Concentrations Assessment of Radon Gas and Some Radioactive Nuclei for Some Region in Basra Governorate By CR-39 Detector

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Abstract.

In this work, eighteen samples were studied distributed over different sites in Basra Governorate from southern Iraq. The CR-39 nuclear trace detector technique was used to reach the results, which showed us, the radium concentrations ranged between (18.52 - 2.169) Becquerel / kg, the environmental factors such as rain, dust and weather erosion have led to a decrease in radium concentrations in these areas which fell within the permissible range of 33 Becquerel / kg. The concentrations of uranium in the samples under study ranged from 0.2622 ppm to 2.239 ppm, is higher than the natural limit of the background radiation (0.2 - 1.2) ppm, which indicates that radioactive pollution has entered the Iraqi environment. As well as we find that the concentration of Radon in some samples has risen by twenty times the normal limit in some samples, which indicates the danger of dealing with the polluted southern environment of Iraq.

Keywords: Radon Isotopes, Radium isotopes, CR-39 detector, 222Rn, 226Ra, 238U and 218Po concentrations, Effective annual dose.

Introduction

Radon is one of the elements of the periodic table and is part of the group of noble elements, such as Helium, Neon, Xenon, and others. Its density is 9.7 3, its boiling point - 61.8, its freezing point - 71.0. It is a radioactive gas that is colourless and odourless. These properties are difficult to detect. Radon is one of the heaviest gases known in nature, with its atomic number 86 and the mass number of its most stable isotope is 222. Radon 222Rn is generated as a result of spontaneous decay of Radium isotope 226Ra, which is present in the earth's crust at a rate of 10-11% [1]. The presence of radium in a region in nature depends on the presence of 238U uranium, which geologists estimate its presence in the earth's crust at a ratio of 3 ppm, and since radium is the main source of Radon in nature and its half-life is equal to 1600, and therefore it is expected that radium is present in all ores that contain U238, which is not distributed uniformly. It is homogeneous in different geological regions, so there are areas that are almost devoid of this element, while there are other areas that contain high concentrations of ores that contain this element, which tangibly affects the Radon concentrations from one region to another because it seeps and is naturally liberated from the ground and groundwater [2]. To the air. Experts estimate that one microgram of 226Ra can produce 0.0001 ml 222Rn under normal conditions of pressure and temperature. The alpha particles emitted as a result of the dissolution of Radon are considered heavy charged particles that cause tremendous effects and disturbances and chemical effects at the molecular...
level when they collide with the atoms of cells that make up tissues and organs of the body, and the average path length of alpha particles in soft tissues is estimated to be around 40\(\mu m\). Its ionizing energy is more than a thousand times higher than the energy of beta particles, and thus it is more destructive to human tissues. Hence the risks of exposure to \(^{222}\text{Rn}\) and its degradation products. Despite the foregoing, part of the annual effective equivalent dose to which people who are in an environment with a normal background radiation are exposed is estimated at around 2 mSv per year, and this is due to the human inhalation of \(^{222}\text{Rn}\) at a rate of 0.8 mSv \[4\]. An increasing numbers of lung cancer cases are being diagnosed among workers in the underground mining and oil extraction operations due to the radon gas accompanying the extraction processes. The widespread interest in radon as an environmental and industrial radioactive pollutant stems from the fact that it is a source of danger to the health of workers in mines and tunnels and to the public health of people alike due to the wide spread of it in the soil, building materials and ground water, including well water and mineral springs. The uranium nucleus (Parent nucleus) is the main source of radon gas, as it is generated from the decomposition of radium, which is mainly from the decomposition products of the uranium chain. Therefore, the detection of radon in high concentrations near the surface of the earth is evidence of the presence of uranium ore at a certain depth \[1-4\]. The present study deals with the study of 18 sites of different soil samples for the purpose of making a quantitative and qualitative assessment of the selected samples by determining the effectiveness of radon gas and obtaining from it indicators and concentrations of parent nucleus and daughter nucleus.

### Material and Methods

#### Study Area and Sample Collection

The southern region of Iraq, especially Basra Governorate, was chosen as a study area in our research due to its exposure to the bombing of depleted uranium munitions during the first and second Gulf War, as well as the high level of radiation background in general as a result of mining and oil extraction operations. Table 1. shows the areas from which samples were collected, distributed over eighteen sites that included a variety of samples selected and at a depth of 10 cm as samples (soil, sediments and soils extracted from oil fields).

| No. | Sample Code | Location | Coordinates | Meridians | latitudes |
|-----|-------------|----------|-------------|-----------|-----------|
| 1   | \(S_1\)    | Al-Barjasia (oil field) | 30\(^0\).382 | 47\(^0\).585 |
| 2   | \(S_2\)    | Shuaiba (oil field) | 30\(^0\).451 | 47\(^0\).668 |
| 3   | \(S_3\)    | Hmar Musharraf (oil field) | 30\(^0\).438 | 47\(^0\).687 |
| 4   | \(S_4\)    | Al-Zubair (oil field) | 30\(^0\).487 | 47\(^0\).612 |
| 5   | \(S_5\)    | Gas compressor (oil field) | 30\(^0\).578 | 47\(^0\).313 |
| 6   | \(S_6\)    | Rumaila North (oil field) | 30\(^0\).560 | 47\(^0\).182 |
| 7   | \(S_7\)    | Al-Eaz marshe(sediment) | 30\(^0\).999 | 47\(^0\).385 |
| 8   | \(S_8\)    | Al-Qurna (sediment) | 31\(^0\).003 | 47\(^0\).401 |
| 9   | \(S_9\)    | Al-Faw (soil) | 29\(^0\).980 | 48\(^0\).476 |
| 10  | \(S_{10}\) | Al-Hartha (soil) | 30\(^0\).692 | 47\(^0\).740 |
| 11  | \(S_{11}\) | Al-madaynah (soil) | 30\(^0\).965 | 47\(^0\).315 |
| 12  | \(S_{12}\) | Rumaila North (soil) | 30\(^0\).500 | 47\(^0\).245 |
| 13  | \(S_{13}\) | Al-Zubair (soil) | 30\(^0\).371 | 47\(^0\).705 |
| 14  | \(S_{14}\) | Rumaila South (soil) | 30\(^0\).433 | 47\(^0\).321 |
| 15  | \(S_{15}\) | Safwan (soil) | 30\(^0\).107 | 47\(^0\).718 |
| 16  | \(S_{16}\) | Al-Qurna (soil) | 30\(^0\).794 | 47\(^0\).584 |
Sample Preparation and Etching Process

The process of irradiation of the trace detector was carried out using test tube technology, after milled samples using a fixed pulveriser and repeatedly to obtain a fine and homogeneous powder in terms of the distribution of the radioactive material in it to be ready for the examination and analysis process. and by adopting a long measurement method The term test tube (cylindrical diffusion chambers) is the preferred technique for determining Radon, Radium and uranium concentrations, As it is possible to obtain the lowest accuracy resulting from the deposition Radon decay products nuclei, which is the polonium nucleus deposited on the surface of the reagent and the inner walls of the reaction chamber through, by controlling the selection of dimensions (radius, height) that achieve that goal. It has been shown that the best dimensions of the test tubes are when the radius is less 1.25 cm and height greater than 5 cm. We set the CR39 detector in the center of the bottom surface of the rubber sealing And the payment was placed quickly after raising the previous payment, which does not contain the detector, in order to avoid the imbalance of the state of balance that was reached, and after that, the system was left for a period of (60) days based on the long-term measurement method. Figure 1: illustrates the technique used.

![Figure 1](image_url)

**Figure 1.** A schematic diagram of the sealed-cup technique

Then the reagents were raised to start the scraping process to show the effects formed in them. The aqueous NaOH solution, with a purity of 98% and a temperature of 70 ± 1 °C, was used in the process of showing the effects formed in the pieces of reagents exposed to the samples, as it is one of the preferred solutions in the process of showing traces in plastic reagents, especially polycarbonate reagents such as CR-39. To obtain the required concentration of the 6.25 M skimming solution, 25 NaOH granules of 40 molecular weight were dissolved in 100 distilled water. The skimming process lasted for four hours, as the reagents were removed from the solution and dried after washing well with distilled water to begin the process of microscopic viewing and calculating the effects formed in them. In order to obtain the actual intensity of the traces of alpha particles emitted from the samples under study. The microscopic viewing process was carried out using an optical microscope type (ALTAU) with 400 x magnification. The process of counting the traces in the reagents was repeated three times in order to ensure the accuracy of the readings and to take the average number of traces of the two readings per unit area of each detector.

**Results and Discussions**
Radon Concentration (\(^{222}\)Rn)

The concentration of Radon gas in air for the different samples is calculated by the following equation [5]:

\[
C_{Rn} \left( \frac{Bq}{m^3} \right) = K \frac{\rho}{T} \quad \text{...} \quad 1
\]

where \(C_{Rn}\) is the concentration of Radon in the air space in \(Bq/m^3\), \(K\) is the calibration factor in \(Bq/m^3\) per tracks \(Cm^2\) dy\(^{-1}\), \(T\) is the exposure time in day and \(\rho\) is the track density in \((\text{tracks} Cm^2)\). The Radon concentration in the samples can be found using the following relationship [6].

\[
C_s \left( Bq/m^3 \right) = \frac{C_{Rn} \lambda_{Rn} h T}{L} \quad \text{...} \quad 2
\]

where \(\lambda_{Rn}\) Radon decay constant and equal to \((0.1814/\text{Day})\), \(h\): distance from the sample surface and CR39 detector which is equal to \(5\ Cm\), \(L\) is the thickness of the sample is equal to \(2\ Cm\). while the mass of each sample was \(150\ gm\). Figure 2:A-B: shows the relationship between trace density and Radon concentrations in the air space and samples equal to 0.9998 and 1 respectively. This result shows a good linear relationship. Table 2 shows the measured Radon concentration in the collected samples. The Radon concentration in the air space ranges from \((1538\ to\ 180)\times10^3\ Bq/m^3\) with an average value of \((7.462)\times10^3\ Bq/m^3\). As for the concentration of dissolved Radon \(C_s\), it ranged from \((41.85\ to\ 4.902)\times10^3\ Bq/m^3\), with an average value of \((20.30)\times10^3\ Bq/m^3\). The results indicated that the highest level of Radon concentration in both cases was in sample number 5 of the Gas compressor (oil field), while the lowest level in sample number 7 was of Al-Eaz marsh (sediment). As well as, The radioactivity values and number of radioactive nuclei radon gas ranged between the lowest value for sample \(S_7\) and the highest value for sample \(S_5\). The International Organization for Radiation Protection (ICRP) has published warnings about the limits of exposure to Radon gas through the permissible limits of \((200-800)\ Bq/m^3\) and confirmed by the International Atomic Energy Agency and the World Health Organization, and from observing the results we obtained, we find that the concentration of Radon The samples have risen by twenty times the normal limit in some samples, which indicates the danger of dealing with the polluted southern environment of Iraq, and which confirms the use of missiles containing depleted uranium by the coalition forces in the second Gulf War in 1991.

![Figure 2: The correlation between track density and Radon concentration. B= C_{Rn} Radon concentrations in the air space. A= C_5= concentration of dissolved Radon](image-url)
Table 2. The track density, radon concentration in air $C_a$ and dissolved $C_x$, radioactivity in (Bq, Bq/Kg) and the number of radioactive nuclei radon gas

| No. | Sample Code | $\rho^{(222)Rn}$ (Track/cm²) | $\left(\frac{222}{}\right)$ (Bq/m³) | $\left(\frac{222}{}\right)$ (Bq/m³) | $A^{(222)Rn}$ Bq/Kg | $A^{(222)Rn}$ Bq | $N(Rn) \times 10^5$ |
|-----|-------------|-----------------------------|--------------------------------|-------------------------------|---------------------|----------------|----------------|
| 1   | $S_1$       | 2523.33±4.041               | 41.49                         | 1.525                         | 27.52               | 4.128          | 19.66         |
| 2   | $S_2$       | 2276±3.512                  | 37.43                         | 1.376                         | 24.83               | 3.724          | 17.73         |
| 3   | $S_3$       | 2211±1.155                  | 36.36                         | 1.336                         | 24.12               | 3.618          | 17.23         |
| 4   | $S_4$       | 1986±2.082                  | 32.67                         | 1.201                         | 21.67               | 3.250          | 15.48         |
| 5   | $S_5$       | 2545±2.517                  | 41.85                         | 1.538                         | 27.76               | 4.164          | 19.83         |
| 6   | $S_6$       | 2211±2.082                  | 36.37                         | 1.337                         | 24.12               | 3.618          | 17.23         |
| 7   | $S_7$       | 296.33±1.528                | 4.902                         | 0.180                         | 3.252               | 0.488          | 2.323         |
| 8   | $S_8$       | 406.67±1.155                | 6.747                         | 0.248                         | 4.476               | 0.671          | 3.197         |
| 9   | $S_9$       | 1981±1.732                  | 32.59                         | 1.198                         | 21.62               | 3.243          | 15.44         |
| 10  | $S_{10}$    | 413.67±1.528                | 6.802                         | 0.250                         | 4.512               | 0.677          | 3.223         |
| 11  | $S_{11}$    | 387.67±1.155                | 6.374                         | 0.234                         | 4.228               | 0.634          | 3.020         |
| 12  | $S_{12}$    | 466.67±2.082                | 7.673                         | 0.282                         | 5.090               | 0.763          | 3.636         |
| 13  | $S_{13}$    | 506.67±2.309                | 8.331                         | 0.306                         | 5.526               | 0.829          | 3.947         |
| 14  | $S_{14}$    | 1427.67±3.055               | 23.48                         | 0.863                         | 15.57               | 2.336          | 11.11         |
| 15  | $S_{15}$    | 883.33±2.082                | 14.69                         | 0.534                         | 9.635               | 1.445          | 6.882         |
| 16  | $S_{16}$    | 893.33±3.215                | 14.52                         | 0.540                         | 9.744               | 1.462          | 6.960         |
| 17  | $S_{17}$    | 416.67±1.528                | 6.851                         | 0.252                         | 4.545               | 0.682          | 3.246         |
| 18  | $S_{18}$    | 385.33±1.155                | 6.336                         | 0.233                         | 4.203               | 0.630          | 3.002         |

Radium Concentration ($^{226}Ra$)

The Radium concentration in collected samples was calculated in Bq/Kg from the following equation[7]:

$$A_{Ra} \left(\frac{Bq}{kg}\right) = \frac{\rho \cdot h \cdot A}{K \cdot T_e \cdot M}$$

where $A_{Ra}$ is the effective radium content of sample in Bq/Kg, $A$: is the surface area of sample which exhaled the radon gas in m², $M$: is the mass of sample in Kg and $T_e$ is the effective exposure time which is calculated by the following equation[8]:

$$T_e = t - \frac{1}{\lambda \left(1 - e^{-\lambda t}\right)}$$

Where $t$ is the exposure time and $\lambda$ is the radon decay constant dy⁻¹. It represents the total irradiation time and equals 60 days, and it has been found that the effective exposure time is equal to 54.5 days. As for Table 3: , it shows the effective radium content, the number of uranium atoms, its weight and its concentration in the samples. The values of the Radium radioactivity ranged between as the lowest value for sample $S_7$ with value 18.52 Bq/Kg and as the highest value for sample $S_8$ with value 2.169 2 Bq/Kg, noting that the size of the studied samples was approximately 0.995×10⁻⁶ m³. In an environmental study conducted by (Saleh and Meqwar, 1995) that included the areas of (Basra, Zubair, Jabal Sanam, and the northern and southern Rumaila fields), it indicated that the The concentrations of radium ranged between (18.52 - 2.169) Bq/Kg. The long war that has passed and the environmental factors such as rain, dust and weather erosion have led to a decrease in radium concentrations in these areas. In general, all measured values fall within the permissible range of 33 Bq/Kg, as shown in Table 3.

Uranium Concentration ($^{238}U$)
Using the equation of radioactive equilibrium for determine the number of atoms of uranium in the samples from the equation [9-17]:

\[ N_U \lambda_U = N_{Rn} \lambda_{Rn} \] ................. (5)

Where \( \lambda_U \) is decay constant of uranium (3.4 \times 10^{-18} \text{sec}^{-1}), After calculating the number of uranium, atoms in each sample we can calculated the mass of uranium (\( W_u \)) in each sample from the following equation [10]:

\[ W_u = N_U A_U N_{av} \] ................. (6)

Where \( N_U \): mass number of uranium \( ^{238}U \), \( N_{av} \): Avogadro number (6.02 \times 10^{23} \text{mol}^{-1}), finally, we can calculated the mass of uranium in unit (ppm) from the following equation [11-18]:

\[ C_u(\text{ppm}) = \frac{W_u}{W_5} \] ................. (7)

Where \( W_5 \): mass of the sample.

It is worth noting that the uranium concentration ranged between as the lowest value for sample \( S_7 \) and as the highest for sample \( S_5 \), with values (2.239 - 0.262) ppm respectively. Where high uranium concentrations were observed in general in the six oil fields samples, and their concentrations were, Al-Barjasia (oil field) 2.220 ppm , Shuaiba (oil field) 2.002 ppm, Hmar Musharraf (oil field) 1.945 ppm, Al-Zubair (oil field) 1.747 ppm, Gas compressor (oil field) 2.239 ppm, Rumaila North (oil field) 1.945 ppm respectively due to excitation of artificially enhanced natural radionuclides (TENORM) through oil extraction processes in oil fields. Also, an increase in the values of uranium concentrations in soil samples for the Al-Faw and South Rumaila regions in \( S_9 \) and \( S_{14} \) respectively, with values of (1.744 - 1.256) ppm respectively, which was attributed to the use of uranium ammunition in the Gulf War operations. Generally, the concentrations of uranium in the samples under study ranged from 0.2622 ppm to 2.239 ppm, is higher than the natural limit of the background radiation (0.2 – 1.2) ppm, which indicates that radioactive pollution has entered the Iraqi environment. Table 3: shows the radioactivity of uranium, the number, weight, and concentration of uranium in the samples.

Table 3: shows the radioactivity of uranium, the number, weight, and concentration of uranium in the samples

| No. | Sample Code | \( A^{(226)Ra} \) Bq/Kg | \( N(U) \times 10^{17} \) | \( A(U) \) Bq | \( C_u(\text{ppm}) \) | \( W_u \) (gm.) \( \times 10^{-5} \) |
|-----|-------------|---------------------|-----------------|--------|----------------|------------------|
| 1   | \( S_1 \)   | 18.36               | 8.425           | 4.114  | 2.220          | 33.29            |
| 2   | \( S_2 \)   | 16.56               | 7.601           | 3.711  | 2.002          | 30.03            |
| 3   | \( S_3 \)   | 16.09               | 7.384           | 3.605  | 1.945          | 29.18            |
| 4   | \( S_4 \)   | 14.45               | 6.633           | 3.239  | 1.747          | 26.21            |
| 5   | \( S_5 \)   | 18.52               | 8.499           | 4.150  | 2.239          | 33.58            |
| 6   | \( S_6 \)   | 16.09               | 7.385           | 3.606  | 1.945          | 29.18            |
| 7   | \( S_7 \)   | 2.169               | 0.995           | 0.486  | 0.262          | 3.933            |
| 8   | \( S_8 \)   | 2.986               | 1.370           | 0.669  | 0.361          | 5.414            |
| 9   | \( S_9 \)   | 14.42               | 6.619           | 3.232  | 1.744          | 26.15            |
| 10  | \( S_{10} \)| 3.010               | 1.381           | 0.674  | 0.364          | 5.458            |
| 11  | \( S_{11} \)| 2.821               | 1.294           | 0.632  | 0.341          | 5.115            |
| 12  | \( S_{12} \)| 3.396               | 1.558           | 0.761  | 0.411          | 6.157            |
| 13  | \( S_{13} \)| 3.687               | 1.692           | 0.826  | 0.446          | 6.685            |
| 14  | \( S_{14} \)| 10.39               | 4.767           | 2.328  | 1.256          | 18.84            |
| 15  | \( S_{15} \)| 6.427               | 2.949           | 1.440  | 0.777          | 11.65            |
| 16  | \( S_{16} \)| 6.500               | 2.983           | 1.456  | 0.786          | 11.79            |
| 17  | \( S_{17} \)| 3.032               | 1.391           | 0.679  | 0.367          | 5.497            |
| 18  | \( S_{18} \)| 2.804               | 1.287           | 0.628  | 0.339          | 5.084            |

Polonium Concentration (\(^{210}Po\)).
As for the concentrations of Radon degradation products emitting alpha particles $^{218}\text{Po}$, $^{218}\text{Po}$, which may be deposited on the walls of the irradiation chamber or on the face of the detector, although their percentage depends on the dimensions of the used chamber, it has been found in a number of studies that their contribution is minimal when it is half the diameter. The cylindrical irradiation chamber 1.4, and the sample distance from the detector is greater than 7. To determine the concentrations of polonium $^{218}\text{Po}$ deposited on the walls of the cylindrical chamber and the face of the detector by the equations 8-9[12-13].

\[
D_{\text{Po}^{218}} = \frac{C_{\text{Rn}}}{4} r \left[ \frac{h}{r+h} \right] \cos \theta_c \ldots \ldots 8 \\
D_{\text{Po}^{218}} = \frac{C_{\text{Rn}}}{4} r \left[ \frac{h}{r+h} \right] \cos \theta_c \frac{r}{R_\alpha} \ldots \ldots 9
\]

In order to calculate the effective annual dose (AEDE), we must consider the following:
✓ Coefficient of conversion from absorbed dose to effective dose
✓ Internal Preoccupation Factor.
Factor 0.7Sv was used as a factor to convert from the air-absorbed dose to the annual effective dose received by adults and used 0.2 which is the percentage of time that a person is exposed in outside, and from these data it was found that the annual effective dose calculated from equation 10: [14-15]:

\[
\text{AEDE}_{\text{outdoor}} \text{ (mSv/y)} = AD \left( \frac{n\text{Gy}}{h} \right) \times 8760 h \times 0.2 \times 0.7 \times \frac{\text{Sv}}{\text{Gy}} \times 10^{-6} \ldots \ldots 10
\]

Whereas, 8760 indicates the number of hours of the year, and the global average annual effective dose is 0.48 mSv.

Table 4: shows $D(218\text{Po})\text{Bq/m}^2$ on the walls of an interaction room and the face of the detector, Annual Effective Dose Equivalent (AEDE) and Excess Lifetime Cancer Risk.

| No. | Sample Code | $D(218\text{Po})\text{Bq/m}^2$ On the walls of an interaction room | $D(218\text{Po})\text{Bq/m}^2$ On the face of the detector | AEDE_outdoor mSv/y |
|-----|-------------|-------------------------------------------------|-------------------------------------------------|-------------------|
| 1   | S_1         | 264.82                                          | 65.089                                          | 14.43             |
| 2   | S_2         | 238.90                                          | 58.718                                          | 13.01             |
| 3   | S_3         | 232.08                                          | 57.041                                          | 12.64             |
| 4   | S_4         | 208.50                                          | 51.246                                          | 11.36             |
| 5   | S_5         | 267.13                                          | 65.657                                          | 14.55             |
| 6   | S_6         | 232.11                                          | 57.050                                          | 12.64             |
| 7   | S_7         | 31.287                                          | 7.690                                           | 1.704             |
| 8   | S_8         | 43.064                                          | 10.584                                          | 2.346             |
| 9   | S_9         | 208.03                                          | 51.131                                          | 11.33             |
| 10  | S_10        | 43.414                                          | 10.670                                          | 2.365             |
| 11  | S_11        | 48.977                                          | 12.038                                          | 2.668             |
| 12  | S_12        | 53.175                                          | 13.069                                          | 2.896             |
| 13  | S_13        | 149.83                                          | 36.827                                          | 8.162             |
| 14  | S_14        | 92.706                                          | 22.786                                          | 5.050             |
| 15  | S_15        | 93.755                                          | 23.043                                          | 5.107             |
| 16  | S_16        | 93.755                                          | 23.043                                          | 5.107             |
From the above table, it is observed that the dose equivalent to radon gas concentrations, ranges between (14.55 - 1.704) mSv/y, this means that some samples have a higher values compared with normal limit of 2 mSv/y. As well as, it was found the Polonium concentration values ranged between (7.69 - 65.657) Bq/m² on the face of the detector and (31.287 - 267.13) Bq/m² on the walls of an interaction room, respectively.

Conclusions
The following conclusions were reached, firstly, the concentration of Radon The samples have risen by twenty times the normal limit in some samples, which indicates the danger of dealing with the polluted southern environment of Iraq, the radium concentrations ranged between (18.52 - 2.169) Becquerel / kg, the environmental factors such as rain, dust and weather erosion have led to a decrease in radium concentrations in these areas which fell within the permissible range of 33 Becquerel / kg. secondly, the concentrations of uranium in the samples under study ranged from 0.2622 ppm to 2.239 ppm, is higher than the natural limit of the background radiation (0.2 - 1.2) ppm, which indicates that radioactive pollution has entered the Iraqi environment, thirdly, it is observed that the dose equivalent to radon gas concentrations, ranges between (14.55 - 1.704) mSv/y, this means that some samples have a higher values compared with normal limit of 2 mSv/y. finally, it was found the Polonium concentration values ranged between (7.69 - 65.657) Bq/m² on the face of the detector and (31.287 - 267.13) Bq/m² on the walls of an interaction room, respectively.

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