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MEASURING CONCENTRATION RADON AND THORON GASES IN SOIL OF THE BABYLON GOVERNORATE

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ABSTRACT

In environmental science the terms Radon (^{222}Rn) and thoron (^{220}Rn) are usually taken to refer to radon isotope family, and have same chemical properties. They are an alpha particle emitter. Thoron`s average activity concentration in soil gas and ground-level outside air is comparable to that of radon.

In our research the concentration of radon and thoron gases were measured in the soil of Babylon, included two depths 10 cm 15 cm represented 18 selected locations. The range concentration of radon in case depth 10 cm between 33.8-9690 Bq/m^3 where in case of 15 cm between 406-8970 Bq/m^3 in range concentration of thoron for depth 10 cm between 33.8-9690, while in depth 15 cm between 183-7520 Bq/m^3.

Keywords: Concentration radon, Thoron Gases, ^{222}Rn, ^{220}Rn

INTRODUCTION

Radon (^{222}Rn) and thoron (^{220}Rn) are naturally occurring radioactive gases. Radon is produced by decay of (^{226}Ra) in the uranium series and decays by alpha particle emission to a polonium (^{218}Po) which by further decay through isotope of lead, bismuth and polonium end with a stable isotope leads (^{212}Pb). Thoron is produced by decay of (^{224}Ra) in the thorium series and decays by alpha particle emission to polonium isotopes (^{216}Po) which decays through isotopes of thallium, lead. Bismuth and polonium end with a stable isotope lead (^{208}Pb).

Radon and thpron are chemically inert, noble gases. They occur in almost materials and for most part (90%) are trapped in the solids carrying their precursors (^{226}Ra and ^{224}Ra)[1].

Thoron`s half-life is (56) second, and upon decay it emits a single alpha particle of energy (6.3) Mev. In comparison radon has half-life of (3.3×10^5) second (3.8 days) and emits a (5.5) Mev energy alpha particle.

There are additional radioactive isotopes after thoron in the thorium decay series which terminates in the stable isotopes (^{208}Pb) (as in figure -1-). [2]

Radon and Thoron in Soil

Radon and thoron enter the air contained in soil by diffusion from soil particles or sometimes from radon-rich ground water at greater depths.

The concentration of radon and thoron in this decreases with decreasing distance from the surface because the gases escape to the open are above the ground. As the exhalation increases the gas concentration in soil air decreases, and vice- versa.

Factor influencing the concentration in soil air also influence exhalation rate, but in the opposite direction. Rain, snow, freezing and increased atmospheric pressure reduce the exhalation rates, while higher wind speeds and temperature increase it.

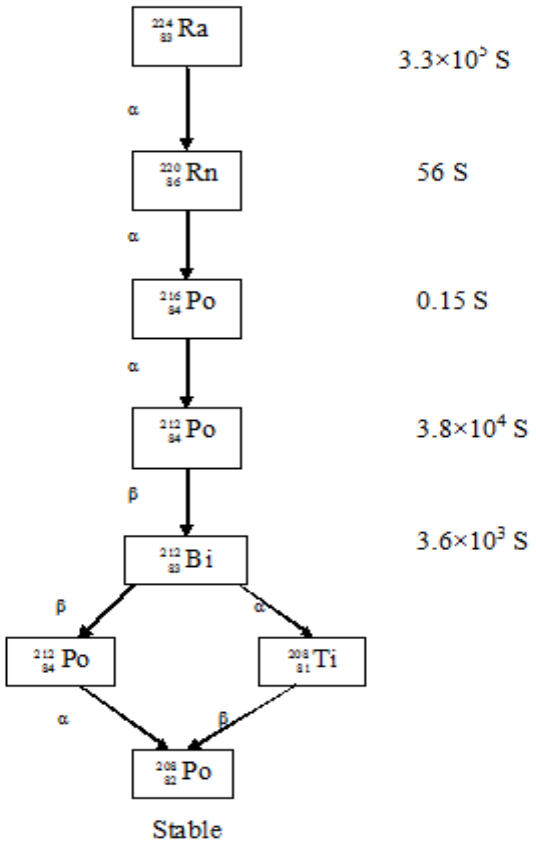

Figure 1. The part of the thororium $^{232}_{90}$ Thedecay series immediately and following thoron $^{220}_{86}$ Rn

The radon concentration in soil has its maximum values in winter, when the ground is frozen, and the rainy periods, unless the rain flushes out the radon from the soils. In areas with high radium, such as uranium mining areas, the exhalation rate is much higher than normal (more than two orders of magnitude greater for uncoverd tailings [3].

The effective dose from radon, thoron and their decay products occupies about (50%) of the whole. The urainium-238 and thorium-232 from which radon and thoron generate exist mainly among soil and rock and they decay at each existing position in the soil and rock [4].

Health Effects

Inhalation of radon daughters increases the chances of lung cancer. The extent of these effects and the risk estimates involved are difficult to determine. Still, the Environmental protection Agency (EPA) estimates that (2-5) percent of airborne radon comes from household water, also (EPA) suggest that an airborne level of 4pCi/L in water is a point at which remedial action should be taken.

Recognize that for every 10,000 pCi/L in water about 1pCi/L will be released in the air. EPA`s proposed limit for radon in water is 300 pCi/L, and estimates that radon in drinking water cause about 168 cancer deaths per year: 89% from lung cancer caused by breathing

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radon released to the indoor air from water and 11% from stomach cancer caused by consuming water containing radon [5].

The first decay product of thoron (polonium216) has a fairly long half-life so it's likely to be breathed into the lungs if its airborne. But because of its long half life, the lungs may be able to push it back out before it decays. These two factors of not having enough time to get out of the soil and into a home, placed thoron in the low risk category for inducing lung cancer. The range of a 5 MeV alpha particle is approximately 3.5 cm in air, or 0.004 cm in tissue, so that alpha particles are not considered to be an external hazard because of their inability to penetrate the outer layer of skin [6].

Experimental Method

In our research (40) site in Babylon governorate have been selected to achievement this study. The following tables illustrated the concentrated of radon and thoron in this sites measured by Bq/ m^3.
The following table shows the percentages of radon gas in Babylon Governorate in depth 10 cm.

Table 1. Percentages of radon gas in Babylon Governorate in depth 10 cm

sequence	*Region*	*First Reading*	*Second Reading*	*Third Reading*	*Fourth Reading*	*Mean*	*±S. D*
S_1	Hay- Al-Cenaay	4260	4710	3710	4754	4610	230
S_2	Nader- Al- Thaltha	2280	1390	374	237	1070	956
S_3	Nader- Al- Thania	272	136	170	1120	425	468
S_4	Nader-AL-oula	1760	1760	1630	1590	1690	87
S_5	Al- Tajai	2690	2380	2690	2790	2700	243
S_6	Residential Buildings (1)	170	238	238	374	255	83.6
S_8	Hay-Al-Atibaa	1830	474	372	1660	1080	766
S_{10}	Al-Nasseg	643	643	609	778	668	750
S_{15}	Al-Askan	1320	3060	3570	3470	2860	1050
S_{16}	Agriculture land	33.8	778	643	1450	583	727
S_{17}	Al- Thubat	1330	1700	1530	1670	1560	170
S_{20}	Al-Akramen	2580	2790	3090	2460	2860	220
S_{22}	Newab Al-Thubat	33.8	778	643	1450	727	583
S_{23}	Al- Muhandisen	1090	646	340	136	553	414
S_{24}	Al- Tuhmazia	541	406	507	304	3050	705
S_{25}	Alshuhadaa (2)	2150	1360	1610	1780	1730	334
S_{26}	Residential Buildings (2)	372	1090	2480	1101	1261	679

S_{27}	Al-Gameya	247	1150	879	1120	812	489
S_{28}	Al-Murtatha	420	2110	2860	2550	1990	1080
S_{29}	Mustafa Ragib	5810	5780	8090	6950	6660	1100
S_{30}	Al-Tenyia	1700	1760	1630	1500	457	58.6
S_{31}	Al-Asatetha	6010	5640	5050	5840	5640	419
S_{32}	Al- AlAskari	4850	4710	4810	6290	5160	736
S_{33}	Al- Muhariben	1670	2750	2920	3260	2650	691
S_{34}	Al- Hukam	2940	4880	5640	5980	4860	1300
S_{35}	Al-Karama	8100	8140	9690	8900	7240	3410
S_{36}	Kadhia	6570	5840	7050	7290	6690	639
S_{37}	Al- Shawi	2450	6460	6910	7700	5880	2340
S_{38}	Al- Jamhuria	1730	1360	1120	884	1280	363
S_{39}	Al-Gamain	2190	1570	782	918	1370	648
S_{40}	Jabaween	1430	2280	2480	2210	2100	462
S_{41}	Gubran	1120	1150	981	1320	1140	139
S_{42}	Muhaizim	2350	4320	5230	6460	4590	1730
S_{43}	Al-Thawra	981	2650	3470	3060	3320	333
S_{44}	Al-Teyara	1330	1700	1530	1670	1560	170
S_{47}	Hay-Al- Gazaer	4130	4570	4370	4090	4290	225
S_{48}	Agriculture land	643	643	609	778	668	75
S_{49}	Agriculture land	2560	2630	3080	3970	1160	1200
S_{50}	Hay-Al- Gazaer (2)	1290	879	677	609	864	308
S_{51}	Bakarli	406	918	781	714	705	217
S_{52}	Al- Wardyia	2630	4820	4100	4750	4080	1020
S_{53}	Hemaier	1120	1120	3640	5090	2740	1970
S_{55}	Al-Kulag	237	372	237	474	330	115

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The following table shows the percentages of radon gas in Babylon Governorate in depth 15 cm.

Table 2. Percentages of radon gas in Babylon Governorate in depth 15 cm

Sequence	*Region*	*First reading*	*second reading*	*third reading*	*fourth reading*	*Mean*	*±S. D*
S_1	Hay- Al-Cenaay	3080	3920	3920	5230	4610	230
S_2	Nader- Al- Thaltha	5920	4180	3690	3660	4360	1060
S_3	Nader- Al- Thania	1330	1700	1530	1670	1560	170
S_4	Nader-AL-oula	406	1690	1890	2350	1580	832
S_5	Al- Tajai	1730	2890	3230	2550	2600	641
S_6	Residential Buildings (1)	1330	1870	2700	3040	2240	781
S_8	Hay-Al-Atibaa	1970	2040	2740	2920	2430	495
S_{14}	Al-Nasseg	1530	63	1180	744	998	444
S_{15}	Al-Askan	1020	5680	7350	8140	5550	3190
S_{17}	Al- Thubat	2310	1890	1870	2040	2030	203
S_{20}	Al-Akramen	1590	1500	947	1160	1300	299
S_{22}	Newab Al-Thubat	609	1420	1390	1700	1280	408
S_{23}	Al- Muhandisen	2150	1360	1610	1780	1730	334
S_{24}	Al- Tuhmazia	4460	4490	3580	5180	4427	107
S_{25}	Alshuhadaa	474	1450	1760	1960	1410	660
S_{26}	Residential Buildings (2)	3150	3460	3280	2750	3170	309
S_{27}	Al-Gameya	1500	1970	2310	1630	1850	365
S_{28}	Al-Murtatha	1500	1970	2310	1630	1850	360
S_{29}	Mustafa Ragib	4540	5840	6810	7490	6170	1280
S_{30}	Al-Tenyia	1406	1690	1890	2530	1870	154
S_{31}	Al-Asatetha	169	1080	2270	2410	1480	1060
S_{32}	Al-Askari	1330	1870	2700	3040	2240	781
S_{33}	Al- Muhariben	3640	3200	3010	3300	3410	308
S_{34}	Al- Hukam	3900	5470	6190	6420	5500	1150
S_{35}	Al-Karama	8630	8970	8040	8150	8450	432

S_{36}	Kadhia	7120	6980	7630	7220	7240	281
S_{37}	Al- Shawi	4820	7320	7250	7700	6770	1320
S_{38}	Al- Jamhuria	1220	2070	2140	2180	1900	455
S_{39}	Al-Gamain	7930	8590	8770	8630	8480	373
S_{40}	Jabaween	2990	3500	3610	2720	3210	420
S_{41}	Gubran	1150	1520	1490	1730	1470	238
S_{42}	Muhaizim	4740	5330	5920	5130	5290	473
S_{43}	Al-Thawra	323o	2960	3370	3320	3220	1090
S_{44}	Al-Teyara	3520	3390	3250	3520	3420	131
S_{45}	Agriculture land	4340	5540	4920	541	3835	762
S_{47}	Hay-Al- Gazaer	4740	400	4850	4430	4570	358
S_{51}	Bakarli	643	918	918	578	764	180
S_{52}	Al- Wardyia	408	2450	2410	3350	2160	1240
S_{53}	Hemaier	440	947	846	1250	871	335
S_{54}	Agriculture land	1630	5850	7730	7390	5650	2800
S_{55}	Al-Kulag	8630	8970	8040	8150	8450	432

The following table shows the percentages of thoron gas in Babylon Governorate in depth 10 cm.

Table 3. Percentages of thoron gas in Babylon Governorate in depth 10 cm

sequence	*Region*	*First Reading*	*Second Reading*	*Third Reading*	*Fourth Reading*	*Mean*	*±S. D*
S_1	Hay- Al-Cenaay	291o	5180	5480	6160	4933	1650
S_2	Nader- Al- Thaltha	181	422	121	240	241	474
S_3	Nader- Al- Thania	120	*No Detect*	2110	3860	1522	638
S_4	Nader-AL-oula	1020	2040	1690	1860	1652	707
S_5	Al- Tajai	1510	2950	2290	1870	2155	651
S_6	Residential Bulding (1)	842	181	422	542	497	490
S_8	Hay-Al-Atibaa	3070	3800	3440	3740	3513	1050
S_{14}	Al-Nasseg	4320	3520	6210	4421	4563	1101

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S_{15}	Al-Askan	1020	1270	1390	1330	1252	683
S_{17}	Al- Thubat	904	899	1210	1450	1116	650
S_{18}	Al-Askari	3000	3550	4290	4230	3768	1115
S_{20}	Al-Akramen	420	1090	540	663	678	553
S_{22}	Newab Al-Thubat	420	1200	600	904	781	562
S_{23}	Al- Muhandisen	182	3440	2910	2730	2316	562
S_{24}	Al- Tuhmazia	780	1200	540	899	854	582
S_{25}	Alshuhadaa	2520	3200	3500	3620	3210	1009
S_{26}	Residential Buildings (2)	1330	2000	1940	1210	1620	767
S_{27}	Al-Gameya	2880	1709	1870	2680	2285	836
S_{28}	Al-Murtatha	60	839	899	720	630	509
S_{29}	Mustafa Ragib	3470	4810	5270	4900	4613	1210
S_{30}	Al-Tenyia	1020	2040	1690	1860	1653	630
S_{31}	Al-Asatetha	3400	5300	4080	4020	2118	1155
S_{32}	Al-Askari	420	1440	969	1140	993	612
S_{33}	Al- Muhariben	784	1330	1570	2170	1464	734
S_{34}	Al- Hukam	3210	6030	4390	5060	4673	1203
S_{35}	Al-Karama	1460	2380	2070	2506	2104	836
S_{36}	Kadhia	2860	4390	3980	4470	3925	1120
S_{37}	Al- Shawi	2410	3270	3330	3470	3120	1000
S_{38}	Al- Jamhuria	2350	2770	3010	2470	2650	938
S_{39}	Al-Gamain	2730	4080	4450	3350	3643	1373
S_{40}	Jabaween	3500	4580	5240	5370	4373	1500
S_{41}	Gubran	1560	1740	1320	780	1350	696
S_{42}	Muhaizim	2050	3010	3270	2970	2825	954
S_{43}	Al-Thawra	2160	3980	3500	3440	3270	1012
S_{44}	Al-Teyara	482	181	422	542	406	732

S_{45}	Agriculture land	360	360	660	360	435	482
S_{47}	Hay-Al- Gazaer	3900	4940	5730	5550	5030	1240
S_{51}	Bakarli	3960	5910	5490	5430	5198	1243
S_{52}	Al- Wardyia	4000	5390	5030	5090	4878	1223
S_{53}	Hemaier	60	1980	2950	2030	2005	767
S_{55}	Al-Kulag	2110	3210	3150	3330	2950	983

The following table shows the percentages of thoron gas in Babylon Governorate in depth 15 cm

Table 4. Percentages of thoron gas in Babylon Governorate in depth 15 cm

Sequence	*Region*	*First Reading*	*Second Reading*	*Third Reading*	*Fourth Reading*	*Mean*	*±S. D*
S_1	Hay- Al-Cenaay	3840	7520	5790	4750	5987	1231
S_2	Nader- Al- Thaltha	970	844	1330	1520	1160	636
S_3	Nader- Al- Thania	2410	3260	2590	3380	2910	628
S_4	Nader-AL-oula	1500	1200	1200	1150	1263	756
S_5	Al- Tajai	844	1210	1930	1930	1479	734
S_6	Residential Bulding (1)	3620	5000	4790	4760	4543	1173
S_8	Hay-Al-Atibaa	3070	3800	3440	3740	3512	1050
S_{14}	Al-Nasseg	3880	4610	5000	3320	4203	1135
S_{15}	Al-Askan	1020	1270	1390	1330	1253	683
S_{17}	Al- Thubat	904	899	1210	1450	1116	650
S_{18}	Al-Askari	3000	3550	4290	4230	3768	1115
S_{20}	Al-Akramen	663	540	1090	420	678	553
S_{22}	Newab Al-Thubat	904	600	1200	420	781	562
S_{23}	Al- Muhandisen	603	60	362	121	286	422
S_{24}	Al- Tuhmazia	660	1380	839	1380	1064	633
S_{25}	Alshuhadaa	720	899	720	540	720	551
S_{26}	Residential Buildings (2)	1330	2000	1940	1210	1620	767
S_{27}	Al-Gameya	1090	2050	1990	1810	1735	774

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S_{28}	Al-Murtatha	1330	1870	2410	2170	1945	790
S_{29}	Mustafa Ragib	4140	4880	4270	4020	4328	1168
S_{30}	Al-Tenyia	552	959	1260	1200	1035	630
S_{31}	Al-Asatetha	240	839	1260	1210	887	582
S_{33}	Al- Muhariben	904	1810	2180	1820	1679	817
S_{34}	Al- Hukam	2970	4880	4390	4510	4188	1149
S_{35}	Al-Karama	975	2560	2010	2500	2011	833
S_{36}	Kadhia	3290	4210	3720	4330	3888	1113
S_{37}	Al- Shawi	2850	3900	4390	4570	3928	1110
S_{38}	Al- Jamhuria	784	1510	1930	1390	1404	1802
S_{39}	Al-Gamain	2730	4080	4450	3350	4673	1073
S_{40}	Jabaween	2050	2170	1990	2110	2080	844
S_{41}	Gubran	1260	1080	1440	1320	1275	685
S_{42}	Muhaizim	1520	2060	1820	1940	1835	820
S_{43}	Al-Thawra	2710	2850	3560	4180	3325	1022
S_{44}	Al-Teyara	1700	1706	1580	1520	1640	722
S_{45}	Agriculture land	1270	1460	2120	240	1273	679
S_{47}	Hay-Al- Gazaer	3720	6640	6030	5060	5363	1278
S_{51}	Bakarli	3840	5430	5730	5060	5015	1223
S_{52}	Al- Wardyia	3010	4580	4220	4360	4043	1116
S_{53}	Hemaier	480	480	839	1250	762	887
S_{55}	Al-Kulag	540	1140	1140	1080	975	612

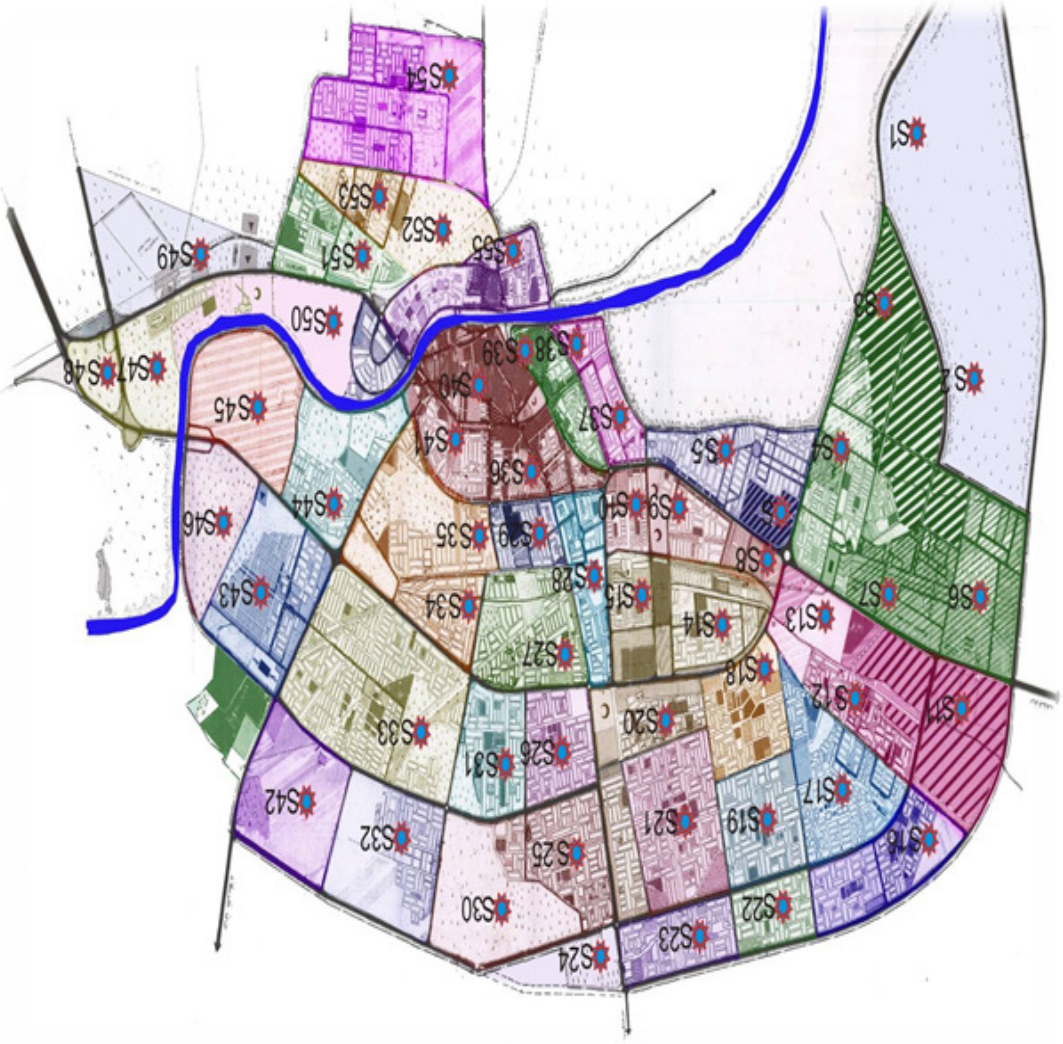

Figure 2. The map of center of Governorate of Babylon

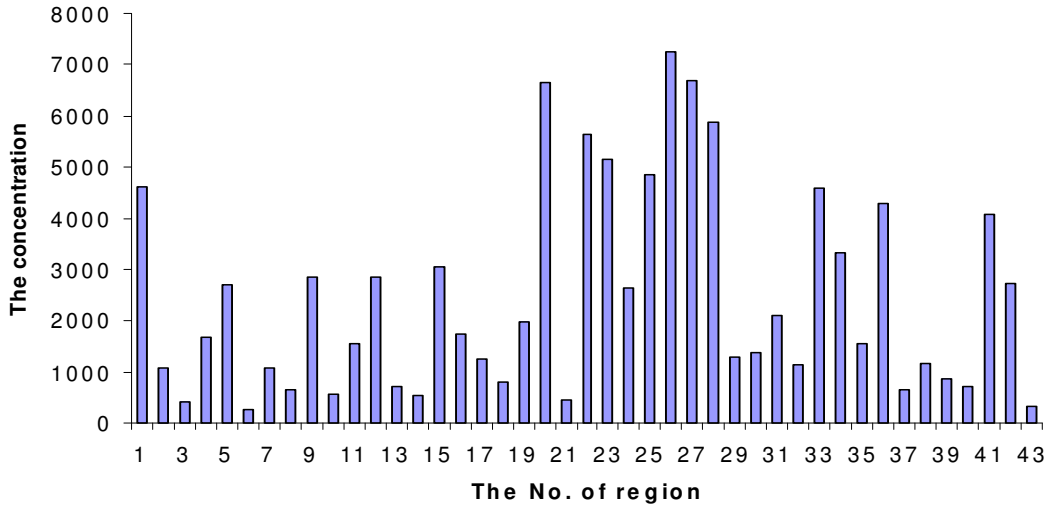

Diagram showing concentration of radon for depth 10 cm in Governorate of Babylon

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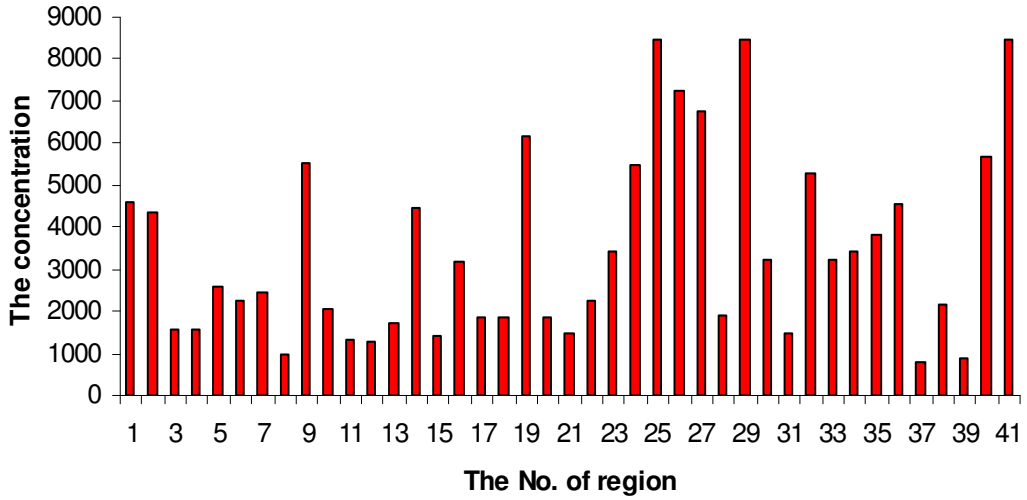

Diagram showing concentration of radon for depth 15 cm in Governorate of Babylon

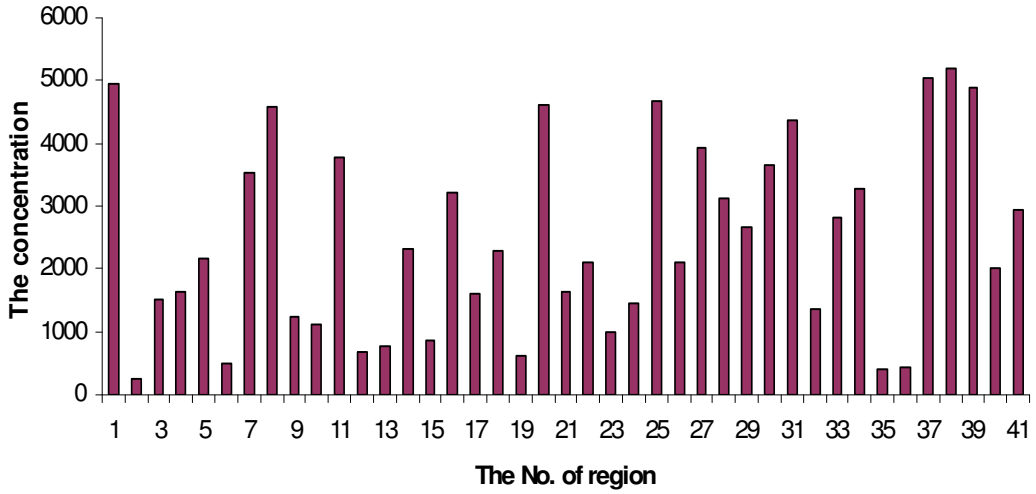

Diagram showing concentration of thoron for depth 10 cm in Governorate of Babylon

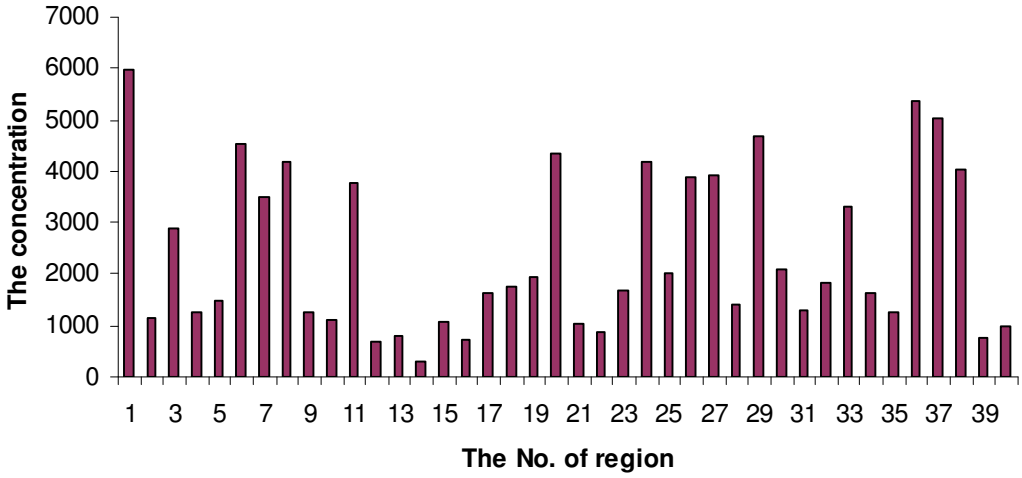

Diagram showing concentration of thoron for depth 10 cm in Governorate of Babylon

RESULT AND DISCUSSION

In the Current research is have been utilize the depths of 10 cm and 15 cm and the results are as follows.

1. The radon concentration for, governorate of Babylon.

   The highest value for depth (10)cm in the Al- Karama region is (9690) Bq/m^3 in Al-Hay Al- Askari, while the highest value for depth (15) cm in the Al- Karama region is (8970) Bq/$m^3$and the lowest value is (406) Bq/m^3 i9n Nader Al- oula.

2. The thoron concentration for, governorate of Babylon.

   The highest value for depth (10)cm in the Bab Al- Hussain region is (5730) Bq/m^3, and the lowest value is 60.3 Bq/m^3 in Hay Al- Muhandessen, while the highest value for depth (15) cm is in the Al-Hay Al- cenaey region is (7520) Bq/$m^3$and the lowest value is (182) Bq/m^3 Hay Al- Muhandessen.

CONCLUSION

1. The concentration for radon and thoron in soil air affected by meteorological factors each as barometric pressure, humidity, rain fall and temperature. Rising barometric pressure has been found in increase the radon concentration in soil air whereas falling pressure causes a decrease of it.
2. A tendency for decreasing concentration with increasing atmospheric pressure has also been observed for radon in soil air. This decrease is believed to be due to a flow of air from outside into the soil gas initially in surface layer to greater depth.
3. The effect of wind speed is believed to be due to increased turbulence at the ground surface which causes a pumping effect on the soil gases.
4. In areas with high radium, such as uranium mining areas, the exhalation rate is much higher than normal (more than two orders of magnitude greater for uncovered tailings.

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