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Correlation between Ground Level Gamma Radiation and Radon Gas Concentration in Soil at Different Baptism Depth of oil Exploration Areas within Serchhip and Kolasib District of Mizoram, India

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Abstract:. *Ground level Gamma Radiation and Radon gas concentration at different depth beneath the ground surface of oil exploration areas in Mizoram, India is studied and correlation graph is drawn. The oil exploration areas including Thenzawl(TZ) in Serchhip district, Meidum(MD) and Zanlawn(ZL) in Kolasib district, are studied. The main instrument utilized for the study was RnDuo machine devised to survey Radon 222 (^{222}Rn) connected to soil probe of 1mtr long to be baptized at different depth. Background gamma radiation survey at ground level is conducted with Russian base Gamma Survey Meter (PM 1405). The background gamma radiation at ground level varies from 168 nSv/hr at TZ-1 to 202 nSv/h at MD-1 location with an average of 182 nSv/h. An in-situ measurement of soil gas was carried out at three different spots at four different depths each namely 10cm, 30cm, 50cm and 70cm. The radon gas concentration beneath the soil, within the study area ranges from 0.10 kBq/m^3 at MD-3 to 1.37 kBq/m^3 at TZ-2 location. A correlation graph between ground level gamma radiation and the radon concentration in soil at different dept shows that the correlation coefficient is lowest at 10cm with R^2=0.012 and highest at 70cm with R^2=0.112. The Radon gas concentration obtained in these areas are below the worldwide average of 35-40 kBq/m^3 .(UNSCEAR 2000).*

Keywords: Soil Probe, in-situ measurement, Gamma survey meter PM-1405

I. INTRODUCTION

Ground soil, not only consists of organic and inorganic compounds but also contains radionuclide namely Uranium, thorium, radium, potassium etc, which are a source of natural radioactivity and contribute to background radiation. The background radiation contribute a considerable percentage of the total radiation exposure to individuals (*Porstendorfer et al., 1994)*. Natural radionuclide are broadly classified into two types as – Cosmogenic (which comes from cosmic ray particles undergoing nuclear reactions) and Primordial (which are in existence since the origin of Earth) *(Radenkovic et al., 2009; Tzortzis et al., 2003)*. The levels of natural background radiation dose rates vary from 1.4 to 2.4 mSv y^{-1} depending on the abundance of primordial radionuclides in the soil and the latitude and longitude of that place (*UNSCEAR 1993)*.

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. Despite porosity, the radon movement in rock depends upon various factors like compaction, fractural, tectonic features like earths thrust, earths faults and earths joints (Choubey *et al.* 1997). The radon concentration at different baptism depth is different (Bourai *et al.*2013). The concentration increases with depth. The deeper the baptism depth the greater the radon concentration (Duggal *et al.* 2013). Radon concentration at different baptism depth of oil

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exploration arease in Serchhip and Kolasib district are studied. 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 aim of the present study is to find the radon concentration at different baptism dept and to draw the correlation graph with the background gamma radiation at ground level.

II. MATERIAL AND METHODS

Mizoram is located in the North Eastern part of India neighbouring the state of Assam in the north. The three oil fields chosen are situated are Meidum and Zanlawn village area located at Kolasib district and Thenzawl area located at Serchhip district respectively. The present study location Thenzawl area stretches from $23^0$18'08.3"N to $23^0$18'12.4"N and between 92'42'5.8"E to 92'47'11.9"E with an elevation range of 2454 ft and 2483 ft from sea level. That of Meidum area stretches from $24^0$10'11.8"N to $24^0$10'12.9"N and between $92^0$35'55.4"E to $92^0$35'58.8"E with an elevation range of 291ft to 331ft from sea level. And that of Zanlawn area stretches from $23^0$59'01.0"N to 23^0 59' 02.6"N and between $92^0$42'47.8"E to 92^0 42'50.8"E with an elevation range of 2110 ft and 2900 ft from sea level. The Fig.1. shows the location maps of oil exploration areas at different districts of Mizoram, India.

2.1. Measurement of Background Gamma radiation using Gamma survey meter PM-1405

At each location of soil sample collection a gamma radiation survey will be conducted with the help of Gamma Survey Meter (PM 1405). Detecting γ radiations is carried out with Survey Meter PM 1405 by detection bloc on the basis of Geiger-Muller counter by transformation of photon to electro-pulses. Detection bloc controlling, transfer of measured data to the main microprocessor controller are carried out by the embedded microprocessor controller as shown in Fig.2. The instrument's operating algorithm ensures continuity of the measurement process, static handling of measurement results, fast adaptation to radiation rate changes and effective output of the information obtained on the LCD. The measurement range for γ radiations is between the range of 0.1μSv/h – 100 mSv/h. The Gamma survey is conducted at the surface of the earth/ground.

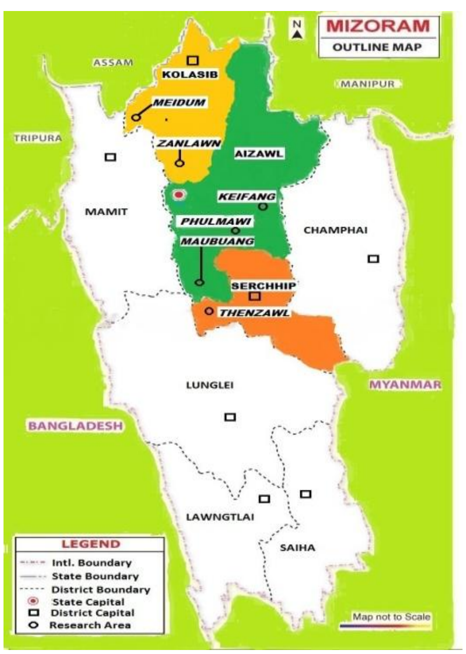

Fig.1. Map of Mizoram showing different Oil Exploration areas (2021)

Fig.2. Gamma survey meter PM-1405

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2.2. *In-situ* measurement of Radon concentration at different baptism depth

The Radon concentration in soil gas was carried out at three oil exploration areas. At each area, three different spots were chosen to cover the entire areas. As a whole, nine (9) spots were chosen in three oil fields. The radon concentration was determined at four different depths namely 10cm, 30cm, 50cm and 70cm. An *in-situ* measurement was done with Smart RnDuo, an instrument specially designed for the purpose. Fig.2. shows the Smart RnDuo for measuring radon concentration in soil gas at different depth which is fitted with a stainless steel probe that could be baptized at different depths. After the probe has been baptised at a particular depth, four reading at 15mins cycle was taken. The mean of the three readings gives the final reading for that depth. Fig.2 shows the block diagram of the mentioned smart RnDuo.

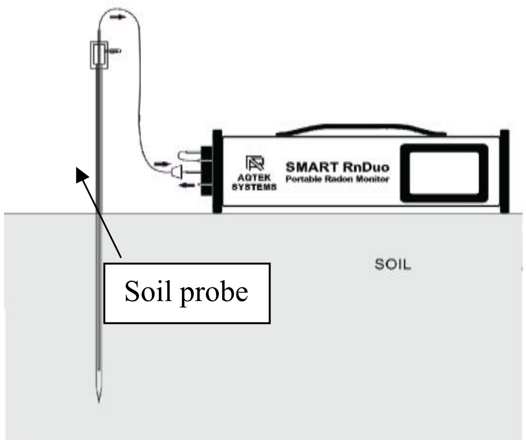

Fig.3. Set up for measurement of radon in soil

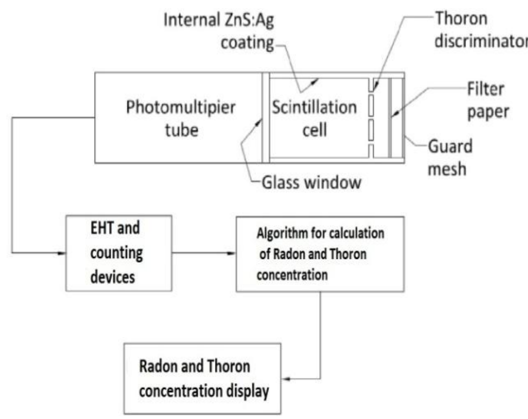

Fig.4. Block diagram of Smart RnDuo

III. RESULTS AND DISCUSSION

The background gamma radiation at each study location is given in Table-1. The same table shows radon concentration at 10cm, 30cm, 50cm and 70cm deep. The radon concentration in Thenzawl location varies from 0.14 kBq/m^3 at 10cm depth to 1.37 kBq/m^3 at 70cm depth. In Meidum location the radon concentration varies from 0.10 kBq/m^3 at 10cm depth to 0.31 kBq/m^3 at 70cm depth. And in Zanawn location it varies from 0.12 kBq/m^3 at 10cm to 0.21 kBq/m^{3}at 70cm. The readings are taken in the month of January 2020. During this month the weather is dry and there are no rainfall for the last 30 days. The soil in the study area is free from moisture.

Table-1. *Gamma Radiation at ground level and Radon Concentration in soil gas at various baptism depth of oil exploration areas in Serchhip and Kolasib district of Mizoram, India*

Sl.	**Sampling**	**Sampling**	**Gamma ground level**	**Baptism**	**Radon Concen-tration kBq/m^3**
No	**Location**	**ID**	**(nSv/hr)**	**Depth**	
1	Thenzawl	TZ-1	168	10cm	0.15
				30cm	0.26
				50cm	0.49
				70cm	0.72
2	Thenzawl	TZ-2	176	10cm	0.81
				30cm	1.08
				50cm	1.23
				70cm	1.37

3	Thenzawl	TZ-3	176	10cm	0.14
				30cm	0.15
				50cm	0.20
				70cm	0.22
4	Meidum	MD-1	202	10cm	0.22
				30cm	0.24
				50cm	0.26
				70cm	0.31
5	Meidum	MD-2	200	10cm	0.12
				30cm	0.13
				50cm	0.14
				70cm	0.15
6	Meidum	MD-3	177	10cm	0.10
				30cm	0.13
				50cm	0.15
				70cm	0.18
7	Zanlawn	ZL-1	189	10cm	0.15
				30cm	0.16
				50cm	0.18
				70cm	0.19
8	Zanlawn	ZL-2	176	10cm	0.12
				30cm	0.13
				50cm	0.15
				70cm	0.16
9	Zanlawn	ZL-3	175	10cm	0.12
				30cm	0.14
				50cm	0.18
				70cm	0.21

The Graph-1, Graph-2 and Graph-3 show radon concentrations at 10cm, 30cm, 50cm and 70cm baptism depth at Thenzawl, Meidum and Zanlawn oil exploration areas respectively.

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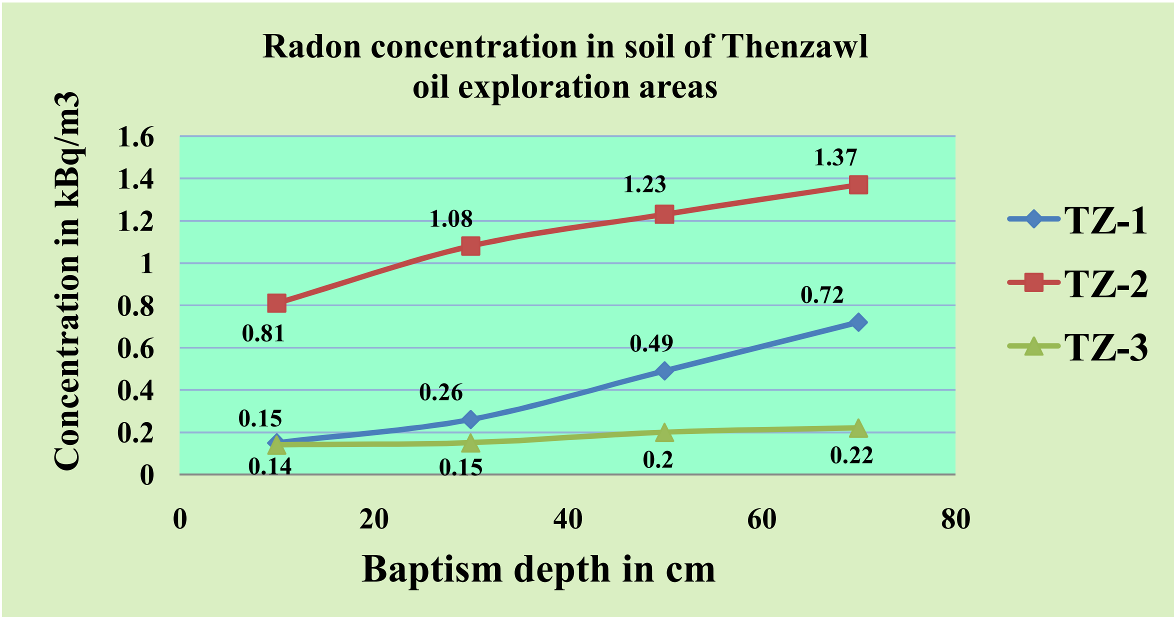
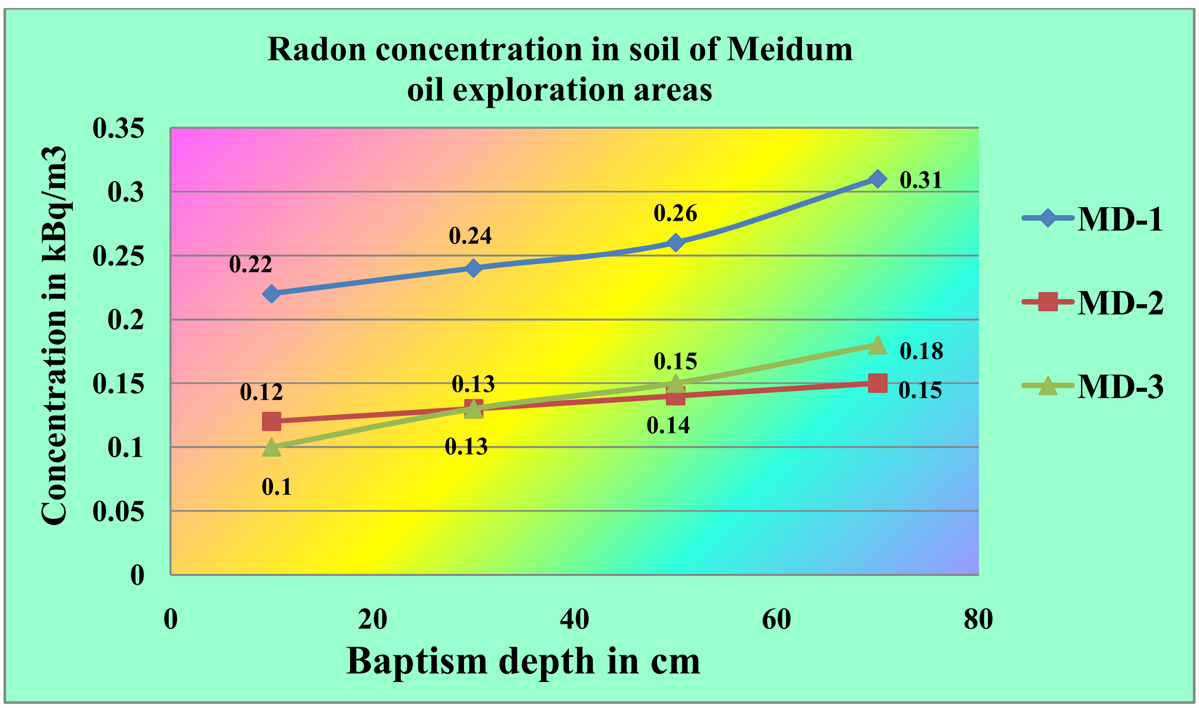


Graph-1. *Radon concentration at different dept in soil of Thenzawl oil exploration area*



Graph-2. *Radon concentration at different depth in soil of Meidum oil exploration area*

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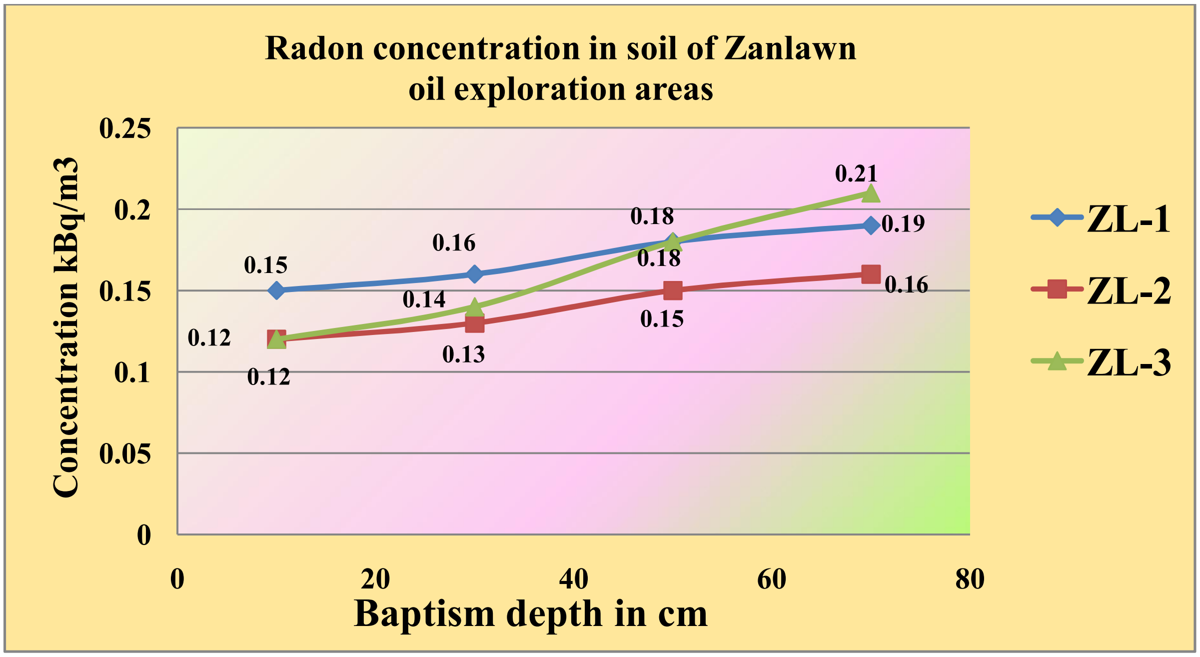
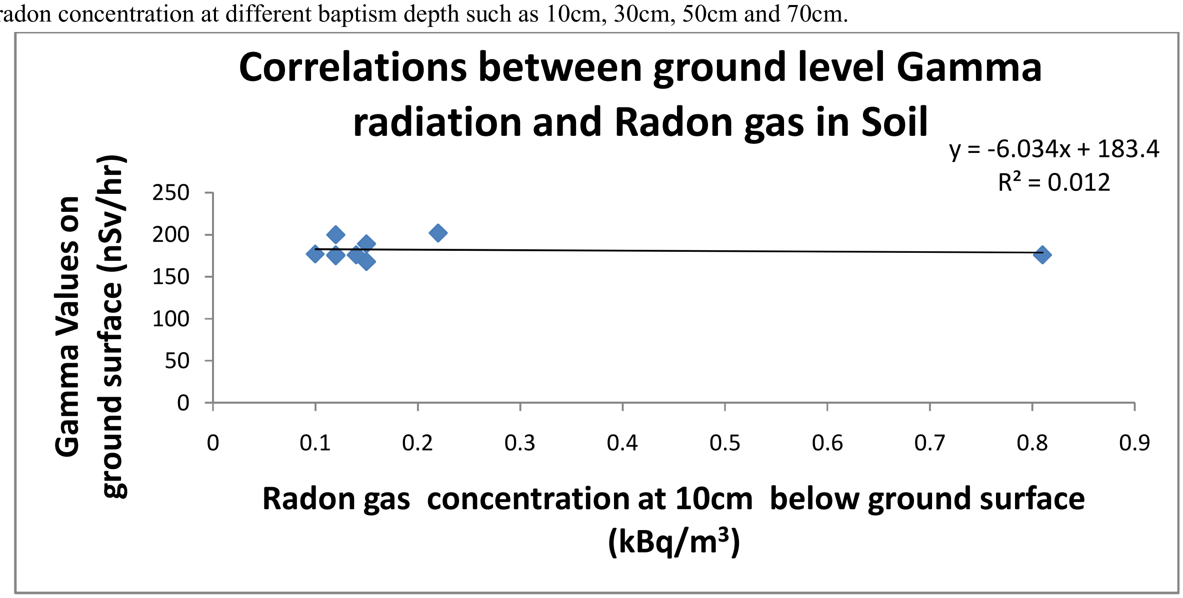


Graph-3. *Radon concentration at different depth in soil of Zanlawn oil exploration area*

The graph-4, graph-5, graph-6 and graph-7 shows the correlation between Ground level gamma radiation and average radon concentration at different baptism depth such as 10cm, 30cm, 50cm and 70cm.



Graph-4. *Correlation between Ground level gamma radiation and Radon concentration at 10cm deep.*

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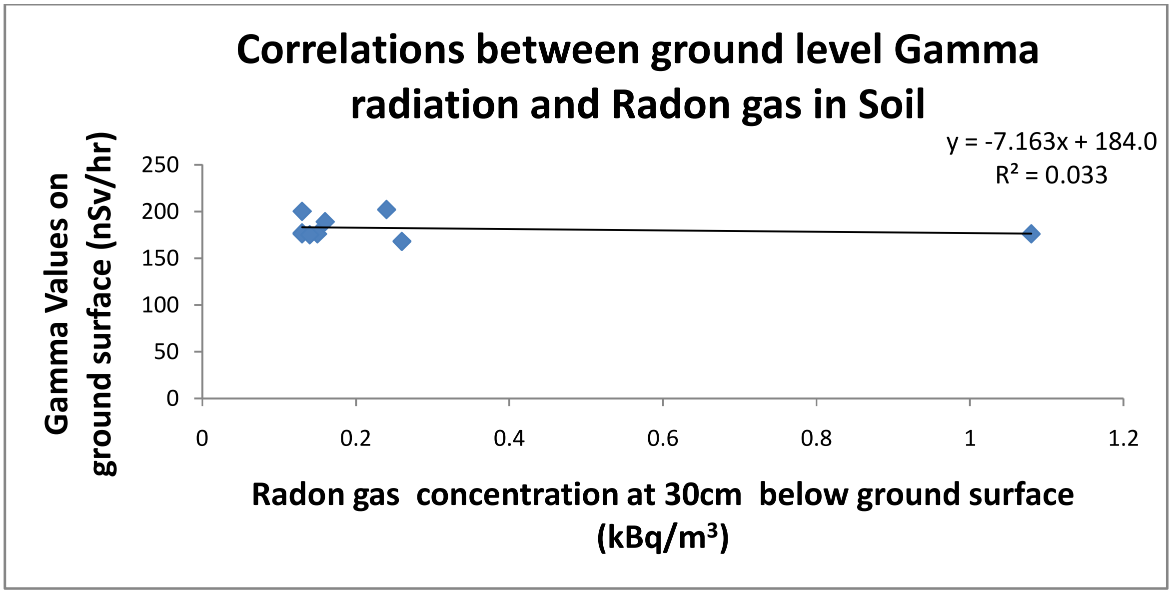
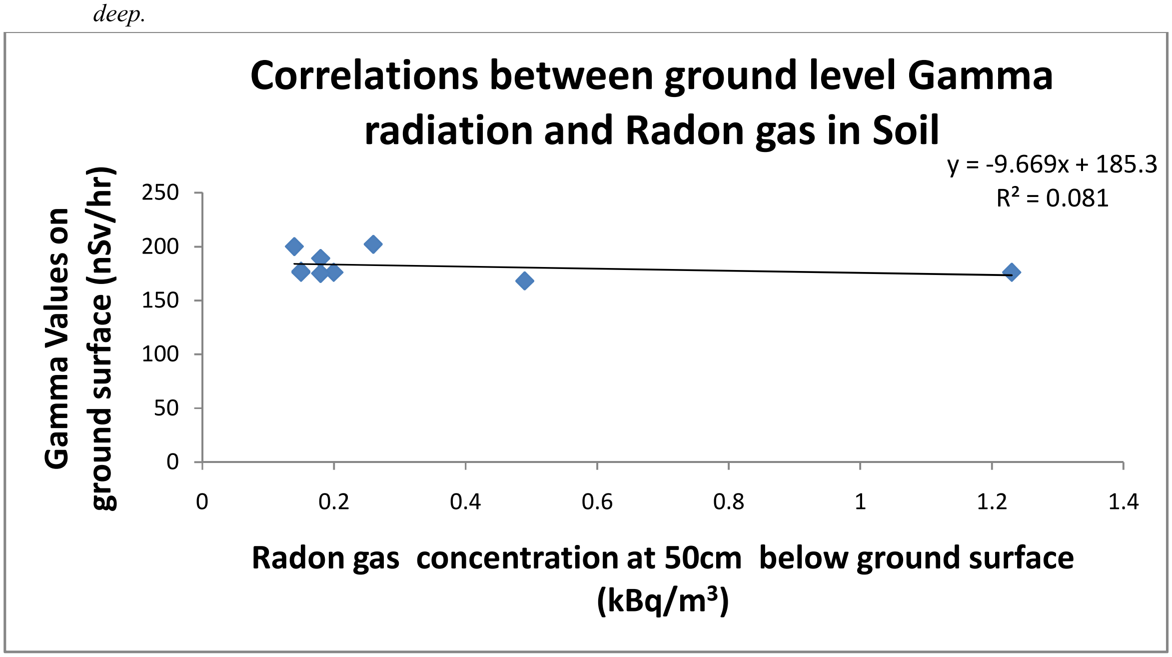


Graph-5. *Correlation between Ground level gamma radiation and Radon concentration at 30cm deep.*



Graph-6. *Correlation between Ground level gamma radiation and Radon concentration at 50cm deep.*

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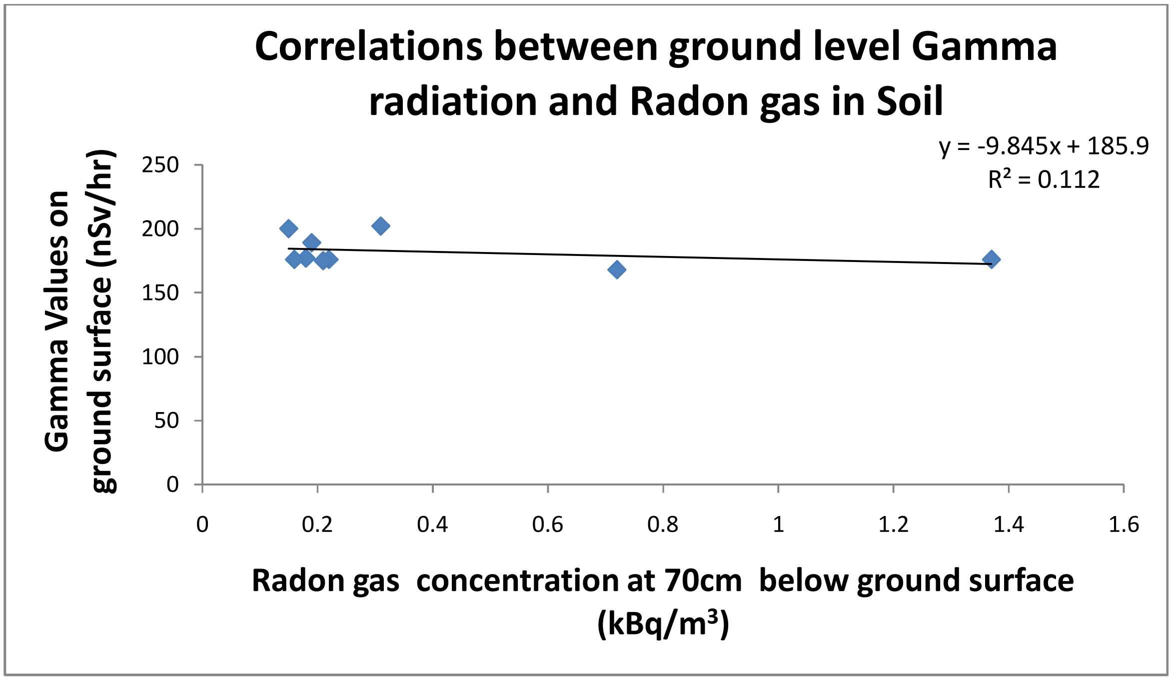

Graph-7. *Correlation between Ground level gamma radiation and Radon concentration at 70cm deep.*

IV. CONCLUSION

The Radon concentration in soil gas of oil exploration areas in Kolasib and Serchhip 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 January 2020. 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. Moreover, the correlation coefficient (R^2) obtained from the graph was least at 10cm with $R^2 = 0.012$ while it is maximum at 70cm deep with $R^2 = 0.112$. This indicates that the gamma radiation had a better correlation with higher radon concentration. The correlations observed are not that good. The possible reason for this poor correlation may be due to the contributing factor. Whereas the radon concentration at different baptism depth is contributed by Uranium 238, on the other hand, the background gamma radiation at ground level is contributed by many cosmic and terrestrial sources like Uranium, potassium, thorium etc. The radon gas concentration obtained in these locations are far below the world average of 35-40 kBq/m^3 (UNSCEAR 2000).

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