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Measurement of Radon Concentration in Soil Gas using RAD7 in the Environs of Al-Najaf Al-Ashraf City-Iraq

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ABSTRACT

Soil gas Radon, ^{222}Rn , concentration was measured at 15 location in the Najaf Al-Ashraf city, using RAD7 radon monitoring system of Durridge company USA. In each location four different depths were taken for soil gas measurements, staring from the ground surface. The results suggested that the largest concentration was 9290±400 Bq/m^3 for 60cm depth at in Al-Amir district, point sample P14, and the smallest concentration was 9±17 Bq/m^3 for 5cm depth at Al-Shoara district, point sample P5. The results obtained from this study indicate that the region has background radioactivity levels within the natural limits.

Keywords: natural radioactivity, Radon, uranium, RAD7.

INTRODUCTION

The main source of ionizing radiation in the earth crust, which continuously exposed the human being, is uranium, thorium and their progeny in the environment [1-2]. Researches carried out in recent decades show that, under normal conditions, more than 70% of a total annual radioactive dose received by people originates from natural sources of ionizing radiation, whereby 54% is due to inhalation and ingestion of natural radioactive gas radon ^{222}Rn and its decay products. Long term exposures to radon via inhalation in closed rooms or caves or open air saturated with Radon gas is the cause of about 10% of all deaths from lung cancer [3-6]. Studied also related to Radon in kidney and malignant melanoma cancer have been reported. Radon is a natural inert radioactive tasteless and odorless gas, whose density is 7.5 times higher than that of air. Radon gas and its radioactive isotopes have special attention among the other naturally radioactive materials, because it has the largest amount of total annual effective dose to humane [7-8]. There are three natural occurring isotopes of Radon; Radon ^{222}Rn , a direct product of ^{226}Ra in the ^{238}U decay series with physical half-life 3.825 days, ^{220}Rn, decay products of ^{232}Th, Thoron ^{220}Rn , half-life 55.6s is a radioactive noble gas exists in natural radon gas as well, and ^{119}Rn, a decay product of ^{235}U, with half life of 3.6s. Among the three radioactive isotopes ^{222}Rn is the most significant. This isotope is found in soil-near air and soil-gas, and, surface water and

groundwater. Because it's relatively long half - life enabling it to migrate quit significant distance before decaying and can be found in the soil gas.

While the plastic detector CR39 or LR-115 (No. 2) and Gamma Spectroscopy were used to estimate Radon concentration in soil [9-10], the solid state alpha detector RAD7 used in the present investigation to provide the Radon concentration in soil gas data, which Iraq is still suffering the lack of such data. Recently, RAD7 was used in many experimental techniques concerning measurement of Radon concentration in different locations for continuous radon monitor [11-14]. The aim of the present work is to determine the radon concentration in soil gas at a specific depth within the soil. To do this, the air must be removed from the soil and delivered to a RAD7 (radon monitoring system) of Durridge Company (USA), without dilution by outside air. The volume of gas removed depends on the technique used to extract it and the porosity of the soil.

MATERIALS AND METHODS

Experimental work

AI-Najaf Al-Ashraf city, with geographical coordinates are 31^{o} 59' 46" North 44^{o} 18' 53" East positioned at the southern west of Iraq at the edge of the western desert. The total area of Al-Najaf Al-Ashraf is 28848 km^2 and the population exceeds 1 million. The study sites covered most part of the Governorate and sampling points are shown in Figure-1.Total of 15 places were tested in each place four different depth were taken. A stainless steel soil gas probes supplied by Durridge Company (USA), were used in the present work. The probe, with a hollow tube and sampling holes near the tip may be inserted into the soil, and air drawn up the tube, and into the RAD7. In the location, we looked for soil containing few stones. The probe connected to RAD7 by pushing the plug-in hose connector into the probe. Tamping down the soil around the probe to prevent the leakage of fresh air into the sample acquisition path or down the outside of the probe to sampling point.

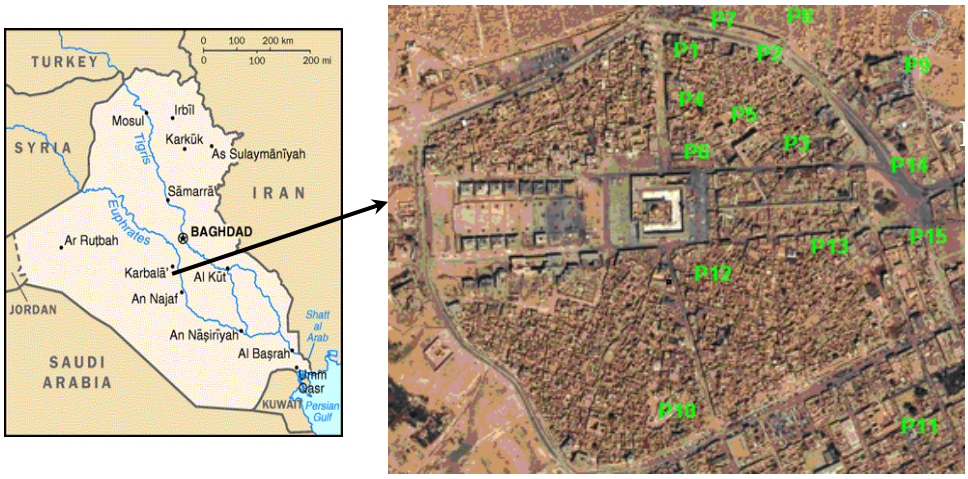

Figure-1. Al-Najaf Al-Ashraf city and the sample point locations (from Google earth)

The RAD7 detector converts alpha radiation directly to an electric signal and has the possibility of determining electronically the energy of each particle, which allows the identification of the isotopes (^{218}Po, ^{214}Po) produced by radiation, so it is possible to instantaneously distinguish between old and new radon, radon from Thoron, and signal from noise.

Figure -2 shows RAD7 with soil probe which in connected in close circuit with a zinc Sulphide coated detection chamber which acts as Scintillatore to detect alpha activity and a glass bulb containing calcium chloride to absorb the moisture. Air was then circulated in a closed circuit for a period of 5-10 min until the radon was uniformly mixed with the air and the resulting alpha activity was recorded and it directly gives the radon concentration. A half hour counting time in the Grab protocol for all sampling points had been taken. In each sampling location four time of measurements of sampling point, the distance between each 10-20cm, then the average reading of RAD7 been taken.

Figure-2. RAD7 measurements for two sample points of soil at Al-Najaf City.

RESULTS AND DISCUSSION

An average value of Radon Activity in Bq/m^3 was calculated for each sampling point. All the results were listed in Table-1, and the average Rodon concentrations as a function of sample point number are shown in Figures-3(a-d). The radioactive level of ^{222}Rn for soil samples, as shown in Table-1, range from 9290 ± 400 Bq/m^3 for sample No.14 at in Al-Amir district at depth 60cm under ground surface, to 158 ± 130 Bq/m^3 at Al-Karama district with the same depth. For depth 35 the concentration varied from 4830 ± 619 Bq/m^3 at P14 to 123 ± 93 Bq/m^3 at P3. While in the depth 25cm, the maximum Radon concentration is $3260 \pm 275 Bq/m^3$ at P14 ,and in the depth 5cm the maximum is 1660 ± 176 Bq/m^3 at sample P14. Looking for the whole data in the table, one can see that in the majority of locations there is linearity between the radon concentrations and the depth for the same sample point as shown in the samples of data in Figures 4(a-d). However large variation of Radon concentration in soil gas over a small depth is well known [15]. Also it is worth to notice the sample point P14 has the maximum Radon concentration for all the four depths compared with other locations.

Table-1. Radon Concentrations in different depths for the fifteen sample points in Al-Najaf Al-Ashraf City

Sample point No.	Location	Radon gas Concentrations in Soil measured in Bq/m^3 for different depth from ground surface			
		60cm	35cm	25cm	5cm
P1	Al-Nafit district	4760±403	3260±219	3120±264	1210±447
P2	Al- Khari district	4260±85	2280±512	1720±245	967±73
P3	Al-Karama district	158±130	123±93	62±60	35±29
P4	Al-Alatebaa district	3060±290	2410±322	1700±213	985±64
P5	Al-Shoara district	580±145	237±44	153±93	9±17
P6	Al-Hussain district	2100±197	1780±487	1460±127	666±111
P7	Al-Jameia district	1230±162	1020±201	777±145	477±146

P8	Al-Jazira	1770±186	1470±350	983±162	843±138
P9	Al-Jama'a district	2780±267	2760±457	1100±61	760±234
P10	Al-Shurta district	2190±220	2150±309	1270±324	915±346
P11	Al-Kudds district	3300±317	2460±433	2270±302	1030±262
P12	Al-Mothenna district	6950±397	3510±118	2240±206	765±178
P13	Al-Eshtiraki district	3120±276	2780±242	1860±258	1170±196
P14	Al-Amir district	9290±400	4830±619	3260±275	1660±176
P15	Al-Kadisia district	3550±205	845±98	434±142	335±60

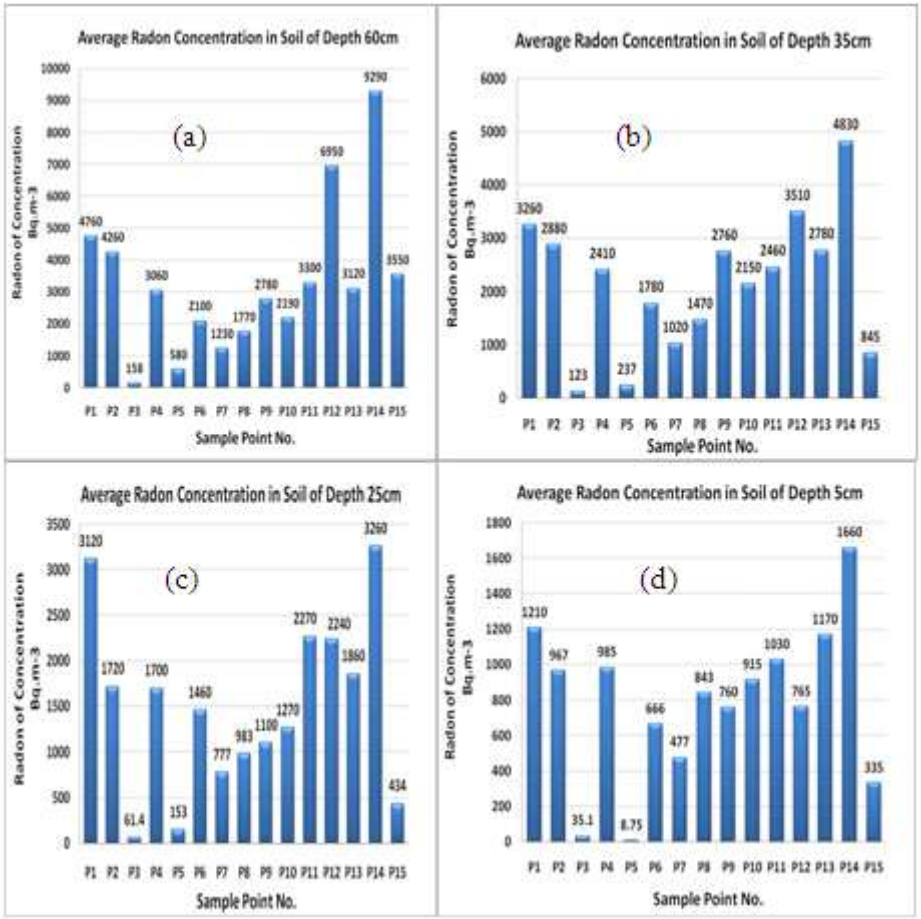

Figure-3. Radon concentration as a function of the sample point number: (a) at depth 60cm, (b) at depth 35cm, (c) at depth 25cm and (d) at depth 5cm.

The average Radon concentration in depth 60cm is 3273± 245 Bq/m^3, in depth 35cm is 2128± 300 Bq/m^3, in depth 25cm is 1494± 192 and in depth 5cm is 788± 165, which also looks as a linear relation with depth. The average radon concentration level in those areas, with higher depth, may be due to the presence of Uranium prospect beneath the soil. In comparison with the Radon measurements in other part of Iraq; we found that, the average Radon concentration in soil measured by passive method in Iraqi Kurdistan is 15.638± 7.38 kBq/m^3 for depth 30cm, which is 4.78 times more [12].This may be due to the geological structure of the Kurdistan area, which is full of solid racks. In Jordan (west of Iraq), particularly in Soum region, the average radon concentration in soil air was reported to be about 15 kBq/m^3 in range from 4 to 21 kBq/m^3 [16].

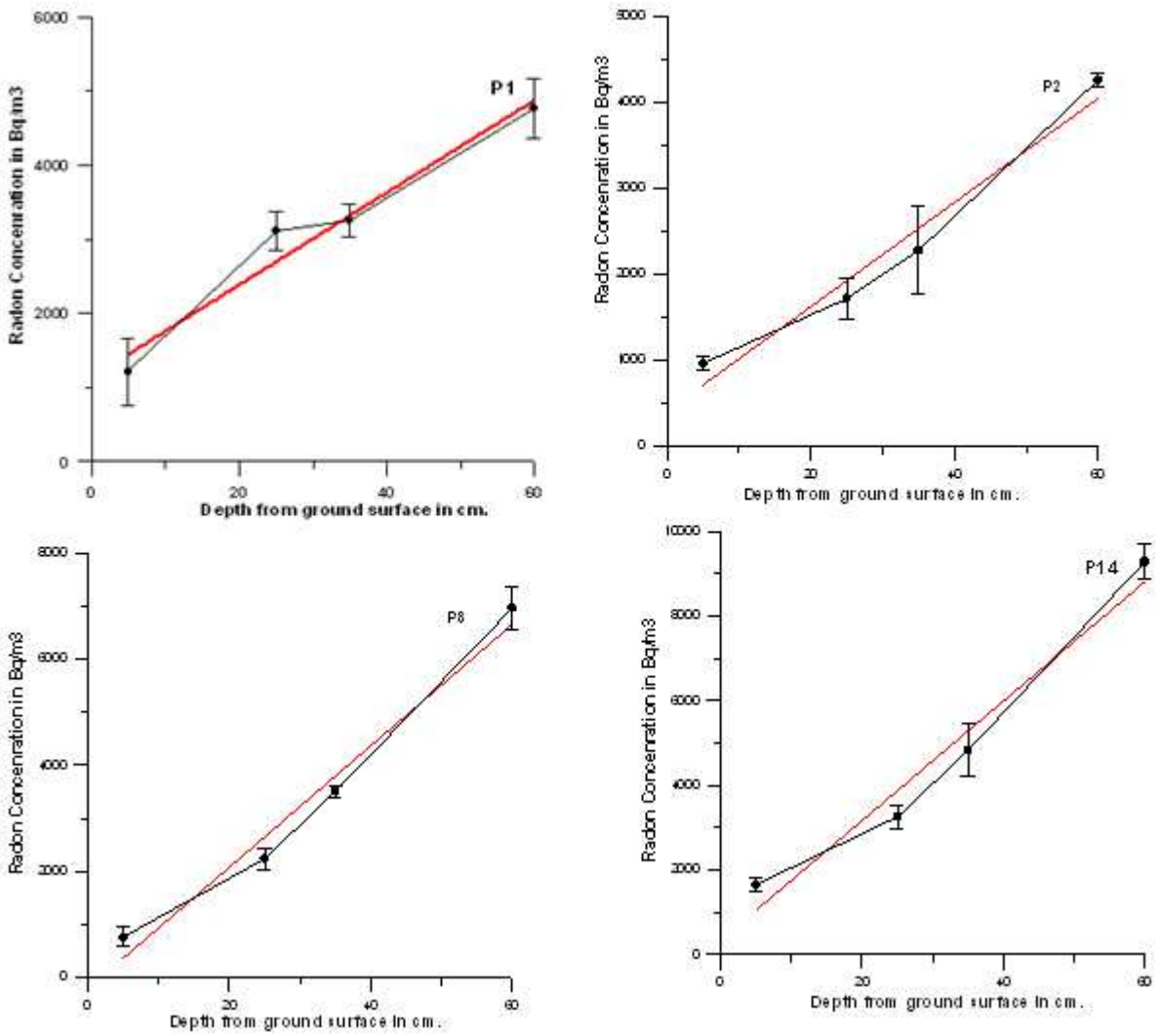

Figure-4. Radon concentration as a function of the depth from the ground surface: P1 for Al-Nafit district, P2 for Al-Khari district, P8 for Al- Jazira district and P14 for Al-Amir district.

CONCLUSION

The results in the present work indicate that the area under investigation has different Radon concentrations according to depth from the ground surface and the locations of the sample point. The concentration increases with depth from the ground surface. The results, in average, are less than the reported average in Kurdistan Iraq or in Jordan. The continuous monitoring, RAD7 probes, are a simpler and fast method of measuring the Radon gas concentration in soil. This kind of measurements, together with permeability of soil, can be helpful in complying new radiation protection regulation to estimate health hazard index due to radiation exposure in Iraq.

REFERENCES

[1] N. Sharama, R. Sharama and H.S. Virk, *Advanced in Applied Science Research*, (**2011**), 2(3), pp 186-190
[2] G. Viruthagiri and K. Ponnarasi, *Advanced in Applied Science Research*, (**2011**), 2(2), pp 103-106
[3] WHO Air Quality Guidelines for Europe. Geneva (**1987**)

[4] NRC (National Research Council). Committee on Health Effects of Exposure to Radon (BEIR VI), and Commission on Life Sciences. Health Effects of Exposure to Radon in Mines and Homes. Washington, D.C. National Academy Press. (**1994**).
[5] G. Monchaux, J.P. Morlier, S. Altmeyer, M. Debroche, and M. *Morin*, *Readiation Research*, (**1999**), V152, No. 5, pp. s137-s140.
[6] L.A. Truta-Popa, W. Hofmann, and C. Cosma, *Radiation protuction Dosometry*, (**2011**), V146, (1-3), pp.34-37
[7] UNSCEAR, sources and effects of ionizing Radiation, United Nation, NY, (**1993**), p. 73.
[8] K. Badham, R. Mehra and R.G. Sonkawade, *Inadian Journal of Pure and Applied Physics*, Vol 48, 508-511, (**2010**)
[9] D. Mazur, M. Janik, J. Loskiewicz, p. Olko and J. Swakon, (**1999**), *Radiation Measurment* 13, pp. 295-300
[10] J. Vaupotic, A. Gregoric, I Kobal, P. Zvab, K. Kozk, J. Mazur, E. Kochowska, and D. Grzaziel, *Natural Hazards and Earht System Sciences*, (**2010**), 10, pp. 895-899
[11] S. Singh, A. Kumar, B. Bajwa, S. Mahjan, V. Kumar and S. Dhar, (**2010**), *Terr. Atom. Ocean*., Vo;. 21, No. 4, pp. 685-695.
[12] A. H. Ismail and M. S. Jaafar, *World Academy of Science, engineering and Technology*,(**2010**), V70, pp 701-704.
[13] K. Badhan, R. Mehra and R.G. Sonkwade, (**2010**), *Indian Journal of Pure and Applied* Physics, V48, pp 508-511.
[14] F. Bouzarjomohri and M.H. Ehrampoosh, (**2008**),*Iran. J. Raiat. Res*. ,6(3), pp. 141-144
[15] N.R. Varley and A.G. Flowers, *Radia. Prot. Dosim*., 77, pp.171-176
[16] K.M.Abumarad and M.H. Al-Tmimi, (**2005**), *Radiation measurements*, 39, pp. 77-80