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A Study of Radon Awareness and Release from Soil of Muzaffarnagar

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Abstract

The present research focus on the extent of soil and gas Rn deliberations at different locations of Muzaffarnagar district of Uttar Pradesh, India. Muzaffarnagar is situated midway on the Delhi - Haridwar/Dehradun National Highway (NH 58) and is also well connected with the national railway network. Different locations are selected for the investigation of soil-gas radon concentrations in and around the faulty region. TheRAD7 and Smart Rn duo technique are used for evaluating the parameters to analyze the soil-gas radon concentrations based on the geophysical and neo-techtonic activities in the studied location.

Keywords: *Soil, Radon, neo-techtonic activities, soil-gas radon concentrations*

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Background

The concentration of the ^{222}Rn due to the soil-gas interaction is dependent on the earth crust and its related local features. The geophysical nature of the Himalayan belt is one of the important factors effecting the soil-gas 222Rn concentrations. The Himalayan belt is the result of collisions of the continents when the Indian plate converged towards the Europe and Asian plate. These processes exhibit the formation of the thrust planes such as Main Central Thrust (MCT), the Main Boundary Thrust (MBT) and the Main Frontal Thrust (MFT)/Himalayan Frontal Fault (HFF) (Gansser, 1964). There is a continuous movement of Indian plate in the north direction due to the seismic activity, therebygenerating neotechtonic along the thrust planes. Consequently, the neotechtonic features are established in the landscape due to the seismic activity. The regions with faults results in the variation of the radioactive gases due to the different geological formation. Accumulation of 222Rn on the top layer of earth depends on geological structure of the particular area. Therefore, the study of the soil-gas 222Rn concentration and its flux in the geological and geomorphic features in the neotechtonic regions is of very much interest to the researchers (Valdiya, 2003).

Geological structure could be subdivided into small zones or ensembles, which contain facture and channels of micro capillaries. ^{222}Rn trapped in these capillaries with zero potential energy having some energy diffuse until it escapes the grain. ^{222}Rn migrates through pores in soil, fractures in soil and along other weak zones, such as shears, faults, thrust etc. (Chaubey et al., 1994; 1999; Ramola et al., 1988a). At fault and active Geo-dynamics zones, ^{222}Rn gas moves upward following the so-called channels and then diffused in ground water and aerial zones (Ball et al., 1991; Chaubey et al., 2001; Hess et al., 1985). Dynamical disturbance in soil and soil may open fracture and channel is higher than that in other zones. Different soil have the different emanating power and thus there is no uniform distribution. Diversity of distribution pattern gives the important valuable information about lithology. It has recognized that lateral variability is primarily attributed to geological parameter (Miles and Ball, 1996; Tanner, 1986). Spatial variation was also shown by radon in local and regional scale. Precise knowledge of geology will give understanding and lapping of the variability. Muzaffarnagar is located in the western part of Uttar Pradesh; it lies in Saharanpur division and it is the municipal board along with the head office of Muzaffarnagar district. The spirit of the city is the mixture of religious places that fascinates countless visitors through the year and industrialized development in the area and it is known as Sugar bowls of India. This is one of the richest districts of UP in terms of having exceptional agricultural lands; due to this reason, this place is also known as Laxmi Nagar. According to Forbes Magazine edition published in 2012 Feb, the per capita income of Muzaffarnagar lies highest in UP state. It is located on National Highway -58, and has well connectivity through roadways and railway network.

Geography of Muzaffarnagar

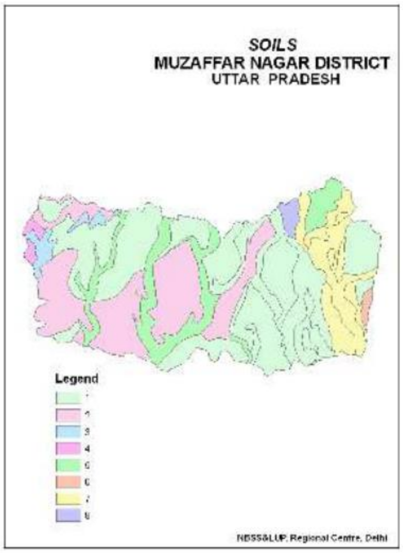
Muzaffarnagar city lies at Longitude 77.6 and Latitude 29.4 As per the exact site of the district given by describes by district administration. The borders of Muzaffarnagar area is attached to Saharanpur and Haridwar district in the North while in the south side it is connected with Meerut and Bagpat areas as well as the eastern part is touched by Bijnor district while the western part is bounded by Panipat and Shamli district. It is Situated in the doab province of Ganges River and Yamuna River, The shape of the district is rectangular and the greatest length if measured from the extreme eastern point to extreme west is sixty one miles and the distance from extreme north to south is thirty six miles. As per the last calculation in the year 2000, the total covered by Muzaffarnagar district is 4049 sqkm. The neighboring states of the district are Haryana on the western part and Uttarakhand on the eastern part. The elevation range of the district falls under 251 to 236 meters.

Selection of Experimental Site

The sites are selected for the study in such a manner that it covers the diverse geophysical characteristics of district Muzaffarnagar region. The soil/gas ^{222}Rn deliberations were studied for selected location covering of the neotechtonic zone which are described in the successive segments.

Soil samples collected from surface and subsurface of eight different locations from the left hand side of Ganga canal in Muzaffarnagar district were usually found neutral to alkaline in reaction (Table 1). Ramesh et al. (2003) also reported the similar results. In his results and investigations he found that the reaction of soil was somewhat basic to soberly chalky (dim soil) and sour to abstemiously acidic as like in red soils). The pH of topsoil (0-15 cm) and subsoil (15-30 cm) at different locations ranged from 6.02 to 8.39 and 6.35 to 8.50, respectively. According to the soil response classification proposed by Brady (1985), 27 samples were neutral (6.35 to 7.50), 26 were slightly alkaline (7.4 to 7.8), 25 were moderately alkaline (7.81 to 8, 4), 2 The sample was strongly alkaline. Alkaline (8.4 to 9.0). A minimum pH of 6.02 was observed at the Jouli site and a maximum pH of 8.39 was observed at the surface (0-15 cm) of Khatauli, while a minimum pH of 6.35 and a maximum pH of 8.50 were observed in the subsoil at Jouli. (15-30 cm at Kamheda (TP)). The relatively high pH of soils may be due to the presence of high base saturation. Gavan etc. (2006) observed that most soils in the Vidarbha region of Maharashtra are neutral to moderately alkaline (pH 7.15 to 8.03). As the soil depth increases, pH also increases.

Soil map



Legend	Description
1 &5	Deep, loamy soils (moderately salinity and sodicity)
2	Deep, loamy soils and silty soils
3	Deep, silty soils and loamy soils (slightly saline and slightly sodic).
4	Deep, silty soils and loamy soils
6	Deep, loamy soils and loamy/sandy soils
7	Deep, sandy soils (slightly flooding) and loamy soils
8	Deep, loamy soils and loamy soils (moderate flooding)

Soil degradation and radiation is another major concern. Of the total 140 million hectares, nearly 120 million hectares are estimated to be degraded to varying degrees. Soil quality deteriorated over time due to a combination of factors, including: B. Improper use of fertilizers, accumulation of heavy and metalloids through various forms of emissions. Over the years, the government has implemented several programs to tackle and rehabilitate degraded lands. These programs include national watershed development projects and rain-fed areas, river basin projects and soil protection in flood-prone river catchment areas, and integrated watershed management programs. The 11th Five Year Plan covered approximately 82 million hectares of degraded land. Some of these plans were incorporated under RKVY and Pradhan Mantri Krishi Sinchayee Yojana during the 12th Plan. In 2014-2015, the government introduced the Soil Health Card (SHC) system. This tests each farm's soil and issues an SHC, telling farmers the health of the soil, fertilizer mix and micronutrients to use. A wide network of soil laboratories has been built for this purpose. The program also stipulates that the SHC be reissued every three years of his life. This includes using digital technology to help farmers keep track of soil samples and test results.

Experimental Procedure

The in-situ soil gas ^{222}Rn attentiveness was measured at almost 40 cm using RAD7 with the help needed equipment factory-made by Durridge. The soil-gas investigation which consists of a hollow steel tube with small holes at the bottom for the gas to enter inside it is infiltrated at the desired depth with the help of strike. The upper end of the probe is connected to a hose connector, which is connected to the desiccant tube to absorb the moisture in the gas entering the RAD7. This moisture free air is introduced inside the detector from inlet channel.

For the ^{222}Rn soil-gas measurement, there are three modes. One is by grab sampling, another by continuous monitoring in standard protocol and third in THORON mode. We have chosen the second mode with protocol chosen as SNIFF mode with a total duration of 3 hours having each cycle of 15 min. The soil probe was inserted into the soilat a depth of 40 cm and ^{222}Rn soil-gas measurement was measured. The ^{222}Rn concentration report of the measurement was obtained from RAD7 printer.

For the measurement of ^{222}Rn surface flux, Smart Rn Duo was coupled to the accumulator having dimensions of diameter 20 cm and height of 10 cm, therefore providing soil surface area of 3.14 m^2 for exhalation from the surface and 2.35 m^3 volume for accumulation of gas in the chamber. The edge of accumulator was deployed properly up to 1 cm inside the soil surface to avoid superficial leakage from the chamber's wall. Fresh scintillation cell (Lucas cell) was inserted inside the Smart Rn Duo detector to avoid any background counts. For this, the Lucas cell was kept inside the Zero ^{222}Rn container for a minimum duration of 4 hours. The Smart Rn Duo was kept in diffusion mode to avoid any type of back diffusion. The pump collects the gas very rapidly and within a very short time, the quantity of accumulated gas inside the chamber becomes much greater than the quantity in the soil. Hence there occurs a back diffusion process in which the gas again moves from place of higher concentration towards place of lower concentration. Each cycle was set for 1 hour and after each cycle the ^{222}Rn builds up in the accumulator increases. After a certain time, there occurs a saturation limit. After that saturation point, the measurement was stopped and the data retrieved was fitted in least square fitting model to yield the ^{222}Rn emission flux.

Results and Discussion

In the study, soil gas ^{222}Rn concentration and ^{222}Rn flux (Surface exhalation rate) were measured along the MBT region, volcanic region, lithological region (Neotechtonic region in Khatauli and Budhana region) of Muzaffarnagar. The measurements were carried out in eight regions viz. Adampur Mochari, Akbarpur, Buwara Kalan, Chhacharpur, Ratighat, Gangdhari, Hausainpur Bopara, Jandheri Jatan and Kailawada Kalan. For the soil-gas ^{222}Rn concentration and ^{222}Rn flux, 4 locations (Khatauli, Budhana, Charthawal, Titavi) were selected in Muzaffarnagar.

Soil-gas Concentration and Radon surface flux in Muzaffarnagar District of Uttar Pradesh

The soil gas concentration was measured at a depth of 40 cm in the surface of neotechtonic region of Muzaffarnagar. The study was carried in the selected four locations spreadin the vicinity of the fault. The surface radon flux exhalation rate was also measured from the similar locations. Table 3.1 shows the values of soil-gas radon concentration and radon flux (surface) in Muzaffarnagar, Uttar Pradesh. The location for the neotechtonic study includes Khatauli, Budhana, Charthawal and Titawi. The soil gas concentration was determined along the fault (i.e. in the fault region) as well as away from the fault (at the certain distance from the fault) both at five different distances. A reference point was selected at particular fault location and the readings were measured along the fault at a depth of 40 cm at a distance of 100, 200, 300, 400 and 500 m.

The maximum and minimum value of Lohai Ramgarh is found to be 6522 Bq/m^3 and 4981 Bq/m^3 at a distance of 400m and 200m, respectively along the fault with an average value of 5692 Bq/m^2. However, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 4215 Bq/m^3 at reference point and 3264 Bq/m^3 at 100m with an average value of 3820 Bq/m^3 respectively. The max and min value of ^{222}Rn surface exhalation was found to be 110 and 81 Bqm^{-2}h^{-1} with an average value of 94Bqm^{-2}h^{-1} shown in Table 1.1.

The maximum and minimum value of Bhudana is found to be 1210 Bq/m^3 and767 Bq/m^3 at a distance of 400m and 200m, respectively along the fault with an average value of 938 Bq/m^2. However, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 897 Bq/m^3 at reference point and 523 Bq/m^3 at 500m with an average value of 640 Bq/m^3 respectively. The max and min value of ^{222}Rn surface exhalation was found to be 71 and 31 Bqm^{-2}h^{-1} with an average value of 52Bqm^{-2}h^{-1}.

The maximum and minimum value of Charthawal is found to be 2587 Bq/m^3 and 1895 Bq/m^3 at a distance of at reference point and 200m, respectively along the fault with an average value of 2142Bq/m^2. However, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 1846Bq/m^3 at reference point and 1116Bq/m^3 at 200m with an average value of 1495Bq/m^3 respectively. The maximum and minimum value of ^{222}Rn surface exhalation was found to be 110 and 81 Bqm^{-2}h^{-1} with an average value of 94 Bqm^{-2}h^{-1}.

The maximum and minimum value of Titawi is found to be 4259 Bq/m^3 and 3046 Bq/m^3 at a distance of at reference point and 400m, respectively along the fault with an average value of 3594 Bq/m^2. However, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 3272 Bq/m^3 at reference point and 2149 Bq/m^3 at 300m with an average value of 2831 Bq/m^3 respectively. The max and min value of ^{222}Rn surface exhalation was found to be 145 and 70 Bqm^{-2}h^{-1} with an average value of 101Bqm^{-2}h^{-1} shown in Table 3.1. These above results were correlated with the uranium contents in the soil from different lithological formations reported by Ramola et al. (2006)

Table 1.1 Measurement of Soil-gas^{222}Rn concentration at 40 cm and ^{222}Rn surface flux in Dist Muzaffarnagar various location

S. No	Location Code	Gamma Survey Meter (µSv/h)	Soiltype	Different Distance (m)	Soil gas conc.(Bq/m^3) At 40 cm		Surface Radon flux (Bq/m^2/h)
					Along the Fault	Away from the Fault	
1.	Khatauli	0.25	Tight dry	0	5569	4215	110
				100	5624	3264	90
				200	4981	4005	95
				300	6024	3981	81
				400	6522	3456	86
				500	5432	3998	101
2.	Bhudana	0.16	Loose	0	1210	897	42
				100	824	692	37
				200	925	587	39
				300	767	561	31
				400	852	600	34
				500	1052	523	46
3.	Charthawal	0.19	Tightwet	0	2587	1846	54
				100	1965	1540	55
				200	1895	1116	31
				300	1946	1324	40
				400	2165	1489	71
				500	2296	1652	63
4.	Titavi	0.18	Tight dry	0	3225	2149	70
				100	3046	2459	86
				200	3124	2963	84
				300	3900	3272	112
				400	4259	3000	106
				500	4012	3145	145

Correlation Soil gas ^{222}Rn concentration with Radon Flux

Fig 1.1 and 1.2 shows the correlation graph between soil gas ^{222}Rn concentrations alongthe fault and away the fault with ^{222}Rn surface exhalation rate. The graph is depicted strong positive correlation in both cases and the positive correlation coefficient (0.88) for along the fault and positive correlation coefficient (0.92) for away the fault. Therefore, it shows that the linear fit line almost exactly fits the data in both cases. The surface exhalation rate much depends upon the emanation, exhalation process and porosity of the deeper part of soil. Soil samples from different formations have different geometries and grain sizes, which also influence the radon release from soil. Due to Neotechtonic Zone along the fault, the concentration value is high in along the fault compare to the away fromthe fault. Other reason of the high value of concentration is the structure of geophysical of the primary source terms (Soil , Soil etc.) and lithological formations in the sampling location. The Muzaffarnagar is covered by metamorphics, comprising of porphyritic granite, metaflysch, carbonaceous phyllites and marble. The mean boundary thrust areawas covered by quartzites, mylonitization and shearing (These are the Source of radium content).

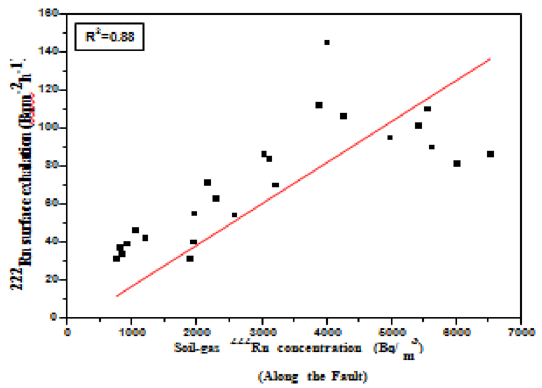


Fig 1.1: ^{222}Rn concentration and ^{222}Rn surface fluxalong the Fault

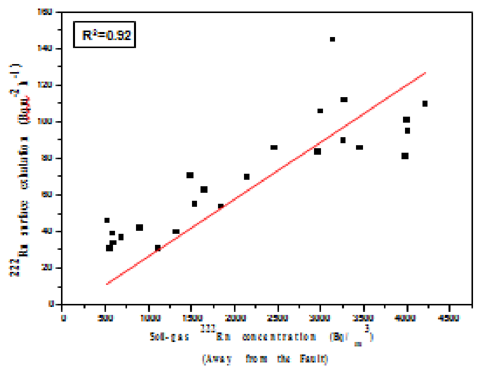


Fig 1.2: ^{222}Rn concentration and ^{222}RnSurface flux away from the Fault

Correlation between the Soil gas ^{222}Rn concentration along and away the fault

Fig 1.3 shows the correlation between the measurements along the fault and away from thefault was plotted. The graph illustrated a strong positive correlation coefficient (0.89), which means that the region along the fault is neotechtonic region but away from the fault is also affected by the neotechtonic activities. The consecutive distances which have taken for measurements are not so far each other by which these zones are affected by faults and by the soil formations.

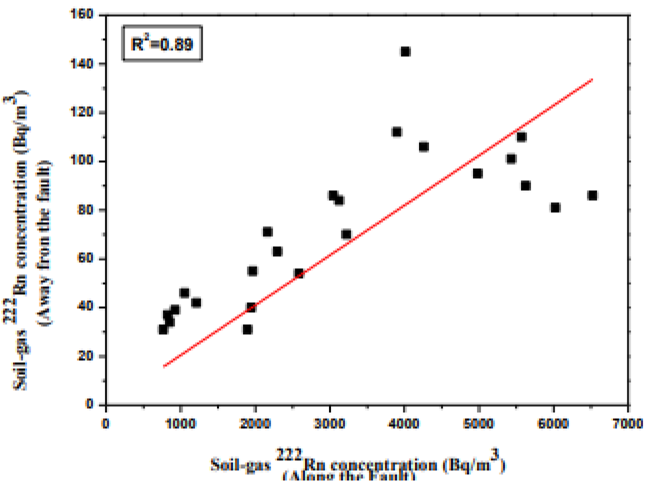


Fig 1.3: Correlation graph of soil ^{222}Rn gas concentration

Soil-gas Concentration and ^{222}Rn surface flux in Muzaffarnagar, Uttar Pradesh

The results of soil-gas radon concentration and radon exhalation rate from source term in different formation of Muzaffarnagar of Uttar Pradesh with gamma radiation dose rate are giving in Table 1.2. These experiments are required because the geology of the area is heterogeneous and the topography is irregular. The locations on geological map are shown in the Fig. 1.2. The soil gas concentration was also measured at a depth of 40 cm in the surface of neotechtonic zone of Muzaffarnagar. The study was carried in the selected four locations spread in the surrounding area of the fault. The surface radon flux exhalation rate was also measured from the similar locations. Table 1.2 shows the values of soil-gas ^{222}Rn concentration and ^{222}Rn surface flux in Muzaffarnagar. The location of the neotechtonic for study includes Adampur Mochari, Akbarpur, Buwara Kalan, Chhacharpur, Ratighat, Gangdhari, Hausainpur Bopara, Jandheri Jatan and Kailawada Kalan. The soil gas concentration was determined inside the fault as well as away from the fault both at five different consecutive distances. A reference point was selected at particular fault location as same as Muzaffarnagar and the readings were measured along the fault at a depth of 40 cm at a distance of 100, 200, 300, 400 and 500m. The maximum and minimum value of Adampur Mochari, Buwara Kalan, is found to be 4562 Bq/m^3 and 2654 Bq/m^3 at a distance of 100m and 400m, respectively along the fault with an average value of 3783 Bq/m^2. On the other hand, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 1936 Bq/m^3 at 400m and 1247 Bq/m^3 at 200m with an average value of 1680 Bq/m^3 respectively. The max and min value of ^{222}Rn surface exhalation was found to be 69 and 42 Bqm^{-2}h^{-1} with an average value of 56Bqm^{-2}h^{-1}.The maximum and minimum value of two different lithogical formation in Adampur Mochari, Buwara Kalan is found to be 2654 Bq/m^3 and 1452 Bq/m^3 at a distance of reference point and 400m, respectively along the fault with an average value of 2052 Bq/m^2 in Chhacharpur, Ratighat,. Though, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 714 Bq/m^3 at reference point and 346 Bq/m^3 at 300m with an average value of 498 Bq/m^3 respectively. The max and min value of ^{222}Rn surface exhalation was found to be 40 and 21 Bqm^{-2}h^{-1} with an average value of 32 Bqm^{-2}h^{-1}. The maximum and minimum value of volcanic region in Gangdhari, Hausainpur Bopara is found to be 912 Bq/m^3 and 714 Bq/m^3 at a distance of 500m and 300m, respectively along the fault with an average value of 818 Bq/m^2. However, the maximum and minimum valueof soil gas ^{222}Rn concentration away from the fault is 385 Bq/m^3 300m and 250 Bq/m^3 at 100 m with an average value of 321 Bq/m^3 respectively. The maximum and minimum value of ^{222}Rn surface exhalation was found to be 58 and 26 Bqm^{-2}h^{-1} with an average value of 42 Bqm^{-2}h^{-1}.

The maximum and minimum value of Jandheri Jatan and Kailawada Kalan is ranged to be 2600 Bq/m^3 and 1974 Bq/m^3 at a distance of at 500m and 400m, respectively along the fault with an average value of 2198 Bq/m^2. However, the maximum and minimum value of soil gas ^{222}Rn concentration away from the fault is 1296 Bq/m^3 at 500m and 831 Bq/m^3 at 400m with an average value of 1090 Bq/m^3 respectively. The maximum and minimum value of ^{222}Rn surface exhalation was found to be 113 Bqm^{-2}h^{-1} and 78 Bqm^{-2}h^{-1} with an average value of 93 Bqm^{-2}h^{-1}.

Correlation Soil gas ^{222}Rn concentration and Radon Flux

Fig. 1.4 and 1.5 shows the correlation graph between soil gas ^{222}Rn concentrations along the fault and away the fault with ^{222}Rn surface exhalation rate. The graph is depicted positive correlation in both cases and the positive correlation coefficient (0.68) for along the fault and positive correlation coefficient (0.72) for away the fault. However, soil-gas concentration is prominently contributed by the transported ^{222}Rn from the deeper earth rather than the nearby upper surface. Therefore the data fits the linear fitting curve. The surface exhalation rate much depends upon the emanation, exhalation process and porosity of the deeper part of soil. Soil samples from different formations have different geometries and grain sizes, which also influence the ^{222}Rn discharge from soil. Due to Neotechtonic Zone along the fault, the concentration value is also almost high in along the fault compare to the away from the fall in Muzaffarnagar region.

Table: 1.2: Measurement of Soil-gas ^{222}Rn concentration and ^{222}Rnsurface flux in Muzaffarnagar, Uttar Pradesh

S. No	Location Code	GPS Coordinates	Gamma Survey Meter (µSv/h)	Soiltype	Different Distance(m)	Soil gas conc.(Bq/m³) At 40cm		Surface Radon flux (Bq/m²/h)
						Insidethe Fault	Away from theFault	
1.	Adampur Mochari, Buwara Kalan	29°17'37.62" N 79°33'33.12" E	0.22	Loose	0	4185	1875	63
					100	4562	1568	52
					200	3378	1247	69
					300	4021	1654	42
					400	2654	1936	51
					500	3897	1800	58
2.	Chhacharpur, Ratighat	29°22'17.51" N 79°25'5.70" E	017	Tight wet	0	2654	714	25
					100	2204	400	29
					200	1857	569	37
					300	2275	346	21
					400	1452	457	40
					500	1867	499	39
3.	Gangdhari, Hausainpur Bopara	29°21'10.44" N 79°35'29.03" E	0.15	Loose dry	0	768	326	46
					100	756	250	34
					200	869	314	26
					300	714	385	58
					400	891	299	51
					500	912	350	37
4.	Jandheri Jatan and Kailawada Kalan	29°23'9.97" N 79°31'33.58" E	0.18	Tight dry	0	2467	1291	90
					100	1978	1125	92
					200	2005	968	81
					300	2164	1026	101
					400	1974	831	78
					500	2600	1296	113

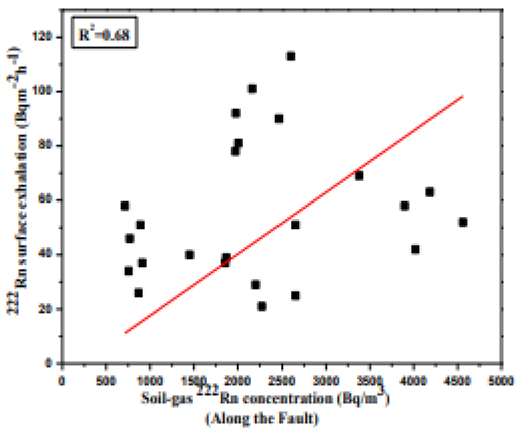


Fig 1.4: ^{222}Rn concentration and ^{222}Rn surface flux alongthe Fault

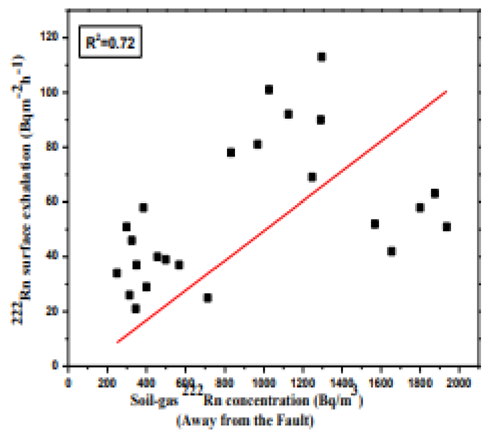


Fig 1.5: ^{222}Rn concentration and ^{222}Rn surface fluxaway from the Fault

Correlation Soil gas ^{222}Rn concentration between along and away the fault

Fig 1.6 shows the correlation between the measurements along the fault and away from the fault. The graph illustrated a strong positive correlation coefficient (0.75), which means that the region along the fault is neo-techtonics region but away from the fault is also affected by the neotechtonic activities. The consecutive distances which have taken for measurements are not so far each other by which these zones are affected by faults and by the soil formations.

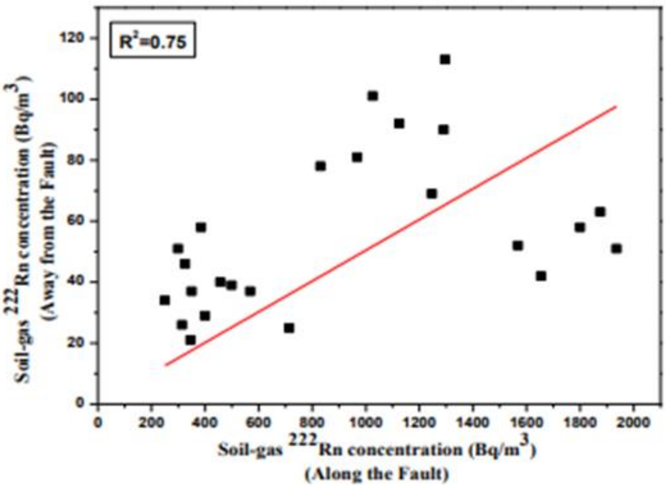


Fig. 1.6: Correlation graph of soil ^{222}Rn gas concentration

It was observed that radon levels are higher in the areas of igneous soil, MBT regionsand lower in loose soil and chalk areas. The higher values in the areas of igneous soil are mainly because of its association with the uranium and thorium mineralization. Natural radioactivity of soil is caused by the presence of uranium thorium and the potassium isotopes. Potassium is a common rock-forming mineral while uranium and thorium occurin very small quantities, but are widespread and more radioactive. The amounts of uranium, thorium and potassium and hence the intensity of the associated gamma radiationare functions of lithology. The average values distributed over the study area were computed to establish the correlation between major radionuclide contents in soil, terrestrial gamma radiation dose rate. Radon levels were found higher in the area consisting of granite, quartz porphyry, schist, phyllites slates and lowest in the area having sedimentary soil , predominantly dominated by quartzite soil as in Chhacharpur, Ratighat, which has loose soil type. The terrestrial gamma radiation dose rate in the area was found correlated with radon concentrations in soil-gas. Soil-gas radon

Concentration was found positively correlated with the radon exhalation rate in the soil. This clearly shows that the soil-gas radon concentration is not only because of the omnipresent uranium but the migration of radon from the deeper part of the earth also contributes to soil-gas radon concentration at earth's surface. However, the contribution to the radon exhalation rate is mainly due to the presence of radium in collected soil samples. No correlation was observed between radon exhalation rate from soil and terrestrial gamma dose rate in the area. The migration of radon in soil-gas and parent radionuclide is much more in the geologically active area like near thrust and fault.

Conclusions

The measurement is done in Neotechtonic regions in Muzaffarnagar District. During the measurement of soil-gas ^{222}Rn concentration and ^{222}Rn surface flux in the study area, variation was measured. This variation in soil-gas concentration is due to the uranium mineralization and the composition of the underlying bedrock present in the study area. The soil of Ramgarh formation consisting of mylonitized porphyritic granitic gneisses Muzaffarnagar thrust in central part of study area. Remaining regions of study area are also covered by these different formations as MBT, volcanic region and lithological formation. The study consists of soil-gas ^{222}Rn concentration at certain depth and ^{222}Rn surface flux in same locations. This is because the ^{222}Rn continuously emanates from deep inside the earth towards the surface of earth. The correlation between the soil-gas ^{222}Rnconcentrationswith the surface^{222}Rn flux was found strong positive correlation in Muzaffarnagar district due to the presence of geophysical and techtonics region.

The ^{222}Rn concentration in the study area is mostly controlled by major tectonic features like thrust, fault and shear zones. The concentration solely depends upon the emanation coefficient of soil from the pores to the open space. The ^{222}Rn surface flux from the study area will be helpful in generating a numerical model on the active measurement of ^{222}Rn from the surface soil to the indoor environment. Further by using different techniques, we can predict the concentration of ^{22}Rn, ^{220}Rn and their descendants.

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