ISSN-1994-697X

Measurement of Radon Concentration in Natural Stones in Basrah Governorate

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ABSTRACT

This study assesses the concentration of radon gas in natural stones used in building in Basra governorate. The stones are collected from eight regions with different locations within the same region. The results shown, by used the Solid State Nuclear Track Detectors (SSNTDs) type CN-85, the range of radon concentration varies from 12.57 Bq/m³ to 39.8 Bq/m³. The range of radon daughters varies from 1.35 mWL to 4.30 mWL. The range of annual exposure dose by Working Level Month (WLM) unit was from 0.048 to 0.154 and range of annual effective dose was from 0.432 mSv/y to 1.386 mSv/y.

INTRODUCTION

Radon is natural radioactive gas without odour, color or taste. It cannot be detected without special equipment. Radon gas produced by radioactive decay of uranium and thorium. Radon is an inert and noble gas, it arise from trace concentrations of uranium series, thorium series and radium in the earth crust and it emanates from soil, rock, stone, sediment and water, and produces decay products in air [1,2].There are three main isotopes of radon in nature; Rn -222 ($T_{½}$ = 3.2 d) and short – lived decay products: Po-218, Pb-214, Bi-214, Pb-210, Bi-210 and Po-212 (Uranium series), Rn – 220 ($T_{½}$ = 55.6 S) Known as thoron it decay products: Po- 216, Pb-212, Bi-212, Po- 212 and Tl- 208 (Thorium series) and radon 219 decay from the chain origination with uranium–235 [3,4,5].Radon decays to from radon daughter. The radon daughter which are solids tends to lodge in the bronchial tree where this daughter emit alpha particles, it can be more damage to tissues coming from the damage of the DNA in cell nuclei leading to uncontrollable cells reproduction and the growth of a cancer in the lung [3,6,7].

In the present work measuring the concentration of radon in one of important material of building (stones), is measured by using SSNTDs technique.

EXPERIMENTAL

The samples of stones were collected from different regions in west and northwest of Basrah city south of Iraq, map (1). The samples of stones was crushed, washed and dray then placed in a plastic container 5 cm diameter and 10 cm in higher. The weight of the sample was 70 gm by higher 1 cm in tube .The area of Solid State Nuclear Track Detectors SSNTDs cellulose nitrate CN – 85 was 1 cm x 1 cm and thickness of 100µm (supplied by Kodak – path – France) was insert inside the container together with the samples, Fig. (1). After the exposure time (90 days), the detectors were removed and etching in 2.5 N of NaOH solution at te

mperature constant (60 C°) for time etching 2 h, after that the detectors was examined and counted visually using an optical microscope with a power of (40 x10).

The concentration of radon gas (Bq/m³) is calculated using the following relation[8].

$$C_{Rn}\,(Bq/m^3) = K\,\rho / T_s \qquad (1)$$

Where **K** is a calibration factor in unit (Bq. d. m^2/ track. Cm^2)[9],

$$K = \rho°/AT_s \qquad (2)$$

ρ° is number of track in standard sample **, A** radon concentration of standard sample,

ρ is a track density (T/cm^2) and T_s is a exposure time in days (d).

The radon daughter by using the Working Level (WL) unit is also calculated by following relation [10,11].

$$C_{Rn}\,(Bq/m^3) = WL \times 3700 / F \qquad (3)$$

Where F is the equilibrium factor from radon has been taken as 0.4 [12]. The annul effective dose in mSv/y is measured by using the conversion factor of

9mSv per Working Level Month (WLM) where 1 WLM = 36 x WL [13].

RESULTS AND DISCUSSION

The results are shown in Table (1) it was found that the concentration of radon varies from 12.57 Bq/m³ to 39.8 Bq/m³. The relationship between the average values of radon concentration at different regions is shown in Figure (2). All values of radon concentration were found lower than the recommended action level 200 – 600 Bq/m³ [13]. The annual dose of radon gas in term of Working Level Month (WLM) is ranged from 0.048 to 0.154, while the effective dose varies from 0.432 mSv/y to 1.386 mSv/y. In figure (3) shown the relationship between the average of the effective dose at different regions. The results of effective dose refer to the values were below the action level 3 – 10 mSv/y which has been recommended by ICRP [13].

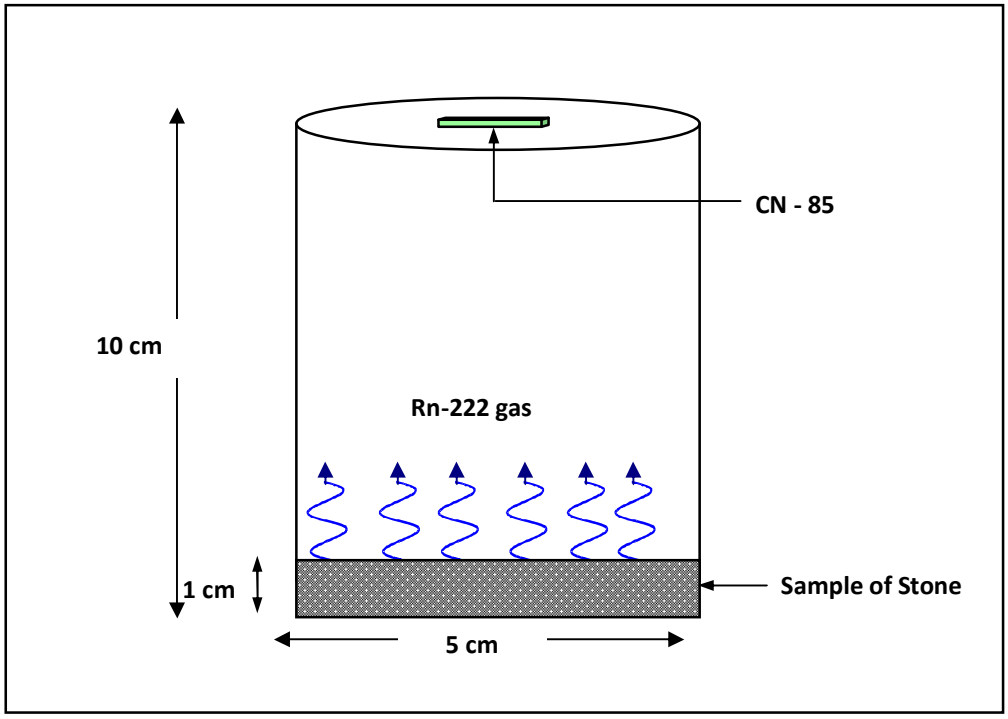


Figure (1) The plastic container used in the present work

Table (1) Track Density (T/cm^2), Concentration of Radon gas (Bq/m^3), Radon Daughter (mWL) and Annual Effective Dose (mSv/y) for different regions in Basrah governorate.

Cod of Regions	Name of Regions	No.of Locations	Tracks Density (T/cm^2)	Radon Concentration (Bq/m^3)	Radon Daughter (mWL)	Annul Exposure Dose (WLM)	Annul Effective Dose (mSv/y)
A	Al Barjsea	1	60	15.71	1.69	0.0608	0.547
		2	50	13.09	1.41	0.050	0.450
		3	63	16.49	1.78	0.064	0.576
		4	57	14.92	1.61	0.057	0.513
		5	69	18.07	1.95	0.070	0.630
		6	61	15.97	1.72	0.061	0.549
B	Average		60	15.71	1.69	0.0608	0.547
		1	50	13.09	1.41	0.050	0.450
		2	48	12.57	1.35	0.048	0.432
		3	51	13.35	1.44	0.051	0.590
	Al Zubair		49.66	13.00	1.40	0.050	0.450

C	Jabal sanam	1	73	19.11	2.06	0.074	0.666
		2	67	17.54	1.89	0.068	0.612
		3	55	14.40	1.55	0.055	0.492
		4	71	18.59	2.00	0.072	0.648
		5	64	16.76	1.81	0.065	0.585
D	Average		66	17.28	1.86	0.066	0.594
	Al Rumila	1	80	20.95	2.26	0.081	0.729
		2	83	21.73	1.34	0.084	0.759
		3	61	15.97	1.72	0.061	0.549
		4	75	19.64	2.12	0.076	0.684
		5	87	22.78	2.46	0.088	0.792
E	**Average**		77.2	20.21	2.18	0.078	0.702
	Bsea	1	152	39.80	4.30	0.154	1.386
		2	102	26.71	2.88	0.103	0.927
		3	114	29.85	3.22	0.115	1.035
		4	97	25.40	2,74	0.980	0.882
F	**Average**		116.25	30.44	3.29	0.118	1.062
	Al Ratic	1	80	20.95	2.26	0.081	0.729
		2	76	19.90	2.15	0.077	0.693
		3	63	16.49	1.78	0.064	0.576
		4	79	20.68	2.23	0.080	0.720

G	Average		74.5	19.51	2.10	0.075	0.675
	Al Artaue	1	80	20.95	2.26	0.081	0.729
		2	64	16.76	1.81	0.065	0.585
		3	76	19.90	2.15	0.077	0.693
H	Average		73.33	19.20	2.07	0.074	0.666
	Kuebda	1	60	15.71	1.69	0.0608	0.547
		2	54	14.14	1.52	0.054	0.586
		3	60	15.71	1.69	0.0608	0.547
		4	59	15.45	1.67	0.061	0.540
	Average		58.25	15.25	1.64	0.059	0.531

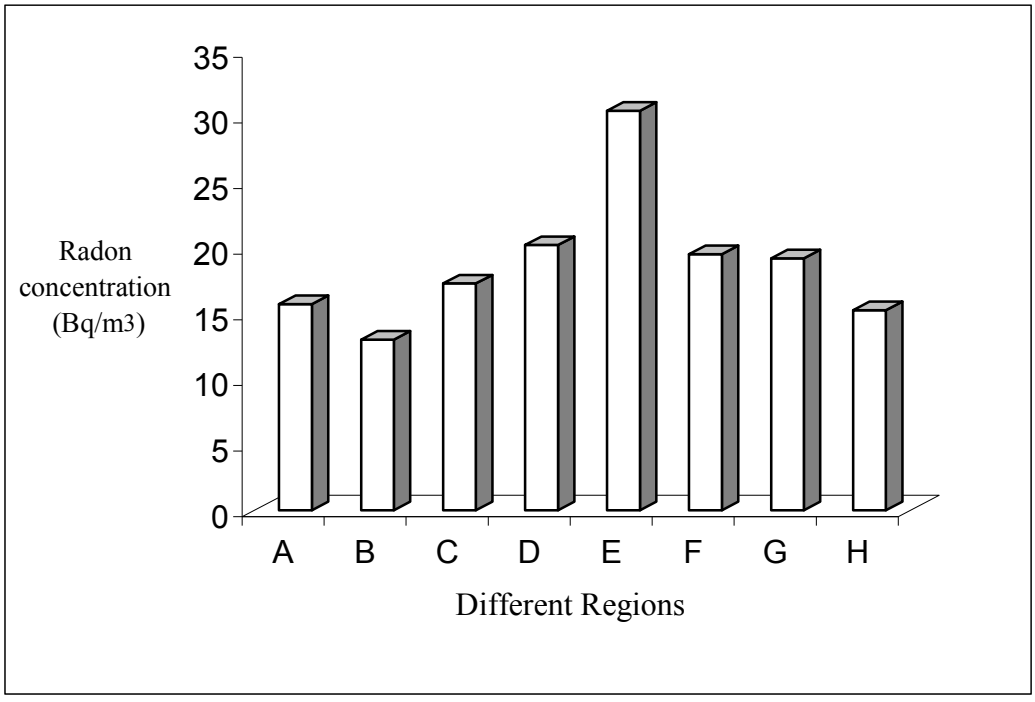


Fig. (2) The average of radon concentration (Bq/m³) to different regions.

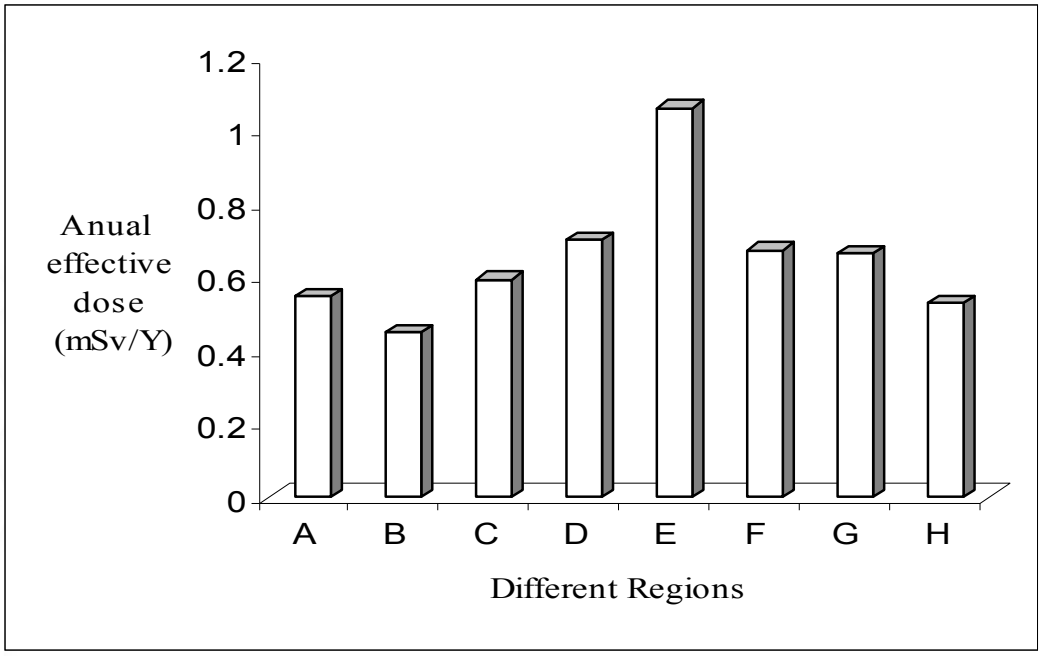
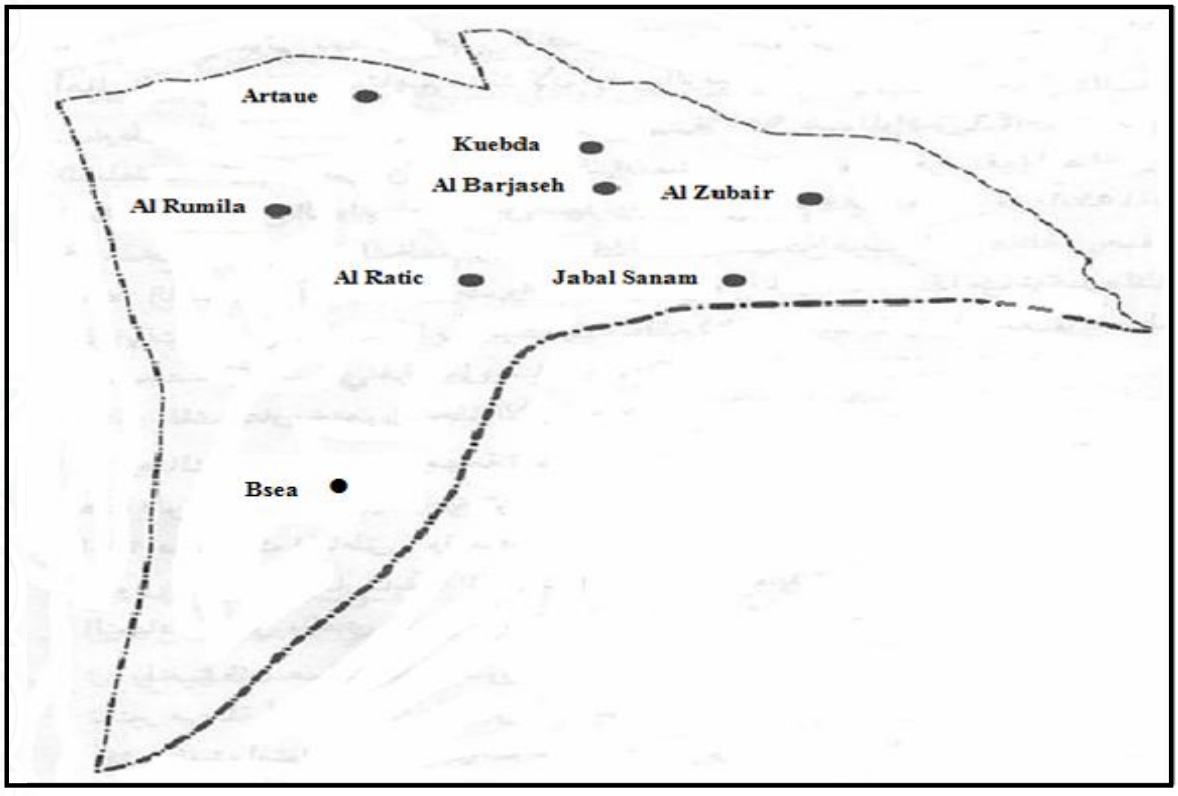


Fig. (3) The average of annual effective dose (mSv/y) to different regions.



Map (1) the different regions in Basrah and Zubair city, south of Iraq.

CONCLUSINS

According to the results of the present work, the concentration of radon gas, radon daughter and the annual effective dose in natural stones for all regions was found to lower or less than the action level which has been recommended by International Commission on Radiological Protection ICRP.

قياس تركيز الرادون في الحصى الطبيعي في محافظة البصرة

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الخلاصة

الدراسة هدفت الى تحديد تركيز غاز الرادون -222 في الحصى الطبيعي المستخدم في محا فظة البصرة. جمعت العينات من ثمانية مناطق لتجميع الحصى ولعدة مواقع لنفس المنطقة. أظهرت النتائج ان مدى تركيز غاز الرادون وبأستخدام كاشف الأثر النووي الصلب نوع CN – 85 كان من $12.57Bq/m^3$ الى $39.80 Bq/m^3$. أما مدى نواتج الرادون فكان من 1.35 mWL الى 4.30 mWL ومدى التعرض السنوي بوحدات WLM كان من 0.048الى 0.154 . أما مدى الجرعه المؤثرة فكان من 0.432 mSv/y الى 1.385 mSv/y .

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ISSN-1994-697X