Measurements of ^{238}U and ^{232}Rn concentrations in sediment of marshes in south of Iraq by using Solid State Nuclear Track Detectors (SSNTDs)

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Abstract

Uranium (^{238}U) concentrations and Radon (^{222}Rn) activity concentration were measured in sediments of marshes in Iraq. (185) samples of sediment were brought from the different stations of three southern governorates, in Basrah governorate which represented Al-Qurna and Al-Mediena marshes and in Thi Qar governorate are represented suq ashukh, Garmat Bani Saeed, Al-Akieka, Al-Chibayish,Al-fohood and Al-hamaar marshes and in Missan governorate are represented Al-kahlaa, Qalaat Saleh, Al-Mejar Al-Kabeer and Al- Azeer marshes. The selected areas were chosen according to civilian population. CR-39 detector and a closed cylindrical plastic container technique were used in this investigation. Maximum concentration of uranium is (4.1719 ppm) which observed in sediment of Al-Kahla marsh in Missan governorate (station number 136 (Al-Seliayl (2))) and minimum concentration is (0.2683 ppm) which observed in sediment of Al- Akiekah. marsh in Thi Qar governorate (station noumber 72 (Al Harbea (2))). The maximum activity of radon concentration is (53471.766 Bq m^{-3}) which observed in the sediment of Al-Kahla marsh in Missan governorate (station number 136(Al-Seliayl (2))) and minimum activity concentration is (3438.699 Bq m^{-3}) which observed in sediments of Al- Akiekah marsh in Thi Qar governorate (station noumber 72 (Al Harbea (2))). In this study most of measured concentrations for uranium and radon in natural limits according to (ICRP) where the concentration of uranium in sediments varies widely, but typically contains about 3 ppm, While other many concentrations are relatively high values, all results in this paper are discussed.

Keywords: Uranium concentration, radon concentrations, sediments , marshes of Iraq , SSNTD.

Introduction

Uranium and radon contents have been measured in various material samples by using alpha spectrometry [1], radiochemical separations [2] and extraction chromatography with anion exchange and alpha spectrometry [3]. In previous researches we have determined the uranium and radon concentrations inside different sediment samples by using solid state nuclear track detector (SSNTD) techniques by calculating the alpha-particles emitted by the uranium and radon series to reach and be registered on the SSNTD. Naturally occurring radionuclide enter the human body mainly by inhalation of air particulates[4] and by ingestion of food and water[5-7] . The marshes population in Iraq lived in marshes in mud houses and drink the water from these marshes directly. These drinking waters contain radioisotopes which dissolved from sediments and present a source for radiation dose exposure. It is necessary to measure the radionuclide content of sediment samples to assess potential radiation doses and, in order to take action to avoid the exposure of consumers to radiation. Uranium and contents were measured in drinking waters in different countries by using various analytical methods [8-12]. Radon (^{222}Rn) is a chemically inert and very mobile gaseous, and it is a decay product of uranium (^{238}U) which is found in all rocks and soils. Radon is very soluble in water. Inhalation and ingestion of radon and its progeny represent the main source of exposure to ionizing radiation for population in most countries. Radon is unique natural gas and radioactive element in all of its isotopes. These two characteristics which are unusual in their combination[13]. Measurement of radon are importance because the radiation dose to human population due to inhalation of radon and its daughters contributes more than 50% of the total dose from natural sources[14].The dose deriving from the presence in the air of ^{222}Rn is linked to the inhalation of its short –lived daughters, which are deposited in the respiratory organs, if deeply inhaled, emit alpha-particles in direct contact with the bronchial and pulmonary epithelium. For these reasons, the dose deriving from the exposure to ^{222}Rn in closed spaces has been placed in direct relation to the risk of lung cancer[15]. Solid state nuclear track detectors (SSNTD) have been extensively used in this regard and almost all branches of science and technology[16-17].Radon concentrations have been measured in different materials samples by using many of methods. In the present study Solid state nuclear track detectors (SSNTDs) have been used for calculating the concentration of uranium and the activity of radon concentration[18-20]. In this work, a method based on calculating the detection efficiencies of the CR-39 SSNTD were used for alpha-particles emitted by the uranium families including those emitted by the radon (^{222}Rn) groups and exploiting the corresponding track densities for evaluating uranium concentrations and radon a-activities inside different sediment samples. This work would be of great help for radiological database of Iraq.

2-Methodology

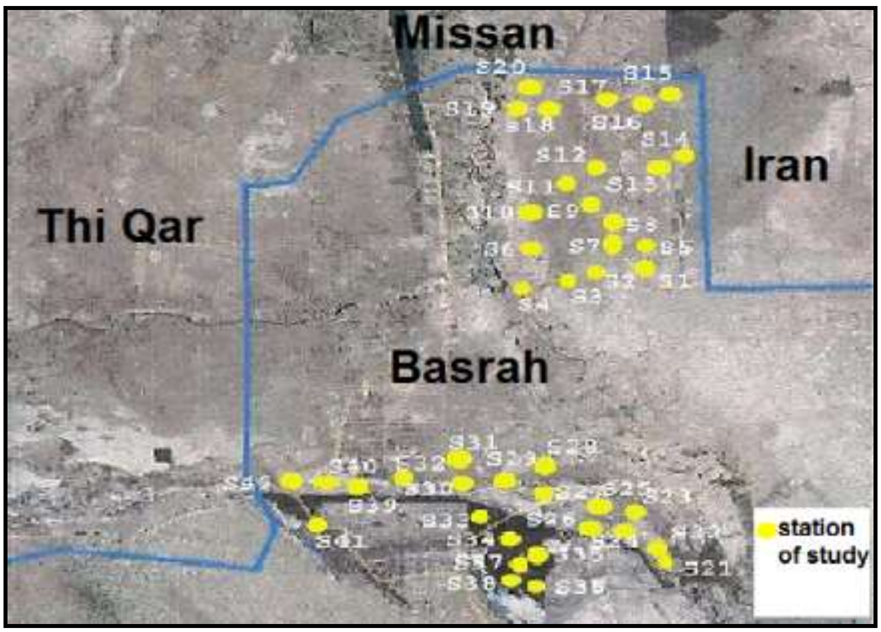
2-1: Experimental

The sediments samples have been collected from 185 locations (villages or stations) in marshes in October 2015. These stations are (42) in Basrah, (83) in Thi Qar and (60) in Missan, as shown in the figures (1), (2) and (3). The sediment samples are taken from the bottom of each location. Each sediment sample is dried in the oven at 110 ^{o}C and milled in the grinder. Finally, all samples are sieved (riddled) in sieve with 300 μm openings. The mass of each sample of sediment is determined and placed at the 8.5cm height in the bottom of the closed cylindrical plastic container which used as a radiated room as shown in the Fig.(4)[21]. The disked shape of the detector CR-39 SSNTD of (1cm x 1cm)in area and 500 μm in thickness is placed at a distance of 8 cm above the sample[21]. Two identical films of CR-39 are used for each sample to get a high accuracy.

The sediments samples leaves in closed cylinders for 22 days to arrived to 98% of optimal equilibrium between radium 226 (^{226}Ra) and radon 222(^{222}Rn).

After arrived to equilibrium case the cover of cylinder is raised quickly to avoid exchange the air inside the cylinder. Another cover is prepared previously with detector film (1x1 cm^2)

in area of CR-39 fixed on it. And the cylinder is left 60 day. This long time of irradiation is necessary to accumulate considerable number of tracks of α-particles that emitted from radon and its progenies. After the irradiation time is finished, the detector film is raised, the raised films were developed in an NaOH solution with chemical etching conditions 6.25 N at 70 ^{o}C for 5 hours for CR-39 films. After the chemical treatment of the CR-39 detector, the visual counting of alpha particles tracks (i.e. N_G) are carried out by means of an optical microscope.



Figure(1): Stations of study in Basrah Governorat

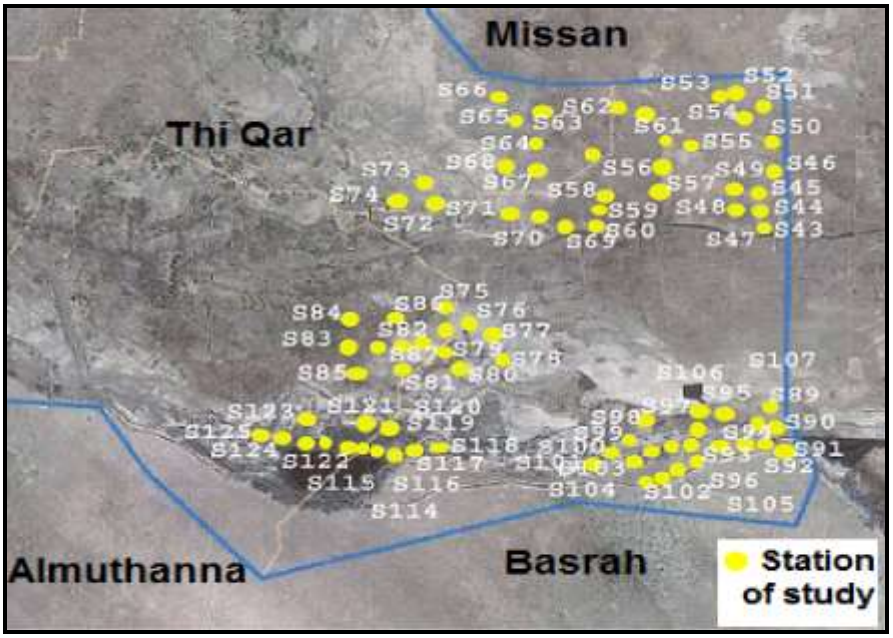


Fig.(2): Stations of study in Thi Qar Governorat

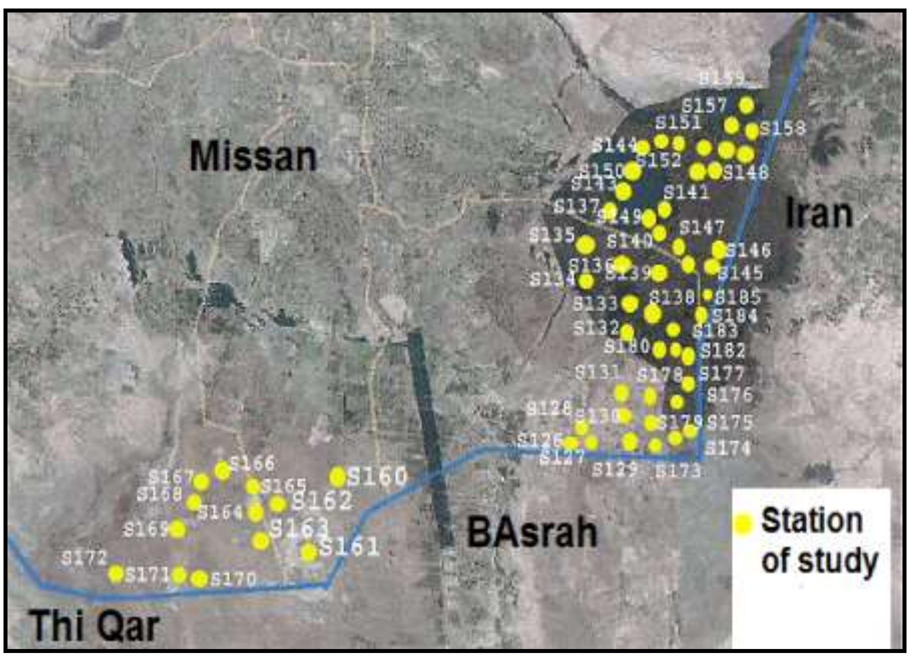


Fig.(3): Stations of study in Missan Governorat

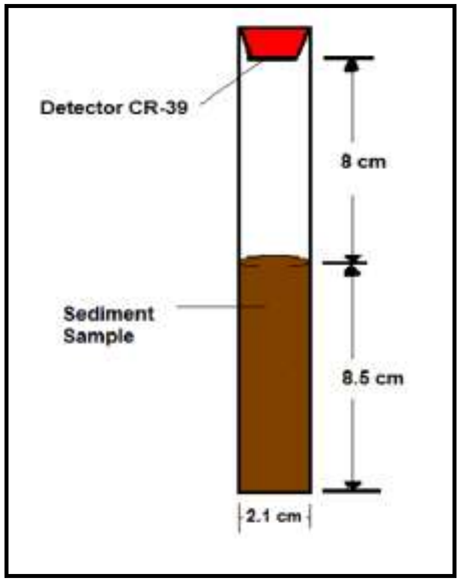


Fig.(4):Arrangement of the CR-39 detector films placed at a distance of 8 cm above a sediment sample in a cylindrical plastic container of 1.05 cm radius.

2-2: Theoretical part

The time required to arrived 98% of optimal equilibrium between radium (^{226}Ra) and radon (^{222}Rn) is calculated from the equilibrium relation for radiation activity [21]:

$$A_{Rn} = A_{Ra}\ (1 - e^{-\lambda_{Rn}\, t}) \quad \text{…….(1)}$$

Where

A_{Rn} is radon activity

A_{Ra} is radium activity

λ_{Rn} is radon decay constant equale 0.1814 d^{-1}

T is the time required to arrived to equilibrium case.

The global alpha particle track densities that registered on CR-39 detector (ρ) are calculated according to the following equations:

$$\rho = \frac{N_G}{A_G} \quad \text{……….(2)}$$

Where A_G is the global area of view .

Radon concentration can be determined by using the following relations [21]:

$$C_{Rna} = \frac{\rho}{KT} \quad \text{………(3)}$$

Where,

ρ is the track density (Track /cm^2)

K is the diffusion constant.

C_{Rna} is the radon concentrations in the air gap in Bq/m^3.

T is the radiated time in day.

The diffusion constant K which measured from the following equation[22]:

$$K = \frac{1}{4}\, r(2\cos\theta_C - r/R_\alpha) \quad \ldots\ldots\ldots.(4)$$

Where:

r is the radius of cylinder which used as a radiated room equal 1.05 cm.

R_α is the range of alpha particles in air which equal 4.015 cm.

θ_C is the critical angle for detector CR-39 which equal 35^o

There for by putting this values in eq.(4) we obtained:

K =0.0312 Tr.cm^{-2}.d^{-1}/Bq when the radiated time(T) measured in day.

Or K=0.3615 cm when the radiated time(T) measured in second.

For calculate radon concentrations in sediment sample we using the following equation[23]:

$$C_{Rns} = \lambda_{Rn}\ C_{Rna}\, h\ T/L \quad \ldots\ldots\ldots..(5)$$

Where

radon concentration in Bq/m^3

λ_{Rn} is radon decay constant equal 0.1814 d^{-1}.

h is the height of air over the sediment sample in cylinder equal 8 cm.

L is the height of the sediment sample in cylinder equal 8.5 cm

T is the radiated time in days equal 60 day.

The radiation activity for radon can be determined from the following equation [23]:

$$A_{Rns} = C_{Rns} V_s \quad \ldots\ldots\ldots\ldots..(6)$$

$$V_s = \pi\, r^2\, L$$

V_s is the volume of sample in m^3.

The number of radon atom N_{Rn} are calculated from the following relation:

$$N_{Rn} = \frac{A_{Rns}}{\lambda_{Rn}}$$

For determined the uranium (**^{238}U)** concentration in the sediment sample we must first determine the number of uranium atom in sample N_U by substituting the number of radon atom N_{Rn} in the following equation[24] :

$$\lambda_{Rn}\ N_{Rn} = \lambda_U\ N_U \quad \ldots\ldots\ldots\ldots(7)$$

Where

λ_{Rn} is radon decay constant equal 2.1 x 10^{-6} S^{-1}

λ_U is uranium decay constant equal 4.9 x 10^{-18} S^{-1}

The mass of uranium W_U in (gm) for the sediment sample can be determined using the following equation[24]:

$$W_U = \frac{N_U A_U}{N_{av}} \quad \text{………(8)}$$

Where:

A_U is the uranium atomic number equal 238.

N_{av} is Avogadro's number equal 6.02 x 10^{23} mol^{-1}

For determined the uranium concentration C_U in ppm unite using the following relation:

$$C_U(ppm) = \frac{W_U}{W_s} x10^6 \quad \text{...……(9)}$$

Where :

W_S is mass of sample in gm.

3. Results and discussion

The C_{Rns} (Bq.m^{-3}) and C_U(ppm) have been determined by using eq's (5) and (9) respectively. The error on track density counting is smaller than 2 % for samples studied. The result data as shown in the tables and figures bellow.

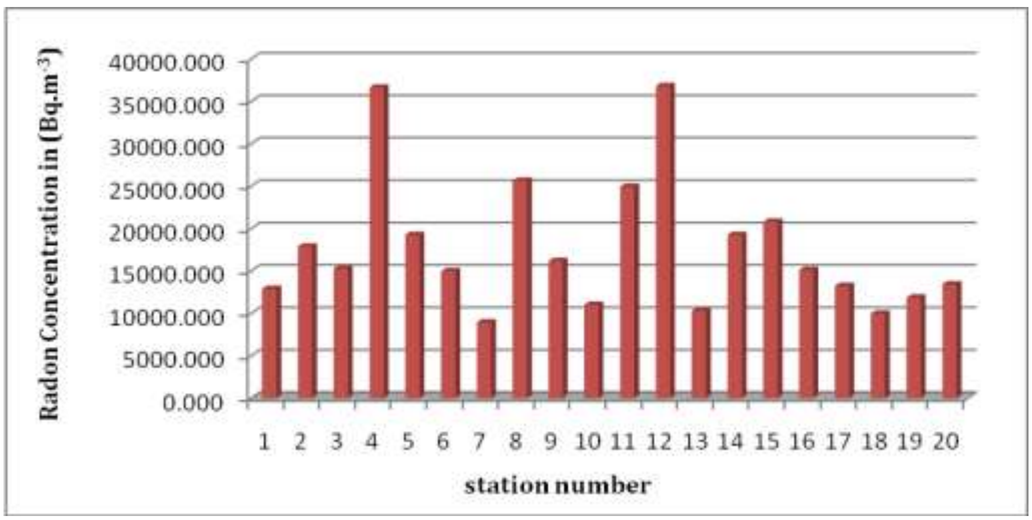
All tables shows the station number, station name, the global track density of CR-39 (ρ_G^{CR}), mass of sample in grams, the activity concentration of ^{222}Rn (C_{Rns}) in Bq.m^{-3} and the concentration of 238U (C_U) in ppm.

The figures (5), (7), (9), (11), (13), (15), (17), (19), (21), (23), (25) and (27) represent the activity of radon concentration with station number for each table bellow, while the figures (6),(8),(10),(12),(14),(16),(18),(20),(22), (24),(26) and (28) represent the uranium concentration with station number.

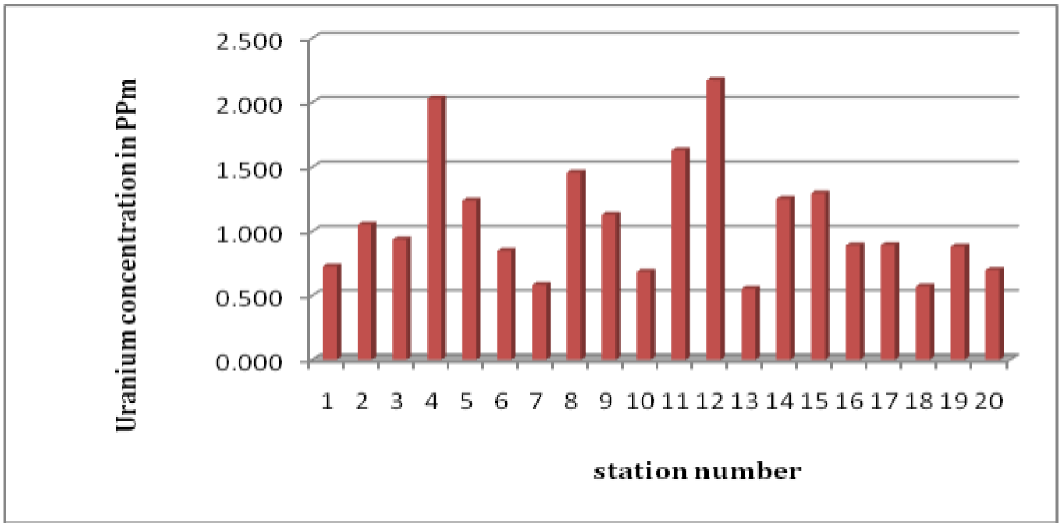
Table(1): The Radon and Uranium Concentrations in the sediments from Al-Qurna marsh in Basrah governorate.

Station Number	*Station name*	*Track Density ρ (Tracklcm²)*	*mass of sample (gm)*	*C_{Rns} (Bq.m^{-3})*	*C_u (ppm)*
1	*Al-Mayah (1)*	*2359.047*	*42.140*	*12895.120*	*0.727*
2	*Al-Mayah (2)*	*3271.212*	*40.360*	*17881.234*	*1.052*
3	*Al-zergan (1)*	*2799.402*	*38.820*	*15302.210*	*0.936*
4	*Al-zergan (2)*	*6699.693*	*42.840*	*36622.142*	*2.030*
5	*Bet Al-Zegmi (1)*	*3522.843*	*36.910*	*19256.713*	*1.239*

6	*Bet Al-Zegmi (2)*	*2736.494*	*41.910*	*14958.340*	*0.847*
7	*Al-Sedied (1)*	*1635.606*	*36.470*	*8940.617*	*0.582*
8	*Al-Sedied (2)*	*4686.640*	*41.730*	*25618.306*	*1.458*
9	*Al-Sedied (3)*	*2956.672*	*33.990*	*16161.884*	*1.129*
10	*Al-Routa (1)*	*2013.053*	*38.150*	*11003.836*	*0.685*
11	*Al-Routa (2)*	*4560.824*	*36.320*	*24930.566*	*1.630*
12	*Al-Routa (3)*	*6731.147*	*40.200*	*36794.077*	*2.173*
13	*Al-Hlechya (1)*	*1887.238*	*44.360*	*10316.096*	*0.552*
14	*Al-Hlechya (2)*	*3522.843*	*36.500*	*19256.713*	*1.253*
15	*Al-Hlechya (3)*	*3805.929*	*38.140*	*20804.128*	*1.295*
16	*Bet Aoffi (1)*	*2767.948*	*40.330*	*15130.275*	*0.891*
17	*Bet Aoffi (2)*	*2421.955*	*35.200*	*13238.990*	*0.893*
18	*Bet Aoffi (3)*	*1824.330*	*41.470*	*9972.226*	*0.571*
19	*Mzearah (1)*	*2170.323*	*31.970*	*11863.511*	*0.881*
20	*Mzearah (2)*	*2453.409*	*45.580*	*13410.925*	*0.699*



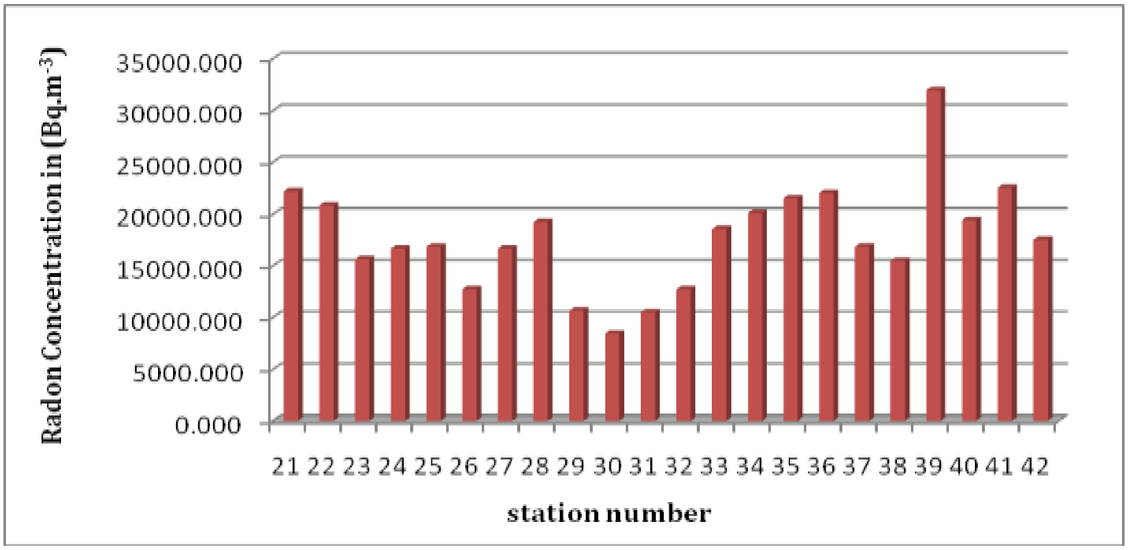
Figure(5): The Radon Concentrations in the sediments from Al-Qurna marsh in Basrah governorate.



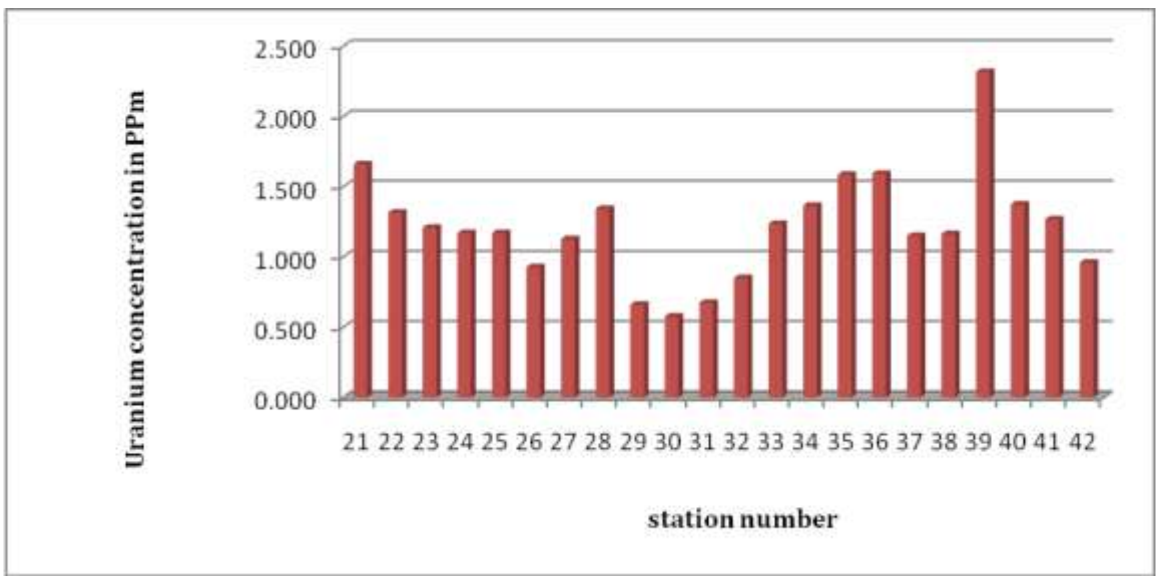
Figure(6): The Uranium Concentrations in the sediments from Al-Qurna marsh in Basrah governorate

Table(2): The Radon and Uranium Concentrations in the sediments from Al-Mediena marshes in Basrah governorate.

Station Number	Station name	Track Density ρ (Tracklcm^2)	mass of sample (gm)	C_{Rns} (Bq.m^{-3})	C_u (ppm)
21	Al-Direiwishi (1)	4057.561	31.720	22179.607	1.660
22	Al-Direiwishi (2)	3805.929	37.530	20804.128	1.316
23	Al-Ajera (1)	2862.310	30.730	15646.080	1.209
24	Al-Ajera (2)	3051.034	33.840	16677.689	1.170
25	Um Hellawi (1)	3082.488	34.200	16849.624	1.170
26	Um Hellawi (2)	2327.593	32.540	12723.186	0.928
27	Al-Heyadir (1)	3051.034	35.090	16677.689	1.128
28	Al-Heyadir (2)	3522.843	34.030	19256.713	1.343
29	Umelha (1)	1950.145	38.360	10659.966	0.660
30	Umelha (2)	1541.244	34.740	8424.812	0.576
31	Al-Maaber (1)	1918.692	36.920	10488.031	0.674
32	Al-Maaber (2)	2327.593	35.520	12723.186	0.850
33	Nahar Saleh (1)	3397.028	35.670	18568.973	1.236
34	Nahar Saleh (2)	3680.113	34.950	20116.388	1.367
35	Al-Sheteat (1)	3931.745	32.180	21491.867	1.586
36	Al-Sheteat (2)	4026.107	32.800	22007.672	1.593
37	Um Al-Hoash (1)	3082.488	34.780	16849.624	1.150
38	Um Al-Hoash (2)	2830.856	31.540	15474.145	1.165
39	Al-Jela' (1)	5850.436	32.760	31979.899	2.318
40	Al-Jela' (2)	3554.297	33.580	19428.648	1.374
41	Al-Khenzeri (1)	4120.469	42.140	22523.477	1.269
42	Al-Khenzeri (2)	3208.304	43.340	17537.364	0.961



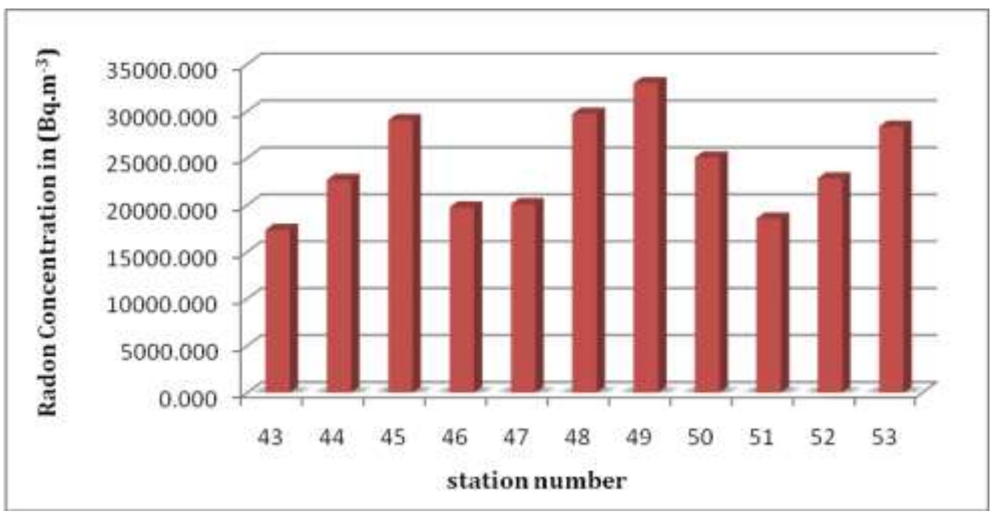
Figure(7): The Radon Concentrations in the sediments from Al- Mediena marshes in Basrah governorate.



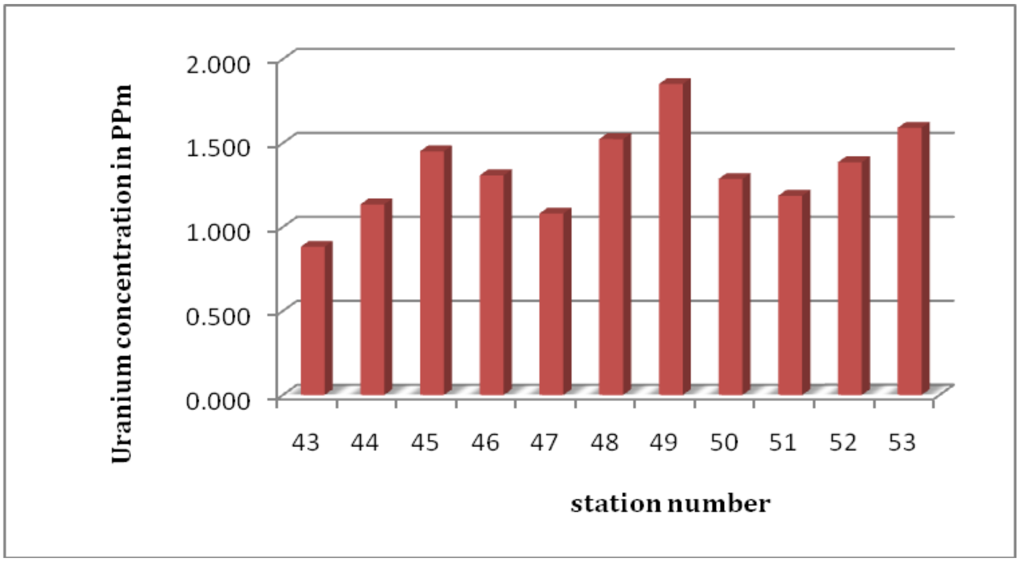
Figure(8): The Uranium Concentrations in the sediments from Al- Mediena marshes in Basrah governorate.

Table(3): The Radon and Uranium Concentrations in the sediments from Suq Ashukh marshes in Thi Qar governorate.

Station Number	*Station name*	*Track Density ρ (Tracklcm²)*	*mass of sample (gm)*	C_{Rns} *(Bq.m⁻³)*	C_u *(ppm)*
43	Al-Newashi (1)	*3176.850*	*46.710*	*17365.429*	*0.883*
44	Al-Newashi (2)	*4151.923*	*47.470*	*22695.412*	*1.135*
45	Al-Hecham (1)	*5315.719*	*47.530*	*29057.005*	*1.451*
46	Al-Hecham (2)	*3617.205*	*35.890*	*19772.518*	*1.308*
47	Al-Tewerar (1)	*3680.113*	*44.190*	*20116.388*	*1.081*
48	Al-Tewerar (2)	*5441.535*	*46.340*	*29744.745*	*1.524*
49	Al-Sehalaat (1)	*6039.160*	*42.320*	*33011.508*	*1.852*
50	Al-Sehalaat (2)	*4592.278*	*46.320*	*25102.501*	*1.287*
51	ALL Esmaeel (1)	*3397.028*	*37.150*	*18568.973*	*1.187*
52	ALL Esmaeel (2)	*4183.377*	*39.160*	*22867.347*	*1.386*
53	All Geweeber	*5189.903*	*42.340*	*28369.265*	*1.591*



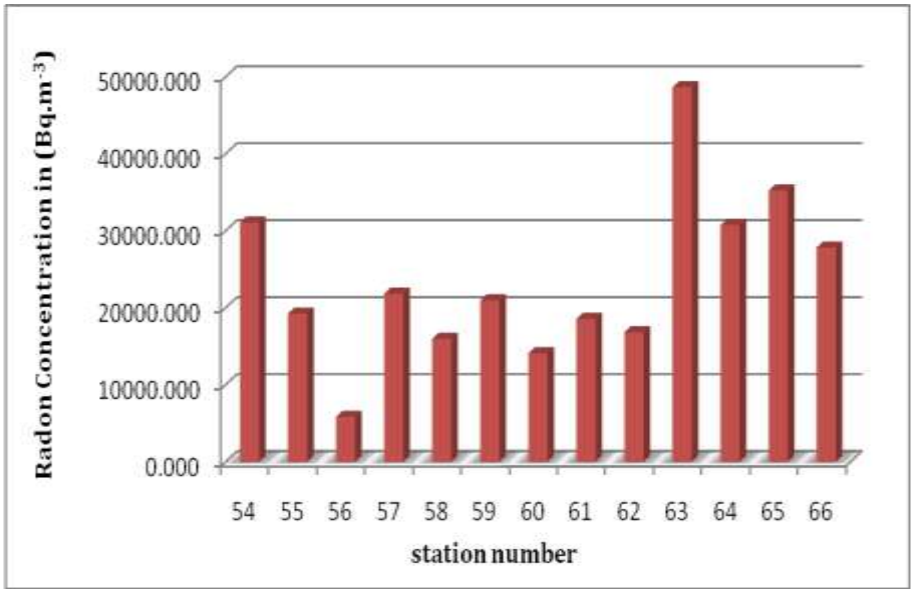
Figure(9): The Radon Concentrations in the sediments from Suq Ashukh marshes in Thi Qar governorate.



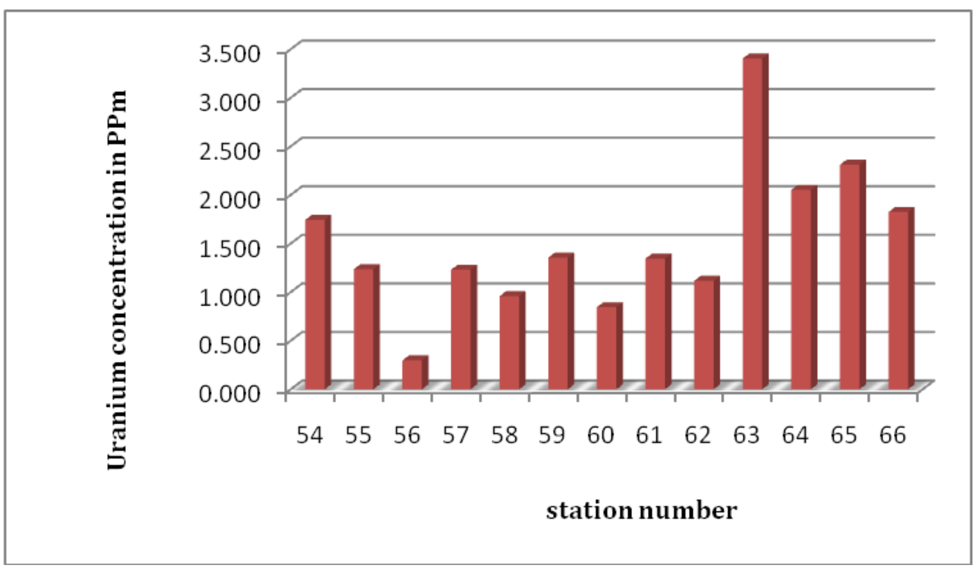
Figure(10). The Uranium Concentrations in the sediments from Suq Ashukh marshes in Thi Qar governorate

Table4-The Radon and Uranium Concentrations in the sediments from Garmat Bani Sae'ed marshes in Thi Qar governorate

Station Number	*Station name*	*Track Density ρ (Tracklcm²)*	*mass of sample (gm)*	*C_{Rns} (Bq.m⁻³)*	*C_u (ppm)*
54	Al Hassan (1)	*5693.167*	*42.370*	*31120.224*	*1.744*
55	Al Hassan (2)	*3522.843*	*36.980*	*19256.713*	*1.236*
56	Al Muslem (1)	*1069.435*	*46.570*	*5845.788*	*0.298*
57	Al Muslem (2)	*3994.653*	*42.110*	*21835.737*	*1.231*
58	Al-Kermashia (1)	*2925.218*	*39.550*	*15989.949*	*0.960*
59	Al-Kermashia (2)	*3837.383*	*36.730*	*20976.063*	*1.356*
60	Al-Ghereafia (1)	*2579.225*	*39.580*	*14098.665*	*0.846*
61	Al-Ghereafia (2)	*3397.028*	*32.750*	*18568.973*	*1.346*
62	Al-Mu'mneen (1)	*3082.488*	*35.830*	*16849.624*	*1.116*
63	Al-Mu'mneen (2)	*8901.470*	*33.920*	*48657.588*	*3.406*
64	Al-Chewamlah (1)	*5630.259*	*35.580*	*30776.354*	*2.054*
65	Al-Chewamlah (2)	*6448.062*	*36.190*	*35246.663*	*2.312*
66	Al-Chewamlah (3)	*5095.541*	*36.230*	*27853.460*	*1.825*



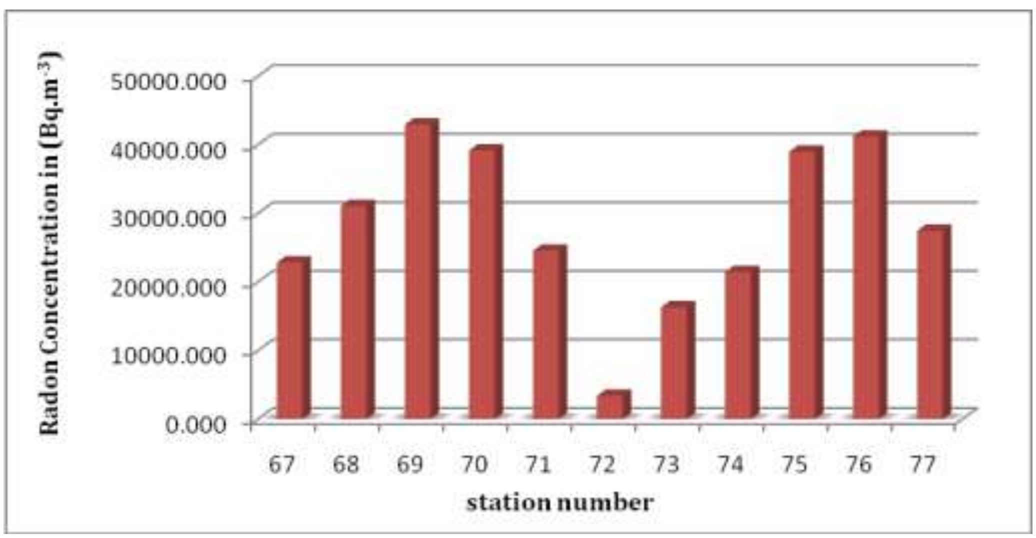
Figure(11): The Radon Concentrations in the sediments from Garmat Bani Sae'ed marshes in Thi Qar governorate.



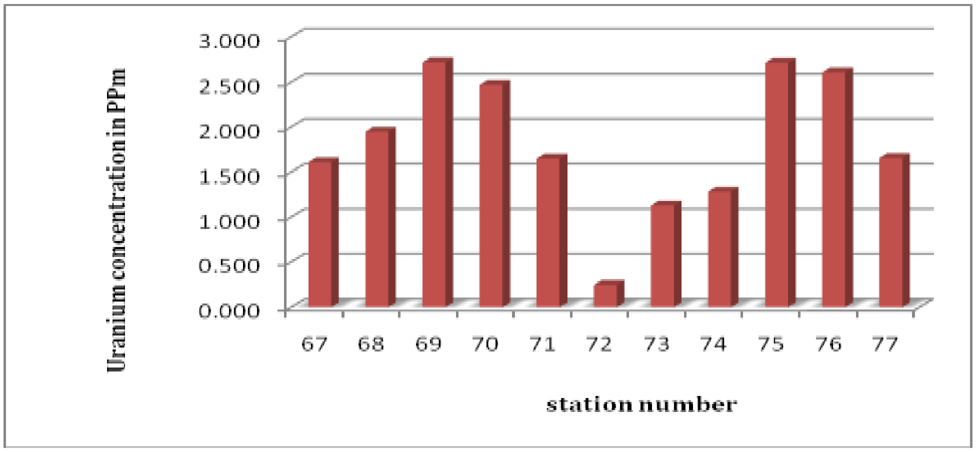
Figure(12): The Uranium Concentrations in the sediments from Garmat Bani Sae'ed marshes in Thi Qar governorate.

Table(5):The Radon and Uranium Concentrations in the sediments from Al-Akiekah marshes in Thi Qar governorate.

Station Number	*Station name*	*Track Density ρ (Tracklcm²)*	*mass of sample (gm)*	*C_{Rns} (Bq.m⁻³)*	*C_u (ppm)*
67	Al Shemees (1)	*4183.377*	*33.760*	*22867.347*	*1.608*
68	Al Shemees (2)	*5693.167*	*37.940*	*31120.224*	*1.947*
69	Al Ebraheam (1)	*7863.490*	*37.530*	*42983.735*	*2.719*
70	Al Ebraheam (2)	*7171.503*	*37.680*	*39201.166*	*2.470*
71	Al Harbea (1)	*4497.916*	*35.430*	*24586.696*	*1.648*
72	Al Harbea (2)	*629.079*	*33.120*	*3438.699*	*0.246*
73	Al Ruhma (1)	*2988.126*	*34.280*	*16333.819*	*1.131*
74	Al Ruhma (2)	*3931.745*	*39.710*	*21491.867*	*1.285*
75	Al Shedead	*7140.049*	*34.140*	*39029.231*	*2.714*
76	Al Ebead (1)	*7548.950*	*37.540*	*41264.386*	*2.610*
77	Al Ebead (2)	*5032.633*	*39.480*	*27509.590*	*1.654*



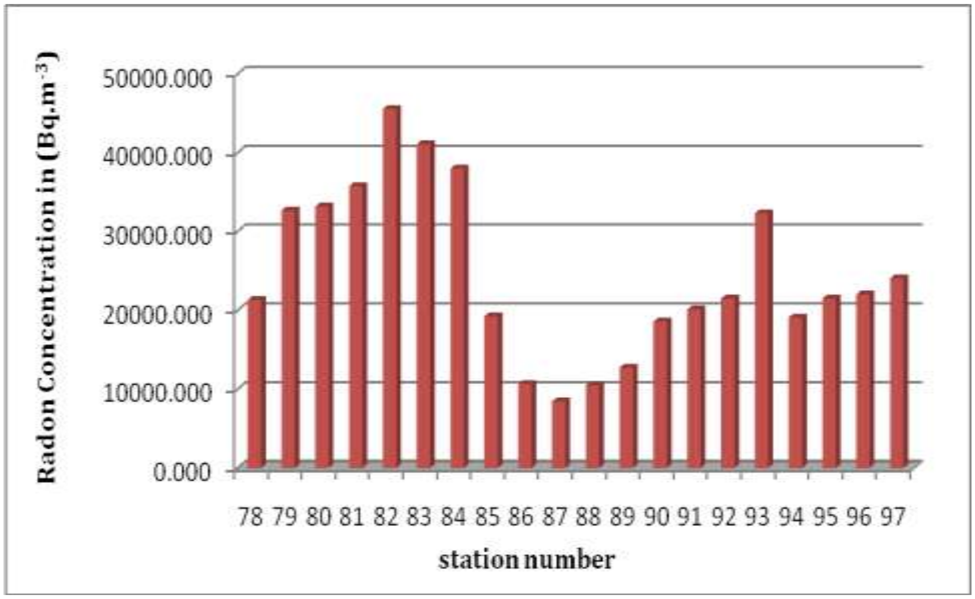
Figure(13): The Radon Concentrations in the sediments from Al- Akiekah marshes in Thi Qar governorate.



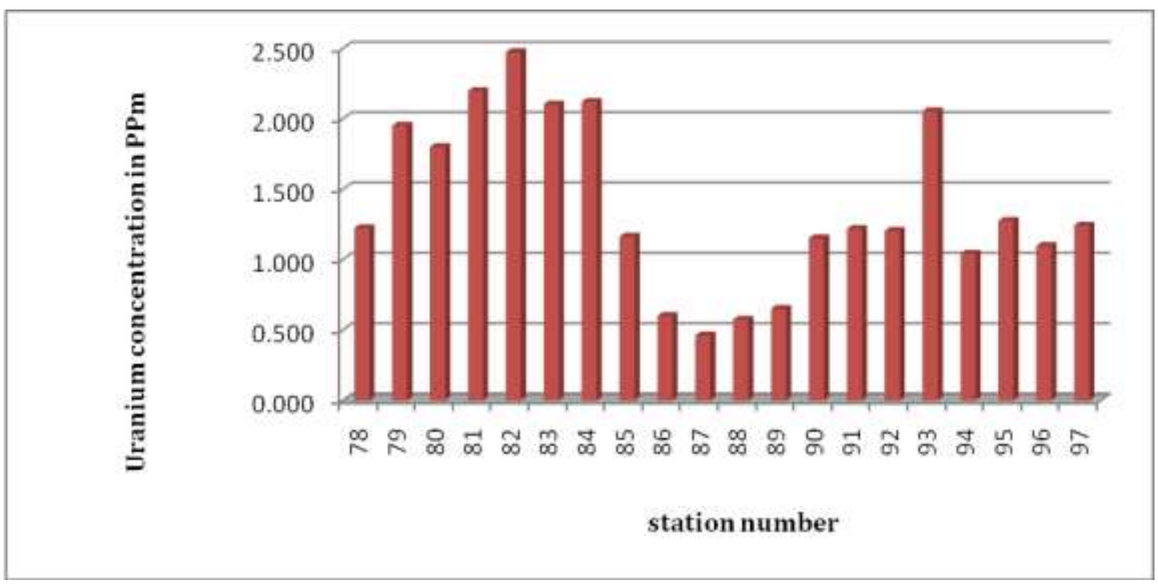
Figure(14): The Uranium Concentrations in the sediments from Al- Akiekah marshes in Thi Qar governorate.

Table(6):The Radon and Uranium Concentrations in sediments from Al-Chibayish marshes in Thi Qar governorate.

Station Number	Station name	Track Density ρ (Track/cm^2)	mass of sample (gm)	C_{Rns} (Bq.m^{-3})	C_u (ppm)
78	Al A'neas (1)	3900.291	41.350	21319.933	1.224
79	Al A'neas (2)	5976.252	39.720	32667.639	1.953
80	Al A'neas (3)	6070.614	43.740	33183.443	1.801
81	Al Eweas (1)	6542.424	38.610	35762.467	2.199
82	Al Eweas (2)	8335.299	43.710	45562.759	2.475
83	Al Eweas (3)	7517.496	46.370	41092.451	2.104
84	Al weneas (1)	6951.325	42.530	37997.622	2.121
85	Al weneas (2)	3522.843	39.290	19256.713	1.164
86	Al weneas (3)	1950.145	42.170	10659.966	0.600
87	Al-Hedadean (1)	1541.244	43.340	8424.812	0.462
88	Al-Hedadean (2)	1918.692	43.320	10488.031	0.575
89	Al-Hedadean (3)	2327.593	46.350	12723.186	0.652
90	Al Ghereag (1)	3397.028	38.250	18568.973	1.153
91	Al Ghereag (2)	3680.113	39.180	20116.388	1.219
92	Al Ghereag (3)	3931.745	42.340	21491.867	1.205
93	Al-Serehaat (1)	5913.344	37.320	32323.769	2.056
94	Al-Serehaat (2)	3491.389	43.490	19084.778	1.042
95	Al Sari (1)	3931.745	39.970	21491.867	1.277
96	Al Sari (2)	4026.107	47.590	22007.672	1.098
97	Al Sari (3)	4403.554	45.980	24070.892	1.243



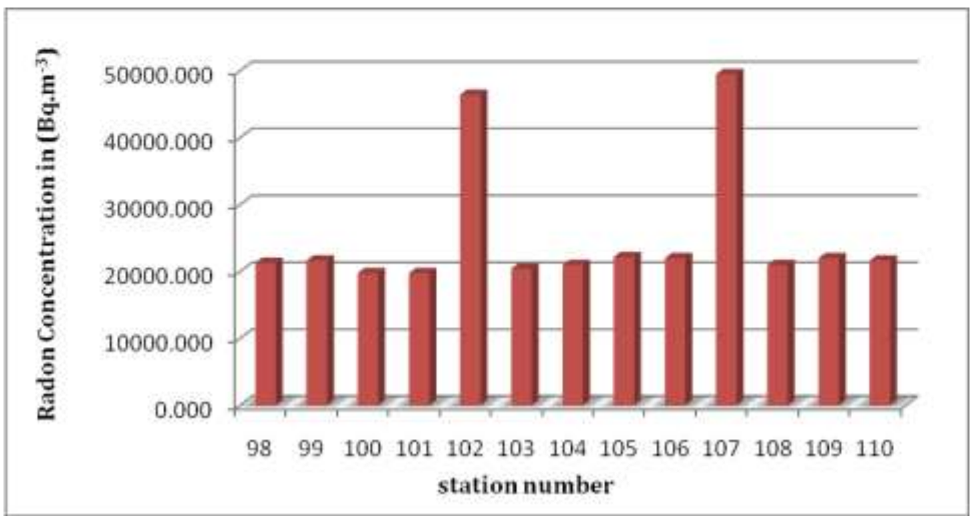
Figure(15): The Radon Concentrations in the sediments from Al-Chibayish marshes in Thi Qar governorate.



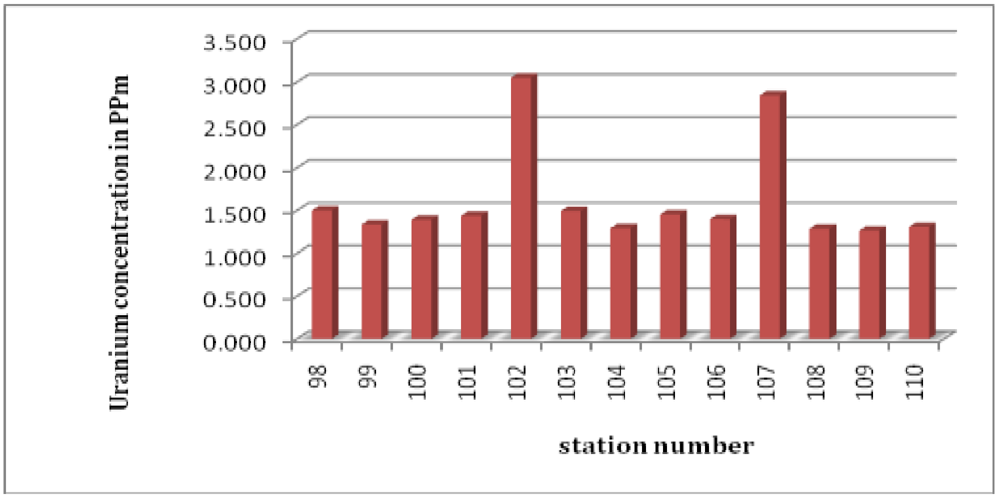
Figure(16): The Uranium Concentrations in the sediments from Al-Chibayish marshes in Thi Qar governorate.

Table(7): The Radon and Uranium Concentrations in the sediments from Al-Fohood marshes in Thi Qar governorate.

Station Number	Station name	Track Density ρ (Tracklcm^2)	mass of sample (gm)	C_{Rns} (Bq.m^{-3})	C_u (ppm)
98	Al-Fohood (1)	3900.291	33.740	21319.933	1.500
99	Al-Fohood (2)	3963.199	38.530	21663.802	1.335
100	Al-Fohood (3)	3617.205	33.750	19772.518	1.391
101	Al-Emaera (1)	3617.205	32.640	19772.518	1.438
102	Al-Emaera (2)	8492.569	36.120	46422.434	3.051
103	Al-Emaera (3)	3743.021	32.540	20460.258	1.493
104	Al Bu Shamh (1)	3837.383	38.540	20976.063	1.292
105	Al Bu Shamh (2)	4057.561	36.230	22179.607	1.453
106	Al Bu Shamh (3)	4026.107	37.340	22007.672	1.399
107	Al Bu Shamh (4)	9058.740	41.340	49517.263	2.844
108	Al-Sadh Al-Betaat (1)	3837.383	38.720	20976.063	1.286
109	Al-Sadh Al-Betaat (2)	4026.107	41.320	22007.672	1.265
110	Al-Sadh Al-Betaat (3)	3963.199	39.340	21663.802	1.307



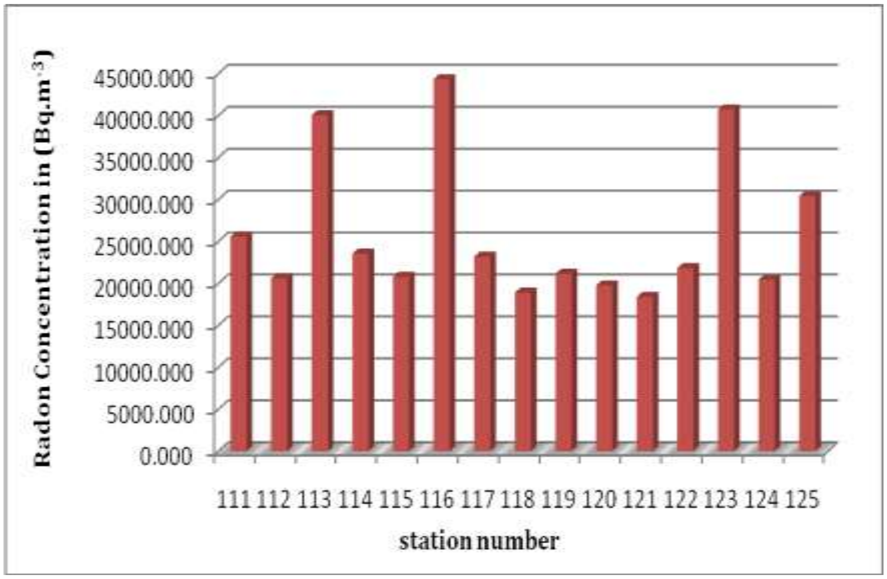
Figure(17): The Radon Concentrations in the sediments from Al-Fohood marshes in Thi Qar governorate.



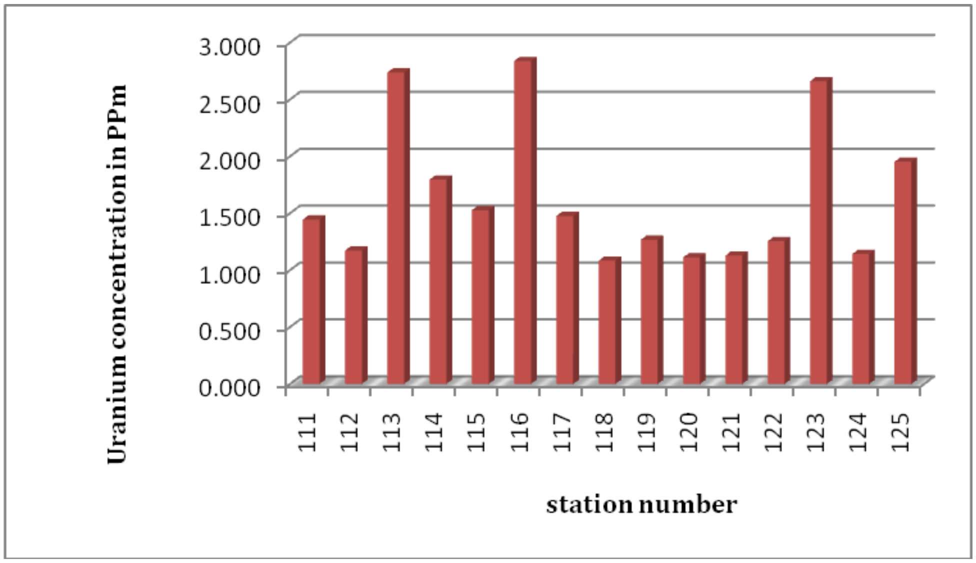
Figure(18): The Uranium Concentrations in the sediments from Al-Fohood marshes in Thi Qar governorate.

Table(8): The Radon and Uranuim Concentrations in the sedements from Al-Hammar marshes in Thi Qar governorate.

Station Number	Station name	Track Density ρ (Tracklcm²)	mass of sample (gm)	C_{Rns} (Bq.m^{-3})	C_u (ppm)
111	Al Farag (1)	4686.640	42.110	25618.306	1.444
112	Al Farag (2)	3774.475	41.800	20632.193	1.172
113	Al Farag (3)	7328.773	34.750	40060.841	2.737
114	Al Farag (4)	4309.192	31.140	23555.087	1.796
115	Al Mezaal (1)	3805.929	32.340	20804.128	1.527
116	Al Mezaal (2)	8115.121	37.110	44359.214	2.838
117	Al Mezaal (3)	4246.285	37.330	23211.217	1.476
118	Al Saheb (1)	3459.936	41.460	18912.843	1.083
119	Al Saheb (2)	3868.837	39.620	21147.998	1.267
120	Al Saheb (3)	3617.205	42.220	19772.518	1.112
121	Al Saheb (4)	3365.574	38.710	18397.039	1.128
122	Bani Hitait (1)	3994.653	41.310	21835.737	1.255
123	Bani Hitait (2)	7454.588	36.370	40748.581	2.660
124	Bani Hitait (3)	3743.021	42.530	20460.258	1.142
125	Bani Hitait (4)	5567.351	36.990	30432.484	1.953



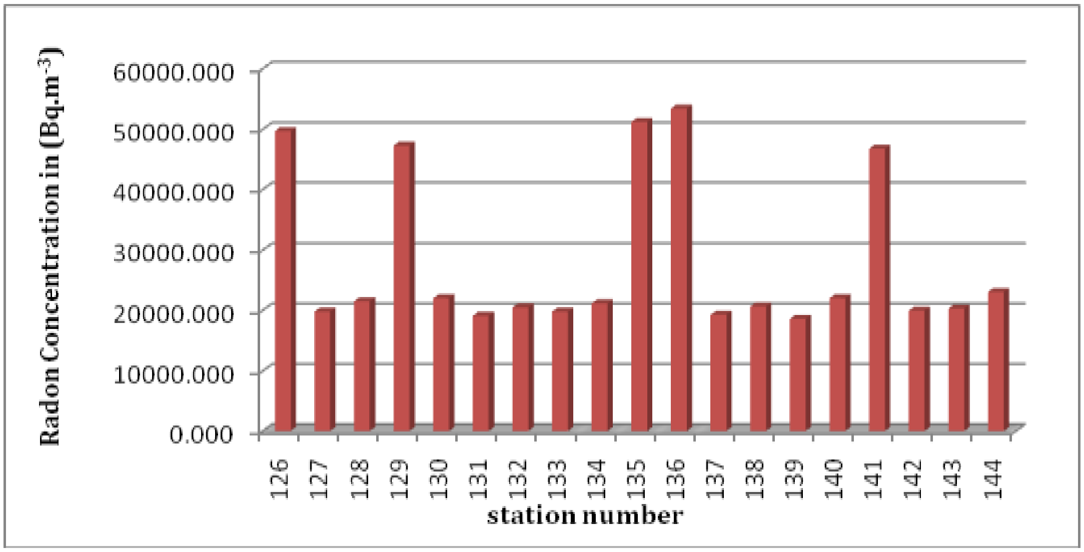
Figure(19): The Radon Concentrations in the sediments from Al-Hammar marshes in Thi Qar governorate.



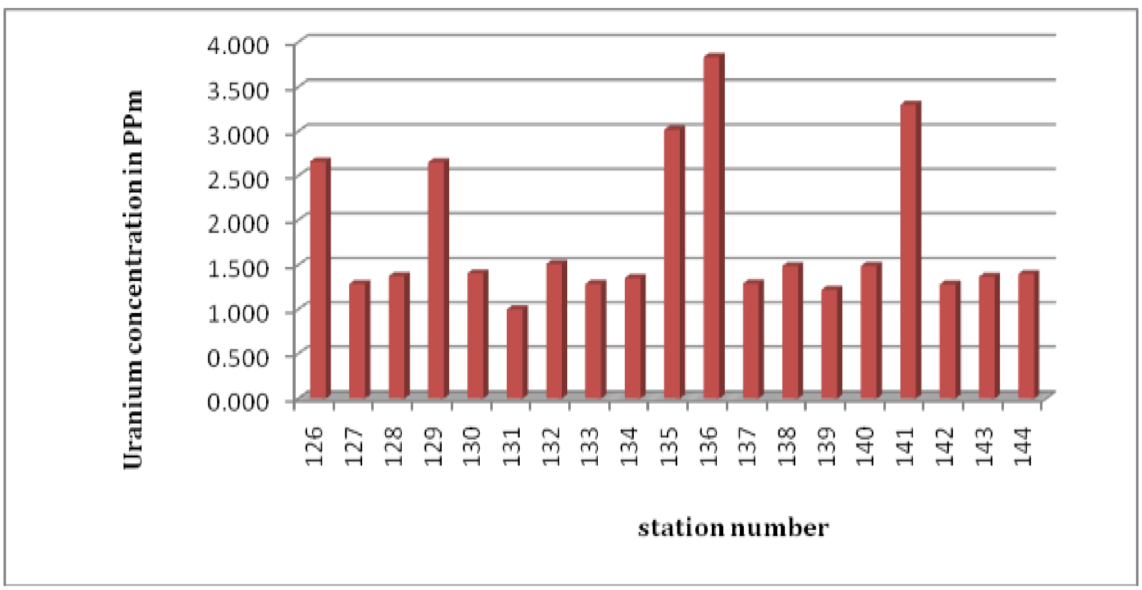
Figure(20): The Uranium Concentrations in the sediments from Al-Hammar marshes in Thi Qar governorate.

Table(9):The Radon and Uranuim Concentrations in the sedements from Al-Kahlaa marshes in Missan governorate.

Station Number	*Station name*	*Track Density ρ (Tracklcm²)*	*mass of sample (gm)*	*C_{Rns} (Bq.m^{-3})*	*C_u (ppm)*
126	*Al-Rada*	*9090.194*	*44.360*	*49689.198*	*2.659*
127	*Al-Ghenamia (1)*	*3617.205*	*36.500*	*19772.518*	*1.286*
128	*Al-Ghenamia (2)*	*3931.745*	*37.140*	*21491.867*	*1.374*
129	*Theal Al-Meayl (1)*	*8649.839*	*42.330*	*47282.108*	*2.652*
130	*Theal Al-Meayl (2)*	*4026.107*	*37.200*	*22007.672*	*1.405*
131	*Al-Debin (1)*	*3491.389*	*45.370*	*19084.778*	*0.999*
132	*Al-Debin (2)*	*3743.021*	*32.170*	*20460.258*	*1.510*
133	*Abu Khassaff (1)*	*3617.205*	*36.480*	*19772.518*	*1.287*
134	*Abu Khassaff (2)*	*3868.837*	*37.130*	*21147.998*	*1.352*
135	*Al-Seliayl (1)*	*9373.280*	*40.300*	*51236.612*	*3.018*
136	*Al-Seliayl (2)*	*9782.181*	*33.120*	*53471.766*	*3.833*
137	*Bet Mensab (1)*	*3522.843*	*35.430*	*19256.713*	*1.290*
138	*Bet Mensab (2)*	*3774.475*	*32.930*	*20632.193*	*1.488*
139	*Al-Agreh*	*3397.028*	*36.140*	*18568.973*	*1.220*
140	*Kriesha*	*4026.107*	*35.120*	*22007.672*	*1.488*
141	*Al-Rafeai (1)*	*8555.4769*	*33.640*	*46766.304*	*3.301*
142	*Al-Rafeai (2)*	*3648.6593*	*37.000*	*19944.453*	*1.280*
143	*Um Neaaj*	*3711.5672*	*35.230*	*20288.323*	*1.367*
144	*Al-Chekah*	*4214.8305*	*39.160*	*23039.282*	*1.397*



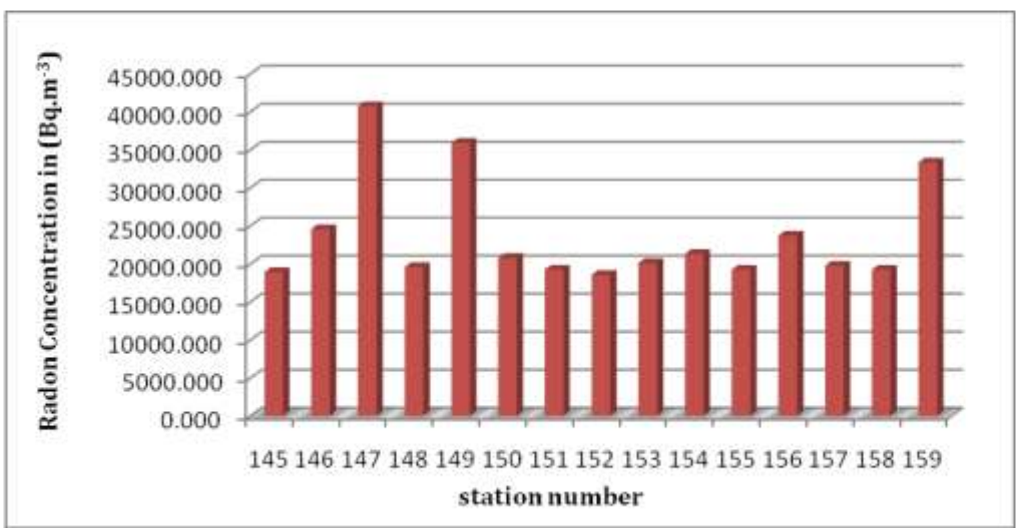
Figure(21): The Radon Concentrations in the sediments from Al-Kahlaa marshes in Missan governorate.



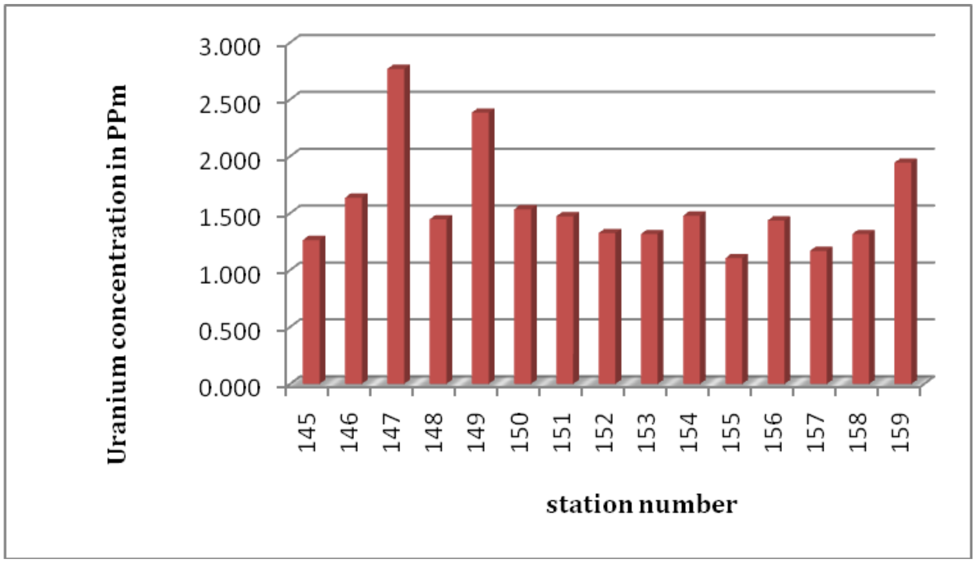
Figure(22): The Uranium Concentrations in the sediments from Al-Kahlaa marshes in Missan governorate.

Table(10): The Radon and Uranuim Concentrations in the sedements from Qalaat Saleh marshes in Missan governorate.

Station Number	Station name	Track Density ρ (Tracklcm^2)	mass of sample (gm)	C_{Rns} (Bq.m^{-3})	C_u (ppm)
145	Mrreibi (1)	3459.936	35.520	18912.843	1.264
146	Mrreibi (2)	4497.916	35.670	24586.696	1.636
147	Mrreibi (3)	7454.588	34.950	40748.581	2.768
148	Al-Terrabah (1)	3585.751	32.180	19600.583	1.446
149	Al-Terrabah (2)	6573.877	35.780	35934.402	2.384
150	Al-Terrabah (3)	3805.929	32.180	20804.128	1.535
151	Al-Terrabah (4)	3522.843	31.040	19256.713	1.473
152	Al-Ehssan (1)	3397.028	33.260	18568.973	1.325
153	Al-Ehssan (2)	3680.113	36.280	20116.388	1.316
154	Al-Ehssan (3)	3900.291	34.230	21319.933	1.479
155	Al-Ehssan (4)	3522.843	41.350	19256.713	1.106
156	Al-Wawi (1)	4340.646	39.220	23727.022	1.436
157	Al-Wawi (2)	3617.205	40.140	19772.518	1.169
158	Al-Wawi (3)	3522.843	34.710	19256.713	1.317
159	Al-Wawi (4)	6102.068	40.710	33355.378	1.945



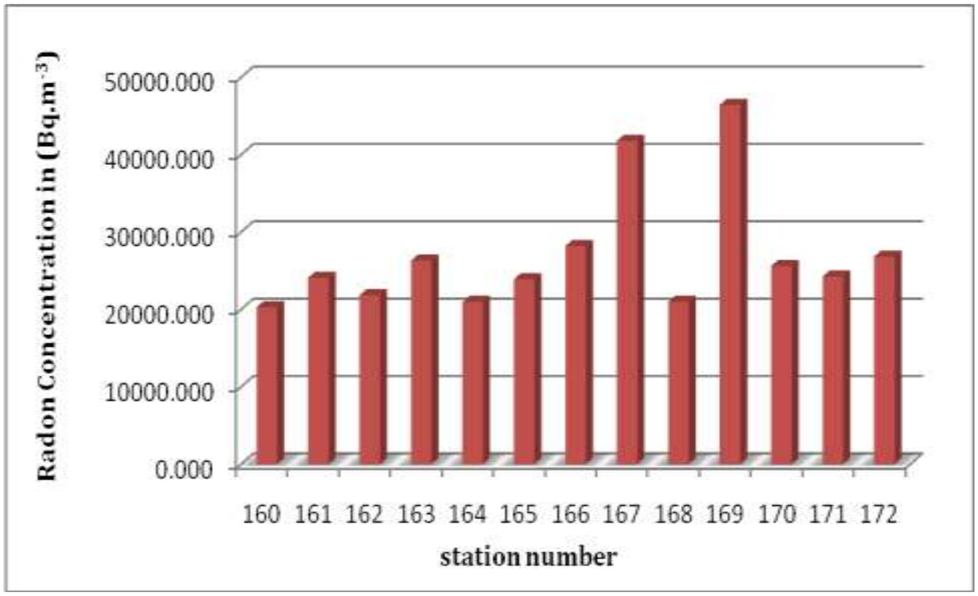
Figure(23): The Radon Concentrations in the sediments from Qalaat Saleh marshes in Missan governorate.



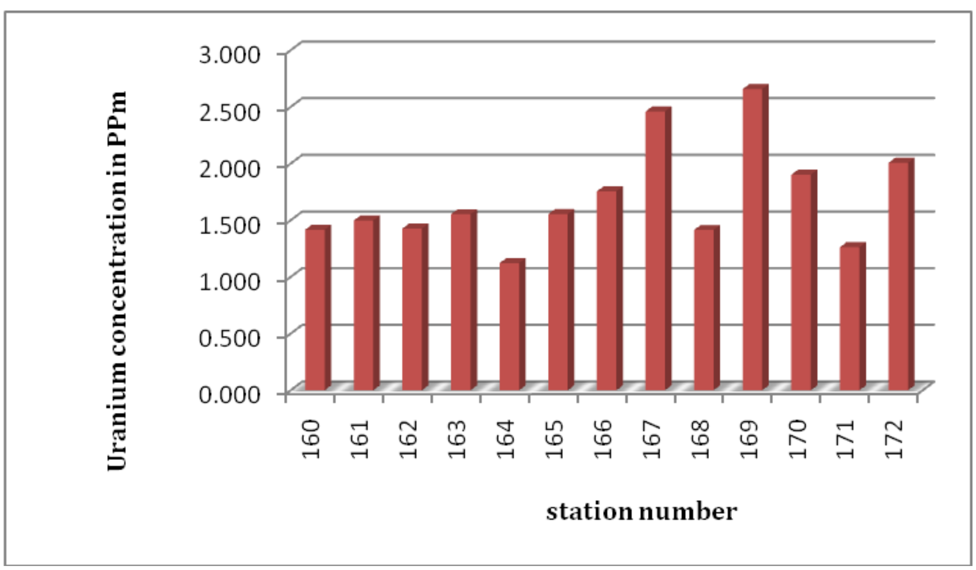
Figure(24): The Uranium Concentrations in the sediments from Qalaat Saleh marshes in Missan governorate.

Table(11): The Radon and Uranium Concentrations in the sediments from Al-Mejar Al-Kabeer marshes in Missan governorate.

Station Number	*Station name*	*Track Density ρ (Tracklcm²)*	*mass of sample (gm)*	C_{Rns} *(Bq.m⁻³)*	C_u *(ppm)*
160	*Al- Addel (1)*	*3711.567*	33.99	*20288.323*	*1.417*
161	*Al- Addel (2)*	*4403.554*	38.15	*24070.892*	*1.498*
162	*Al-Wadieh (1)*	*3994.653*	36.32	*21835.737*	*1.427*
163	*Al-Wadieh (2)*	*4812.456*	40.2	*26306.046*	*1.554*
164	*Abu Sbour (1)*	*3837.383*	44.36	*20976.063*	*1.123*
165	*Abu Sbour (2)*	*4372.100*	36.5	*23898.957*	*1.555*
166	*Al-Seagall (1)*	*5158.449*	38.14	*28197.330*	*1.755*
167	*Al-Seagall (2)*	*7643.312*	40.33	*41780.190*	*2.460*
168	*Um Al-Housh (1)*	*3837.383*	35.2	*20976.063*	*1.415*
169	*Um Al-Housh (2)*	*8492.569*	41.47	*46422.434*	*2.658*
170	*Nahar Al-Aiz*	*4686.640*	31.97	*25618.306*	*1.902*
171	*Al-Khummes*	*4435.008*	45.58	*24242.826*	*1.263*
172	*Al-Heddam*	*4906.818*	31.72	*26821.851*	*2.008*



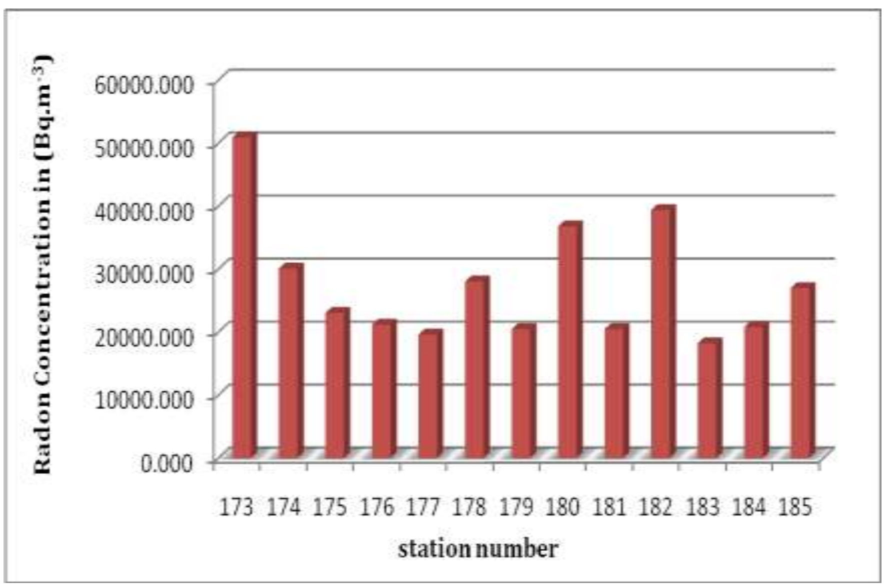
Figure(25): The Radon Concentrations in the sediments from Al-Mejar Al-Kabeer marshes in Missan governorate.



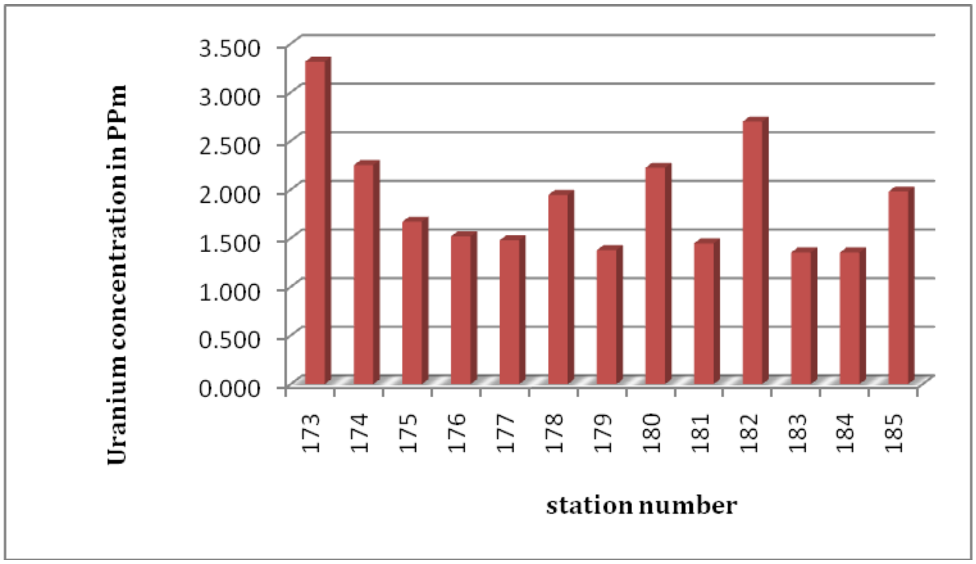
Figure(26): The Uranium Concentrations in the sediments from Al-Mejar Al-Kabeer marshes in Missan governorate.

Table(12): The Radon and Uranuim Concentrations in the sedements from Al-Azeer marshes in Missan governorate.

Station Number	Station name	Track Density ρ (Tracklcm²)	mass of sample (gm)	C_{Rns} (Bq.m⁻³)	C_u (ppm)
173	Al-Swdah (1)	9310.372	36.430	50892.742	3.317
174	Al-Swdah (2)	5504.443	31.720	30088.614	2.252
175	Al-Swdah (3)	4214.831	32.740	23039.282	1.671
176	Al-Swdah (4)	3868.837	33.020	21147.998	1.521
177	Al-Bedhah (1)	3585.751	31.440	19600.583	1.480
178	Al-Bedhah (2)	5126.995	34.190	28025.395	1.946
179	Al-Bedhah (3)	3743.021	35.230	20460.258	1.379
180	Al-Bedhah (4)	6731.147	39.260	36794.077	2.225
181	Al-Bedhah (5)	3743.021	33.540	20460.258	1.448
182	Al-Abiedh (1)	7202.957	34.620	39373.101	2.700
183	Al-Abiedh (2)	3334.120	31.920	18225.104	1.356
184	Al-Abiedh (3)	3805.929	36.470	20804.128	1.354
185	Al-Abiedh (4)	4938.272	32.350	26993.786	1.981



Figure(27): The Radon Concentrations in the sediments from Al-Azeer marshes in Missan governorate.



Figure(28): The Uranium Concentrations in the sediments from Al-Azeer marshes in Missan governorate.

The figures above reflects great variability of radon and uranium concentrations in study region. There are many parameters effect on this results. One of these parameters is due to the structure of sediments, when contents of radium and uranium are high, the radon concentration was increased and vice versa. There are clear correlation relation between the uranium and radon concentrations, but the non correlated values are due to the different in mass(or density) of sample for the used volume for it. From the results which shown in above tables and figures, it is observed that most of measured concentrations for uranium and radon in natural limits according to (ICRP) where the concentration of uranium in sediment varies widely, but typically contains about 3 ppm [25]. While there are 31 stations have relatively high concentrations for uranium, this stations numbers are 4 and 12 in Al-Qurna marsh, 39 in Al-mediena Marsh both in Basrah governorate, 49 in Suq Ashukh marsh, 63 and 65 in Garmat Bani Sae'ed marsh, 69,70,75 and 76 in Al-Akiekah marsh, 81,82,83,84 and 93 in Al-Chibayish marsh, 102 and 107 in Al-fohood marsh, 113,116 and 123 in Al-Hammar marsh, all in Thi Qar governorate, 126,129,135,136 and 141 in Al-Kahlaa Marsh, 147 in Qalaat Saleh marsh, 167 and 169 in Al-Mejar Al-Kabeer marsh, 173,180 and 182 in Al-Azeer marsh, all in Missan governorate. Same stations have relatively high concentrations of radon. The high concentrations of radon in many stations of study are caused by high concentrations of uranium in this stations, and the high concentrations of uranium are came from natural existing of radioactive elements in the earth crust and which changed with time or from external polluted factors like industry and wars. Radon concentrations which measured in this study is relatively greater than another previous study in 2009 for same study region[26] because of the change in geological structure and environmental conditions for Iraqi marshes in last previous eight years.

Conclusions

In this study uranium concentrations and activity of radon concentrations have been measured in the sediments of marshes in south of Iraq. CR-39 detector with a closed cylindrical plastic container technique Which used for first once in measurements for this study region . Determination of uranium concentrations is the first investigation and study provided a data base of uranium in Iraqi marshes. The activity of radon concentrations which previously determined in 2009 by using different technique [26] but in this work the activity of radon concentrations are relatively different from the data in reference(26) because of change in geological structure and environmental conditions for Iraqi marshes in last previous eight years, therefore, the new data for radon provided an update for the radon database in Iraq.

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قياس تراكيز اليورانيوم والرادون في رواسب اهوار جنوب العراق باستخدام كواشف الاثر النووي الصلبة

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الخلاصة

في هذا البحث تم قياس تركيز اليورانيوم وفعالية تركيز الرادون في رواسب اهوار جنوب العراق. لقد جلبت 185 عينه من الرواسب من محطات مختلفة من ثلاث محافظات وهي محافظة البصره والمتمثلة بهور القرنه وهور المدينه ومحافظة ذي قار والمتمثلة بهور سوك الشيوخ وهور كرمة بني سعيد وهور العكيكة وهور الجبايش وهور الفهود وهور الحمار ومحافظة ميسان والمتمثلة بهور الكحلاء وهور قلعة صالح وهور المجر الكبير وهور العزير. تم انتقاء محطات الدراسة قرب التجمعات السكانية. لاستحصال النتائج في هذا البحث تم استخدام تقنية الكاشف النووي CR-39 والاسطوانه البلاستيكية المغلقه . تم قياس اعلى تركيز لليورانيوم والبالغ (4.1719 ppm) في محافظة ميسان هور الكحلاء المحطة رقم 136 (الصلايل(2)، كما تم قياس اقل تركيز لليورانيوم والبالغ (0. 2683 ppm) في محافظة ذي قار هور العكيكة المحطة رقم 72 (الحربية(2)). تم قياس اعلى فعالية تركيز للرادون والبالغ (53471.766 Bq.m-3) في محافظة ميسان هور الكحلاء المحطة رقم 136 (الصلايل(2)) ، كما تم قياس اقل فعالية تركيز للرادون والبالغ (3438.699 Bq.m-3) في محافظة ذي قار هور العكيكة المحطة رقم 72 (الحربية(2)). في هذه الدراسة اغلب تراكيز اليورانيوم والرادون المقاسة هي ضمن الحدود الطبيعية تبعا الى القيم المعتمدة من قبل (ICRP) حيث ان قيم اليورانيوم في الرواسب يمثل مدى واسع من القيم الا انها يجب ان لا تتجاوز (3 ppm) في الحالة المثالية. بينما هناك عدة تراكيز تعتبر عاليه نسبيا وكل هذه النتائج قد تم مناقشتها في هذا البحث.

الكلمات المفتاحية: تركيز اليورانيوم ، تركيز الرادون، رواسب،اهوار العراق، كواشف الاثر النووي الصلبة.