The Study on Annual Effective Dose of Different Kinds of Soil in Yangon University of Education Using Solid State Nuclear Track Detectors (LR115)

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Abstract

Samples of soil from different University hostels have been analyzed for radon concentrations and annual effective dose. For the measurement, alpha sensitive LR115 Solid State Nuclear Track Detectors (SSNDT) were used. In this research, the calculated value of radon concentration emanated from the soil samples varied from 28 ± 24.665 Bqm^{-3} to 314 ± 41.589Bqm^{-3} and the average annual effective dose is varied from 0.48 ± 0.424 m Svy^{-1} to 5.40 ± 0.715 m Svy^{-1}. According to these results, it was not found the higher level of radon concentration and the annual effective dose which are lower than 14m Svy^{-1}, the ICRP recommended level.

Key words: LR-115 type II, Radon Concentration, Annual Effective Dose

Introduction

The natural radioactivity is the main component to human exposure. Radon (^{222}Rn) and their short lived decay products are recognized as the most important contributors to committed effective dose received by population due to natural sources. Radon is emitted from uranium, a naturally occurring mineral in rocks, sand and soil: thus, radon is present virtually everywhere on the earth, but particularly over land. Although it cannot be detected by a person's senses, radon and its radioactive products are a health concern because they can cause lung cancer when inhaled over long duration. Radon monitoring has become a global phenomenon due to its health hazard inside the dwelling as well as an environment. There are three isotopes of radon ^{219}Rn (actinon), ^{220}Rn (thoron) and ^{222}Rn (radon) and they belong to the decay chain of ^{235}U, ^{232}Th and ^{238}U respectively. Radon (^{222}Rn) is colorless, odorless, and tasteless and is an α –emitter that decays with a half-life of 3.82 days into a series of radon progeny.

The exposure of population to high concentrations of radon and its daughters for a long period lead to pathological effects like the respiratory functional changes and the occurrence of lung cancer. Most of the radon that enters a building comes directly from soil that is in contact with or beneath the basement or foundation. And building materials such as cements and bricks were making up of rocks, mud and sand. Radon is also found in building materials to enter a home and indoor air. Radon can only be measured by specialized measurement. There are two kinds of radon measurement. They are short-term measurement and long-term measurement. In short-term measurement, radon level can be measured during two to seven days. In long-term measurement, radon level can be measured during three to twelve months. Long-term measurement will provide best estimate of average exposure over time. Since radon is an alpha emitter, it may damage lung tissue after inhalation. The short lived decay products of radon are responsible for most of the hazards by inhalation. Lung cancer, skin cancer and kidney diseases are the health effects attributed to inhalation of radon-decay products. As the radon in the atmosphere (indoor and outdoor), rod, sand and soil contributes the largest fraction of the natural radiation dose to population, enhanced in tracking its concentration is thus fundamental for radiation protection and health.

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Table 1. The eight soil samples of different locations

Sample Number	University hostel Regions
S-1	YUOE
S-2	Bagan
S-3	Takaung
S-4	Nawaday
S-5	OhnTaw
S-6	Duyar
S-7	Pyay
S-8	Popa

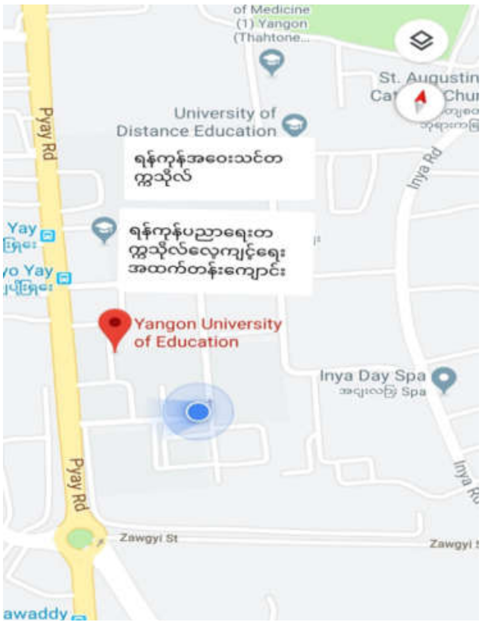


Figure 1. Location of Yangon University of Education

Samples: In this research work, the fields of measurement were chosen at the public places where University hostel regions such as YUOE, Bagan, Takaung, Nawaday, OhnTaw, Duyar, Pyay, Popa as shown in Figure 1. The aims to find out the alpha track density and radon concentration, eight kinds of soil samples were observed by using Solid State Nuclear Track Detector (LR115).Photograph of those samples are shown in Figure 2. The various soil samples of different locations in Yangon University hostel regions are presented in Table 1.

Figure 2. Photograph of showing can technique for

Sample Preparation : To find out the radon concentration Solid State Nuclear Track Detectors (SSNTD) LR115 were used. SSNTDs are based on the created in a solid along the path of heavily ionizing particles such alpha particles and other ions. A known amount (0.08 kg) of the soil samples and these samples were placed in each plastic can. SSNTD LR-115 plastic detectors (1cm×1cm), were fixed on the top of the lid of each can with tape such that, sensitive side of the detector faced the specimen. The cans were tightly closed from the top and sealed. The exposure times were 100 days. The schematic diagram of the can technique as shown in Figure 3.

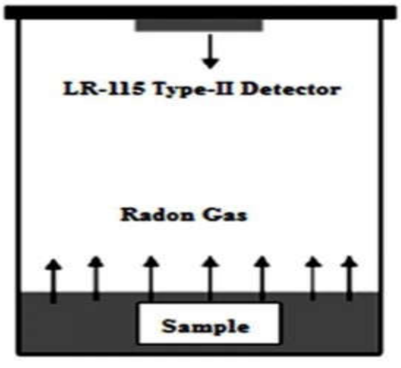


Figure 3. The Schematic Diagram of the Can Technique

LR-115 Type II Detector (SSNTD): The plastic track detector LR-115 Type II is cellulose nitrate red dyed film, manufactured by Kodak Path, France. The sensitive surface for alpha particle, red dyed, is of 12µm thickness of cellulose nitrate (CN)layer on a colorless inert backing materials and the base is 100µm polyester. The structure of LR-115 Type II ($C_6H_8O_9N_2$) is shown in Figure 4.Its advantage is that after suitable etching, the tracks appear as colorless holes against a red background. Obviously, only one side of this film is sensitive, and this must be determined before use. Etched tracks show up as bright holes in a dark red background, and are very clearly visible under a low power microscope of magnification at 40X-100X.

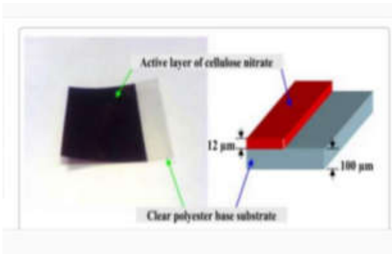


Figure 4. The structure of LR-115 Type II detector

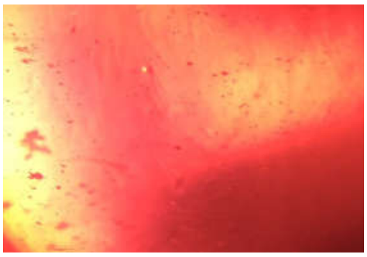
Optical Microscope Used in the Present Work: In this research, the counting and measuring diameter of the chemically etched tracks were carried out by using the optical microscope as shown in Figure 5. The microscope consists of eyepiece 10x magnification and four lenses each with 10, 20, 40 and 100 times magnification. The generation of ion tracks of specified size and shape requires a microscopic control of the achieved results. Its great advantage of optical microscopy is using with ease requiring only little preparation. The tracks formed are viewed under different magnifications as the display monitor. The visible area containing tracks in SSNTDs will vary depending upon the magnification used. The numbers of track are usually counted at a suitable magnification.

Figure 5. Optical Microscope (400x)

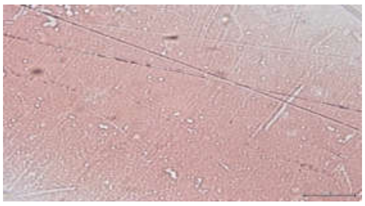
Etching System: The exposure time of detectors was 100 days long. At the end of the exposure time, the detectors were removed and subjected to a chemical etching process in 6N NaOH solution. To obtain 6N solution, 24g of NaOH pellets (99% purity) were mixed up 100ml distilled water into the measuring cylinder and stirred with a glass rod, until all NaOH pellets were dissolved. And then this solution was poured into a glass beaker. This beaker was heated on the electric stove to reach temperature 70˚C. When the temperature reached at 70˚C for 1 hour. During etching, the temperature was kept constant with and accuracy of ±1. The chemical etching of SSNTD as shown in Figure 6. After it was etched, the detector was washed and dried and tracks produced by alpha particle were observed and counted under an optical microscope (400x).

Figure 6. Chemical Etching of SSNTD

Etching of Detectors: The beaker with 6N NaOH solution 100 ml was heated on a stove with temperature controller. When the temperature reached at 70℃, the radon exposed LR-115 detectors were put into the beaker for 1 hour. During etching, the temperature was kept constant with and accuracy of ± 1℃. After etching, the solution in the beaker was poured into another beaker through small plastic sieve with handle, so that the detectors can be easily and firstly collected. Then the detectors were washed under the running until the surface of the detectors became cleaned from etchant. Finally, the detectors were taken out and dried with filter paper. The photographs of alpha track in LR-115 due to radon from eight kinds of soil samples are shown in Figure 7 to Figure 15.

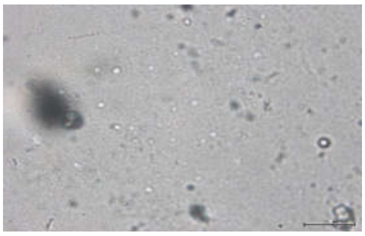


Background



Sample1

Sample 2



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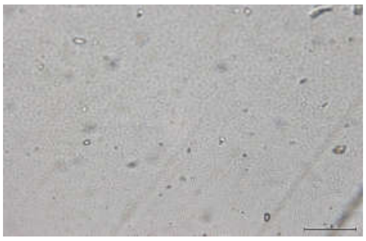
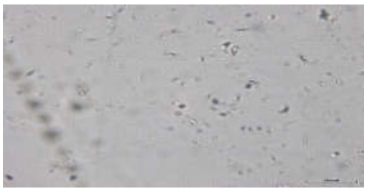


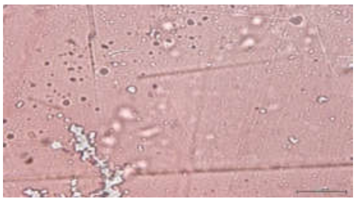
Sample 4

Sample 5

Sample 6



Sample 7



Sample 8

Figure 7. Photographs of Alpha Tracks in LR-115 due to Radon from Soil Samples

Results and Discussion

In this research, radon emanated from eight kinds of soil samples has been measured. Estimation of radon concentrations in soil is due to health hazards point of view and environmental pollution. To analyze the radon concentration in soil samples, solid state nuclear detection technique was used.

For the measurement, sensitive LR-115 plastic track detectors were used. By using calibration factor of 1Bqm^{-3} =0.0172mSvy^{-1}, the track density was converted to the radon activity concentration. Based upon the available data obtained the dissolved radon concentration and annual effective dose have been calculated. In the present investigation, the calculated value of alpha track density varied from 1.41 ± 1.237 track cm^{-2}day^{-1} to 15.74 ± 2.086 track cm^{-2}day^{-1}, the radon concentration varied from28 ± 24.665Bqm^{-3} to 314 ± 41.589Bqm^{-3} and the annual effective dose varied from 0.48 ± 0.424 mSvy^{-1} to 5.40 ± 0.715mSvy^{-1}. The calculated values of alpha track densities, radon concentration and annual effectives doses for eight soil samples were collected from different university hostels are presented in table (2). It can be seen clearly from the results that the radon concentration varies appreciably from sample to sample. According to international recommendations, the annual effective dose due to radon in soil samples varies from 0.48 ± 0.424 mSvy^{-1} to 5.40 ± 0.715mSvy^{-1} which are lower than 14mSvy^{-1}, the annual effective dose also lies below in the ICRP recommendation dose.(ICRP, January 26,2018)

Table 2. The Alpha Track Density, Radon Concentration and Annual Effective Dose of eight soil samples.

Sr.No	Samples	Alpha Track Density (track cm^{-2} day^{-1})	Radon concentration (Bqm^{-3})	Annual effective Dose(mSvy^{-1})
1	Sample1	15.74 ± 2.086	314 ± 41.589	5.40 ± 0.715
2	Sample2	9.4 ± 2.087	187 ± 41.61	3.22 ± 0.715
3	Sample3	1.41 ± 1.237	28 ± 24.665	0.48 ± 0.424
4	Sample4	8.57 ± 1.743	171 ± 34.755	2.94 ± 0.597
5	Sample5	9.38 ± 1.557	187 ± 31.057	3.22 ± 0.534
6	Sample6	5.73 ± 1.599	114 ± 31.886	1.97 ± 0.548
7	Sample7	2.78 ± 1.056	55 ± 21.048	0.95 ± 0.362
8	Sample8	13.01 ± 1.794	259 ± 35.772	4.46 ± 0.615

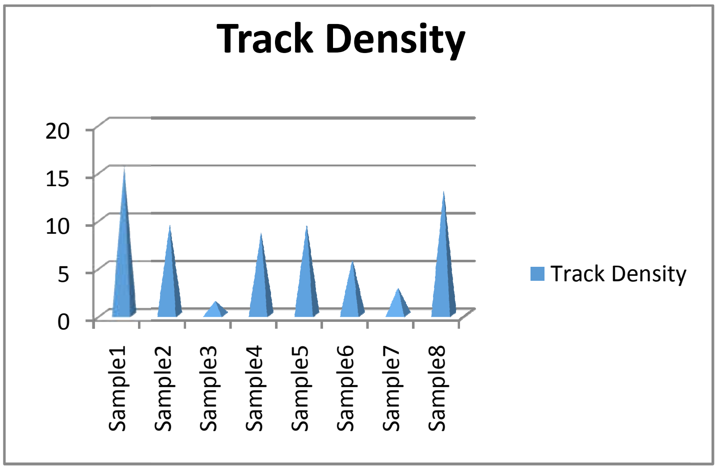


Figure 8. The Comparison Graph of Alpha Track Density of the Soil Samples

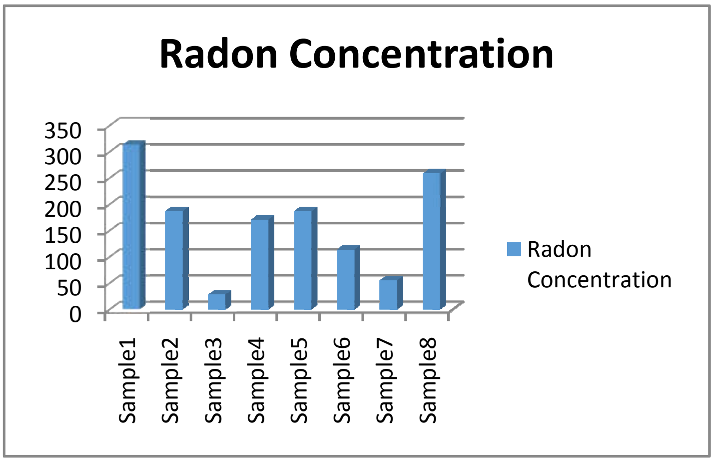


Figure 9. The Comparison Graph of Radon Concentration of the Soil Samples

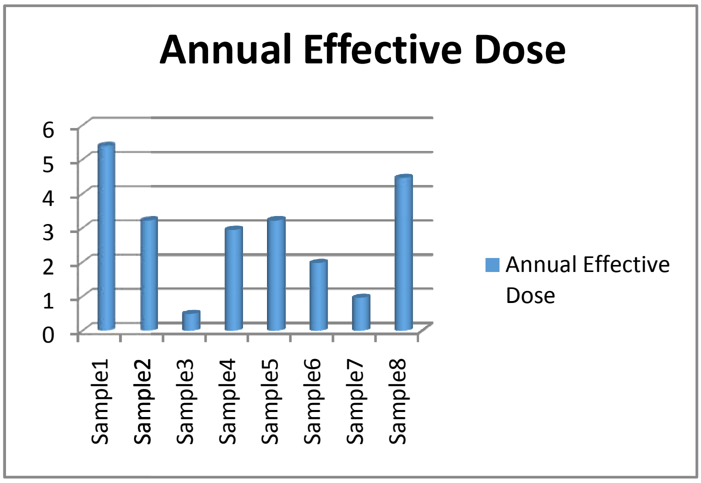


Figure 10. The Comparison Graph of Annual Effective Dose of the Soil Samples

Conclusion

According to the obtained data in Table (2), it is obvious that the sample (1) (soil sample from YUOE region) has the highest radon concentration and annual effective dose compared with the other soil samples. The annual effective dose in that sample (1) is lower than ICRP limited level. The value of annual effective dose recommend by International Commission on Radiological Protection Publication is $14mSvy^{-1}$(ICRP, January 26, 2018). So, the tested radon level is low in soil samples. It is seen from the data that the low level of radon in eight soil samples typically does not cause health hazards to users as well as community.

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