RADON CONCENTRATION IN SOIL OF FALLUJAH, RAMADI, DIAYALA, WASIT AND NEARBY BAGHDAD SITES USING *ssntds*

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Abstract

Solid state nuclear track detectors are increasingly being used to obtain the radon concentration in soil of some regions of Iraq. Several samples of soil were collected from Al – Anbar, Wasit, Diayala and Baghdad nearby sites to evaluate the radon concentration. CR – 39 plastic track detectors was used as a measurement device with cylindrical diffusion Technique. Results shows higher concentration was recorded in Al – Ramadi city which was equal to 143.1 Bq/m^3, while the lower radon concentration was found in Diayala governorate which was equal to 21.504 Bq/m^3. By making a comparison between results and the permissible limits of radon concentration in soil of ICRP, we found that all sites of the study are in agreement with the permissible limits.

تراكيز الرادون في تربة الفلوجة والرمادي وديالى وواسط ومناطق اطراف بغداد باستخدام كواشف الاثر النووي الحالة الصلبة

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الخلاصة

يهدف البحث الحالي الى ايجاد تراكيز غاز الرادون في التربة في بعض مناطق العراق باستخدام كواشف الاثر النووي الحالة الصلبة. تم جمع عدة نماذج من التربة من مدينة الفلوجة، محافظة واسط، ومحافظة ديالى ومناطق اطراف بغداد لقياس تراكيز غاز الرادون فيها. استخدم كاشف الاثر النووي من نوع CR–39 البوليمري وباستخدام تقنية اسطوانة الانتشار كتقنية قياس. بينت النتائج ان اعلى التراكيز كانت في مدينة الرمادي وتساوي Bq/m^3 (143.1 ± 0.1)، بينما اقل التراكيز كانت قد سجلت في منطقة بلدروز التابعة لمحافظة ديالى والتي كانت مساوية الى Bq/m^3 (21.5±0.99). من مقارنة النتائج مع المحددات العالمية للمنظمة الدولية للوقاية من الاشعاع ICRP، فان جميع المناطق هي ضمن الحدود المسموحة.

Introduction

Radon, first discovered in 1900 by Friedrich Ernest Dorn, was the third radioactive element to be discovered after radium and polonium [1]. When radon undergoes a radioactive decay it emits ionizing radiation in the form of α–particles. It also produces short–lived decay products often called progeny or daughters, some of which are also radioactive [2]. The progeny are not gases and can easily attach to dust and other particles. Those particles can be transported by air and can also be breathed. Inhaled radon Rn-222 progeny are the most important source of irradiation of the human respiratory tract. Epidemiological studies of

under miners of uranium and other minerals have provided reasonably firm estimation for the risk of lung cancer associated with exposure to radon progeny [3]. In soil, the radiation be on the surface to about 1–2cm and 90% of radiation removed due to rain fall. Soil and rocks rich with uranium are the main source of radioactive materials. Radon–222 has a half life of 3.8 days, long enough to diffuse into the atmosphere through the solid rocks and soil [4]. Soil radon activity under normal environmental conditions is influenced by soil moisture content, barometric pressure variations, temperature and structure of soil. Loose sandy soil allows the maximum diffusion of radon gas, whereas frozen, compacted or clay soil inhibits its flow. The radiation from radon and its daughter's products is a great risk of lung cancer by inhalation of air with high radon and radon daughter concentrations at a period time [5]. In consequence of this, radon has been identified as a second leading cause of lung cancer after smoking [6]. Radon concentration in soil affected by many factors in addition to soil properties, such as the seasonally variations. The level of radon in soil during winter is low since the soil is wet, humid and of lower porosity that may decrease the diffusion of radon gas [7]. While in summer, the soil becomes less humid and the porosity increases but the ventilation throughout soil granules decreases slightly due to the drying of plants, which makes radon level decreases [8]. The objective of this study is to measure the radon concentrations level in different sites of some Iraqi regions. Additionally, a comparison of results to permissible limits also presents.

Experimental

Twenty samples were collected from different sites in Iraq, were seven from Al–Falluja city, three from Baghdad, Diayala and Wasit, and one from Al–Mahmoodiya, Al–Yosufia, Al–Ramadi and Abu–Ghraib. The samples were crashed and milled into a powder with sieve of 250 μm, dried and sealed into the exposure unit with 5.0 g weight. The exposure unit is a test tube of known dimensions and diameter with enclosed rubber cover. CR–39 (Pershore, U. K., 250 μm thick) plastic detector used in the present work due to its simplicity, high sensitivity to α–particles and abundant. The cylindrical diffusion technique was used as a measurement technique with diameter of 2.5 cm, Figure (1) shows a simple form to the diffusion cylinder.

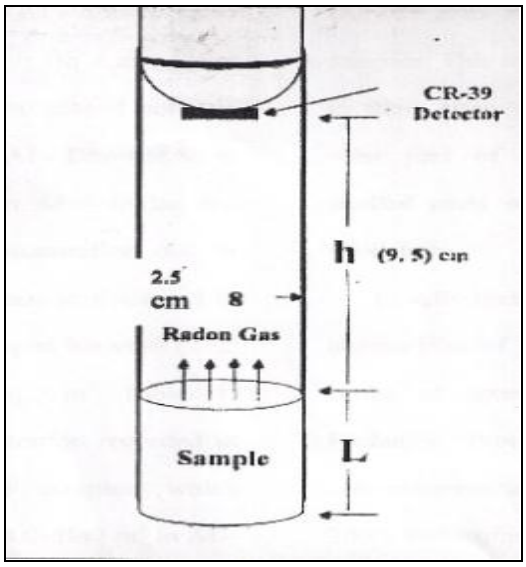

Figure 1: A simple form of Cylinder Diffusion Technique used in this work.

Samples were put in the test tubes and enclosed with rubber cover and left to 22 days to get the secular equilibrium between radium and its daughters. After the end of equilibrium time, the covers were instead by others contains CR–39 detectors and enclosed to be exposed to the samples. The exposure time was 40 days. At the end of exposure time, detectors were removed and etched with etching solution using NaOH with 6.25 N in water bath at 60°C ± 1 for 4 hr. Then, the detectors were washed with distilled water, dried and scanned under optical microscope with 400× magnification. To measure radon concentration in samples first, the diffusion constant (k) of the system was calculated, by using the equation [9]:

$$K = 0.25\times r\,(2\cos\theta_c - r / R_\alpha) \quad \ldots\ldots\ldots (1)$$

Where:

r = radius of diffusion cylinder,

R_α= range of alpha particles in air that produced and emit From Rn–222 which is equal to 4.15cm, an

θ_c = critical angle of CR – 39 detector = 35°.

Radon concentration (in Bq/m^3) in the air of samples was estimated using the equation [10]:

$$C_a = \rho / k \times t \quad \ldots\ldots\ldots (2)$$

Where:

C_a =radon concentration in air of sample (Bq/m^3),

ρ = track density ($track/cm^2$)

and

t = time of exposure (hr).

Results and discussion

Using the long term detectors in the form of CR–39 plastic track detectors, radon concentration was calculated. The cylindrical diffusion tubes as an exposure device was used in this research and due to its dimension and by using eq. 1, the diffusion constant (k) was equal to 0.4047 track.cm^{-2}/hr.Bq.m^{-3}. This value was used to calculate radon concentration in the samples. Notice that k depends on the dimensions of the device. The final results for radon concentration (in Bq/m^3) in the soil samples were delivered using eq. (2). Tables 1 – 4 show radon concentration in Al – Falluja city, Diayala, Wasit, and Baghdad and nearby sites respectively. Table 1 shows radon concentration in Falluja city and Al – Ramadi. Results showed higher concentration in Al – Ramadi city which was equal to 143.1 ± 0.1 Bq/m^3 followed by Al – Shorta Sq. in Falluja city 102.3±0.9 Bq/m^3. Other sites radon concentration ranged between 100.5±1.6 Bq/m^3 in Al–Dhobaat Sq. to 73.6 ± 2.3 Bq/m^3 in Al–Joulan Sq. which was the less concentration due to radon gas.

In Diayala sites, as delivered in Table 2, the results ranged between 27.2±8.1–21.5±0.9 Bq/m^3. Table 3 represents radon concentration recorded in Wasit governorate soil samples, which ranged between 52.0 ± 0.8 Bq/m^3 in Al – Numaniyah to 45.1±1.0 Bq/m^3 in Al – Kut city. In Baghdad and nearby Baghdad sites, which represented in Table 4, Abu – Ghraib site recorded the highest concentration which was equal to 63.0±1.0 Bq/m^3, and the lowest recorded in Al–Ghazaliya site where the concentration was 30.3±1.2 Bq/m^3.

Table 1: Radon Concentration in Al – Falluja city and Al – Ramadi (Bq/m^3)

No.	Site Name	Radon Concentration (Bq/m^3)	% less from ICRP Permissible limits
1	Al - Askary	93.404 ± 5.36	- 49.705
2	Al - Dhobaat	100.590 ± 1.60	- 53.269
3	Al - Shorta	102.323 ± 0.998	- 48.838
4	Al -Moalemeen	85.515 ± 1.06	- 57.24
5	Al - Joulan	73.663 ± 2.34	- 63.168
6	Al - Shohadaa	80.098 ± 2.09	- 59.951
7	Al – Nazal	87.764 ± 1.16	- 56.118
8	Al – Ramadi city	143.10 ± 0.113	- 28.45

Table 2: Radon Concentration in Diayala Governorate (Bq/m^3)

No.	Site Name	Radon Concentration (Bq/m^3)	% less from ICRP Permissible limits
1	Baqubah city	21.998 ± 1.12	- 89.001
2	Baladrooz	21.504 ± 0.99	- 89.248
3	Khan Bany Saad	27.231 ± 8.14	- 86.38

Table 3: Radon Concentration in Wasit Governorate (Bq/m^3)

No.	Site Name	Radon Concentration (Bq/m^3)	% less from ICRP Permissible limits
1	Al – Kut city	45.110 ± 1.06	- 77.44
2	Al - Numaniyah	52.039 ± 0.85	- 73.98
3	Al - Azezeya	48.986 ± 0.28	- 75.507

Table 4: Radon Concentration Baghdad and nearby Baghdad sites (Bq/m^3)

No.	Site Name	Radon Concentration (Bq/m^3)	% less from ICRP Permissible limits
1	Al – Dora city	43.025 ± 0.52	- 78.487
2	Al - Ghazaliya	30.323 ± 1.233	- 84.833
3	Al - Shaab	32.780 ± 0.740	- 83.61
4	Al -Mahmoodiya	50.442 ± 2.13	- 74.77
5	Al - Yousifiya	41.531 ± 0.36	- 79.73
6	Abu - Ghraib	63.040 ± 1.018	- 68.487

By comparison of results of all sites, the west sites represented by Al–Ramadi city followed by Al–Falluja sites were much more than other sited due to radon concentration, while the east Part of Iraq represented by Diayala sites recorded the less between samples. This may refer to the type of soil in these sites, and may refer to that the west part of Iraq and especially

the studied parts were military bombs until soon dates.

Results included in addition to that a comparison of results to the permissible limits of International Commission of Radiation Protection (ICRP) of radon concentration in soil, which is equal to 200 – 800 Bq/m^3 [11]. The comparison showed that all sites of study are in agreement with these limits.

Conclusions

From this research, we can conclude the following points:

1. The cylindrical diffusion device is a good simple technique to measures radon concentration without any need to prepare standard samples.
2. The west part of Iraq was containing high radon concentration in soil than other selected parts due to this research.
3. All sites of study are unpolluted sites with radon gas, since all were within ICRP Permissible Limits.

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