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# Calculating Radiation Dose of Radon Using Technical Analysis of the Spectrums Gamma in Najaf City

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## Abstract

The radioactivity of radium-226 isotope has measured in the samples of soil in the places chosen from Najaf city by using the complete system of multi-channel analyzer.

Eight samples have collected from regions:

1-Al-Ansar (4 samples)
2-Al-Fateh at Al-Hurya side (3 samples)
3-Al-Rashadih at AL-Kufa (1 sample)

There are no researches studied the radioactivity of soil in Najaf city. The concentration of radium is high in Al-Fateh region location (2), where it's reached (1200±6.68) Bq/Kg and found that the radiation of exposure dose of radon gas in those region limits (1.42mSv/y) is greater than the allowed limits and where it's reached 1 mSv. The concentration of radium is lowest level in Al-Fateh region location (1) ,where it's reached (150±24.95) Bq/Kg and the dose arise from the radon gas in those region by limits (0.17mSv/y).

We have concluded that the main reason of the cancer diseases in those regions resulted by used the chemical of fertilizers and insecticides (it have high radioactivity), which its pollution the soil, the water of rivers, the drinking water, and the underground water.

## الخلاصة

جرى قياس النشاط الاشعاعي للنظير الراديوم–226 في نماذج تربة من مناطق منتخبة من مدينة النجف بأستخدام منظومة متكاملة من محلل متعدد القنوات , حيث تم جمع ثمانية نماذج من المناطق التالية:

1–حي الانصار(اربع نماذج)

2–الفتح ناحية الحرية(ثلاث نماذج)

3–حي الرشادية في الكوفة(نموذج واحد)

حيث بينت الدراسة عدم وجود دراسات سابقة لقياس النشاط الإشعاعي للتربة في مدينة النجف.

وجد من خلال الدراسة ان تركيز الراديوم مرتفع في منطقة الفتح الموقع (2) حيث بلغ (1200±6.68 Bq/Kg) ووجد ان الجرعة الاشعاعية المؤثرة لغاز الرادون في تلك المنطقة بحدود (1.42mSv/y) وهو اعلى من الحدود المسموح بها والبالغ 1 ملي سيفرت .اما اقل تركيز للراديوم فوجد في منطقة الفتح موقع(1) حيث بلغ (150±24.95 Bq/Kg) وكانت الجرعة الناجمة عن الرادون في المنطقة بحدود (0.17mSv/y).

استنتجنا من خلال الدراسة ان السبب الرئيسي لامراض السرطان في تلك المناطق ناتج من استخدام الاسمدة الكيمياوية ومبيدات الحشرات(ذات مستوى عالي من الاشعاع) التي تلوث التربة ومياه الانهار ومياه الشرب والمياه الجوفية .

## 1-Introduction

The natural radioactivity in the most of globe is varies within diverse limits relatively, Iraq is located within these regions, return to radioactivity in the earth's crust to the chains of radioactive (U-238, U-235, Th-232) (Marouf, 1989).

The radium in the soil return to a series of Uranium U-238,if the radium-226 found by high quantity cause the existence of radon gas in the air ,and change of the concentration of radon gas accordingly to change the concentration of radium in the soil and the rocks.

The distribution of radon is depend the speed of its production in the rocks, and its exit from the soil (Abdel-Fatah, 1972; Hok, *al.,* 1990),the radon gas when enter to the human cavity (lungs) by inhalation, and after the passage of half-life of this the gas (3.8d) produces the radionuclide (Bi-212, Pb-214, Po-218)

The concentration of radon in the closed houses higher than outdoors and good the ventilation places, and the radon rally from the ground and sources others, such as buildings materials (The proceedings of training course of radiation,1997; IAEA,1990).

The Iraqi environmental is one of the regions with normal background radiation; there are areas in Iraq with high natural radioactivity as Akashat region because of the phosphate rocks (it have rich with Uranium) (Marouf, 2000).

The phosphate rocks are use mainly as a source of phosphorus in the phosphate fertilizers, and the ores of sedimentary phosphates rocks contain a high concentration of Uranium, while the volcanic ores contain few concentration of Uranium (Babu, *et al.,* 2008),the phosphate fertilizers used in the agriculture consider as a source of radiation.

The radiological survey of soil and the vegetation have done in the farms Egypt to identify the level of background radiation, by using high purity germanium detector to measure the natural of concentrations for Uranium-238 , thorium-232 and potassium-40 in those samples, so the samples of fertilizers have analyzed from the trade market ,where its contain radioactive materials. The results have showed that the concentrations of Uranium-238, Thorium-232 and Potassium-40 were (1.27-950.09) Bq/Kg, (0.73-162.16) Bq/kg and(10.22-23845.24) Bq/kg, respectively (www. merrcac.com).

The natural radioactivity of soil in Iraq had studied in 1996 year, where diagnosed 22 radionuclide, return to the series of natural decay of Uranium, Thorium and Potassium by using high purity germanium detector. The results were showed that Iraq soil is contain radioactivity within the allowed limits, except regions of phosphate rocks.(Al Hussen,1996).

The Yassin, *et al.,* have measured radon-222 concentration in the air inside the houses of Gaza Strip by using detector CR-39, where they found that the concentration of radon ranged between (13–97) $Bq/m^3$(http//www.iugaza.edu.ps/ara/research).

## 2-**The Theoretical Part**

The samples have putted in receptacle by capacity (2Kg) of its analysis by period of time to accumulation the spectrum (3h).the activity has calculated of the element radium per units (Bq/Kg) at energy 186.20MeV, by using the equation (Husain,2004, G-Knoll,2000):

$$A(\frac{Bq}{Kg}) = \frac{N_s - N_b}{\in \%xI\%xtxW} \qquad (1)$$

Where's:

$N_s$ = The net area of peak with sample

$N_b$ = The net area of peak without sample

$\in$ = The absolute efficiency.

I = The relative intensity of isotope

t = Accumulate time per second

W = Weight used in units (kg)

The concentration of radon has calculated in the soil by using the equation (UNSCEAR,1993):

$$C_{Soil} = F_r x \rho x C_{Ra} \qquad (2)$$

Where's:
$C_{Ra}$ = Concentration of radium (Bq/Kg)
$\rho$ = Density of soil (1600Kg)
$F_r$ = Emission rate (0.1)
$C_{Soil}$ = Radon concentration in the soil ($Bq/m^3$)

The concentration of radon has calculated in the air by using the equation:

$$C_{Air} = C_{Soil} \sqrt{\frac{d_{Soil}}{D_{Air}}} \qquad (3)$$

Where's:
$C_{Air}$ = Concentration of radon in the air ($Bq/m^3$)
$D_{Soil}$ = Proliferation constant in the soil ($0.5x10^{-4}$ $m^2/sec$)
$D_{Air}$ = Steady proliferation in the air (5 $m^2/sec$)

The dose resulted by gas inhalation has calculated by (UNSCEAR,1988):

$$H_p = IC_p x I_P x D_{CE} \qquad (4)$$

Where's:
$IC_P$ = Concentration of radon in the air
$I_p$ = Amount of consumption of the air outside the home ($1600m^3/y$)
$D_{CE}$ = Conversion factor of radon gas in units ($1.3x10^{-9}$ SV/Bq)

## 3-The Experimental Part

### 3-1:The preparation system

The Analysis system was used gamma ray spectra to determine the radioactivity (see fig.1),the consisted of sodium iodide detector activated by thallium with size 4.5cm X 4cm and multi-channel analyzer, to show the spectrum energy.

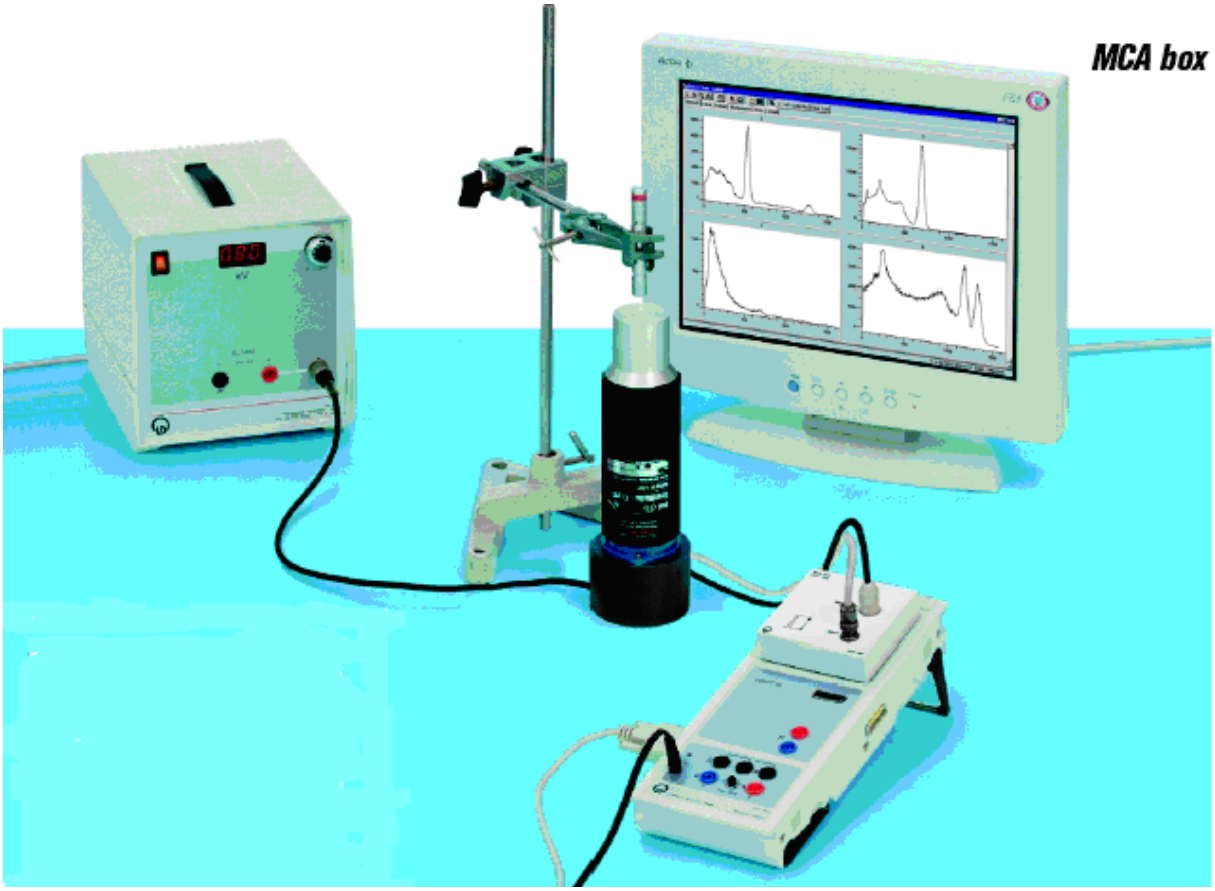


**Figure (1) Illustrate striped of the electronic system in present work**

**Procedures:**

A - The relative stability of the voltage detector, which equal to 540 volts.

B– Efficiency has been calculated and the calibration energy has been don for the system by using radioactive sources (Co60, Cs137, Na22, Am241, Ra226), with activity (8.9, 31, 11.28, 335, 3.29) KBq, respectively and by average energy (1252.5, 662,892.5, 36.67, 360.35) KeV, respectively. The purpose of this calibration is to determine the incident photon energy of each channel.

C– The detector has been shielded by blocks of lead with thickness 15cm for the protection of detector from background ray, and the spectra of radiation background have accumulated by using time of (3) hours.

D–The energy spectrum has extracted for each sample in the same accumulation time of radiation background.

## 3-2: The Prepare samples

Eight samples have been chosen in najaf city, as seen in the map (fig.2),and these regions are :

1-Al-Ansar (4 samples, see fig.3)

2-Al-Fateh at Al-Hureeh side (3 samples, see fig.4),

3-Al Rashadih at AL-Kufa (1 sample)

Regions (1, 2) have chosen because the spread of cancer diseases and the region (3) has chosen for the compare.

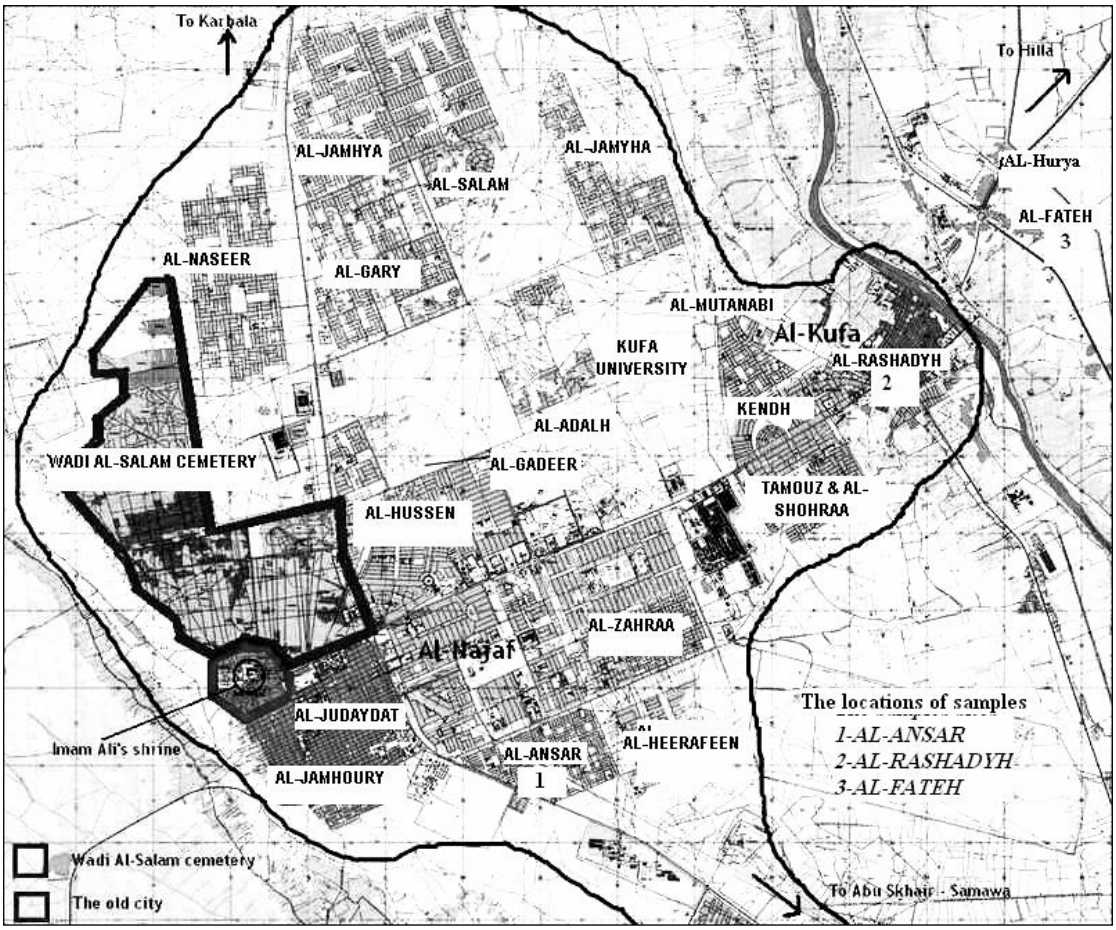


**Figure (2) The administrative Najaf city map**

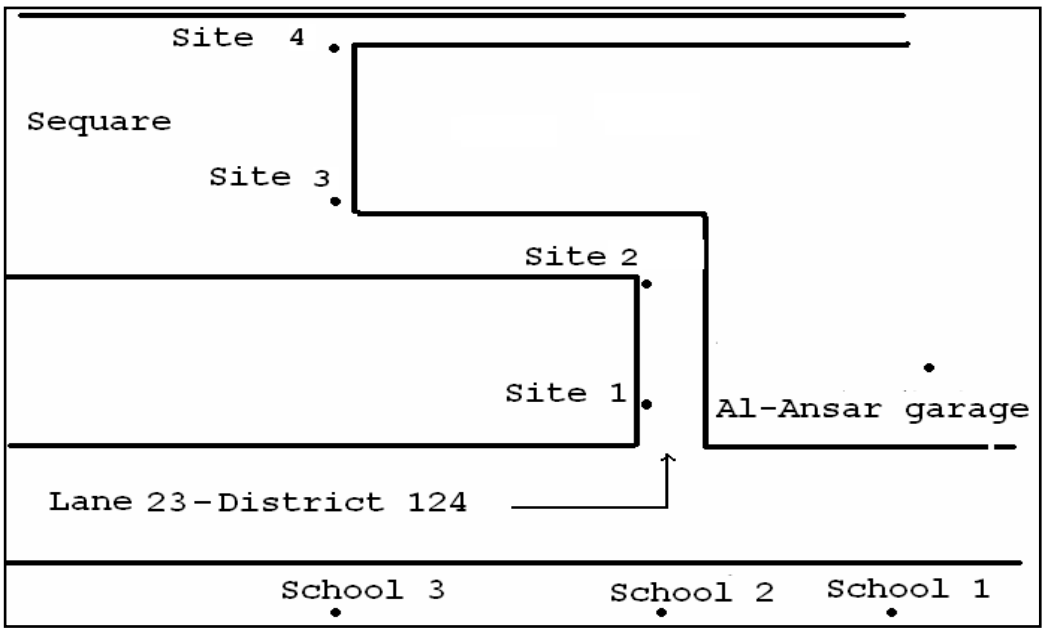


**Figure (3) Shows section of Al-Ansar map**

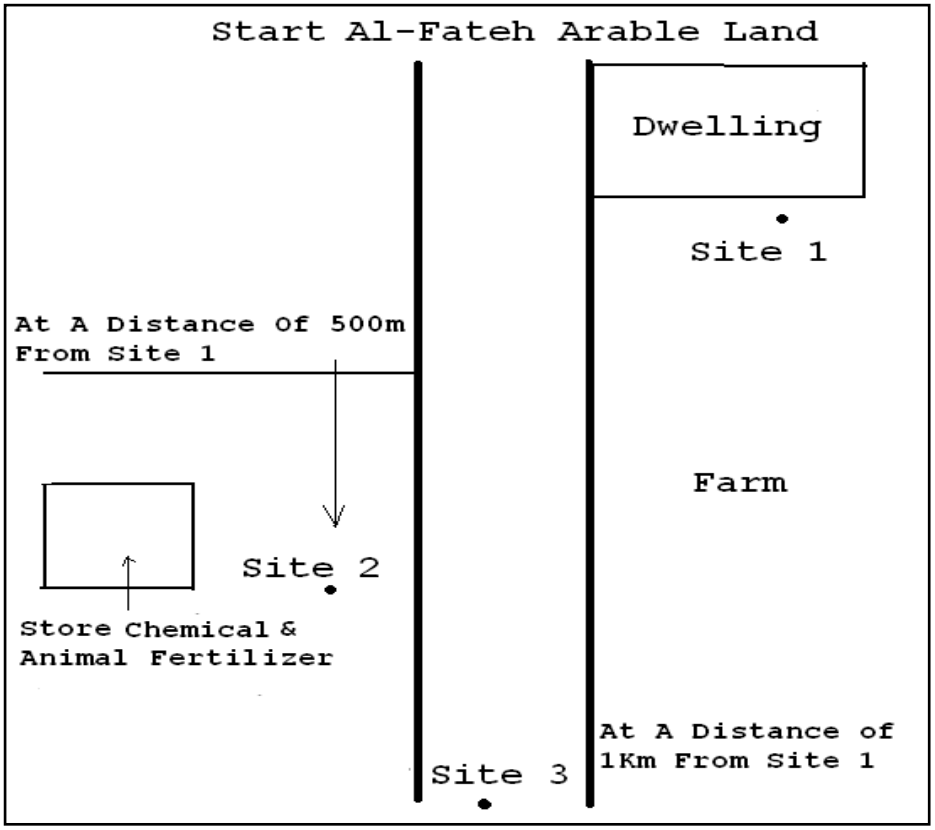


**Figure (4) Shows section of Al-Fateh map**

The samples have prepared as follows:
A –The soil samples have tacked by depth 20cm and by diameter 15cm .
B- The samples have drained by the sunlight by a period of 72 hours.
C– The samples have grinded by using mill, and then sifting through the clip has a diameter of hole 1mm to obtain a homogeneous samples.
D–The samples have putted in bags milestone by weight (2 Kg) and we have written on bags the date and the place.

## 4-**Results and discussion**

We have found the radon concentration in the soil samples at the rang between ((27-216) $X10^3$)Bq/Kg (in two regions Al-Fateh (1) and Al-Fateh(2)), respectively(see table 1).

The radium in Al Fateh (2) region is high because the using hazardous chemical fertilizers excessively such as (the super phosphate, a French blue and the fertilizer compound) from different origins, as well as the use of pesticides in the agricultural areas.

The radon concentration have calculated in the air and the soil (see table 2), and then we found that regions which have high Radium and Radon gas concentrations.

The dose resulted has calculated from the inhalation of radon gas (see table 3).

**Table (1) Concentration of radium in soil samples**

| Location | (Bq/Kg)Concentration |
|---|---|
| Al-Ansar(1) | 250±17.51 |
| Al-Ansar(2) | 300±21.85 |
| (3)Al-Ansar | 640±11.64 |
| Al-Ansar(4) | 750±10.2 |
| Al-Rashadyh | 800±14.55 |
| Al-Fateh(1) | 150±24.95 |
| Al-Fateh(2) | 1200±6.68 |
| Al-Fateh(3) | 700±12.21 |

**Table (2) Concentration of radon in soil samples and air**

| Location | Concentration of radon in soil $X10^3(Bq/m^3)$ | Concentration of radon in air$(Bq/m^3)$ |
|---|---|---|
| Al-Ansar(1) | 45 | 142.3 |
| Al-Ansar(2) | 54 | 170.76 |
| Al-Ansar(3) | 115.2 | 364.29 |
| Al-Ansar(4) | 135 | 426.9 |
| Al-Rashadyh | 144 | 455.35 |
| Al-Fateh(1) | 27 | 85.38 |
| Al-Fateh(2) | 216 | 683.05 |
| Al-Fateh(3) | 126 | 398.44 |

**Table (3) Dose caused by the radon gas inhalation**

| Location | (mSv/y)( Dose Resulted) |
|---|---|
| Al-Ansar(1) | 0.29 |
| Al-Ansar(2) | 0.35 |
| Al-Ansar(3) | 0.75 |
| Al-Ansar(4) | 0.88 |
| Al-Rashadyh | 0.94 |
| Al-Fateh(1) | 0.17 |
| Al-Fateh(2) | 1.42 |
| Al-Fateh(3) | 0.82 |

## 5-Conclusions

1– Al-Fateh (2) region is contains the Radium-226 concentration highly, where its consider the main reason for the production of radon gas.

2– The results were compared with the allowed limits of radiation exposure dose, which is (1mSev) (IAEA,1996),where found it (1.42mSv/y) ,and it's high value.

3- We have found that the main reason of cancer diseases in those regions resulted by used the chemical of fertilizers and insecticides (it have high radioactivity), which it have polluted the soil and the waters of rivers (the pollution by the wash of soil or by the rains ,where these the rains drift the fertilizers and the radionuclides from the soil to rivers), the drinking water(the pollution by move the contaminates from

rivers to the waters stations) , and the underground waters, where use these waters for the drinking.

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