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The Measurement of Radionuclides Level in Different Iraqi Building Material Samples from Baghdad City

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A B S T R A C T

Measurement of naturally and artificial radionuclide concentrations deposited in Iraqi building materials used in housing construction in the Baghdad city. Six samples from different sites have chosen. (Soil, Gipson, Cement, Brick, Sand, Gravel). The high purity Germanium detector (HpGe) have been used to measure the concentration of gamma emitter radionuclides from both uranium – radium and thorium series, ^{40}K and ^{137}Cs. The spectra for each sample were analyzed for (7200 sec). The percentage errors were calculated. The range of specific activities for studied radionuclides were as follows: The average concentrations of ^{238}U is between (13-70) Bq/kg, ^{232}Th is (2-34) Bq/kg, ^{40}K is (39-880) Bq/kg, and ^{137}Cs is (0.2-6) Bq/kg.

1. Introduction

Our world is radioactive and has been since it was formed. Over 60 radionuclides can be existed in soil, water, and air, and additionally in us, being that we are manufacture of our environment (Ali et al., 2011). Humans risky to natural and artificial radiation source. Natural radiation participates about 80% to the whole entire dose is greater important and precocious. Interest needs to be paid to the exposure from artificial sources which represent 20% of the whole dose (Kaleel et al., 2012). Natural occurring radionuclides, also called terrestrial or primordial radionuclides, are present in different quantities in the earth's crust (rocks and soil). Terrestrial radionuclides include the decay radionuclides in the series of thorium (^{232}Th) uranium (^{238}U) and a nonseries decay natural radionuclides such as ^{87}Rb, ^{40}K, ^{138}La ^{147}Sm, and ^{176}Lu (Ajithra et al., 2017). The major contribution to external exposure in outdoor is from gamma radiation emitted by these terrestrial radionuclides at most (^{232}Th) uranium (^{238}U) and ^{40}K UNSCEAR. 2010).

All building materials have different amounts of natural radioactivity nuclides, materials derived from soil and rock contain mainly natural radioisotopes of the thorium ^{232}Th and uranium ^{238}U series, and the radioisotope of potassium ^{40}K. In uranium series, the decay chain segment begin from radium ^{226}Ra is radiologically the most important and, therefore, reference is often made to radium instead of uranium (European Commisson. 1999; NORM. 2005). This presence has been recognized since the early 1930s. However, it received minimal interest until the last few decades, when the role of terrestrial radiation as the main contributor to the collective efficient dose of the world's populations has been recognized. Moreover, measurement of concentrations of some artificial radionuclides such as ^{137}Cs, ^{90}Sr and others in building materials is very important to evaluate the contribution of those artificial radionuclides to the population's effective dose as well as to evaluate the amount of the radioactive fallout in the region (UNSCEAR. 1993). The worldwide mean indoor effective dose due to gamma rays from building materials is fated to be around 0.4 mSv per year ,were specified in some areas around the world, e.g., in India, Brazil, U.K., Nigeria, Egypt and U.S.A. (UNSEAR 2000).

In Iraq there is no data concerning levels and concentrations of natural and artificial radionuclides in building materials. Therefore, this study planned to measure such levels of radioactivites for the demand of using such

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building materials, used in housing constructions in the Baghdad city.

2. Materials and Method

The studied samples included six different kinds of Iraqi building materials (Soil, Gipson, Cement, Brick, Sand, and Gravel). That used in housing construction, the samples have been collected from different parts from Baghdad city. The samples were dried and crushed to produce 1 kg fine powder; these samples were sealed in plastic flasks. The gamma-ray spectra from the samples were record using High purity Germanium detector (HpGe) with resolution of (2.0 keV) at (1332) keV gamma line for isotope (^{60}Co). The spectra for each sample were analyzed for 7200 sec.

The activity concentration in the sample is obtained by (Mohamed, 2016):

$$A = \frac{c}{m.I.\varepsilon.t}$$

Where: A is the concentration of the given radionuclides in ($\frac{Bq}{kg}$), C is the net area under the curve (count), *m* is the mass of the sample (kg), I is the intensity, ε is the absolute efficiency at energy E and *t* is the measuring time (sec.). The samples are of Iraqi origin.

3. Results and Discussion

Concentrations for ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs for six samples, obtained from analysis of the studied samples are given in Table -1, in Bq/kgm. The 609, 583, 1460 and 661 keV gamma- ray lines were used to calculate concentrations of ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs respectively. The relative errors of the measured concentrations lie between (5%) in the higher experimental concentrations and increased to about (40%) in lowest concentrations. The range of specific activities for studied radionuclides were as follows: The average concentrations of ^{238}U is between(13-70) Bq/kg, ^{232}Th is (2-34) Bq/kgm, ^{40}K is (39-880) Bq/kg, and ^{137}Cs is (0.2-6) Bq/kg as shown in Table -1.

Table -1: The average activity concentrations ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs in Bq/kg for building materials used in Baghdad area Iraq.

Sample	^{238}U	^{232}Th	^{40}K	^{137}Cs
Soil	54.6	14.2	877.6	5.61
Sand	13.7	2.1	39.9	0.24
Gepson	19.9	3.6	206	1.0
Cement	67.7	10.	384	0.5
Gravel	18.3	33.3	366	--
Brick	48.2	17.3	745	0.19

By comparison, between samples of the research, it is clear that cement samples have the highest concentration for ^{238}U and Gravel samples have the highest concentration for ^{232}Th and soil samples have the highest concentration for ^{40}K and ^{137}Cs. The presence of ^{137}Cs concentrations is attributed to the Chernobyl reactor accident.

Table 2 compares the reported values of the radionuclide's activities for selected building materials, obtained in other countries with those determined in this study. As shown from the table, the radioactivity in building materials varied from one country to another. Thorium and potassium are not uniformly distributed in soil or rocks, from which building materials are derived, but the radioactivity varies, often greatly, over a distance of some meters. The measured values of thorium and potassium contents show only the average radioactivity in building materials used in Baghdad area.

Table 2: comparison between the activity concentrations in Baghdad building materials with that of other countries of the world.

Material	Countries	^{232}Th	^{40}K	References
Cement	Cameron	15	277	(Ngachin et al., 2007)
	Finland	26	241	(NEA-OECD, 1979)
	Norway	18	241	(NEA-OECD, 1979)
	Sweden	47	241	(NEA-OECD, 1979)
	U.K.	18	155	(NEA-OECD, 1979)
	Egypt	11.1	48.6	(Ahmed et al., 1998)
	Zambia	32	134	(Hayumbu et al., 1995)
	Iraq	10	384	Present work
Sand	Hong	27.1	841	(Yu et al., 1992)
	Kong	18	807	(Malanca et al., 1993)
	Brazil	26	714	(Hayumbu et al., 1995)
	Zambia	3.3	47.3	(Ahmed et al., 1998)
	Egypt	64.4	455.8	(Kumer et al., 1999)
	India	2.1	39.9	Present work
	Iraq			
Gravels	Australia	14.8	171	(Bou-Rabee et al., 1996)
	U.S.A.	33.3	14.8	(Ingersoll, 1983)
	Pakistan	9.9	51.3	(Tufail M., et al., 1992)
	Egypt	23	193	(El-Taher, 2010).
	Nederland	12.6	140	(Aders et al., 1985)
	Iraq	33.3	366	Present work
Gipson	Brazil	N.D	18.1	(NEA-OECD, 1979)
	Kuwait	0.55	17.4	(Kumer et al., 1999)
	Bangladesh	21.4	294	(Mantazul, 1998)
	Italy	2	12	(Rizzo et al., 2001
	Egypt	55	116	(El-Taher, 2010) (21)
	Iraq	3.6	206	Present work

4. Conclusions

Measurement of naturally and artificial radionuclide concentrations deposited in Iraqi building materials used in housing construction in the Baghdad city. Six samples from various sites had chosen. (Soil, Gipson, Cement, Brick, Sand, Gravel). Gamma ray spectrometry is powerful experimental instrument in studying natural radioactivity and measuring

elementals concentrations in different building materials. The obtained results show that the most majority of the building materials used in Baghdad area have the exemption level, thus they can be exempted from all controls concerning their radioactivity. Thus, from the radiation safety, these materials are less than the recommended level for their gamma dose rates; therefore, they can be used for all types of republic buildings.

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قياس مستوى النويدات المشعة في عينات مواد البناء العراقية المختلفة من مدينة بغداد

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الخلاصة

قياس التراكيز الطبيعية والصناعية للنويدات المشعة المترسبة في مواد البناء العراقية المستخدمة في بناء المساكن في مدينة بغداد. تم اختيار ستة عينات من مواقع مختلفة. (تربة، جبسون، أسمنت، طوب، رمل، حصى). تم استخدام كاشف الجرمانيوم عالي النقاء (HpGe) لقياس تركيز النويدات المشعة الباعثة لجاما من كل من سلسلة اليورانيوم والثوريوم والبوتاسيوم -40و السيزيوم – 137. تم تحليل أطياف كل عينة لمدة (7200 ثانية). تم حساب نسبة الأخطاء. كان مدى الأنشطة المحددة للنويدات المشعة المدروسة على النحو التالي: متوسط تركيزات اليورانيوم -238 بين (13-70) بيكريل / كغم والثوريوم -232 بين (2-34) بيكريل / كغم والبوتاسيوم -40هي (39-880) بيكريل / كغم والسيزيوم – 137 هي (0.2-6) بيكريل / كغم.