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Graph of Correlation between Background Gamma Radiation and Radon Concentration in Soil of Meidum and Zanlawn Oil Exploration Areas in Mizoram

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Abstract: ***Background gamma radiation on earth surface and radon concentration at different depth beneath the ground surface of oil exploration areas the oil exploration areas of Meidum(MD) and Zanlawn(ZL) in Mizoram, 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 177 nSv/hr at MD-3 to 202 nSv/h at MD-1 location with an average of 186.5 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 1.31 kBq/m^3 at MD-1 location. A correlation graph between ground level gamma radiation and the radon concentration in soil at different dept shows that the correlation coefficient is highest at 10cm with R^2=0.466 and lowest at 70cm with R^2=0.175. The Radon gas concentration obtained in these areas are below the worldwide average of 35-40 kBq/m^3 .(UNSCEAR 2000).***

Keywords: RnDuo, Soil Probe, in-situ measurement, Meidum, Zanlawn

I. INTRODUCTION

It is readily known that 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 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

The state of Mizoram is located in the North Eastern part of India neighbouring the state of Assam in the north. The two oil fields chosen are situated are Meidum and Zanlawn village area located at the boundary of Assam.

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The present study location 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.

A. 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.

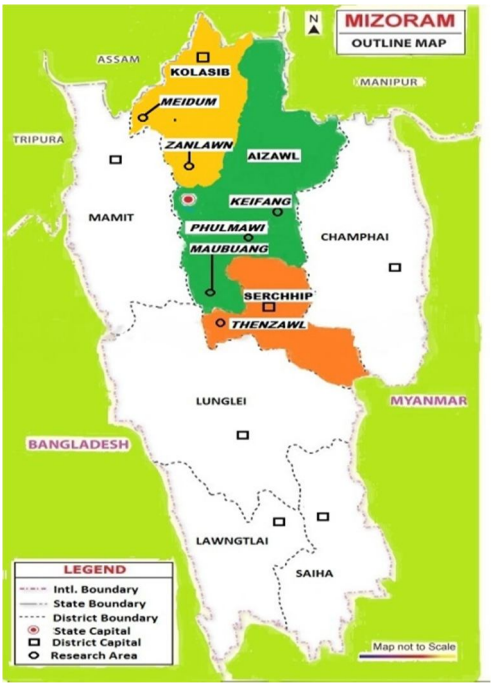

Fig.1. Map of Mizoram showing different Oil Exploration areas (2021)

Fig.2. Gamma survey meter PM-1405

B. In-situ measurement of radon concentration at different baptism depth

The Radon concentration in soil gas was carried out at two oil exploration areas. At each area, three different spots were chosen to cover the entire areas. As a whole, six spots were chosen in all. 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.3. shows the set up 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. Fig.4. shows the block diagram of Smart RnDuo. After the probe has been baptised at a particular depth, four reading at 15mins cycle was taken. The mean of the three readings give the final reading for that depth.

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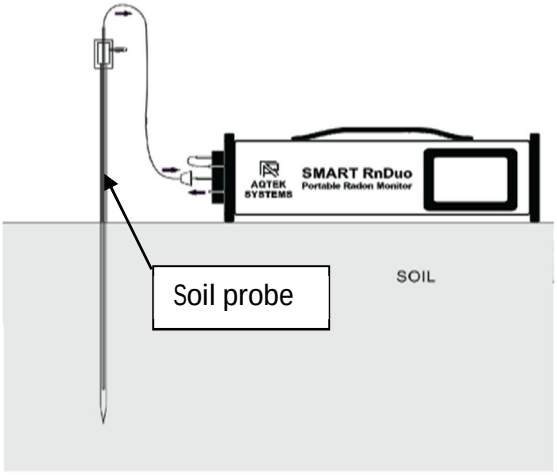

Fig.3. Set up for measurement of radon in soil

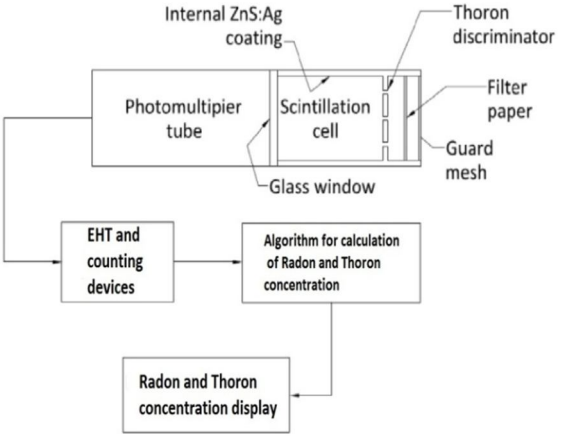

Fig.4. Block diagram of Smart RnDuo

III. RESULTS AND DISCUSSION

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. 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^3at 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 Kolasib district of Mizoram, India

Sl. No	Sampling Location	Sampling ID	Gamma ground level (nSv/hr)	Baptism Depth	Radon Concen-tration kBq/m^3
1	Meidum	MD-1	202	10cm	0.22
				30cm	0.24
				50cm	0.26
				70cm	0.31
2	Meidum	MD-2	200	10cm	0.12
				30cm	0.13
				50cm	0.14
				70cm	0.15
3	Meidum	MD-3	177	10cm	0.10
				30cm	0.13
				50cm	0.15
				70cm	0.18
4	Zanlawn	ZL-1	189	10cm	0.15
				30cm	0.16
				50cm	0.18
				70cm	0.19
5	Zanlawn	ZL-2	176	10cm	0.12
				30cm	0.13
				50cm	0.15
				70cm	0.16
6	Zanlawn	ZL-3	175	10cm	0.12
				30cm	0.14
				50cm	0.18
				70cm	0.21

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

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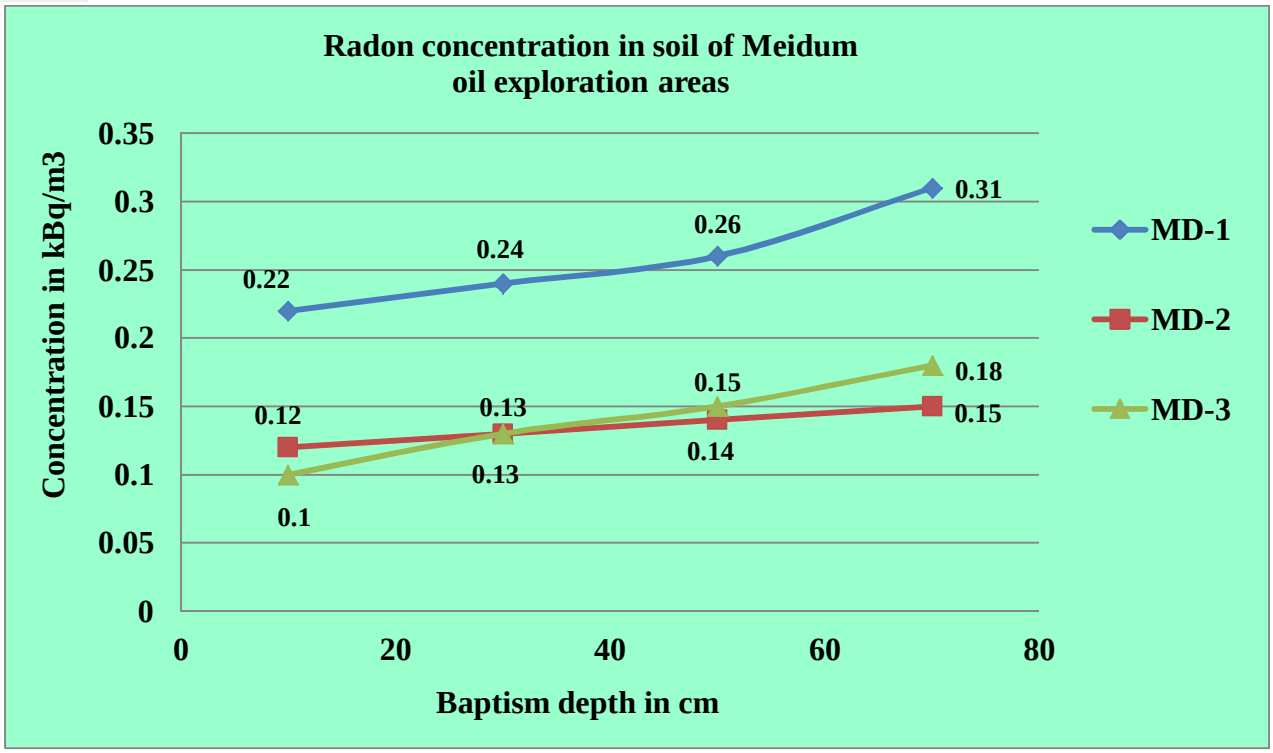
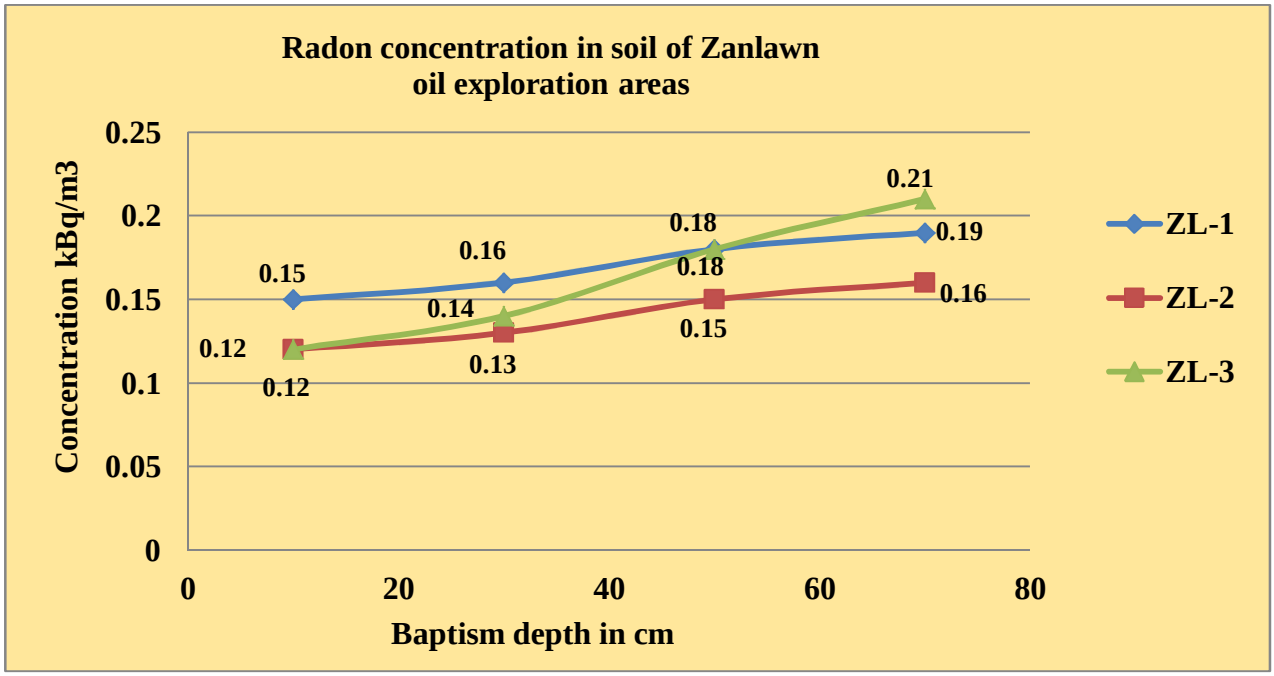


Graph-1. Radon concentration at different depth in soil of Meidum oil exploration area



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

The graph-3, graph-4, graph-5 and graph-6 shows the correlation between Ground level gamma radiation and average radon concentration in soil at different baptism depth such as 10cm, 30cm, 50cm and 70cm. The Pearson R^2 indicates the correlation at different depth.

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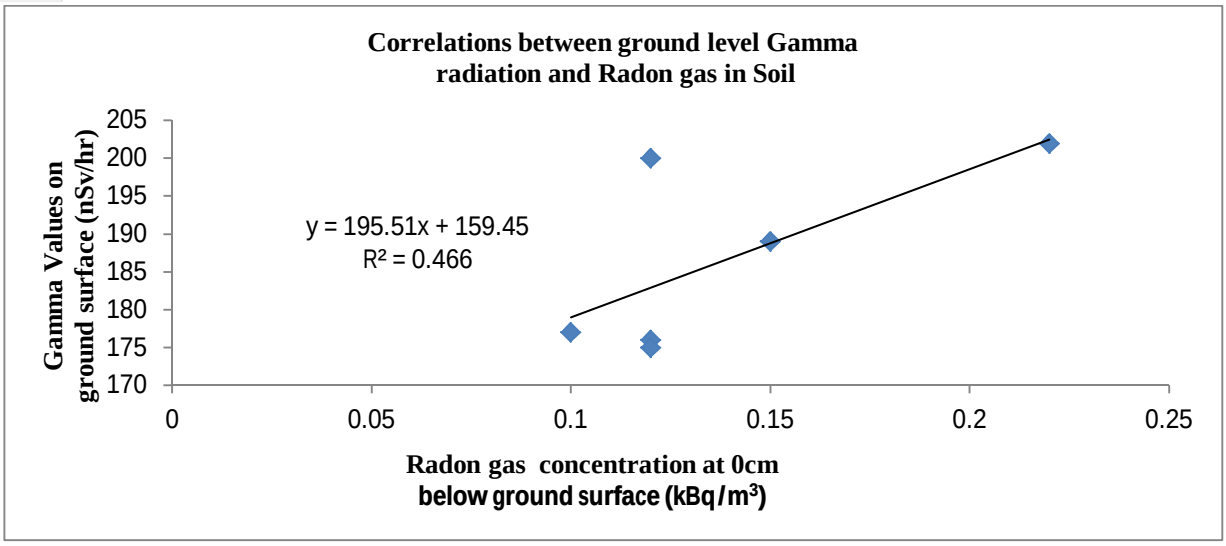
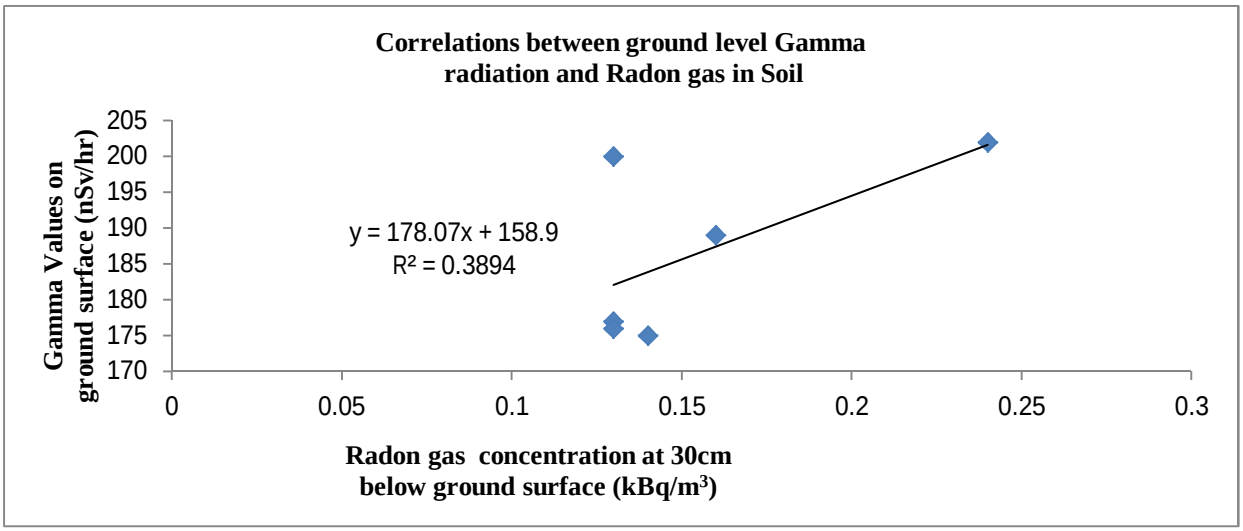
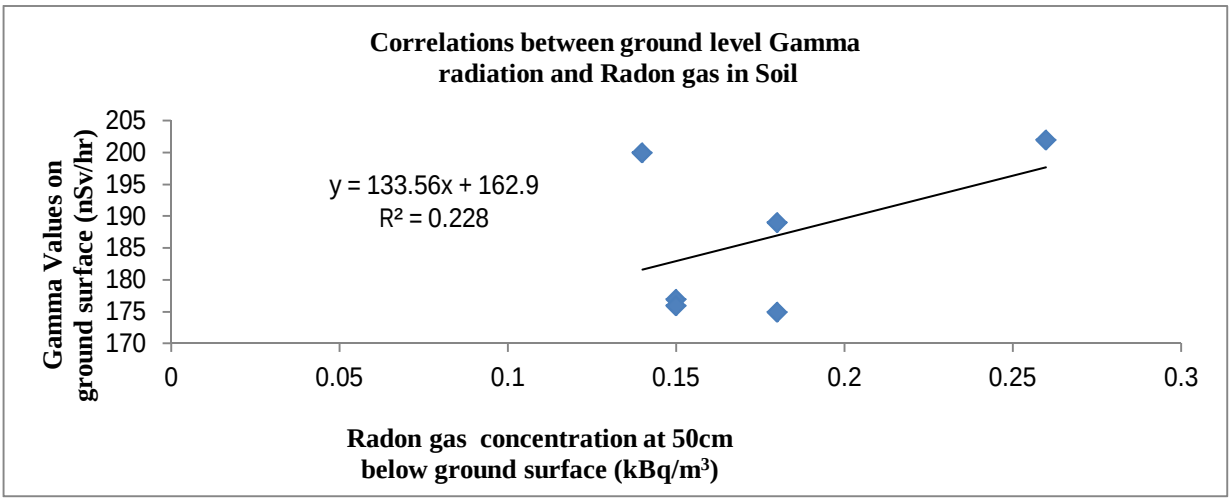


Graph-3. Correlation between Ground level gamma radiation and Radon concentration at 10cm deep.



Graph-4. Correlation between Ground level gamma radiation and Radon concentration at 30cm deep.



Graph-5. Correlation between Ground level gamma radiation and Radon concentration at 50cm deep.

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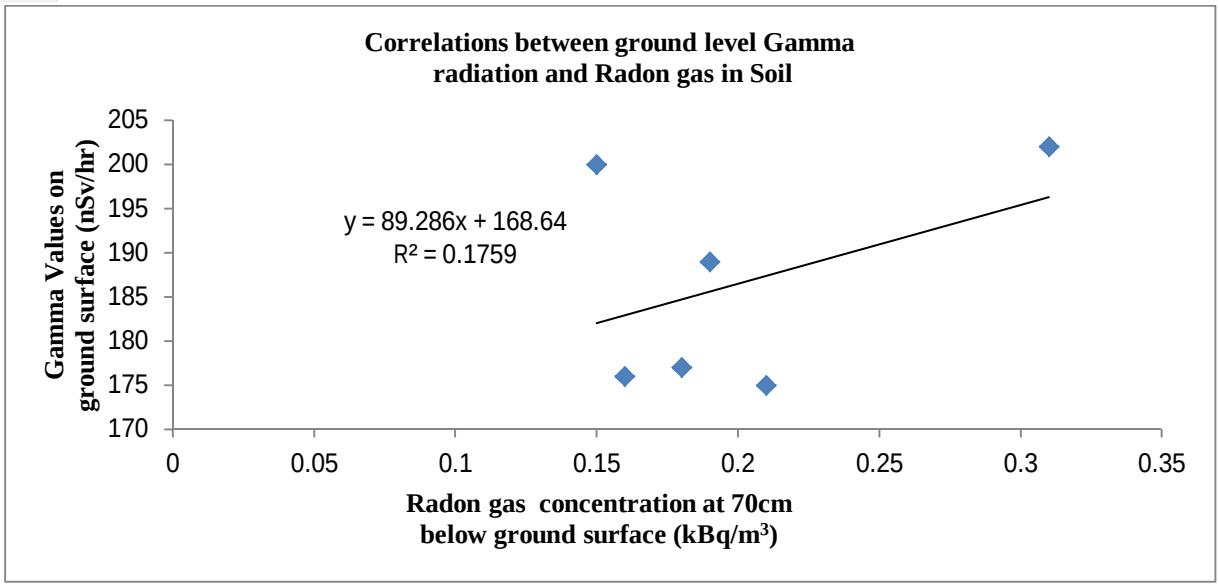


Graph-6. Correlation between Ground level gamma radiation and Radon concentration at 70cm deep.

IV. CONCLUSION

The Radon concentration in soil gas of Meidum and Zanlawn oil exploration areas in 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. But, the correlation coefficient (R^2) obtained from the graph was highest at 10cm with $R^2 = 0.466$ while it is maximum at 70cm deep with $R^2 = 0.175$. This indicates that the gamma radiation had a better correlation close to the surface. 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).

REFERENCES

[1] Ali, N., Khan, E. U., Akhter, P., Khan, F. and Waheed, A. (2010). Estimation of mean annual effective dose through radon concentration in the water and indoor air of Islamabad and Murree; Radiat. Prot. Dosim. Vol. **141(2),** 183–191.

[2] Choubey, V. M., Sharma, K. K., and Ramola, R.C., (1997). Geology of radon occurrence around Jari in Parvati Valley, Himachal Pradesh, India; J. Environ. Radioact. Vol. **34(2),** 139– 148.

[3] Bajwa, B.S., Singh, H., Singh, J., Singh, S., and Sonkawade, R.G. (2010). Environmental radioactivity: A case study in HHP granitic region of Tusham ring complex Haryana, India; Geophys. Res. Abst. **12** EGU2010–1888.

[4] Bourai, A.A., Aswal, S., Dangwal, A., Rawat, M., Prasad, M., Naithani Prasad, N., Joshi, V., and Ramola, R.C. (2013). Measurement of radon flux and soil-gas radon concentration along the main central thrust, Garhwal Himalaya, using SRM and RAD7 detectors; Acta Geophys. Vol. **61(4),** 950–957.

[5] Duggal, V., Mehra, R., and Rani, A. (2015). Study of radium and radon exhalation rate in soil samples from areas of northern Rajasthan. J. Geol. Soc. Of India. Vol. **86(3)**, 331- 336.

[6] International Commission on Radiological Protection (ICRP) (1993). Protection against Radon 222 at homes and at work. ICRP Publication 65, Annals of ICRP 23(2).

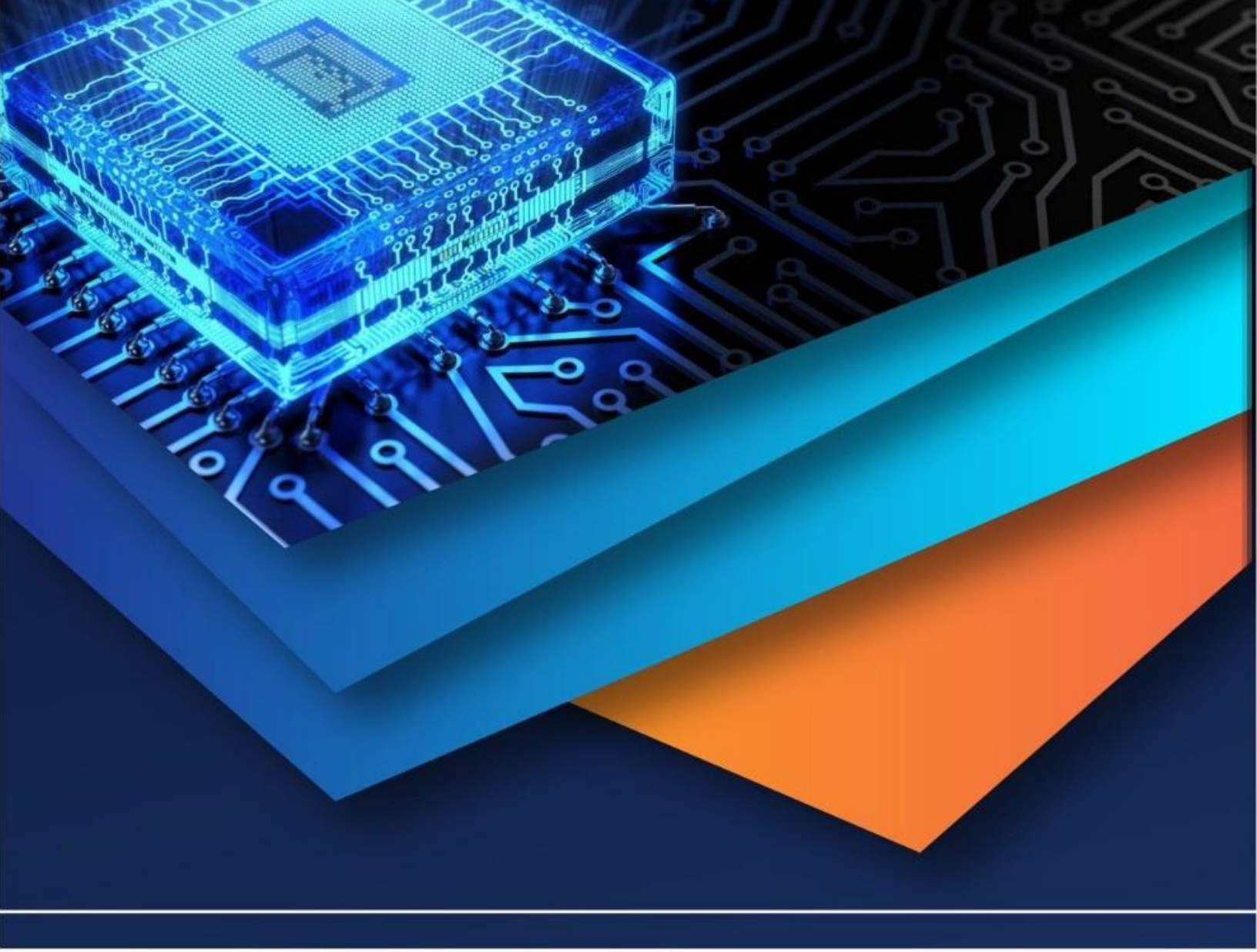
[7] Mehra, R., and Bala, P., (2013). Estimation of annual effective dose due to radon level in indoor air and soil gas in Hamirpur district of Himachal Pradesh. J. Geochem. Exploration. Vol. 104(1), 25-31.

[8] Mujahid, S.A.,, Hussain, S., and Ramzan, M. (2010). Measurement of radon exhalation rate and soil gas radon concentration in areas of southern Punjab, Pakistan. Radiat. Prot. Dosim. Vol. 140(3), 300–303.

[9] Prasad, Y., Prasad, G., Gusain, G.S.,, Badoni, M., and Ramola, R.C.,(2008). Radon exhalation rate from soil samples of South Kumaun Lesser Himalayas, India. Radiat. Meas. Vol. 43(S1), S369-S374.

[10] Miles, J.C.H., Porstendorfer J, Butterweek G, Reineking A. (1994). Daily variation of the radon concentration indoors and outdoors and the influence of meteorological parameters. Health Phys. Vol. 67(3), 283-287.

[11] Radenkovic, M. B., Alshikh, S. M., Andric, V. B., and Miljanic, S. S.(2009). Radioactivity of Sand from Several Renowned Public Beaches and Assessment of the Corresponding Environmental Risks. Journal of the Serbian Chemical Society. Vol. 74(4), 461-470.
[12] Singh, J., Singh, H., Singh, S., and Bajwa, B.S. (2010b). Measurement of soil gas radon and its correlation with indoor radon around some areas of Upper Siwaliks, India. J. Radiol. Prot. Vol. 30(1), 63–71.
[13] Tzortzis, M., Tsertos, H., Christofides, S., Christodoulides, G. (2003). Gamma ray measurements of naturally occurring radioactive samples from Cyprus characteristic geological rocks. Radiation Measurements. Vol. 37(3), 221-229.
[14] UNSCEAR (1993). Sources and effects of ionizing radiation: United Nations Scientific Committee on the Effects of Atomic Radiation, New York.
[15] UNSCEAR (2000). Sources and effects of ionizing radiation; United nations Scientific Committee on the Effects of Atomic Radiation report to the General Assembly with Scientific Annexes, United nations, New York.



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