STUDY OF RADON GAS CONCENTRATION AT DIFFERENT DEPTH IN SOIL OF OIL EXPLORATION AREAS WITHIN AIZAWL DISTRICT OF MIZORAM, INDIA

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Abstract : Study of soil gas radon concentration is carried out in different oil exploration areas of Aizawl district, Mizoram, India. Three oil exploration areas namely, Phulmawi(PM), Maubuang(MB) and Keifang(KF) are studied. The study was conducted with RnDuo machine devised to survey Radon 222 (^{222}Rn) fitted with a soil probe of 120cm long. The radon soil gas concentration was studied at four different depths like 10cm, 30cm, 50cm and 70cm. For each location, an in-situ measurement of soil gas concentration was carried out at three different spots to cover the entire areas. The minimum value of radon concentration is observed at KF-2 spots at 10cm depth; whereas a maximum concentration is observed at MB-2 spot at 70cm depth. The radon concentration in soil gas ranges from 0.10kBq/m^3 to 1.60kBq/m^3 within the study areas. It has been observed that there is no significant rise in the concentration of Radon gas within these areas as compared to studies conducted at different parts of India. The study further concludes that the radon gas concentration obtained in these locations is below the worldwide average.

Keywords: Soil Probe, RnDuo, in-situ measurement.

1. INTRODUCTION

Radon is a gas that comes from the naturally occurring radionuclide. The isotope ^{222}Rn is mostly the decay product of ^{238}U (approximately 55%) of the internal radiation exposed to human (ICPR 1993) and it is found in almost all types of soil. Radon penetrates through the ground and comes out to the air. It is present in the water also. Despite porosity, the radon movement in rock depends upon compaction, fractural, tectonic features like earths thrust, earths faults and earths joints (Choubey *et al.* 1997). Oil and gases were drawn from the earth crust. It is interesting to diagnose the possible differences in Radon Concentration in soil gas of those areas. In India and Pakistan, radon survey in soil gas was carried out at different parts and locations (Mujahid *et al.* 2008; Ali *et al.* 2010; Prasad *et al.* 2005, 2008; Bajwa *et al.* 2010; Singh *et al.* 2010; Mehra and Bala 2013).

The main aim of the present study is to see if the Radon gas Concentration present in soil gas of these three oil exploration areas in Aizawl district of Mizoram were extremely high or low in concentration as compared to any other non-oil exploration areas in various other places in India. The table 1 and 2 given below clearly shows and compares the various Radon gas concentration obtained at the study areas and at different non-oil exploration areas in India. We can thus further study the percentage of difference in the increase or decrease of Radon concentrations. Any difference will indicate the likely contribution of crude oil present inside the earth that causes a variation in the final Radon concentration counts. In oil exploration areas, it is eminent that huge crude deposits are present that may have the potential to contribute for either the increase or decrease in the concentration of Radon gas as compared to normal earth thrust.

2. STUDY AREA

Mizoram is located in the North Eastern part of India. There are all together Six major oil exploration areas in Mizoram such as Meidum and Zanlawn area located at Kolasib district; Phulmawi, Maubuang and Keifang area located at Aizawl district and Thenzawl area located at Serchhip district respectively. The present study location Phulmawi area stretches from $23^0$35'29.9"N to $23^0$35'33.1"N and between 92'51'23.0"E to 92'51'25.0"E with an elevation range of 2900 ft and 2956 ft from sea level. That of Maubuang area stretches from $23^0$29'42.7"N to 23^0 29'47.3"N and between $92^0$42'3.6"E to 92^0 42'5.8"E with an elevation range of 2870 ft and 2885 ft from sea level. And that of Keifangarea stretches from $23^0$39'12.5"N to $23^0$39'14.2"N and between $92^0$57'0.9"E to $92^0$57'1.7"E with an elevation range of 2915ft to 2927ft from sea level.

The Figure.1 shows the location maps of all the oil exploration areas in Mizoram. Out of these six oil exploration areas, during this presentation, studies were conducted from three areas present in Aizawl district.

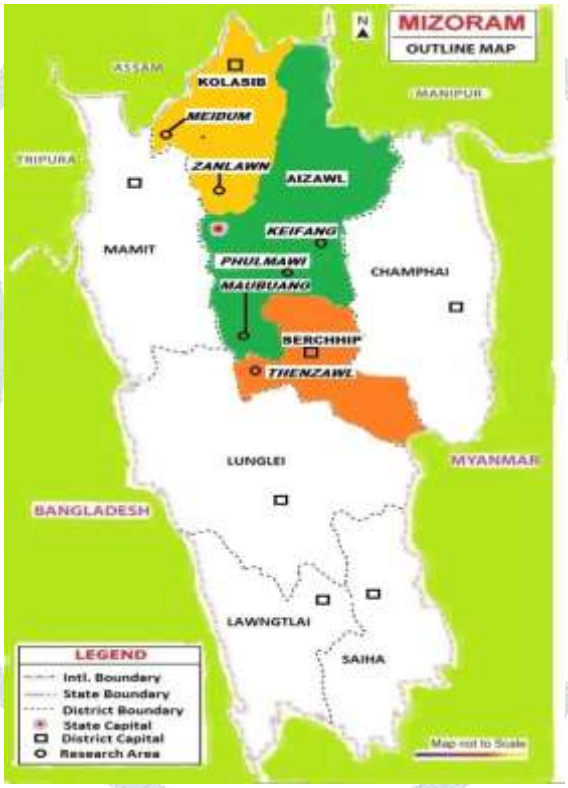


Fig.1. Map of Mizoram showing different Oil Exploration areas (2020)

3. INSTRUMENTS

3.1. SMART RADON AND THORON MONITOR (RnDuo)

The model RnDuo fitted with Soil probe(shown in Fig.2.) and the block diagram of Smart RnDuo (Fig.3.) is a technologically advanced portable continuous radon / thoron monitor, designed for multiple applications in radon and thoron studies. For radon measurements, sample gas is collected into a scintillation cell (150 cc) by diffusion process. During diffusive sampling, the gas passes through a "progeny filter" and "thoron discriminator" eliminating radon/thoron progenies and thoron. The thoron discriminator based on "diffusion-time delay" does not allow the short lived thoron 220Rn (half-life 55.6 s) to pass through. The radon measurements in RnDuo are based on detection of alpha emitted from radon and its decay products formed inside a scintillation cell volume. The alpha scintillations from radon and its decay products formed inside the cell are continuously counted by the PMT and the associated counting electronics.

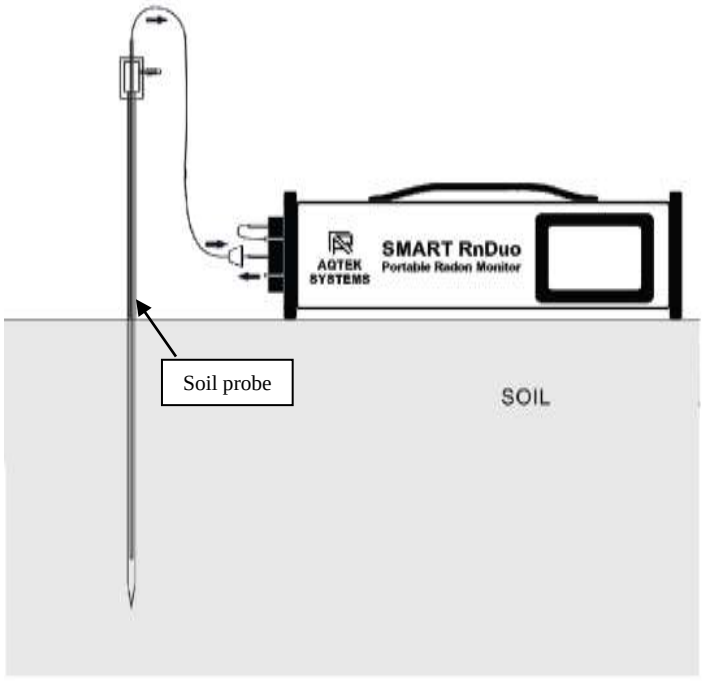


Fig.2. Soil probe for measurement of radon gas in soil

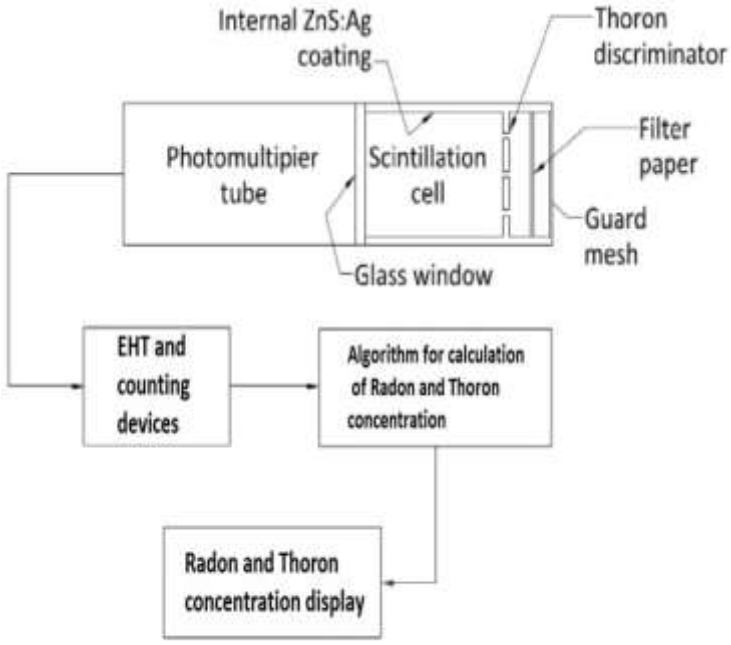


Fig.3. Block diagram of Smart RnDuo

3.2. SOIL PROBE

Soil probe provided with RnDuo system is utilized for the measurement of radon gas concentration in soil. Soil probe of various lengths are available. For the present investigation soil probe of 120cm in length is engaged. The soil probe is made of stainless steel with hollow inside for the passage of gas. An inner pipe can be inserted in the probe which is further fitted with the head. And the head is utilized for safe hammering point. The soil probe could thenbe hammered with a wooden block on the head till it reached the required depth. The head isthen removed and RnDuo monitor is connected to the inlet port of the soil probe thus enabling the completion of the set up and ready for reading.

4. METHODOLOGY

4.1. MEASUREMENT OF RADON GAS CONCENTRATION IN SOIL

After choosing desired location for the study, the soil probe marked at different desired length is set for immersion. The soil probe is then hammered with a wooden block on the head till it reached the required depth. An *in-situ* measurement was done with an instrument specially designed for the purpose namely Smart RnDuo monitor connected to the inlet port of the soil probe. The online monitor should have minimum interference from humidity.The Radon concentration in soil gas was carried out at three different spots in one oil exploration area. Three oil exploration areas are chosen which comprise of 9 spots. The radon concentration was determined at four different depths namely 10cm, 30cm, 50cm and 70cm. After the probe has been baptised at a required depth, The pump is manually turned on for 1-2 minutes by putting Pump setting On in Rn222 mode before recording the first reading and at consecutive depth before taking any readings. The gas present in the soil then passes through the soil probe and through the pipe connecting the inlet hole of the RnDuo instrument. This gas is first collected to the scintillation counter by the process of diffusion. The gas then passes through the progeny filter and thoron discriminator that filters away the thoron 220Rn gas and all the progenies of radon that has a half life of merely 55.6secs.The radon gas is then measured based on detection of alpha emitted from radon and its decay products formed inside the scintillation cell volume. Four reading at 15mins cycle was taken for each depth. The mean of the three readings gives the final reading for the chosen depth. This is done to ensure that the required accurate concentrations are obtained. The maximum radon concentration in soil gas in kBq/m^3 at different depth is obtained. A graph is plotted against the concentration in kBq/m^3 and soil depth in cm.

5. RESULT AND DISCUSSION

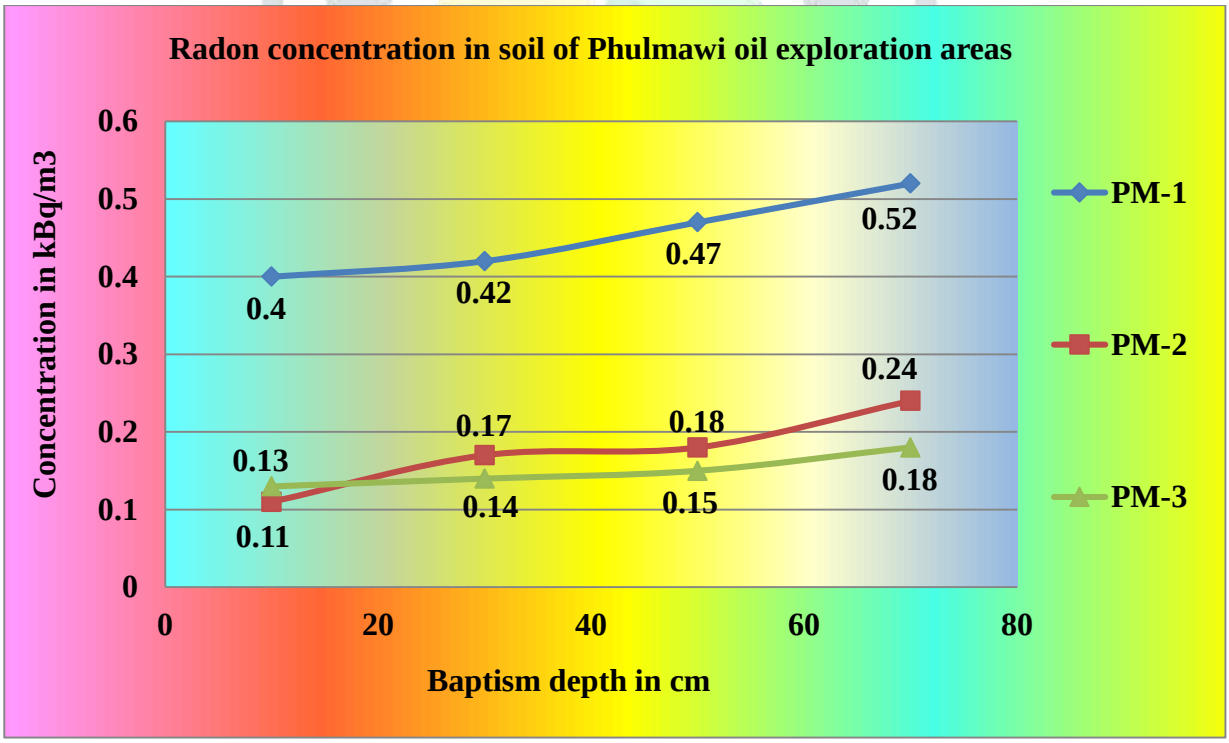
The result and observation of Radon Concentration in soil gas of these three different oil exploration areas in Aizawl district of Mizoram are given in Table 1. The radon concentration in Phulmawi location varies from 0.11kBq/m^3 at 10cmdepth to 0.52kBq/m^3 at 70cm depth. In Maubuang location it varies from 0.15kBq/m^3at 10cm to 1.60kBq/m^3at 70cm. In Keifang location the radon concentration varies from 0.10kBq/m^3at 10cm depth to 0.40kBq/m^3 at 70cm depth. The readings are taken in the month of December 2018. During this month the weather is dry and there is no rainfall for the last 30 days. The soil in the study area is found to be free from moisture content.

Study of soil types of these oil exploration areas is also conducted. A mean of soil type classification in Phulmawi oil exploration areas shows that 87.20% are sand, 6.38% are silt and 6.42% are clay. In Maubuang areas, the mean soil type classification shows that 86.55% are sand, 3.98% are silt and 9.47% are clay. In Keifang oil exploration areas, the mean soil type classification of the different study location shows that 95.58% are sand, 2.02% are silt and 3.40% are clay. It is, therefore, found that around 90% of the soil of these study areas are mostly sand. There is no sign of rocks and sediments. The radon concentration is mostly higher in rocks and sediments which is, but, missing in the soil types of the oil field of the study areas. This may have contributed to the low concentration of radon gas in the area.

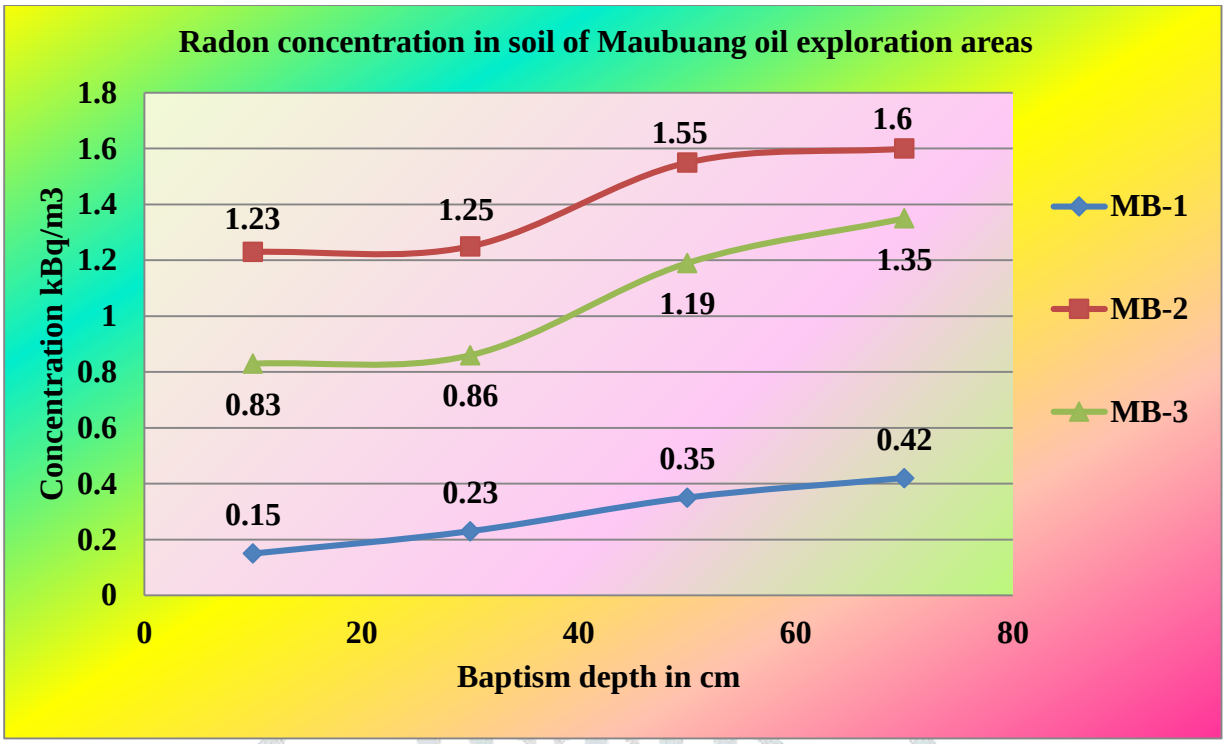
Table-1. *Radon Concentration in soil gas at various Baptism depth of oil exploration areas in Aizawl district of Mizoram, India*

Sl. No	Sampling Location	Sampling ID	GPS Location (Latitude/Longitude)	Baptism Depth	Radon Concen-trationkBq/m^3
1	Phulmawi	PM-1	Elev(ft) : 2900	10cm	0.40
			North : $23^0$35’33.1”	30cm	0.42
			East : 92’51’25.0”	50cm	0.47
				70cm	0.52
2	Phulmawi	PM-2	Elev(ft) : 2901	10cm	0.11
			North : $23^0$35’32.0”	30cm	0.17
			East : 92’51’24.8”	50cm	0.18
				70cm	0.24
3	Phulmawi	PM-3	Elev(ft) : 2956	10cm	0.13
			North : $23^0$35’29.9”	30cm	0.14

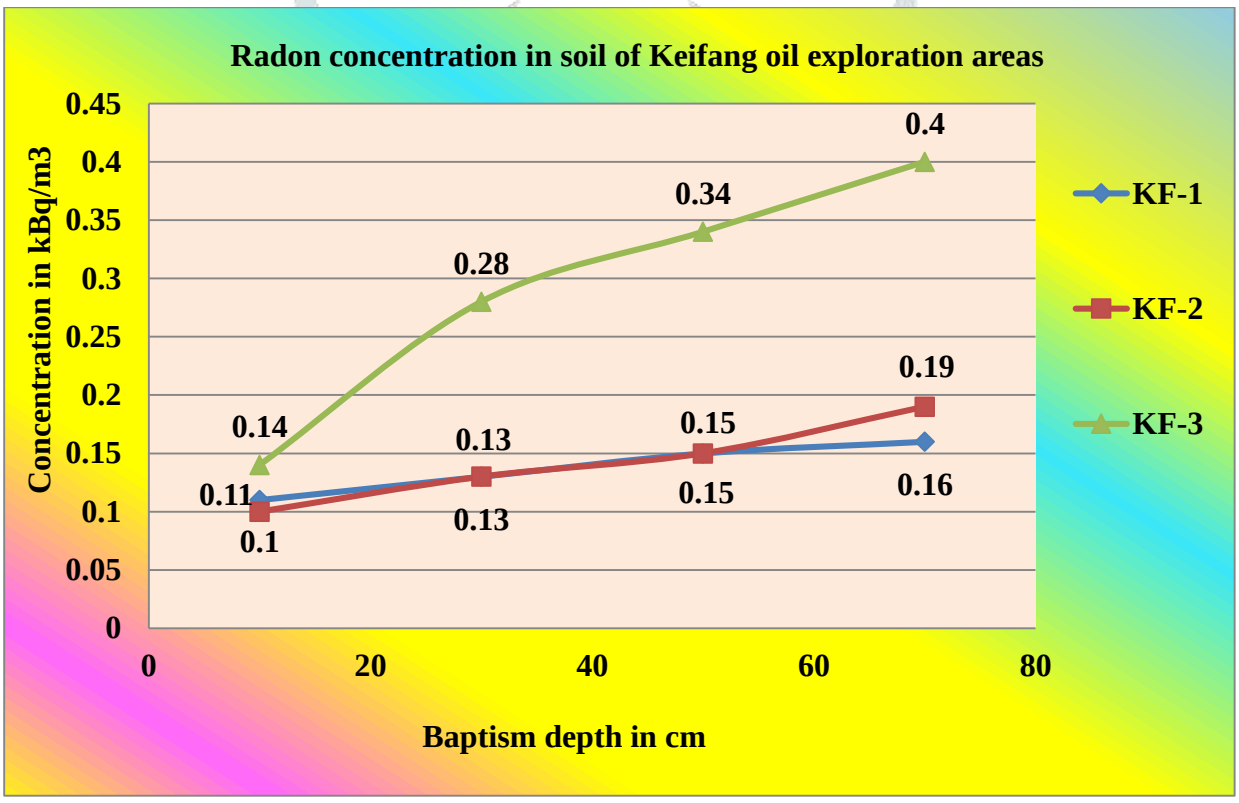
			East	: 92’51’23.0”	50cm	0.15
					70cm	0.18
4	Maubuang	MB-1	Elev(ft)	: 2875	10cm	0.15
			North	: 23^0 29’45.5”	30cm	0.23
			East	: 92^0 42’4.3”	50cm	0.35
					70cm	0.42
5	Maubuang	MB-2	Elev(ft)	: 2870	10cm	1.23
			North	: 23^0 29’47.3”	30cm	1.25
			East	: 92^0 42’5.8”	50cm	1.55
					70cm	1.60
6	Maubuang	MB-3	Elev(ft)	: 2885	10cm	0.83
			North	: $23^0$29’42.7”	30cm	0.86
			East	: $92^0$42’3.6”	50cm	1.19
					70cm	1.35
7	Keifang	KF-1	Elev(ft)	: 2927	10cm	0.11
			North	: $23^0$39’14.2”	30cm	0.13
			East	: $92^0$57’1.2”	50cm	0.15
					70cm	0.16
8	Keifang	KF-2	Elev(ft)	: 2915	10cm	0.10
			North	: $23^0$39’12.5”	30cm	0.13
			East	: $92^0$57’1.7”	50cm	0.15
					70cm	0.19
9	Keifang	KF-3	Elev(ft)	: 2918	10cm	0.14
			North	: $23^0$39’13.7”	30cm	0.28
			East	: $92^0$57’0.9”	50cm	0.34
					70cm	0.40



Graph-1. *Radon concentration in soil at different spot of Phulmawi oil exploration areas*



Graph-2. *Radon concentration in soil at different spot of Maubuang oil exploration areas*



Graph-3. *Radon concentration in soil at different spot of Keifang oil exploration areas*

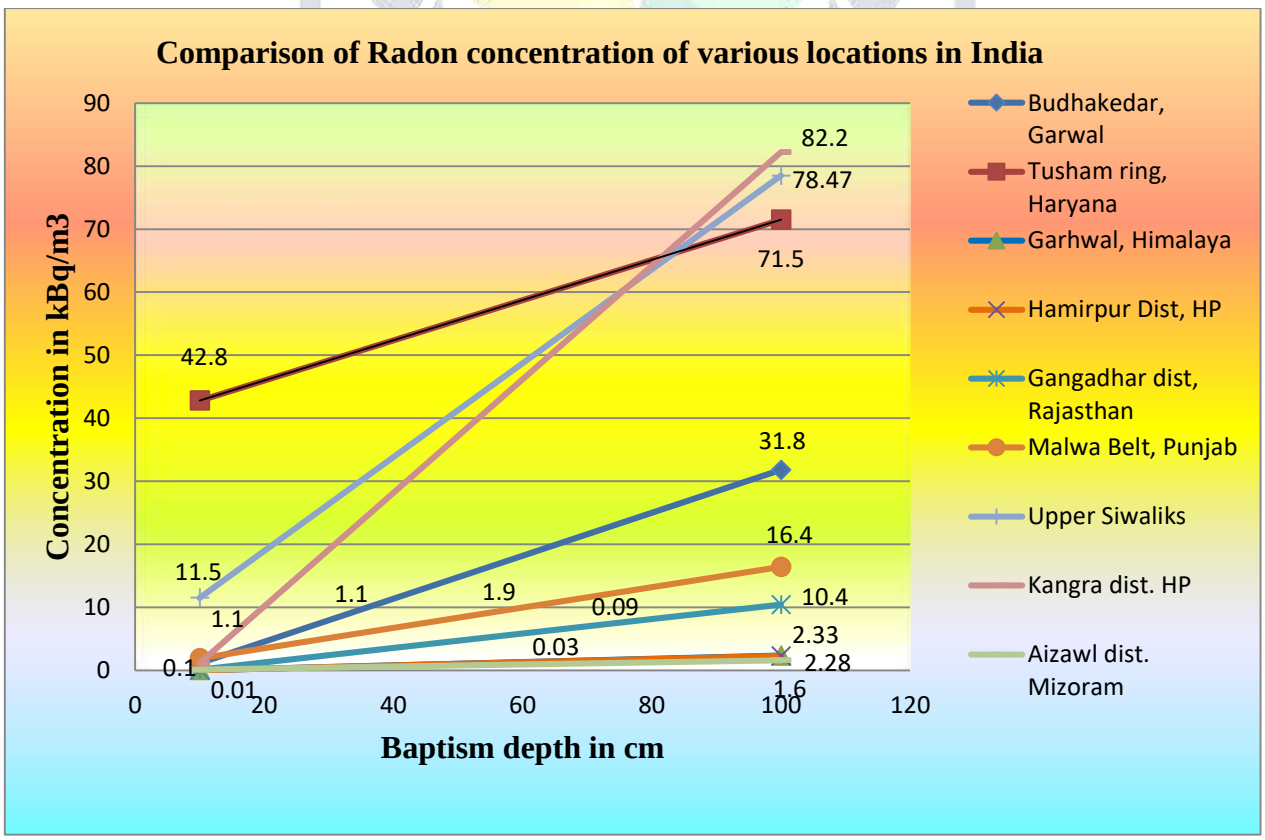
6. COMPARISON WITH STUDIES FROM OTHER AREAS IN INDIA

The study to determine the radon concentration in soil gas is also carried out at various places in India. The concentration was found to vary between 1.10kBq/m^3 to 31.80kBq/m^3 in the Budhakedar area of Tehri Garhwal (Prasad *et al.* 2008). In Tusham ring complex Haryana the radon concentration varies between 42.80kBq/m^3 to 71.50kBq/m^3 (Bajwa *et al.*,2010). The radon concentration in soil gas ranges from 0.01 kBq/m^3 to 2.33 kBq/m^3 in Garhwal, Himalaya (Bourai *et al.*, 2013). The radon concentration as reported from Hamirpur district, Himachal Pradesh, India varies between 0.03kBq/m^3 to 2.28kBq/m^3 (Mehra and Bala 2013). In Kangra district, Himachal Pradesh the radon soil gas concentration varies from 1.10kBq/$m^3$to

82.20kBq/m^3 (Singh *et al.*,2006) and in Gangadhar district of Rajasthan the radon gas concentration varies between 0.09kBq/m^3 to 10.40kBq/m^3. The radon gas concentration Malwa belt, Punjab is found to vary between 1.90kBq/m^3 to 16.40kBq/m^3 and lastly the concentration in Upper Siwaliks ranger from 11.50kBq/m^3 to 78.47kBq/m^3 which is quite high. Most of the Radon Concentration in Soil Gas as obtained from various other locations falls within the range of the present investigation except those in the Tusham ring complex of Haryana and Malwa belt, punjab. Moreover the radon concentration in soil gas as obtained in this study are found to be less than the worldwide average value of 35kBq/m^3 for outdoor radon activity recommended by United Nations Scientific committee on the Effects of Atomic Radiation (UNSCEAR 2000).

Table-2. *Radon gas Concentration in soil at various places in India*

Sl. No	Locations	Concentration kBq/m^3. Range(10cm-100cm)	References
1	Budhakedar, tehri Garwal	1.10 - 31.80	Prasad *et al.* (2008)
2	Tusham ring, Haryana	42.80 - 71.50	Balwa *et al.* (2010)
3	Garhwal Himalaya	0.01 – 2.33	Bourai *et al.* (2013)
4	Hamirpur district, HP.	0.03 – 2.28	Mehra and Bala (2013)
5	Kangra district, HP.	1.10-82.20	Singh *et al.* (2006)
6	Ganganagar District Rajasthan	0.09 – 10.40	Duggal *et al.* (2013)
7	Malwa belt, Punjab	1.90 – 16.40	Kumar *et al.* (2011)
8	Upper Siwaliks, India	11.50-78.47	Singh *et al.* (2010a)
9	Oil Exploration areas from Aizawl district, Mizoram	0.10 – 1.60	Present investigation



Graph-4. *Minimum and Maximum Radon concentration in soil of various locations in India*

7. CONCLUSION

The Radon concentration in soil gas of oil exploration areas in Aizawl district of Mizoram is studied. An *in situ* measurement was taken at four different depth such as 10cm, 30cm, 50cm and 70cm with the help of a Smart RnDuo and a stainless steel probe. The study was carried out during winter season in the month of December 2018. The soil has no moisture content. It has been observed that the concentration of radon gas increases as we baptize the soil probe deeper and deeper. This means that for every spot chosen, the radon gas concentration at 10cm deep is lowest and the radon gas concentration at 70cm is highest and the concentration at 30cm and 50 cm lie in between. The radon gas concentration within Aizawl district does not show any notable difference in the concentration as compared to results obtained from other locations within India.. With the present study we may conclude by saying that the concentration of radon soil gas that emanates in oil exploration areas in Aizawl district of Mizoram, India does not increase the radon gas concentration. This may be because of less uranium deposits within the areas. The radon gas concentration obtained in these locations isfar below the world average of 35-40 kBq/m^3.

8. ACKNOWLEDGEMENT

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