Measurement of Radon-222 Concentration in Soil Samples of some Sulfuric Spring in Hit City Using CR-39 Detector

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Abstract:

In this study, concentrations of radon were measured for seventeen samples of soil distributed in three Sulphuric Spring, in addition to other regions as a background in Hit City in AL-Anbar Governorate. The radon concentrations in soil samples measured by using alpha-emitters registration that emits from radon (^{222}Rn) in (*CR-39*) track detector.

The concentrations values were calculated by a comparison with standard samples. The results show that the radon concentrations in first spring varies from (258.253- 347.762 Bq/m^3), second spring (230.374-305.209 Bq/m^3), third spring (292.002-336.023 Bq/m^3) and the average radon concentration in other regions (187.821 Bq/m^3).

As a conclusion of the study radon concentration in Sulphuric Spring is relatively higher than the background.

Key words: Radon concentration, soil, sulfuric spring, nuclear track detector; CR-39.

Introduction:

Radon (^{222}Rn) is a radioactive gas with a half-life 3.823d that is an element of the periodic table and falls within the noble group elements (Helium, Neon and Xenon, etc.). It is difficult to detect radon because it's a colourless and odorless gas. Its Atomic number is (86), boiling point (-61.8 ^oC), freezing point (-71.0 ^oC) and density (9.73 $Kg.m^{-3}$), and it is produced by the decay of the natural radioactive uranium series, which starts with uranium (^{238}U) [1].

Uranium is a very widely distributed element in the earth's crust, it is presented naturally everywhere in soil, sand and rock in various concentration from one place to another. Radon is considered to be one of the most dangerous radioactive elements in the environment [2]. It’s character as a noble gas allows it to spread through the atmosphere. The greatest fraction of natural radiation exposure in humans results from inhalation indoor and work places of the decay products of radon.[3]

Radon gas can diffuse or be transported to some distance through fissures in the rock structure and find its way into the soil and surrounding material. Therefore, radon measurement is the most promising method for detecting uranium deposits.

A Can technique which used in this study based on the registration of alpha tracks from ^{222}Rn on alpha sensitive track detector that was developed for uranium or radon exploration. The detector is exposed to the soil gas for a specific period of time. The alpha tracks are registered on the detector

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and the tracks density gives a measure of ^{222}Rn concentration in the soil. As it is a very simple technique, it can be implemented easily for field studies, since they do not require electronic system [4].

Materials and Methods:

1- Collection of soil samples.

Samples of soil were taken from locations of study for seventeen samples of soil, distributed in three Sulphuric Spring, in addition to other regions as a background in Hit City in AL-Anbar Governorate, from depth (5-10 cm). Then the samples were cleaned, dried, milled and sifted by using special sieve (250 µm in diameter)[5].

2- Irradiation of the detectors

Each sample of soil was taken with the weight (12 gm) and placed in plastic Can. The dimensions of the Can minimize the effect of gas thoron. Pieces of (CR-39) track detectors (1×1 cm^2 area) were fixed under the cover of plastic Can, which contain the soil samples. The exposure time was (30 days), as shown in Fig. (1)[6,7].

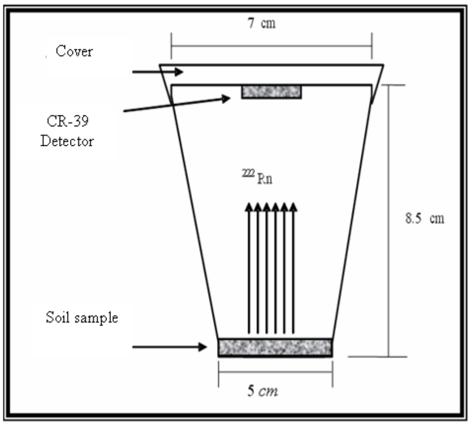

Fig. (1) Radon gas (^{222}Rn) estimation by using (CR-39) detector for soil sample[8].

3- Chemical etching and microscopic scanning

After the exposure time, the detectors were etched in a 6.25N aqueous solution of NaOH maintained at 60 ˚C for 6 hr, which was the normal employed etching time [8]. The detectors were rinsed with distilled water and dried in air. The track density was recorded using an optical microscope with (400x)[9].

The density of the tracks (ρ) in the detectors, was calculated according to the following relation:

$$(\rho_x) = \frac{N_{ave}}{A}$$

Where

ρ: Track density.

N: Average of total tracks.

A: Area of field view.

4- Radon concentration

Radon gas (^{222}Rn) concentration in the soil samples was measured by making a comparison between track densities registered on the detectors of the sample and that of the standard geological sample, from the relation[8]**:**

$$\frac{C_X}{\rho_X} = \frac{C_S}{\rho_S}$$

Where

C_S, C_X: radon exposure (Bq/m^3) for standard and sample respectively.

ρ_S, ρ_X: track density ($Trtack/mm^2$) for standard and sample respectively.

And $C_X = C_S \frac{\rho_X}{\rho_S}$

Figure (2) Shows this relation, when (slope = ρ_S / C_S)

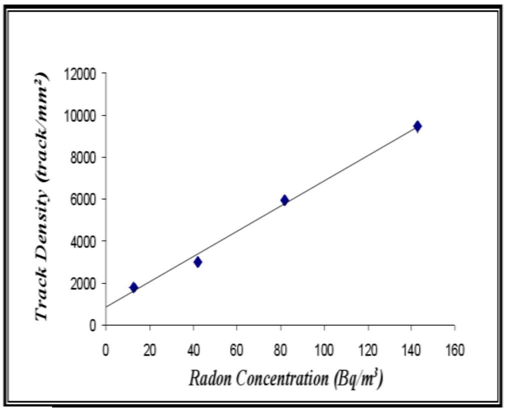

Fig. (2) The relation between track density and radon concentration for standard geological soil samples [8].

Results and Discussion:

The following table shows the measurements obtained, it includes tracks density, concentrations of radon and rates for different study areas.

Table (1) Radon concentration in soil samples

Study Region	Location	Samples	Tracks Density ($Track/mm^2$)	Radon Concentrations (Bq/m^3)	Average Concentration (Bq/m^3)
Hit City / AL-Anbar Governorate	First spring (2 Km from the City Center)	A1	20431.03 ± 1079.022	347.762	300.562 ± 32.167
		B1	15172.41 ± 832.837	258.253	
		C1	18879.31 ± 1109.21	321.350	
		D1	16896.55 ± 726.960	287.600	
		E1	18189.66 ±1181.311	309.611	
		F1	16379.31 ±1465.235	278.796	
	Second spring (1.5 Km from the City Center)	A2	13534.480 ± 913.232	230.374	262.655± 31.402
		B2	14827.57 ± 890.341	252.384	
		C2	17931.03 ± 1665.675	305.209	
		D2	15431.03 ± 754.823	262.655	
	Third spring (2.5 Km from the City Center)	A3	19224.14 ±1468.051	327.219	314.746± 20.385
		B3	17844.83 ± 999.570	303.741	
		C3	19741.38 ± 1032.085	336.023	
		D3	17155.17 ± 857.266	292.002	
	Background	Al-Jamiya District	10948.28±709.717	186.353	187.821± 1.467
		Al-Dura District	11120.69±948.711	189.288	
		Al-Mualimeen District	11034.48±729.186	187.821	

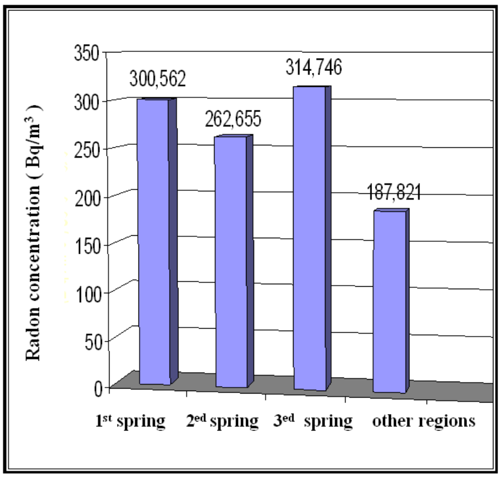

Fig. (3) Shows the average concentration of radon in soil samples for study areas

Table (1) shows the radon concentration in soil samples for three Sulphuric Spring and other regions as a background. The radon level in each location was normal and varies from (258.253 to 347.762 Bq/m^3) for first spring while the second spring varies from (230.374 to 305.209 Bq/m^3) and from (292.002 to 336.023 Bq/m^3) for third spring; the background regions varies from (186.353 to 189.288 Bq/m^3).

Figure (3) shows the average radon concentration in soil samples for three Sulphuric Spring and the background, the radon concentration in Sulphuric Spring is relatively higher than the background this is due to differences in the composition of the soil in the abundance of minerals and ores in the ground of Sulphuric Spring. Take into consideration that the background radiation had been taken from residential areas and the outskirts of the city.

In conclusion, we found that the radon levels in soil of Sulphuric Spring are within the acceptable values (800 Bq/m^3) give it by the WHO[10].

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قياس تركيز الرادون-222 في نماذج ترب بعض العيون الكبريتية في مدينة هيت باستخدام الكاشف CR-39

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الخـلاصة:

تم في هذا البحث قياس تراكيز غاز الرادون لسبعة عشر عينة ترابية موزعة في ثلاثة عيون كبريتية بالاضافة الى مناطق اخرى كخلفية اشعاعية في قضاء هيت بمحافظة الانبار عن طريق تسجيلِ اثار بواعث ألفا المنبعثة من غاز الرادون (^{222}Rn) في كاشِف الأثر النووي (CR-39).

تم تحديد التراكيز بالحسابات المعتمدة على المقارنة مع العينات القياسية، ومن خلال النتائج المستحصلة وجدنا ان تراكيز الرادون في نماذج الترب للعين الكبريتي الاول بين ($258.253-347.762\ Bq/m^3$) وللعين الكبريتي الثاني ($230.374-305.209\ Bq/m^3$) والعين الثالث ($292.002-336.023\ Bq/m^3$) وان معدل التركيز في المناطق الاخرى ($187.821\ Bq/m^3$). ويتضحُ من خلال النتائج انَّ تركيز غاز الرادون في العيون الكبريتية أعلى نسبياً من الخلفية الاشعاعية للمنطقة.