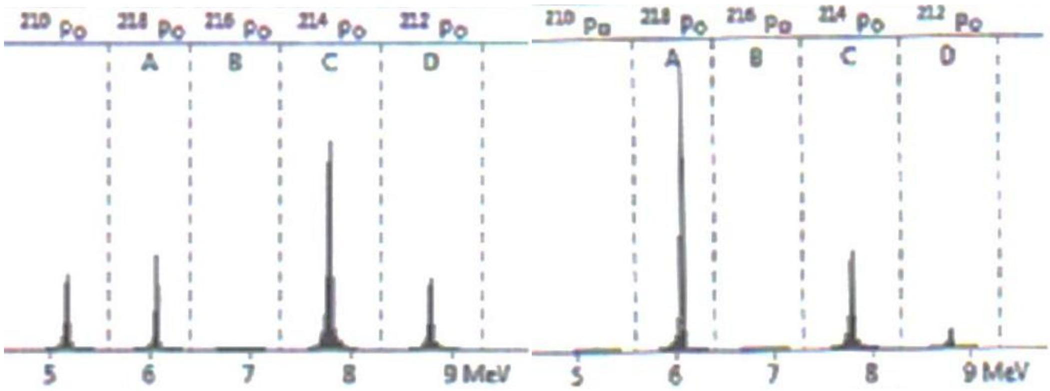


Figure 7 Operational Radon Spectra for water samples from different locatoins

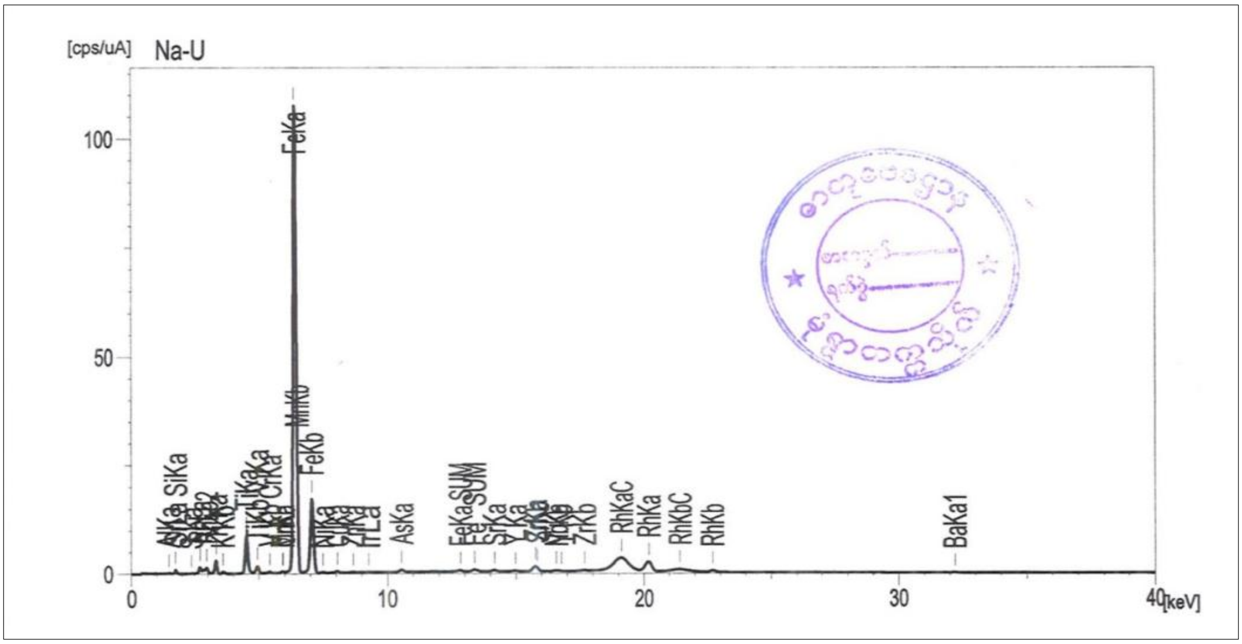


Figure 8 EDXRF spectrum of 5ft depth variation

Discussion

When analyses the synthetic spectra for soil samples at 5ft, 10ft, 12ft, 14ft and 16ft depths, the following peaks are observed. At 5.3 MeV, a persistent peak will be developed as resultant of Polonium-210 buildup. At 6.00MeV, after less than one hour of exposure to radon (new radon) Po-218 peak A. At 6.78MeV, the RAD7 spectrum while continuous sampling thoron laden air (new thoron) Po-216 peak B. At 7.69MeV, the RAD7 spectrum after purging the instrument with radon-free air for more than 10 minutes (old radon) following exposure to radon. Po-214 peak C. At 8.78MeV, the spectrum after discontinuing a lengthy (old thoron) sampling of thoron laden air, Po 212. Peak D.

In water samples from Kyatkatkale spring and Kanni tailing dam, the contents of lead are not detected because those are lower than the limit of detection (Pb< 0.006 mg/L). The potassium contents for these samples are 1.53 mg/L and 0.99 mg/L. The Analytical report described lead concentration for safety limit and monitor potassium for K^{40} activity. This result showed that these in low risk of radon exposure due to K^{40} which contribute only 0.012 % to natural potassium.

Conclusion

For the depths less than 5ft the recoil radon transported more easily to the air, so the activity should be less. In the depths more than 5ft the rocks soil grains constituted more compact with small or without pore space. The recoil radon at that depths should embedded in the grains, then the radon activity may decrease. The height of the peaks on the spectrum depend on the concentration of the radon and to which radon had exposed. According to the results, the depth 5ft has the highest specific activity and the depth 10ft has the lowest specific activity. The radon level of the depth 12ft, 14ft and 16ft are lower than the ICRP (International Commission on Radiological Protection) recommendation level. The qualitative results indicated the highest silicon content is in soil from 12ft depth as 65.83 %. But specific activity at the depth 5ft is higher than the ICRP recommendation level. It may cause health risks to the mine workers in less than 3 years. It is not seriously effect to the workers because the workers isn't stay longer at this depth.However, continuous monitoring of radon concentration of water from other hilly region and mining area is need for radiation safety as radon can cause some malignancies in human. Radon is believed to be the second largest cause of lung cancer, after smoking.

Acknowledgements

I am greatly indebted to Professor Dr Khin Khin Win, Head of Department of Physics, University of Yangon, for her kind permission to carry out my research work. I also would like to thank Professor Dr Myo Lwin, Department of Physics and Professor Dr Aye Aye Thant, Department of Physics, University of Yangon for their valuable suggestion. I am deeply grateful to my supervisor, Dr Yin Maung Maung, Professor, Department of Physics, University of Yangon, for his valuable guidance and helpful advice to carry out this research work. I also thank to my Co-Supervisor, Dr Tin Tin Phyo Lwin, Assistant Lecturer, Department of Physics, University of Yangon, for her helpful guidance and suggestion throughout this work. I also deeply thank to Dr Kyi Thar Myint, Professor (Retd), Department of Physics, West Yangon University for her valuable advice and guidance in carry out this research.I would like to thank all people who encourage and support me during the undertaking of this work.

References

A. El-Sersy, M Mansy and A Hussein, (2003), Effect of environmental conditions on radon concentration-track density calibration factor of solid state nuclear track detectors.

ICRP : The (2007) Recommendations of International Commission on Radiological Protection. ICRP Publication 103.

W.J. Speelman, R-Lindsay, R.T. Newman, R.J.de Meijer, (2006) TA-6 Radiation Protection of the Public and the Environment. Radon Generation And Transport In And Around A Gold-Mine Trilings Dam In South Africa.

http://www.epa.gov/radiation/radionaclides/radon.html
http://www.radongas.org/