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Measurement of Radon and Thoron progeny concentration in some dwellings of Nagaland state - an initial report

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ABSTRACT

Measurement of Radon and Thoron progeny concentrations using direct Radon/Thoron progeny sensor are made in some dwellings in the state of Nagaland, India. The measurement shows that the mean Radon progeny concentration ranges in between 1.85 Bq/m^3 to 10.68 Bq/m^3 and for thoron progeny, the concentration varies in the range 0.06 Bq/m^3 to 2.67 Bq/m^3.

Keywords: Radon, Thoron, DTPS, DRPS.

INTRODUCTION

There has been an increasing concern regarding exposure to radon (^{222}Rn), thoron (^{220}Rn) and their progeny due to their detrimental effects on human health. In fact, out of 98% of the average radiation dose received by man from natural sources about 52% is due to breathing of radon, thoron and their progeny present in dwellings [1]. The presence of radon/thoron in the atmosphere is a serious health hazards due to quick diffusion of the progeny to surrounding atmosphere, particularly when it remains in enclosed places such as houses, caves and mines. In recent years, health hazard related to radon and its progeny has received the attention of the scientific community mainly due to the increased incidence of lung cancer among the uranium miners [2-4]. The main contributors of indoor radon are: (i) diffusion from building elements - 21%; (ii) diffusion from subjacent earth - 15%; (iii) advection from subjacent earth - 41%; (iv) infiltration by outdoor air - 20%; (v) de-emanation from water supply - 2%; (vi) consumption of natural gas - 1%. . It is understood that the indoor radon concentration varies with the construction material of buildings, ventilation patterns, in addition to the seasonal and diurnal variations [5] There have been several studies on radon and thoron measurements by several authors using passive methods [6-18]. It had been the usual practice to calculate both the Radon and Thoron progeny concentration from the measured gas concentration using an assumed equilibrium factor. However, this process of progeny concentration estimation involves a lot of uncertainty especially in the case of thoron progeny [5]. Thus in order to provide a realistic assessment of these species in the indoor environment, it is necessary to conduct direct measurements of radon and thoron progeny, since inhalation doses are predominantly due to decay products of radon and thoron, and not due to the gases themselves. With the development of Direct Thoron Progeny Sensor (DTPS) and Direct Radon Progeny sensor (DRPS) [19], one can measure the progeny concentration directly with these detectors [20-21]. These are passive solid state nuclear track detectors (SSNTDs) mounted with energy degrader foils of suitable thicknesses so as to selectively register the alpha particles emitted from deposited progeny atoms.

Radon is naturally found in uranium ores, phosphate rock, shales, igneous and metamorphic rocks such as granite, gneiss, and schist; and, to a lesser degree, in common rocks such as limestone [22]. In Nagaland, the sedimentary rocks accounts for nearly 90 % of the area whereas the rest is being occupied by igneous (Ophilit Belt) and metamorphic rocks. The sedimentary rocks mostly sand stone (Barail Group),shale (Disang group) Pelagic and Volcanogenic Sedimentsand lime stone [23] Although radon problem is so far not seen as a major concern in India, there is still a need to delineate the variability of radon levels in Indian dwellings. This requires systematic studies for collecting, centralizing and interpreting the data obtained through different groups with reliable techniques. Thus it was felt that a detail study on the presence of Radon and Thoron would be very useful for data base creation for the state of Nagaland. Present paper is an initial results about the study carried out in some dwellings of Nagaland. For this study, DTPS and DRPS detectors developed by BARC, are used to measure progeny concentration of both Radon and Thoron.

MATERIALS AND METHODS

Preparation of DTPS and DRPS detector

Direct Radon and Thoron progeny sensors (DRPS and DTPS) have been developed for estimating the time integrated progeny deposition fluxes in the environment have been used for this study. Fig.1. Show the DTPS and RDPS detector used for this study.

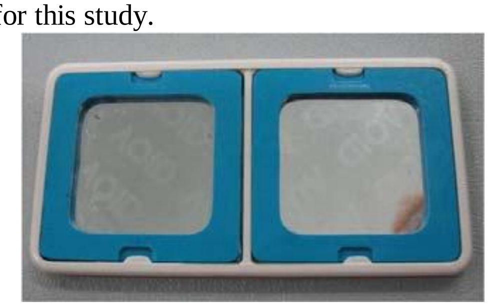

Fig.1. Direct Radon and Thoron progeny sensors [5]

These detectors are developed by Radiological Physics and Advisory Division of BARC, India.
These are made of passive nuclear track detectors (LR-115) mounted with absorbers of appropriate thickness.

Installation of the detectors

The detectors are installed inside the houses of different types ranging from RCC to wooden to Assam types. There are around 40 houses selected for this study in different locations of Wokha town, Kohima town, Dimapur and Chumedima areas of Nagaland. Fig.2 shows the district locations where the measurements were done.

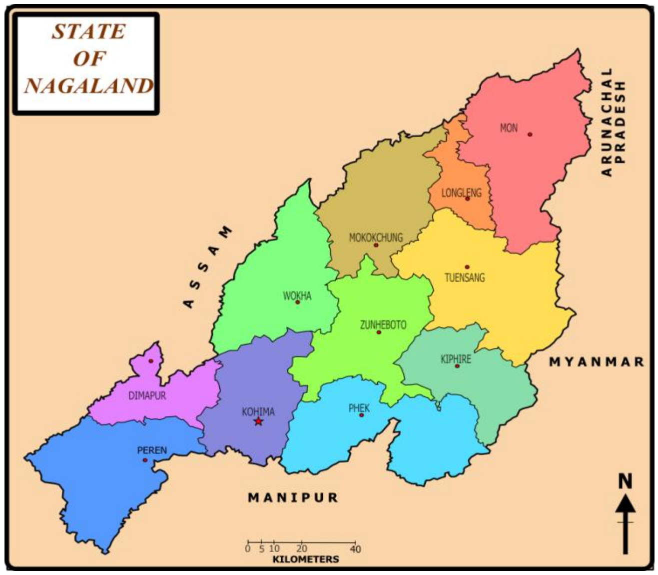

Fig. 2. Area of radon, thoron study is highlighted in the map.

The dosimeters are hung from the ceiling of the selected houses at a height of minimum 1.5 m from floor and at least 10 cm away from any surface for a period of about 90 days during the periods April to June. Bedroom ceiling is preferred as this is a room where one has maximum occupancy. After the period of exposure is over the detector is retrieved and chemically etched using 2.5 N NaOH solution at constant temperature of 60ºC for 90 minutes. The etched SSNTD films are then counted by using a spark counter.

RESULTS AND DISCUSSION

The Radon and Thoron progeny concentration are derived from the number of tracks formed in the detectors exposed to different houses using the following equation. The number of tracks per unit area per unit time (T) is correlated to the Equilibrium Equivalent Progeny Concentration (EEC) in air by the following equation [5] using the Sensitivity factor (S) [19].

$$EEC(Bqm^{-3}) = \frac{T(Tracks.cm^{-2}.d^{-1})}{S(Tracks.cm^{-2}.d^{-1} / EEC(Bq.m^{-3})}$$

For ^{220}Rn progeny, the absorber is 50 μm aluminized Mylar which selectively detects only 8.78 MeV α-particles emitted from ^{212}Po; while for ^{222}Rn progeny, the absorber is a combination of aluminized Mylar and cellulose nitrate of effective thickness 37 μm to detect mainly 7.67 MeV α-particles emitted from ^{214}Po. The basic principle of operation of these sensors is that the LR-115 detector detects the alpha particles emitted from the deposited progeny atoms.

Table 1. EERC and EETC level in some locations in Wokha Town

Location	EERC (Bq/m^3)	EETC (Bq/m^3)
Forest Colony	4.81	0.43
Lower Forest Colony	2.53	0.27
High School	2.96	0.51
G.A.	5.06	1.60
Mindlane	4.51	0.72
Etsuchika (upper)	3.09	0.48

Etsuchika (middle)	9.94	0.41
Etsuchika (Lower)	4.75	0.06
Tsumung (b)	2.16	0.87
Mean	3.71 (Bq/m^3)	0.59 (Bq/m^3)

Using this correlation, Radon progeny concentration is found to be in the range of 1.85 Bq/m^3 to 10.68 Bq/m^3. Similarly for thoron progeny concentration varies in the range 0.06 Bq/m^3 to 2.67 Bq/m^3. Tables 1,2 & 3 list the Radon and Thoron progeny concentration in Bq/m^3 in three different district of Nagaland viz., Wokha, Dimapur and Kohima. In the tables, the radon and thron progeny concentration are expressed as EETC - Equilibrium Equivalent Thoron Concentration and EERC- Equilibrium Equivalent Thoron Concentration in the tables. It has been observed that in most of the dwellings radon and thoron progeny concentration are quite low.

Table 2. EERC and EETC level in some locations in Dimapur Town and Chumukedima area

Location	EERC (Bq/m^3)	EETC (Bq/m3)
Nagarjan	2.04	0.47
Thilixu	4.14	0.36
Darogapathar	5.99	0.85
Padampukuri	3.15	0.34
Notun Basti	1.98	0.26
Kacharigaon	4.01	0.63
Senjum	2.26	0.46
Sub-Jail	1.85	0.24
PWD colony	2.96	0.15
Midlane	2.35	0.09
Eros lane	1.54	0.11
Purana Bazar	3.21	0.69
Burma Camp	10.68	2.67
Chumukedima- Water Supply (east)	6.42	0.83
Chumukedima-Patkai	9.01	1.73
Chumukedima-Ward no 2	8.84	1.70
Chumukedima-Ward no 5	2.51	2.59
Mean	3.89 Bq/m^3 * excluding Burma Camp sample	0.83 Bq/m^3

Table 3. EERC and EETC level in some locations of Kohima Town

Location	EERC (Bq/m^3)	EETC (Bq/m^3)
Old Minister Hill 291	2.10	0.14
A.G. Colony 292	3.36	1.37
New Minister Hill 293	2.59	0.26
Forest Colony 294	2.35	0.28
Paramedical Area 295	4.69	0.57
Agri Colony 296	2.59	0.66
Jail Area 297	4.69	0.15
Midlane 298	7.22	0.96
Chandmari 299	0.68	0.11
P.W.D. colony 300	2.96	0.70
Mean	3.32 (Bq/m^3)	0.52 (Bq/m^3)

Only in the two locations of Chumukedima (patkai area and ward no2) the value of radon progeny concentration is observed to be around 9 Bq/m^3 and also in the Burma camp area EERC is found to be 10.68 Bq/m^3. Similarly in the Wokha town, in one dwelling in Etsuchika (middle) area, it is found to 9.94 Bq/m^3. The mean value of the progeny concentration is shown in fig.1.

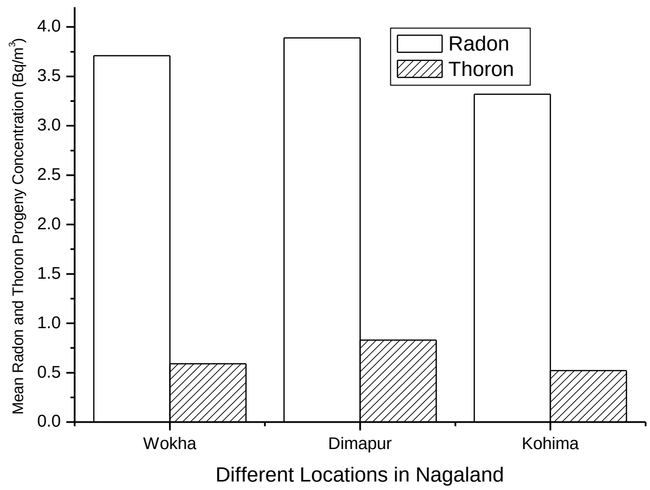

Fig.3. Plot of mean radon and thoron concentration in three districts towns of Nagaland

There has been a report [24] about Radon measurements in the Kohima District of Nagaland. in the year 1997, where potential alpha energy concentration (PAEC) of radon daughters are measured using LR-115film in bare mode. The geometrical mean of the concentrations in Kohima (Nagaland), are reported to be 88 Bq.m^{-3}[24]. Fig. 4 shows the correlation plot of measured radon progeny (EECR) vs. thoron progeny (EECT) , which shows a poor correlation.

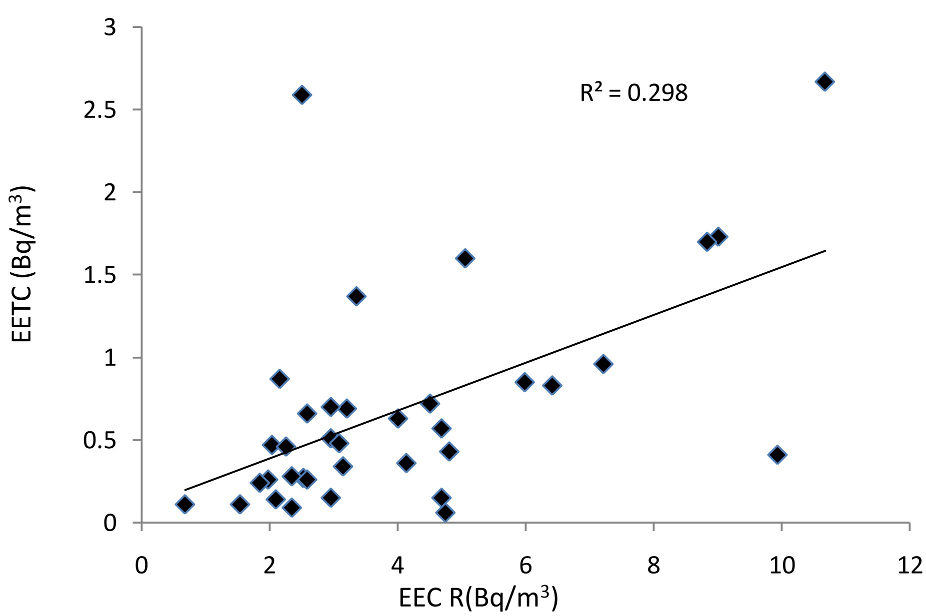

Fig.4. Correlation plot of EECR versus EECT

APPLICATIONS

Understanding the Radon and Thoron progeny level is very important due to its health effect on populations. From the present study, it is understood that decay product concentration has been in the range of 1.85 Bq/m^3 to 10.68 Bq/m^3 for radon and in the range of 0.06 Bq/m^3 to 2.67 Bq/m^3 for Thoron.

CONCLUSIONS

Time integrated direct decay product concentration in indoor environments has been carried out in 3 districts of Nagaland using passive direct radon/thoron progeny sensors. The decay product concentration has been measured in the range of 1.85 Bq/m^3 to 10.68 Bq/m^3 for radon and in the range of 0.06 Bq/m^3 to 2.67 Bq/m^3. The highest radon progeny concentration was measured as 10.68 Bq/m^3 in Burma Camp area of Dimapur district and and that for thoron progeny was 2.59 Bq/m^3 in Chumukedima area of Dimapur. It was observed that there is poor correlation between radon progeny and thoron progeny. More studies are in progress to estimate the equilibrium factor by measuring simultaneously the gas and progeny concentration and to study their seasonal dependence.

REFERENCES

[1] "United Nations Scientific Committee on Effects of Atomic Radiation. Sources and effects of ionizing radiation. UNSCEAR", no. A/AC/82/R-441, **1988**.

[2] "ICRP (International Commission on Radiological Protection). Lung cancer risk from indoor exposures to radon daughters", ICRP Publication 50. Ann. ICRP, 17(1), Pergamon, pp. 1–60, 1987.

[3] J.H. Lubin, Z. Liang, Z. Hrubec, G. Pershagen, J.B. Schoenberg, W.J. Blot, J.B. Klotz, Z.Y. Xu, and J.D. Jr. Boice, *Cancer Causes Control*, **1994**, 5, 114–128.

[4] "NRC (National Research Council—Committee on Health Risks of Exposure to Radon). Health effects of exposure to radon", BEIR VI. *National Academy Press*, **1999**.

[5] "Handbook on Radon Transport Models and Measurement Methods", published by Radiological Physics and Advisory Division, Health Safety and Environment Group, Bhabha Atomic Research Centre, Mumbai-400085, **2011**.

[6] F.J. Aldenkamp, R.J. De Meijer, L.W. Put, P. Stoop, *Rad. Prot. Dosim.*, **1992**, 45(1-4), 449-453.

[7] K.K. Dwivedi, S. Ghosh, A. Srivastava, R. Lalramagzami, C. Laldawngliana, D. Sinha, T.V. Ramachandran, *Radiat. Meas*., **1996**, 26, 291-296.

[8] V.K. Shukla, S.J. Sartendel, T.V. Ramachandran, *Rad.Prot.and Envir*., **2001**, 24, 437-439.

[9] K. Kant, S.K. Chakravarti, *Ind. J. Pure & Appl. Phys*., **2004**, 42, 157-161.

[10] S Darby, D Hill, A Auvinen, J M Barros-Dios, H Baysson, F Bochicchio, *British Medical Journal*, **2005**, 330 (7485), 223-234.

[11] W. Zhuo, T. Iida, Furakawa, *J. Nucl. Sci. and Tech*., **2006**, 43(4), 479-482.

[12] G.M. Mudd, *J. Envir. Radio*, 2008, 99, 288-315.

[13] A.K. Mahur, R. Kumar, M. Mishra, A. Azam and R. Prasad, *Indian J. Phys*., **2009**, 83 (8), 1177-1181.

[14] R.C. Ramola, *Radiat. Prot. Dosim*., **2010**, 141(4), 379–382.

[15] D. Barooah, S. Phukan, R. Baruah, *Indian Journal of pure and applied Physics*, **2011**, 49, 665-668.

[16] R. Mishra, Y.S. Mayya, H.S. Kushwaha, *J. Aerosol. Sci*., **2009**, 40, 1–15.

[17] B.K. Sahoo, Y.S. Mayya, B.K. Sapra, J.J. Gaware, K.S. Banerjee, H.S. Kushwaha, *Radiation Measurements*, **2010**, 45, 237-241.

[18] B.K. Sahoo, B.K. Sapra, J.J. Gaware, S.D. Kanse, Y.S. Mayya, *Sci of Total Environment*, **2011**, 409, 2635-264.

[19] R Mishra, Y.S. Mayya, *Radiat. Meas*., **2008**, 43, 1408–1416.

[20] Y. S. Mayya , R. Mishra, R. Prajith, A. C. Gole, B. K. Sapra, M. P. Chougaonkar, R. R. K. Nair, R. C. Ramola, N. Karunakara, P. K. M. Koya, *Radiation Protection Dosimetry* , **2012**, 1–7.

[21] R. Mishra, Y.S. Mayya, L.Tommasino, *Radiat. Prot. Dosim*., **2012**, 150(2), 150–157. 2012.

[22] T. Godish, Boca Raton, FL. CRC Press LLC, **2001**.

[23] “Nagaland: State Geology and Mineral maps”, published by Geological survery of India.

[24] A. K. Singh, A. J. Khan, R. Prasad, *Radiat. Prot. Dosim.*, **1997**, 74, 3,189–192.