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Radon gas concentration at different baptism depth in soil of oil exploration areas within Kolasib district of Mizoram, India

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Abstract:
Radon gas concentration at different depth beneath the ground surface is studied at different oil exploration areas of Mizoram, India. The oil exploration areas including Meidum(MD) and Zanlawn(ZL) locations are studied. The main instrument utilized for the study was RnDuo machine devised to survey Radon 222 (^{222}Rn). The other instrument is a soil probe of 1mtr long to be baptised at different depth. The study was conducted at four different depths namely 10cm, 30cm, 50cm and 70cm. For each oil exploration areas, an in-situ measurement of soil gas was carried out at three different spots to cover the oil fields. The minimum value of radon gas concentration is observed at MD-3 spots at 10cm deep; and the maximum concentration is recorded at MD-1 spot at 70cm deep. The radon gas concentration beneath the soil, within the study area ranges from 0.10 kBq/m^3 to 0.31 kBq/m^3. 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.

1. Introduction

The Radon gas 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 as well. 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). Like the name suggests, oil and gases were drawn from oil exploration areas. It is interesting to study the 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 and compare if the Radon gas present beneath the ground surface of these oil exploration areas of Kolasib district were extremely high or low as compared to any other areas. The table 1, given in this paper shows the various Radon gas concentration obtained from the study area. The table 2, on the other hand shows the various radon gas concentration already

obtained at different areas worldwide. Depending upon our finding, further experimentation is planned. Any major variance in the radon gas concentration will indicate the contribution of crude oil and its by-products. In oil exploration areas, it is eminent that huge crude deposits may have the potential to contribute for either the increase or decrease in the concentration of Radon gas concentrations as compared to non oil exploration areas.

2. Study area

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

The present study location 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 map of all the oil exploration areas in Mizoram. Out of these six oil exploration areas, during this presentation, studies were conducted from two areas present in Kolasib district.

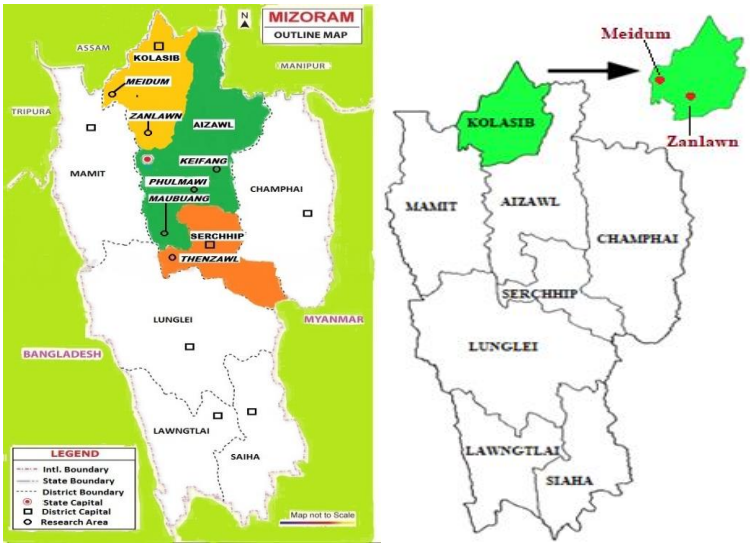


Fig.1 (a) (b)

Fig.1 (a). Map of Mizoram showing different location of oil Exploration areas (2020).
(b). Map of Mizoram showing oil exploration areas in Kolasib district.

3. Methodology

The Radon concentration in soil gas was carried out at three different spots in one oil exploration area. Three oil exploration areas are chosen for the study comprising of 9 spots. The radon concentration was determined at four different depths namely 10cm, 30cm, 50cm and 70cm. An *in-situ* measurement was done with an instrument specially designed for the purpose namely Smart RnDuo. 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, with the RnDuo fitted, four reading at 15mins cycle was taken. The mean of the three readings gives the final reading for that depth. Fig.3 shows the block diagram of the mentioned smart RnDuo.

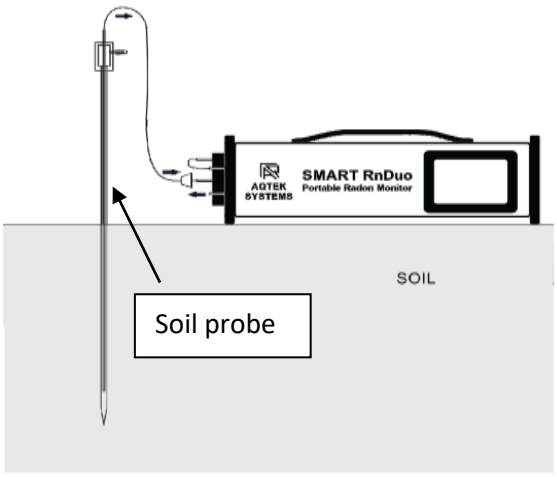


Fig.2. Set up for measurement of radon in soil

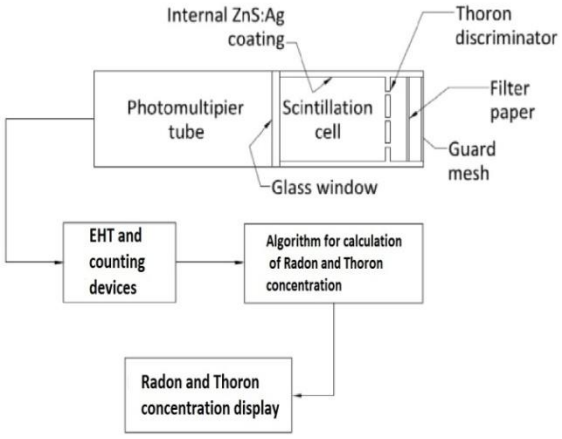


Fig.3. Block diagram of Smart RnDuo

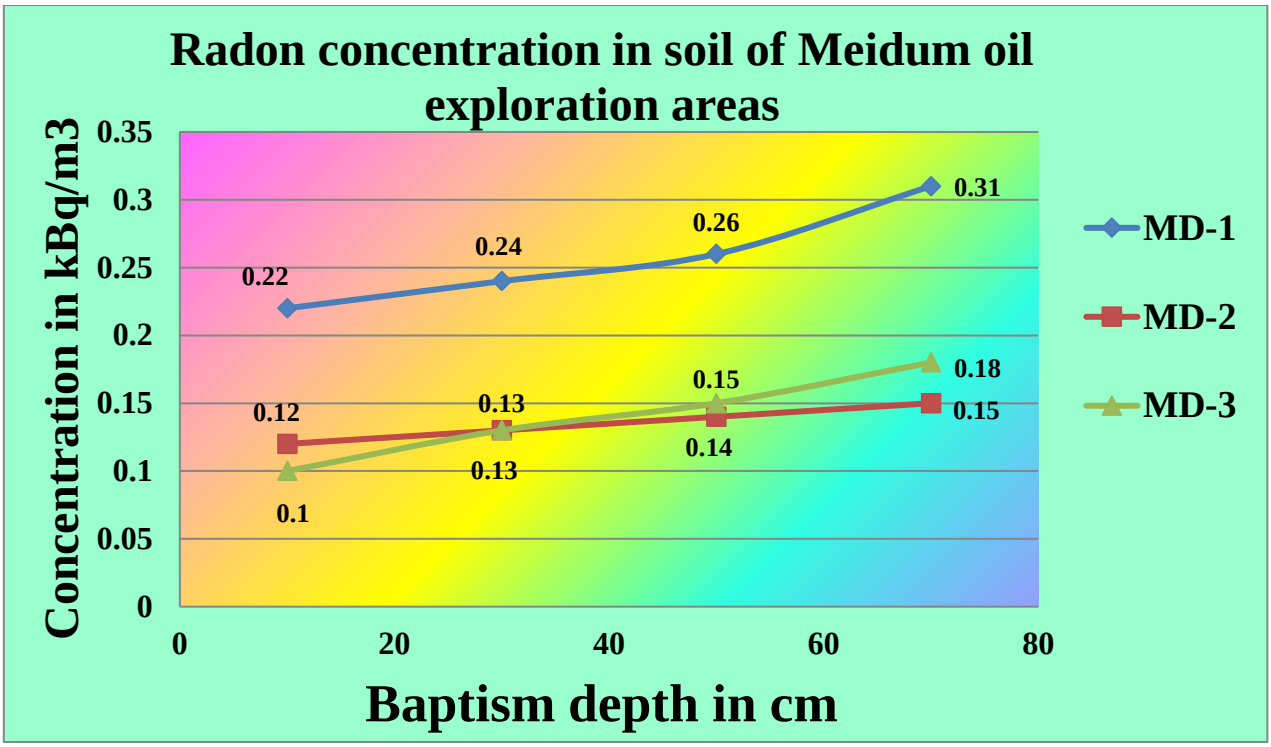
4. Result and Discussion

The result and observation of Radon Concentration in soil gas of two different oil exploration areas in Kolasib district of Mizoram are given in Table 1. below. The radon concentration in Thenzawl location varies from 0.10 kBq/m^3 at 10cm depth to 0.31 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^3at 70cm. The readings are taken in the month of January. 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.

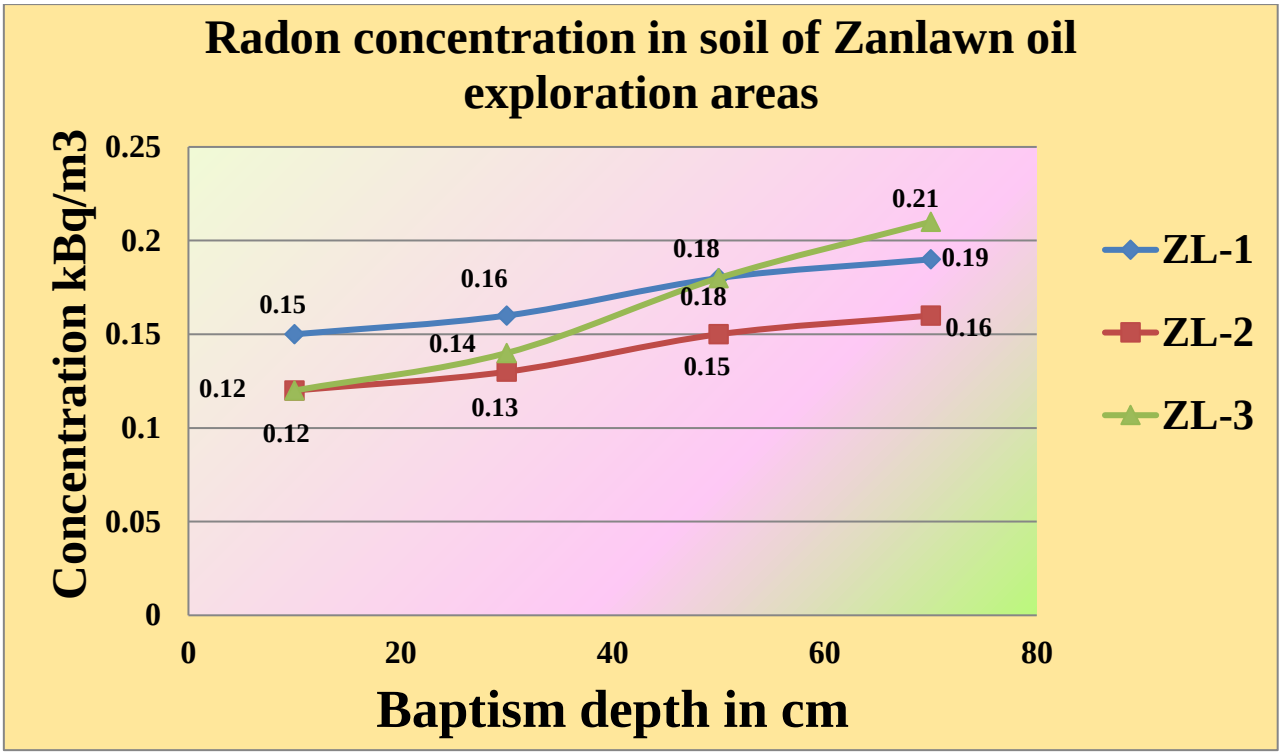
Table-1. *Radon Concentration in soil gas at various baptism depth of oil exploration areas in Serchhip district and Kolasib district of Mizoram, India*

Sl. No	Sampling Location	Sampling ID	GPS Location (Latitude/Longitude)		Baptism Depth	Radon Concentration kBq/m^3
1	Meidum	MD-1	Elev(ft)	: 331	10cm	0.22
			North	: 24^0 10' 12.9"	30cm	0.24
			East	: 92^0 35'57.7"	50cm	0.26
					70cm	0.31
2	Meidum	MD-2	Elev(ft)	: 329	10cm	0.12
			North	: 24^0 10' 12.0"	30cm	0.13
			East	: 92^0 35'55.4"	50cm	0.14
					70cm	0.15
3	Meidum	MD-3	Elev(ft)	: 291	10cm	0.10
			North	: 24^0 10'11.8"	30cm	0.13
			East	: 92^0 35'58.8"	50cm	0.15
					70cm	0.18
4	Zanlawn	ZL-1	Elev(ft)	: 2900	10cm	0.15
			North	: 23^0 59'01.3"	30cm	0.16
			East	: 92^0 42'47.8"	50cm	0.18

					70cm	0.19
5	Zanlawn	ZL-2	Elev(ft)	: 2110	10cm	0.12
			North	: 23^0 59’02.6”	30cm	0.13
			East	: 92^0 42’47.9”	50cm	0.15
					70cm	0.16
6	Zanlawn	ZL-3	Elev(ft)	: 2119	10cm	0.12
			North	: 23^0 59’01.0”	30cm	0.14
			East	: 92^0 42’50.8”	50cm	0.18
					70cm	0.21



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



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

5. Comparison with studies from other non-oil exploration areas in India

The Table-2 shows radon concentrations in soil obtained from various other investigators. Prasad *et al.* (2008) have reported the concentration that varies from 1.10 kBq/m^3 to 31.80 kBq/m^3 in the Budhakedar area of Tehri Garhwal, India. Bajwa *et al.* (2010) have found the radon concentration that varies from 42.80 kBq/m^3 to 71.50 kBq/m^3 in Tusham ring complex, Haryana, India. The radon concentration in soil gas ranges from 0.01 kBq/m^3 to 2.33 kBq/m^3 in Garhwal, Himalaya, India.(Bourai *et al.* 2013). The radon concentration as reported from Hamirpur district, Himachal Pradesh, India varies from 0.03 kBq/m^3 to 2.28 kBq/m^3. (Mehra and Bala. 2013). Kumar *et al.*(2011) have found the radon concentration in soil of Malwa belt Punjab to vary from 1.90 kBq/m^3 to 16.40 kBq/m^3. The radon concentration in soil of Murree, Pakistan as obtained by Ali *et al.* (2010) varies between 0.61 kBq/m^3 to 3.89 kBq/m^3 only. This is very close to that obtained by Mujahid *et al.*(2010) in Southern Punjab, Pakistan whic varies between 0.42 kBq/m^3 to 3.56 kBq/m^3. The radon concentration in soil as obtained by Ali *et al.* (2010) in Islamabad, Pakistan ranges from 17.34 kBq/m^3 to 72.52 kBq/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. Moreover the radon concentration in soil gas as obtained in this study are found to be less than the worldwide average value 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 and Pakistan*

Sl. No	Locations	Concentration kBq/m^3.	References
1	Tusham ring, Haryana granitic regions	42.8 - 71.5	(Bajwa *et al.* 2010)
2	Islamabad, Pakistan, soil	17.34 - 72.52	(Ali *et al.* 2010)
3	Tusham ring, Haryana non-granitic regions	16.3 - 44.1	(Bajwa *et al.* 2010)
4	Hamirpur district, HP, soil	0.035 - 2.28	(Mehra and Bala 2013)
5	Upper Siwaliks, India, soil	11.50 - 78.47	(Singh *et al.* 2010)
6	Malwa belt, Punjab, soil	1.90 - 16.40	(Kumar *et al.* 2011)
7	Kangra district, HP, soil	1.10 - 82.20	(Singh *et al.* 2006)
8	Budhakedar, Tehri Garhwal, soil	1.10 - 31.80	(Prasad *et al.* 2008)
9	Murree, Pakistan, soil	0.61 - 3.89	(Ali *et al.* 2010)
10	Southern Punjab, Pakistan, soil	0.42 - 3.56	(Mujahid *et al.* 2010)
11	***Meidum and Zanlawn oil Exploration areas***	0.10 - 0.31	***Present investigation***
12	Garhwal Himalaya, soil	0.012 - 2.33	(Bourai *et al.* 2013)

The radon concentration in soil gas of oil exploration areas is found to be higher than the dwelling radon concentration of non oil exploration areas. But the soil radon concentration as obtained in the study areas were found to be less than the worldwide average value of 35 kBq/m^3 for outdoor radon activity recommended by United Nations Scientific committee on the Effects of Atomic Radiation (UNSCEAR 2000).

The fig.4 shows minimum and maximum *radon concentration in soil* of some areas taken from Table 2. The Radon Concentration in Soil of the study areas were found to be less than the worldwide average value of 35 kBq/m^3 for outdoor radon activity recommended by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2000).

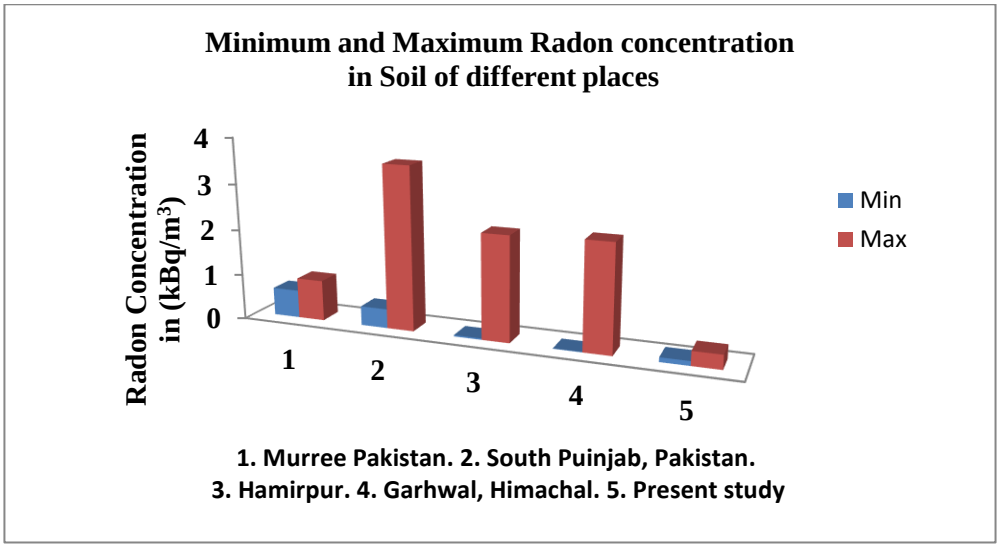


Fig.4. *Minimum and Maximum Radon concentration in soil of various locations in India*

The Table-3 shows radon gas concentrations in dwelling and outdoor region obtained from various other investigators. Ali *et al.* (2010) have reported the concentration that varies from 0.043 kBq/m^3 to 0.097 kBq/m^3 in Islamabad, Pakistan. Duggal *et al.* (2014) have found the outdoor radon concentration that varies from 0.09 kBq/m^3 to 10.40 kBq/m^3 in Gangadhar district, Rajasthan. The radon concentration in air also ranges from 0.035 kBq/m^3 to 0.096 kBq/m^3 in Hamirpur district, Himachal Pradesh.(Mehra and Bala. 2013). The radon concentration in dwellings as reported by Rohmingliana *et al.* (2010) from Serchhip district, Mizoram varies from 0.028 kBq/m^3 to 0.072 kBq/m^3. The radon concentration in dwellings as reported by Vanchhawng Lalmuanpuia *et al.* (2009) from Aizawl district, Mizoram also ranges from 0.027 kBq/m^3 to 0.085 kBq/m^3. Vanchhawng Lalmuanpui *et al.* (2009) also reported the dwelling radon concentration of Kolasib district to vary from 0.021 kBq/m^3 to 0.093 kBq/m^3 which is very likely with the radon concentration abtained in Aizawl district. Kant *et al.* (2004) have obtained radon concentration in oil refinery dwelling, Haryana between 0.055 kBq/m^3 to 0.195 kBq/m^3; whereas he obtained 0.034 kBq/m^3 to 0.129 kBq/m^3 in City dwelling of Haryana. He also obtained a radon concentration of 0.046 kBq/m^3 to 0.190 kBq/m^3 in Oil refinery environment of Haryana. The three radings obtained by Kant *et al.* in Haryana are very close to each other. Ali *et al*. (2010) also reported a radon concentration of 0.018 kBq/m^3 to 0.042 kBq/m^3 in Murree, Pakistan environment.

Table-3. *Radon gas Concentration in dwellings and outdoor of various places*

Sl. No	**Locations**	**Concentration kBq/m^3.**	**References**
1	Islamabad, Pakistan, air	0.043 - 0.097	(Ali *et al.* 2010)
2	***Meidum and Zanlawn oil exploration areas***	0.10 - 0.31	***Present investigation***
3	Gangadhar Dist Rajasthan, air	0.09 - 10.40	(Duggal *et al.* 2014)
4	Hamirpur district, HP, air	0.035 - 0.096	(Mehra and Bala 2013)
5	Serchhip district, Mizoram, Dwellings	0.028 - 0.072	(Rohmingliana 2010)
6	Aizawl district, Mizoram, Dwellings	0.027 - 0.085	(Lalmuanpuia 2009)
7	Kolasib district, Mizoram Dwellings	0.021 - 0.093	(Lalmuanpuia 2009)
8	Oil refinery environment, Haryana	0.046 - 0.190	(Kant *et al.* 2004)
9	Oil refinery dwelling, Haryana	0.055 - 0.195	(Kant *et al.* 2004)
10	City dwelling, Haryana	0.034 - 0.129	(Kant *et al.* 2004)
11	Murree, Pakistan, air	0.018 - 0.042	(Ali *et al.* 2010)

The fig.5 shows minimum and maximum radon concentration in dwellings and outdoor areas taken from Table 2. The Radon Concentration in dwellings and outdoor areas were found to be very much less than the Radon Concentration in Soil of the study areas. All the concentrations were but very less as compared to the worldwide average value of 35 kBq/m^3 for outdoor radon activity recommended by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2000).

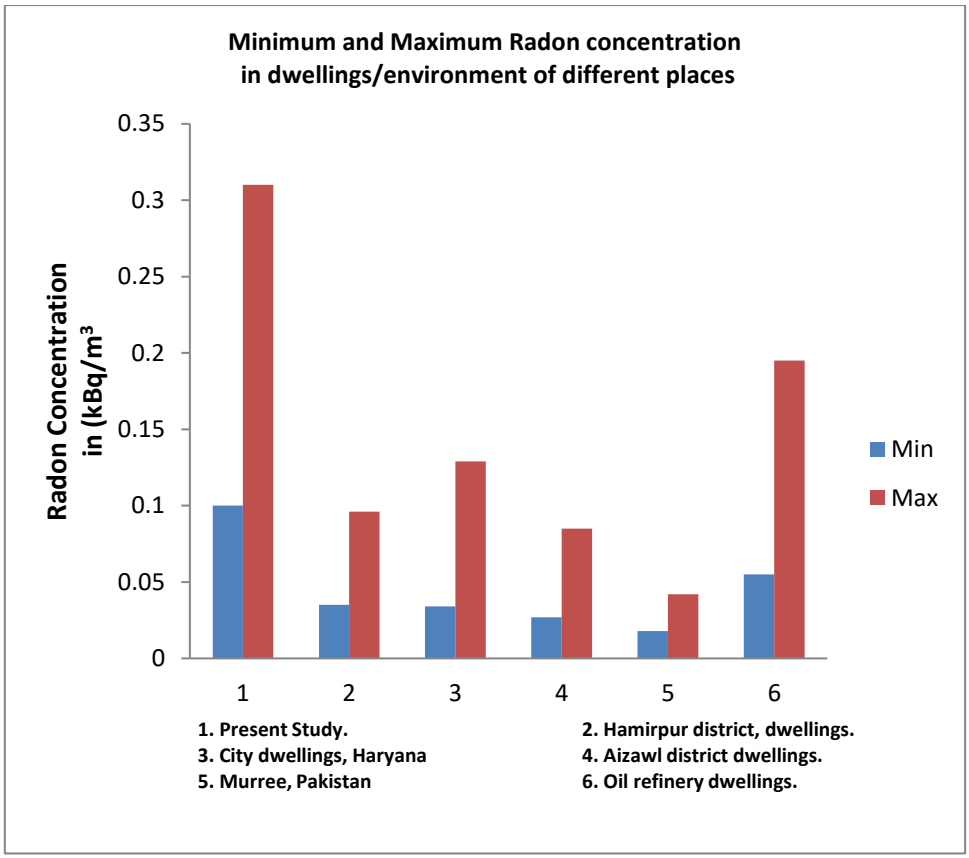


Fig.5. *Comparison of minimum and maximum radon concentration in dwellings of some areas in India and Pakistan with the present study.*

6. Conclusion

The Radon concentration in soil gas of oil exploration areas in Kolasib 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. 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 Kolasib 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 Kolasib 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 are far below the world average of 35-40 kBq/m^3.

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