Radon Activity And Exhalation Rate In Building Materials From Crushing Zone Of Shivalik Foothills In India

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ABSTRACT: The crushing zone in Shivalik foothills are about 230-260 Kms. North of New Dehi, the Capital of India comprising three states Haryana , Himachal Pradesh and Utter Pradesh. Building materials like stones and stone dust are used in the construction of buildings in and around Delhi. The presence of Uranium in host rocks and prevalence of a confined atmosphere within mines could result in enhanced concentration of radon and its progeny. Inhalation of radon daughter products is a major contributor of radiation dose to population. **MATERIAL AND METHODS:** In present study LR-115 type-II detectors were used in Canister technique. **RESULTS:** The radon concentration level in stones collected from various sites of study area of Haryana, Utter Pradesh and Himachal Pradesh varies from 472-1036 Bq m^{-3}, 457-853 Bq m^{-3} and 899-1493 Bq m^{-3} respectively. The Radon concentration level in stone dust collected from various sites of study area of Haryana, Utter Pradesh and Himachal Pradesh varies from 1066-1371 Bq m^{-3} , 563-1038 Bq m^{-3} and 1028-1646 Bq m^{-3} respectively. Based on the data mass and Surface exhalation rates were also calculated as shown in the tables.
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INTRODUCTION:

Monitoring and measuring of any type of radioactivity in material to the environment is necessary for environmental protection. Measurement of natural radioactivity in building materials is very important to determine the amount of change of the natural background activity with time. Studies of natural radioactivity are necessary not only because of their radiological impact, but also because they act as excellent biochemical and geochemical traces in the environment. Although natural radioactivity is found in rocks and soils throughout the crust of earth. The large scale mining activities have the potential to enhance the background radiation levels prevailing in the region[1].The main source of continuous radiation exposure to human are building materials which acts as a medium of migration for transfer of radionuclides to the biological systems and hence, it is the basic indicator of radiological contamination in the indoor environment[2].

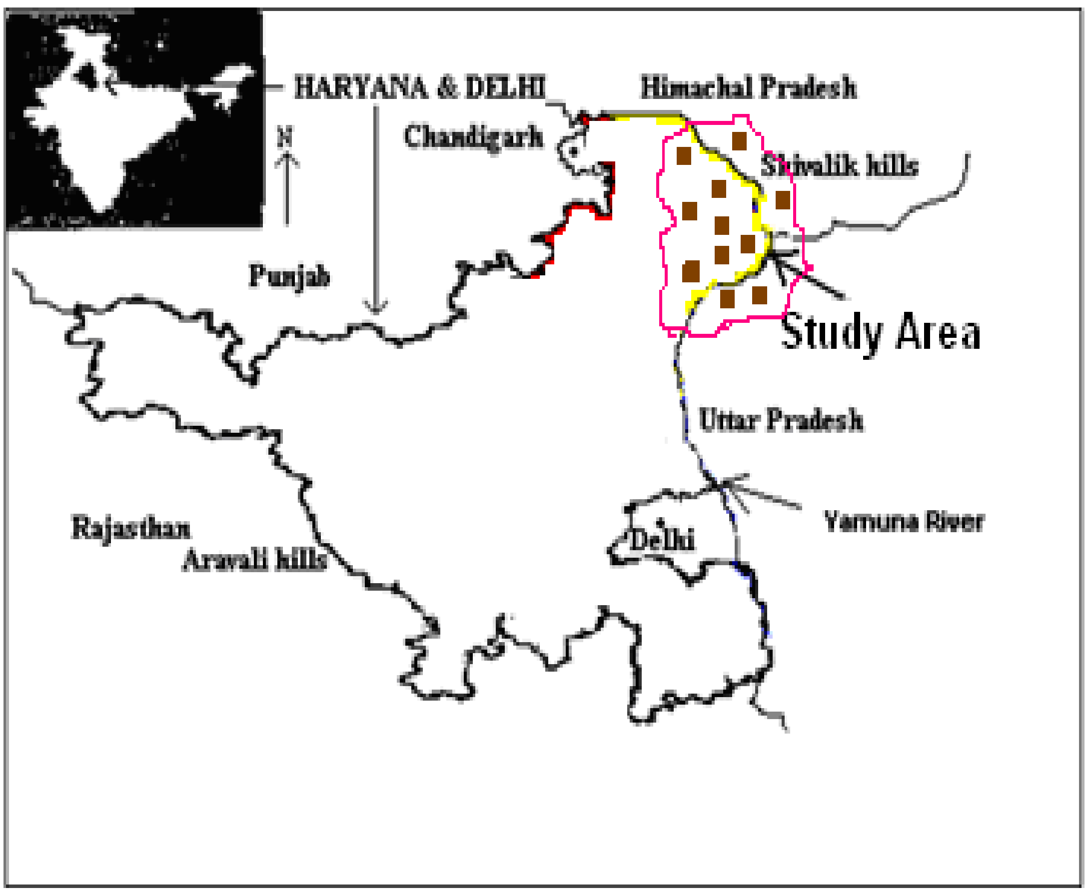
Radon *(*222Rn*)* is a noble gas and is formed by the decay of 226Ra, which is one of the nuclides formed in the disintegration series from 238U. In principle, the amount of radon formed in rocks and soils depends on their uranium content[3]. However, this alone is not decisive in determining the radon concentration in air, it is also determined by the extent to which the radon atoms formed actually emanates from the mineral grains and whether radon can leave the pore space either by diffusion or together with a flow of air. The construction materials also significantly contribute toward the indoor radon (Durrani and Ilic, 1997). Permeability of the material is a main factor affecting radon levels in dwellings. As the measurement of material permeability is difficult, the exhalation rate, which is the number of radon atoms leaving the material per unit surface area per unit time from the ground, is thought to be a better indicator of radon risk. Contribution of radon and its progeny to the total effective dose has been reported to be more than 50% (UNSCEAR, 2000). It is a major contributor toward an increased lung cancer risk in the population [4]. 222Rn and its decay products due to their health hazards have been a cause of concern, as these radionuclides may reach quite high levels in buildings with lack of adequate ventilation or strong sources of radon. In this regard, radon measurements are being pursued all over the world as well as at national level and extensive data are available in the open literature.

The interest behind the study in this part of North India is mainly due to its contribution to construction material used in dwellings which is densely populated. The stone and stone dust are used in various forms in construction of dwellings in northern part of India. In order to assess the radiological hazards due to natural radioactivity associated with these radionuclides, calculations of the radon concentration and exhalation rates are important indicators.

Hopefully, the results of this study and the interpretation presented below will enable undertaking more thorough research, requiring the analysis of natural radioactivity in many more samples and regions. In this context, the present work tries to develop reference data of natural radioactivity for the stones and stone dust of the areas under investigation, and to evaluate their radiological consequence if used as building materials. Moreover, this evaluation would also provide a baseline data for estimating the change in environmental radiation.

In the present study authors collected the samples from crushing zone situated in Haryana, Himachal and Utter Pradesh in Shivalik foothills in northern part of India. Here mining at large scale is taking place and the building material is being used in Northern part of India. The aim of the present study is to estimate the possible health risk in dwellings where this building material is used. The results are important from radiation protection point of view. The aim of the work is also to explore the possibility of uranium exploration and radiation hazard due to uranium and radium in the study area.

"The Geographical map of Study Area"



METHODOLOGY:

For the measurement of radon concentration and its exhalation rates in building materials Canister technique was used[5], Samples of stones and stone dust were collected from different sites and crushers from the study area.. A known amount of sample was oven dried were put in the plastic canister. LR-115 type-II plastic track detectors were fixed on the bottom of lid of each canister with tape such that sensitive side of the detector faced the sample. The canisters were tightly closed from the top and sealed. The size of the detectors was 1cm. X 1cm. and were exposed to samples for 100 days At the end of the exposure time, the detectors were removed and subjected to a chemical etching process in 2.5N NaOH solution at 60 degree centigrade for 90 minutes. The detectors were washed and dried. The tracks produced by the alpha particles were observed and counted under an optical Olympus microscope at 600X. The measured track density was converted into radon concentration using a calibration factor(.021 tracks/cm2/day = 1 Bq/m3) as used by other workers.[5-8]

The surface and mass exhalation rates of radon have also been calculated using following formulae[9,10]:

$$E_M = \frac{CV\lambda}{M[T + (1/\lambda)\{\exp(-\lambda T) - 1\}]} \quad (\text{Bq Kg}^{-1}\,\text{h}^{-1}) \text{ for mass exhalation rate}$$

$$E_A = \frac{CV\lambda}{A[T + (1/\lambda)\{\exp(-\lambda T) - 1\}]} \quad (\text{Bq m}^{-2}\,\text{h}^{-1}) \text{ for surface exhalation rate}$$

Where C is the Integrated radon exposure (Bq m^{-3} h^{1}), M is the mass of sample (Kg), V is the volume of air in canister (m^3), T is the time of exposure (hrs), λ is the decay constant for radon (h^{-1}) and A is the area covered by the canister or Surface area of the sample (m^2).

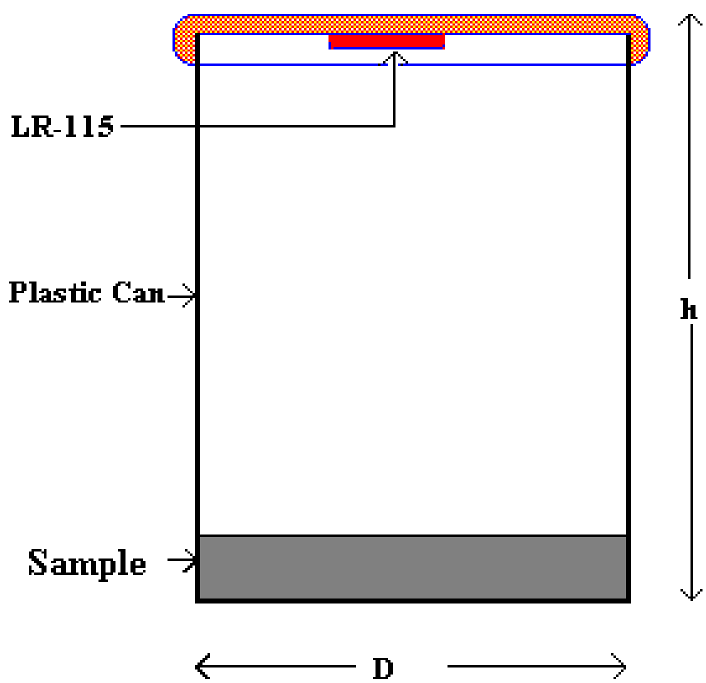


Figure 1. The Canister used for the measurement of radon concentration and exhalation rates from different samples

Table 1. Stone Samples-Crushing Zone Haryana

S No	Sample Collecting Site	Radon Concentration (Bq/m3)	Mass Exhalation Rate (mBq/kg/hr)	Surface Exhalation Rate (mBq/m2/hr)
1	Mujaid Wala -1	1036	35	940
2	Mujaid Wala -2	1021	34	927
3	Near Kaveri Stones-1	990	31	890
4	Near Kaveri Stones-2	960	30	863
5	Koliwala-1	640	22	589
6	Koliwala-2	579	21	533
7	BegamPur-1	594	17	529
8	BegamPur-2	640	19	569
9	Pallewala-1	487	14	433
10	Pallewala-2	472	14	420
AM±SE		**742**±73	**24**±3	**669**±67

Table 2. Stone Samples- Crushing Zone Utter Pradesh

S No	Sample Collecting Site	Radon Concentration (Bq/m3)	Mass Exhalation Rate (mBq/kg/hr)	Surface Exhalation Rate (mBq/m2/hr)
1	Baratha-1	853	29	774
2	Baratha-2	838	28	761
3	Kheri-1	564	23	529
4	Kheri-2	533	22	500
5	Fatehpur-1	457	14	411
6	Fatehpur-2	472	15	424
7	Kansepur-1	670	27	629
8	Kansepur-2	594	24	557
9	Nanihari-1	610	25	572
10	Nanihari-2	609	25	572
AM±SE		**620±43**	**23±2**	**573**±38

Table 3. Stone Samples- Crushing Zone Himachal Pradesh

S No	Sample Collecting Site	Radon Concentration (Bq/m3)	Mass Exhalation Rate (mBq/kg/hr)	Surface Exhalation Rate (mBq/m2/hr)
1	Paonta Sahib-1	944	37	861
2	Paonta Sahib-2	914	36	834
3	MainPur Dewda-1	960	38	876
4	MainPur Dewda-2	899	35	820
5	Nawwada-1	1249	49	1139
6	Nawwada-2	1280	51	1167
7	Ram Pur Ghat-1	1333	52	1216
8	Ram Pur Ghat-2	1356	54	1237
9	Yamuna River Bed-1	1447	57	1319
10	Yamuna River Bed-2	1493	59	1361
AM±SE		**1177±74**	**47±3**	**1083±67**

Table 4. Stone Dust Samples- Crushing Zone Haryana

S No	Sample Collecting Site	Radon Concentration (Bq/m3)	Mass Exhalation Rate (mBq/kg/hr)	Surface Exhalation Rate (mBq/m2/hr)
1	Mujaid Wala -1	1310	52	1195
2	Mujaid Wala -2	1371	54	1251
3	Near Kaveri Stones-1	1173	46	1070
4	Near Kaveri Stones-2	1188	47	1084
5	Koliwala-1	1118	45	1056
6	Koliwala-2	1066	42	972
7	BegamPur-1	1219	48	1112
8	BegamPur-2	1280	51	1168
9	Pallewala-1	1249	50	1139
10	Pallewala-2	1280	51	1168
AM±SE		**1225**±29	**49**±1	**1121**±25

Table 5. Stone Dust Samples- Crushing Zone Utter Pradesh

S No	Sample Collecting Site	Radon Concentration (Bq/m3)	Mass Exhalation Rate (mBq/kg/hr)	Surface Exhalation Rate (mBq/m2/hr)
1	Baratha-1	975	39	914
2	Baratha-2	944	38	885
3	Kheri-1	944	38	885
4	Kheri-2	899	37	843
5	Fatehpur-1	625	25	586
6	Fatehpur-2	563	23	528
7	Kansepur-1	1036	41	971
8	Kansepur-2	1038	42	974
9	Nanihari-1	1028	40	964
10	Nanihari-2	1006	39	943
AM±SE		**906±55**	**36±2**	**849±50**

Table 6. Stone Dust Samples- Crushing Zone Himachal Pradesh

S No	Sample Collecting Site	Radon Concentration (Bq/m3)	Mass Exhalation Rate (mBq/kg/hr)	Surface Exhalation Rate (mBq/m2/hr)
1	Paonta Sahib-1	1036	41	945
2	Paonta Sahib-2	1028	40	937
3	MainPur Dewda-1	1097	44	1001
4	MainPur Dewda-2	1066	42	972
5	Nawwada-1	1188	47	1084
6	Nawwada-2	1158	46	1056
7	Ram Pur Ghat-1	1508	60	1375
8	Ram Pur Ghat-2	1539	61	1404
9	Yamuna River bed-1	1646	65	1501
10	Yamuna River bed-2	1584	63	1445
AM±SE		**1285±80**	**51±3**	**1172±73**

RESULTS AND DISCUSSION:

The average level of radon concentration in stones samples from crushing zone of Haryana, Utter Pradesh and Himachal are 742±73 Bq/m3, 620±43 Bq/m3 and 1177±74 Bq/m3 respectively. The average values of mass exhalation rates are 24±3 mBq/kg/hr in Haryana, 23±2 mBq/kg/hr in Utter Pradesh and 47±3 mBq/kg/hr in Himachal in stones samples. The average values of surface exhalation rate are 669±67 mBq/m2/hr in Haryana 573± 38 mBq/m2/hr in Utter Pradesh and 1083±67 mBq/m2/hr in Himachal in stone samples.

The average level of radon concentration in stone dust samples from crushing zone of Haryana, Utter Pradesh and Himachal are 1225±29 Bq/m3, 906±55 Bq/m3 and 1285±80 Bq/m3 respectively. The average values of mass exhalation rates are 49±1 mBq/kg/hr in Haryana, 36±2 mBq/kg/hr in Utter Pradesh and 51±3 mBq/kg/hr in Himachal in stone dust samples. The average values of surface exhalation rate are 1121±25 mBq/m2/hr in Haryana, 849± 50 mBq/m2/hr in Utter Pradesh and 1172±73 mBq/m2/hr in Himachal in stone samples

It can be seen from the results that radon concentration varies appreciably from sample to sample in both stones and stone dust. It is due to the fact that stone and stone dust samples collected from different places may have different Uranium contents.

CONCLUSION:

The measurements indicate normal to some higher levels of radon concentration emanated from stones and stone dust samples collected from different sites of Haryana, Utter Pardesh, Himachal crushing zones in Shivalik foothills. The average values of radon concentration and exhalation rate are highest in samples collected from Himachal crushing zone area and lowest in Utter Pardesh zone area in both stones as well as in stone dust samples. The level of radon concentration and exhalation rate increases as we move toward Shivalik hills. It may be due to higher Uranium contents in the underground soil of hilly area. Higher Uranium and radon contents have been shown in soil and rock samples in similar studies [11-12].

The radon concentration in stone and stone dust samples from crushing zone of Himachal is higher in Yamuna River bed area and Mujaid Wala area in Haryana crushing zone which is with in safe limits.

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