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Assessment of human exposures to natural sources of radiation and radon-222 from soil around the production factories of cement in Egypt

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ABSTRACT

Soil samples were collected around two cement companies are Sinai and Suez cement factories in Egypt, which are both producing factories of cement in Egypt. The natural radioactivity concentrations are the mean absorbed doses of ^{40}K, ^{238}U and ^{232}Th at various selected locations were determined. The mean radionuclide's concentration of ^{40}K, ^{238}U and ^{232}Th were 202.53±21.5, 24.80±9.7 and 35.47±11.1 Bq kg^{-1} for Suez factory at selected sites. Also these values were 141.60±28.3, 31.27±7.6 and 28.20±11.7 Bq kg^{-1} respectively in the same order for Sinai factory at selected locations. The activity concentrations of Rn^{222} in the air with the activities of Ra^{226} that contents in vegetables. The survey revealed that the radiation doses due to natural radio nuclides in the environment under investigation are very low and insignificant to cause any serious health problems to the people living in the area.

KEYWORDS

Radioactivity concentration;
Absorbed dose;
Gamma spectrometer;
Radon-222.

INTRODUCTION

Radionuclide's, radiation and radioactivity has been an essential constituent of the earth since its creation. Radionuclide's are classified according to their origins to Naturally Occurring Radioactive Materials (NORM), Technologically Enhanced Natural Occurring Radioactive Material (TENORM) and man-made or anthropogenic radionuclide's. Man-made radionuclide's do not exist naturally and are created via human activities that vary with time and location according to domestic and/or world nuclear activities and other factors. Sources of man-made radionuclide's include nuclear tests, nuclear power plants and reprocessing facilities, sources used for medical, industrial and agricultural applications, and sources used for research purposes[1]. Both NORM and TENORM have the same natural origin but TENORM exists as a result of human activities, such as tobacco smoking, uranium and phosphate mining and milling, air travel, coal fired power plants, oil exploration and others, that enhanced and

modified the concentration of NORM, their environmental distribution and radiation exposure dose to human-beings. Generally, some of the non-nuclear industrial processes supplied a considerable contribution to the radio-ecological pollution such as phosphate ore mining and phosphate fertilizers manufacture and agricultural applications[1].

Natural environmental radioactivity arises mainly from primordial radionuclide's, such as ^{40}K, and the radionuclide's from ^{232}Th- and ^{238}U-series, which occur at trace levels in all ground formations[2]. It is important to monitor the terrestrial background radiation mainly due to these natural radionuclide's in soil.

Several studies performed worldwide have measured the activity concentration of natural radionuclide's in soil[3-5]. Data regarding levels of natural radioactivity in soils and the corresponding radiation doses to the population are lacking for most parts of Egypt.

Monitoring of any release of radioactivity material to the environment is necessary for environmental protection. Measurement of natural radioactivity in soil is very important to determine the amount of change of the natural background activity with time as a result of any radioactivity release. Studies of natural radioactivity are necessary not only because of their radiological impact, but also because they act as excellent biochemical and geochemical traces in the environment. Although natural radioactivity is found in rocks and soils throughout the earth. Several publications deal with measuring low levels of naturally occurring radioactive isotopes[6,7]. Our present aim is to study the deviations from the normal background levels owing to the presence of enhanced concentration of natural radioactive minerals in the soil.

Humans are exposed to ionizing radiation from numerous sources in the environment. Among them include the cosmic rays and natural radionuclide sources in air, food and drinking water[8]. It is well known that a large percentage of human exposure to ionizing radiation comes from natural origin, the major contributors being the naturally occurring radioactive elements of the uranium and thorium series and the non-series radioactive potassium[9]. Over the years, there has been an increase of industrial establishments of socio-economic purposes, which has led to the release of different types of materials into the environment thus constituting environmental pollution. With recent trends in increase in industrial concentrations, environmental pollutions has been on the increase and has been of great concern to both international and national development in situations anticipated by the enormous impact of pollution to the ecosystem.

The two major raw materials in the production of cement, limestone and shale are of geological origin and they are known to contain some natural radioactive elements. It is envisaged that the by-product resulting from the process of cement production may find ways into the underground water systems, the river and may settle on the soil surface, hence, representing a direct and indirect exposure pathways to man in his environment, through soil to plant to man pathway and water to man. The gamma radiation from natural radionuclide's and cosmic rays constitute the external exposure while those derivable from foods and drinking water constitute internal exposure to humans[10].

MATERIALS AND METHOD

Soil samples were collected at selected locations from sites around the two cement factories mentioned. The soil samples were dried, pulverized and packed in 200g by mass in cylindrical plastic container of radius 3 inch and height 3.5inch, which sits on the 3 inch x 3 inch HPGe detector with high geometry. The containers are sealed for about four weeks to ensure radioactive equilibrium between the parent radionuclide's and their gaseous daughter decay products in the uranium and thorium series[11].

Each sample containing soil grain weighing about 200 g was stored in standardized polyethylene containers. The containers were sealed to avoid any possibility of out gassing of radon and kept for a period of 1 month to make sure the samples attained the radioactive equilibrium between ^{226}Ra with its decay products in the uranium series. It was assumed that ^{232}Th is in secular equilibrium with ^{228}Ra. For the measurement of activity concentrations of natu-

rally occurring radionuclide's of ^{226}Ra, ^{232}Th, and ^{40}K in soil samples, a high purity germanium (HPGe) detector based gamma ray spectrometer with a relative efficiency of 30% was employed. HPGe detector was coupled with a Canberra multichannel analyzer (MCA). The resolution (FWHM) of the spectrometry system was 1.8 keV at 1332 keV gamma-ray line of ^{60}Co. Spectrum of every sample was collected for 54000 seconds (15 h). Spectrum analysis was performed with computer software and activity concentrations of 3 natural radionuclide's were determined. To reduce the background effect, the detector was shielded in a 10 cm wall lead covering lined with 2 mm copper and 2 mm cadmium foils. The concentration of ^{238}U was estimated from 1.76 Mev transition line of 2.14Bi, while that of ^{232}Th was estimated from 2.615 Mev of 208Th and gamma energy value of 1.465 Mev was used to determine the concentration of ^{40}K in all the samples. In order to determine the background radiation distribution in the environment around the detector, an empty sealed container was counted for 10 hrs[12].

RESULTS AND DISCUSSION

Annual effective dose equivalent (AEDE)

The concentrations of potassium, thorium and uranium together with the dose contributions to the environment at selected locations are given in TABLES (1) and (2). From estimates, it is observed that the mean dose decreases with increase in distance from the factory site. For Sinai site, the mean dose was found to vary with the range 19.67 – 51.12, the normal mean dose of 38.35nGyhr^{-1} was found just at the factory site and found to decrease to 31.0nGyhr^{-1} at a distance of 25,000m (2.5Km) from the factory site. For Suez, almost the same trend was observed with the mean dose ranges from 19.67–55.26 nGyhr^{-1}. On the factory site, the mean dose is 55.26nGyhr-1 and found to be 19.670nGyhr^{-1} at a distance of 25,000m (2.5Km) from the factory site. Whenever, at 1000m, the mean dose increased to 39.58nGyhr^{-1}, but relatively showed a decreasing trend with distance increasing from the factory site. The other factory On the factory site, the mean dose is 38.35nGyhr^{-1} and found to be 19.670nGyhr^{-1} at a distance of 25,000m (2.5Km) from the factory site. Whenever, at 1000m, the mean dose increased to 38.10nGyhr^{-1}.

The radiation dose is calculated using the equation:

$$D = 0.429\ C_{Ra} + 0.666\ C_{Th} + 0.042\ C_K \quad (1)$$

where C_{Ra}, C_{Th} and C_k are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K respectively in Bq/kg. With this equation, the radiation level in an environment can be assessed if within or outside an accepted recommended standard level by regulating authorities. The overall mean radiation dose for Sinai was found to be 38.53nGy/hr while the overall mean for Suez was found to be 41.91nGy/hr. The mean radionuclide's concentration at specific locations from Sinai ranged between 67.0 ± 6.0 and 257.0 ± 34.0 for ^{40}K, 11.0 ± 6.0 and 68.0 ± 16.0 for ^{238}U and 19.0 ± 6.0 and 42.0 ± 15.0 for ^{232}Th. The radionuclide's concentration ranges between 67.0 ± 16.0 and 267.0 ± 39.0 for ^{40}K, 11.0 ± 6.0 and 31.0 ± 12.0 for ^{238}U and 19.0 ± 6.0 and 48.0 ± 19.0 for ^{232}Th.

Representative gamma index (Iγ):

Number of indices dealing with the assessment of the excess gamma radiation arising from building materials such as external and internal hazard indices and gamma concentration indices has been proposed by several investigators[13,15–17]. In this study, the gamma index (Iγ) was calculated as proposed by the European Commission[13]:

$$I\gamma = C_{Ra} / 150 + C_{Th} /100 + C_K /1500 \quad (2)$$

where CR_a, C_{Th} and C_K are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in Bqkg^{-1}, respectively. The mean values of Iγ calculated from the measured activity concentration of ^{226}Ra, ^{232}Th and ^{40}K are presented in TABLE 4 for different cement types and the regions where they were collected. The mean calculated values of Iγ for the studied samples from Suez values varied in the range between 0.31–0.86 and studied sample from Sinai values in range between for 0.31–0.80 for the regions which were less than the critical value of unity. So far, several alpha indices have been proposed to assess the exposure

level due to radon inhalation originating from building materials[13]. The alpha index was determined by the following formula:

$$I_\alpha = C_{Ra} / 200 \ (Bq\ kg^{-1}) \quad (3)$$

where CRa (Bq kg^{-1}) is the activity concentration of ^{226}Ra assumed in equilibrium with ^{238}U. The recommended exemption and upper level of ^{226}Ra activity concentrations in building materials are 100 and 200 Bq kg^{-1}, respectively, as suggested by ICRP[14]. These considerations are reflected in the alpha index. The recommended upper limit concentration of ^{226}Ra is 200 Bq kg^{-1}, for which I_α=1. The mean computed I_α values for the studied cement samples are given in TABLE 3,4 for the different cement types and the regions where they were collected. The values of I_α of Suez values varied in the range between 0.06 to 0.34, and the values from Sinai between 0.06 to 0.34. For the safe use of a material in the construction of dwellings, I_α should be less than unity. The mean calculated values were less than unity.

Radiation hazard indices calculation

Different known radiation health hazard indices analysis is been use in radiation studies to arrive at a better and safer conclusion on the health status of a radiated or irradiated person and environment in recent studies. To assess the radiation hazards associated with the study soil samples, six quantities have been defined[20].

Radium equivalent activity (Ra_{eq})

Radium equivalent (R_{aeq}) is a common index used to compare the specific activities of materials containing ^{226}Ra, ^{232}Th and ^{40}K by a single quantity, which takes into account the radiation hazards associated with them. The activity index provides a useful guideline in regulating the safety standard dwellings. The radium equivalent activity represents a weighted sum of activities of the above mentioned natural radionuclide's and is based on the estimation that 1Bq/kg of ^{226}Ra, 0.7Bq/kg of ^{232}Th, and 13Bq/kg of ^{40}K produce the same radiation dose rates. The radium equivalent activity index is given as[21].

$$Ra_{eq} = C_{Ra} + 1.43\ C_{th} + 0.077 C_k \quad (4)$$

Where: C_{Ra}, C_{th}, C_k are the radioactivity concentration in Bq/kg of ^{238}U, ^{232}Th, and ^{40}K. The world average of Raeq in soils is 89 Bq kg^{-1}[18]. As reference, the permissible dose limit for public which is recommended by ICRP (1991)[19] is 1.5 mSv y-1 or equivalent to 370 Bq kg^{-1}. The mean calculated Raeq values are shown in TABLE (3,4), for the different soil sample. The minimum (43.33 Bq kg^{-1}) and (43.33 Bq kg^{-1}) and the maximum (110.85 Bq kg^{-1}) and (120.20 Bq kg^{-1}). The mean Ra_{eq} values of all the measured samples were almost lower than the limit value of 370 Bq kg^{-1} recommended by the Organization for Economic Cooperation and Development.

External hazard index (H_{ex})

Many radionuclide's occur naturally in terrestrial soils and rocks and upon decay, these radionuclide's produce an external radiation field to which all human beings are exposed. In terms of dose, the principal primordial radionuclide's are ^{232}Th, ^{238}U and ^{40}K. Thorium and uranium head series of radionuclide's that produce significant human exposure. The external hazard index (H_{ex}) is defined as[21].

$$H_{ex} = (C_U/370 + C_{Th}/259 + C_K/4810) < 1 \quad (5)$$

Where : C_{Ra}, C_{th}, C_k are the radioactivity concentration in Bq/kg of ^{238}U, ^{232}Th, and ^{40}K. The value of this index must be less than unity for the radiation hazard to be negligible. equal to unity corresponds to the upper limit of Ra_{eq} (370Bq/Kg)[20].

Internal hazard index (H_{in})

The internal hazard index (H_{in}) is given as (Beretka and Mathew 1985).

$$H_{in} = (C_U/185 + C_{Th}/259 + C_K/4810) < 1 \quad (6)$$

H_{in} should be less than unity for the radiation hazard to be negligible. Internal exposure to radon are very hazardous this can lead to respiratory diseases like asthma and cancer. The values of H_{ex} for the studied soil samples range from 0.12 to 0.30, and from 0.12 to 0.32 with an average value of 0.23 and 0.25 are less than unity. While the values of H_{in} for the studied soil samples are less than unity too. value is TABLE 3,4. Hence the annual effective dose due to radioactivity in the samples studied is less

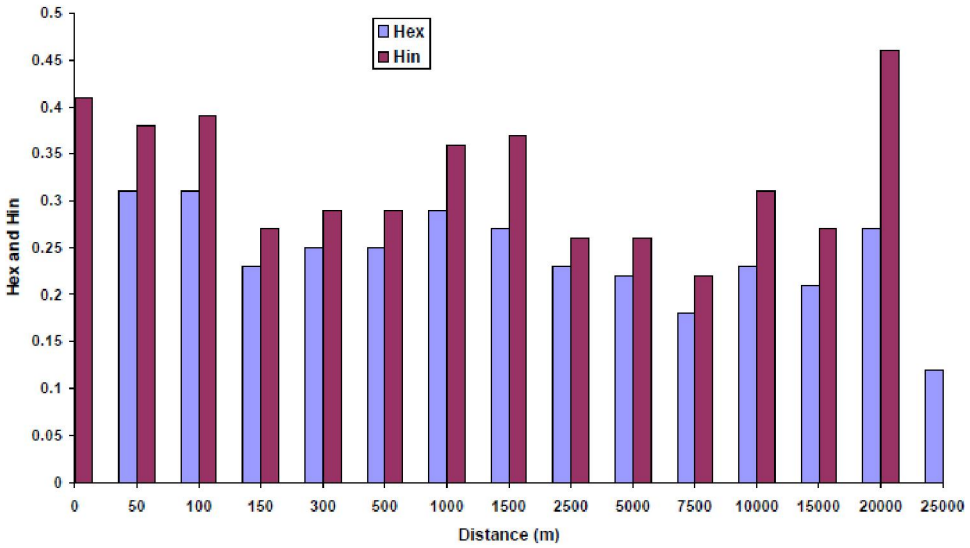

Figure 1 : Hazard external, internal dose in Suez cement factory

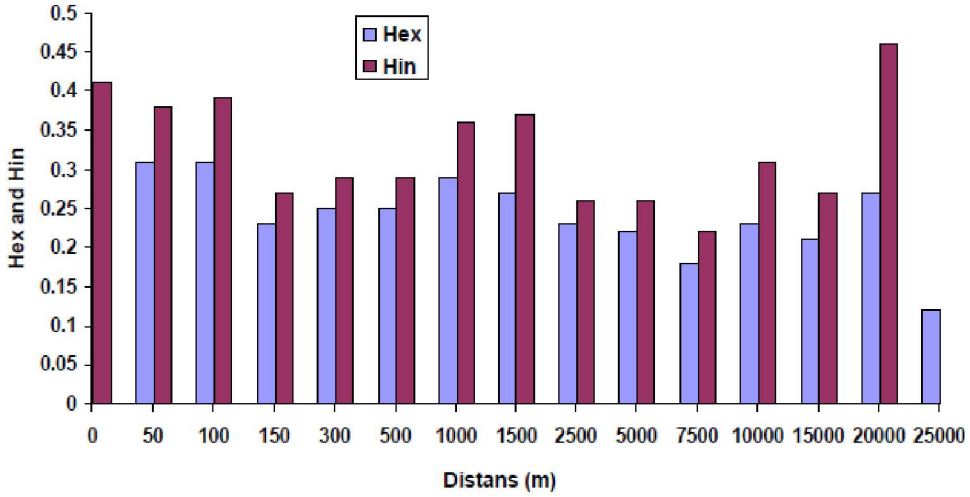

Figure 2 : Hazard external, internal dose in Sinai factory

than 1.5 mSv y^{-1}. Indoor radon levels will probably increase with increasing concentrations of ^{226}Ra (or uranium) in the soils (or in building materials).

Figure 1 and 3 show that the hazard internal, external are increases the closer we get from the factory this in Sinai and Suez factures. Figure 2, 4 shown that the I_{alpha}, I_{gamma} are increases the closer we get from the factory this in Sinai and Suez factures.

Evaluation of indoor ^{222}Rn

The method used in this study involves combining the knowledge of Ra content in the building material, based on gamma spectrometry, with an assumed Rn emanation rate[22]. The conversion factors used to calculate the emanation rate for different building materials are given in the report by the United Nations Scientific Committee on the Effects of Atomic Radiation[23]. Three dimensions of dwelling were considered as.

1 4.8 m × 4.8 m × 3.0 m
2 4.8 m × 3.6 m × 3.0 m
3 3.6 m × 3.6 m × 3.0 m

Using the dimensions of room stated and the data from TABLE 1, the contribution from concrete to the indoor Rn concentrations were calculated by the expression[23]:

$$C_{in} = C_o + (e * A)/(\lambda + v) V \quad (7)$$

C_{in} = indoor Rn concentration (Bq m^{-3})
C_o = outdoor Rn concentration (Bq m^{-3})
A = area of room (m^2)
λ = decay constant of ^{222}Rn (0.00755 h^{-1})

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TABLE 1 : Mean radionuclide's concentration at specific locations away from Sinai Factory

Distance (m)	C_u (Bq/Kg)	C_{th} (Bq/Kg)	C_k (Bq/Kg)	D (nGy|\h)	Deff(AEDE) outdoor (mSv\y)	Deff(AEDE) indoor (mSv\y)	ELCR =Deff*DL *RF
0	31	42	257	51.12	0.06	0.25	0.22
50	28	42	126	44.27	0.05	0.22	0.19
100	32	36	207	45.77	0.06	0.22	0.20
150	21	38	150	39.56	0.05	0.19	0.17
300	21	28	118	32.01	0.04	0.16	0.14
500	27	29	168	37.49	0.05	0.18	0.16
1000	22	26	108	30.81	0.04	0.15	0.13
1500	35	32	76	39.21	0.05	0.19	0.17
2500	31	33	86	38.40	0.05	0.19	0.16
5000	29	31	185	40.36	0.05	0.20	0.17
7500	20	33	173	36.95	0.05	0.18	0.16
10000	24	31	186	38.10	0.05	0.19	0.16
15000	23	29	150	34.89	0.04	0.17	0.15
20000	68	20	67	46.63	0.06	0.23	0.20
25000	11	19	67	19.67	0.02	0.10	0.08
Mean	28.20	31.27	141.60	38.35	0.05	0.19	0.16

TABLE 2 : Mean radionuclide's concentration at specific locations away from Suez Factory

Distance (m)	C_u (Bq/Kg)	C_{th} (Bq/Kg)	C_k (Bq/Kg)	D (nGy|\h)	Deff(AEDE) outdoor (mSv\y)	Deff(AEDE) indoor (mSv\y)	ELCR =Deff*DL *RF
0	31	48	267	55.26	0.07	0.27	0.24
50	28	47	248	52.46	0.06	0.26	0.23
100	32	44	243	52.24	0.06	0.26	0.22
150	16	37	216	39.38	0.05	0.19	0.17
300	15	42	238	42.94	0.05	0.21	0.18
500	15	42	241	43.06	0.05	0.21	0.18
1000	25	46	234	49.87	0.06	0.24	0.21
1500	38	30	230	45.78	0.06	0.22	0.20
2500	10	41	210	38.84	0.05	0.19	0.17
5000	16	33	224	37.23	0.05	0.18	0.16
7500	14	25	218	31.08	0.04	0.15	0.13
10000	30	29	185	39.58	0.05	0.19	0.17
15000	23	29	150	34.89	0.04	0.17	0.15
20000	68	20	67	46.63	0.06	0.23	0.20
25000	11	19	67	19.67	0.02	0.10	0.08
Mean	24.80	35.47	202.53	41.93	0.05	0.21	0.18

v = ventilation rate and
V = volume of room (m^3)

The outdoor Rn concentration was taken as 10 Bq m^{-3}, the world average reported by the United

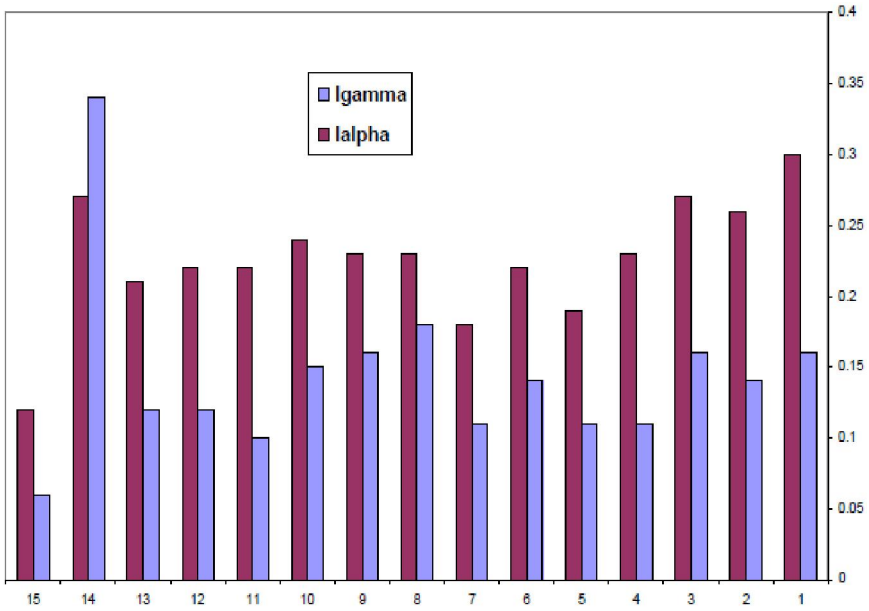

Figure 3 : I_{alpha}, I_{gamma} in Suez cement factory

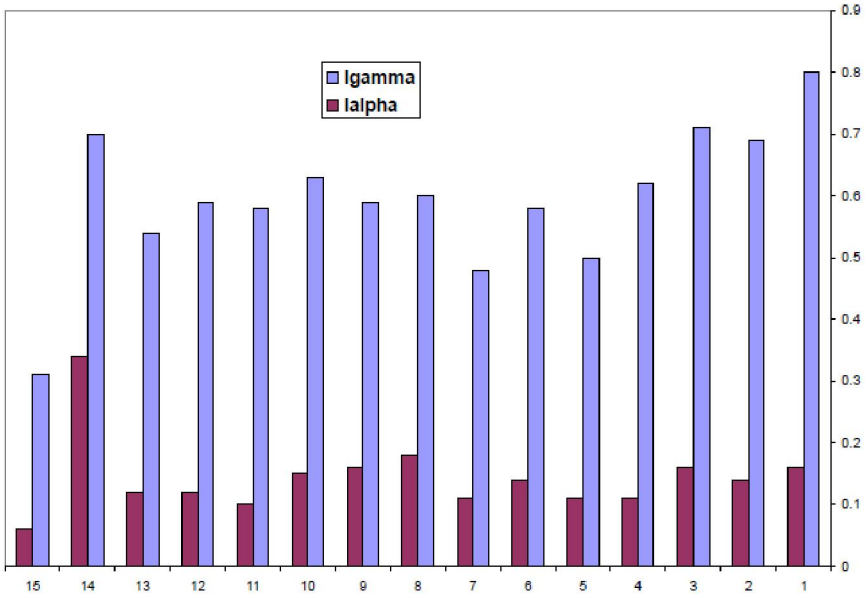

Figure 4 : I_{alpha}, I_{gamma} in Sinai factory

Nations Scientific Committee on the Effects of Atomic Radiation[25]. Ventilation rate of 1 h^{-1} was assumed. This according to[22] is more common for houses that are less energy efficient and covers a wide spectrum of houses seen throughout the world.

The annual effective dose was calculated using the following equation[24]:

$$E = C_{in} \times E_F \times T \times D_C \quad (8)$$

Where E is annual effective dose, E_F is equilibrium factor, T is the occupancy and D_C is the dose coefficient.

The Ra^{226} activity concentrations were measured for 15 soil samples. The data of these study are given in TABLE (5). The activity concentrations of Ra^{226} in soil samples ranges from 37 ± to 11 ± with mean value of 25.8 Bq/Kg. From the results in TABLE (5) appear the higher concentration of Ra^{226} in regions of 1,2,3,4,5,6,7,8 and 10,11,12,13,14 this is due to the natural state and creation of soil. The radioactive radon gas that arises from the disintegration of U^{238} and Th^{232} in the earth's crust is considered the main source of exposure to ionizing radiation for

TABLE 3 : I_{alpha}, I_{gamma} and Hazard external, internal dose in Sinai cement factory

Distance (m)	C_a (ppm)	C_{th} (ppm)	C_k (ppm)	Ra_{eq} (Bq/Kg)	ER (micro R/h)	Iγ	I? = C_u/200	H_{ex}	H_{in}
0	2.49	10.37	0.04	120.20	110.85	0.80	0.16	0.30	0.38
50	2.25	10.37	0.04	114.31	97.76	0.69	0.14	0.26	0.34
100	2.57	8.89	0.03	113.63	99.42	0.71	0.16	0.27	0.36
150	1.69	9.39	0.04	85.54	86.89	0.62	0.11	0.23	0.29
300	1.69	6.92	0.03	93.39	70.13	0.50	0.11	0.19	0.25
500	2.17	7.16	0.03	93.62	81.41	0.58	0.14	0.22	0.29
1000	1.77	6.42	0.02	108.80	67.50	0.48	0.11	0.18	0.24
1500	2.81	7.90	0.03	98.61	86.61	0.60	0.18	0.23	0.33
2500	2.49	8.15	0.03	84.80	84.81	0.59	0.16	0.23	0.31
5000	2.33	7.66	0.03	80.44	87.58	0.63	0.15	0.24	0.31
7500	1.61	8.15	0.03	66.54	80.51	0.58	0.10	0.22	0.27
10000	1.93	7.66	0.03	85.72	82.65	0.59	0.12	0.22	0.29
15000	1.85	7.16	0.03	76.02	76.02	0.54	0.12	0.21	0.27
20000	5.46	4.94	0.02	101.76	101.76	0.70	0.34	0.27	0.46
25000	0.88	4.69	0.02	43.33	43.33	0.31	0.06	0.12	0.15

TABLE 4 : I_{alpha}, I_{gamma} and Hazard external, internal dose in Suez cement factory

Distance (m)	C_a (ppm)	C_{th} (ppm)	C_k (ppm)	Ra_{eq} (Bq/Kg)	ER (micro R/h)	Iγ	I? = C_u/200	H_{ex}	H_{in}
0	2.49	11.86	1.03	223.34	223.34	0.86	0.16	0.32	0.41
50	2.25	11.61	0.96	194.19	194.19	0.82	0.14	0.31	0.38
100	2.57	10.87	0.94	199.37	199.37	0.82	0.16	0.31	0.39
150	1.29	9.14	0.83	173.91	173.91	0.62	0.08	0.23	0.27
300	1.20	10.37	0.92	139.98	139.98	0.68	0.08	0.25	0.29
500	1.20	10.37	0.93	163.15	163.15	0.68	0.08	0.25	0.29
1000	2.01	11.36	0.90	134.45	134.45	0.78	0.13	0.29	0.36
1500	3.05	7.41	0.89	170.34	170.34	0.71	0.19	0.27	0.37
2500	0.80	10.13	0.81	167.35	167.35	0.62	0.05	0.23	0.26
5000	1.29	8.15	0.87	175.64	175.64	0.59	0.08	0.22	0.26
7500	1.12	6.18	0.84	162.03	162.03	0.49	0.07	0.18	0.22
10000	2.41	7.16	0.71	166.31	166.31	0.61	0.15	0.23	0.31
15000	1.85	7.16	0.58	152.33	152.33	0.54	0.12	0.21	0.27
20000	5.46	4.94	0.26	197.59	197.59	0.70	0.34	0.27	0.46
25000	0.88	4.69	0.26	86.47	86.47	0.31	0.06	0.12	0.15

humans that representing 40% of the annual accumulated dose[18], therefore the present study some of mathematical equations models are used to estimate the activity concentrations of Rn^{222} in the air with the activities of Ra^{226} that contents in vegetables, as well as the doses rates that results from the vegetables consumption and from inhalation of radon gas were considered, TABLE (5) consists of these estimated concentrations and doses values respectively. The data of the doses rates from the vegetables consumption and inhalation of radon gas that given in TABLE (5) within the allowed limits that equal

TABLE 5 : Evaluation of indoor ^{222}Rn

Distance (m)	A_{Ra}(Bq/Kg)	Gs(n) = F_r. ρ. CRa(n)	Ca(n)=Gs(n) $(d_{soil} / D_{air})^{1/2}$	Hp =(Cp. Ip. DCF) $*10^{-7}$	$C_{in}(n) = C_o +$ $(e * A/ (\lambda + v) V)$	$C_n(n) =$ A_n. $C_{Ra}(n)$
0	28	5040	79.69	2083.20	81.86	1.24
50	31	5580	88.23	1881.60	90.40	1.12
100	33	5940	93.92	2150.40	96.09	1.28
150	18	3240	51.23	1075.20	53.40	0.64
300	16	2880	45.54	1008.00	47.71	0.60
500	19	3420	54.07	1008.00	56.25	0.60
1000	28	5040	79.69	1680.00	81.86	1.00
1500	37	6660	105.30	2553.60	107.47	1.52
2500	11	1980	31.31	672.00	33.48	0.40
5000	17	3060	48.38	1075.20	50.55	0.64
7500	16	2880	45.54	940.80	47.71	0.56
10000	28	5040	79.69	2016.00	81.86	1.20
15000	24	4320	68.31	1545.60	70.48	0.92
20000	69	12420	196.38	4569.60	198.55	2.72
25000	12	2160	34.15	739.20	36.32	0.44
Mean	25.80	4644.00	73.43	1666.56	75.60	0.99

(1msv/y) [FAO.1977, IAEA,1996] in all regions that selected in the present search.

CONCLUSION

We concluded that the average values of radium equivalent of around the tow cement companies, Sinai and Suez cement factories. of soil samples are normal to the recommended maximum value 370 Bq/kg. The values of dose rate for soil samples are lower than the international average mean value 41.93 and 38.35nGy/h[1]. The calculate average external hazard index and internal hazard are lower than unity. From the above results, it is noticed the level of radioactivity of soil samples are lower than the permissible levels. According to the UNSCEAR[18], the population weighted average of indoor radon concentration is 40 Bq m^{-3}. Shows in TABLE.5 the samples at 2500 and 25000m less than 40 Bqm^{-3} and another samples are higher than this level.

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REFERENCE

[1] Unscear; United nations scientific committee on the effects of atomic radiation, Sources Effects and Risk of Ionizing Radiation United Nations, New York, **(1988)**.

[2] A.M.Gbadebo; Natural radionuclide's distribution in the granitic rocks and soils of abandoned quarry sites, Abeokuta, Southwestern Nigeria, Asian Journal of Applied Sciences, **4**, 176-185 **(2011)**.

[3] McAulay, Morgan; The measured activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K were compared with the values reported worldwide, **(1988)**.

[4] S.N.A.Tahir, A.S.Alaamer; Determination of natural radioactivity in rock salt and radiation doses due to its ingestion, J.Radiol.Protect, **28**, 233-236 **(2008)**.

[5] Said Rahman; Natural radioactivity measurements in Pakistan, J.Radiol.Prot., **28**, 443 **(2008)**.

[6] K.Debertin, J.Ren; Measurement of activity of radioactive samples in Marinelli beakers, Nucl Instrum, Methods Phys Res A **278**, 541 549 (**1989)**.

[7] A.Sroor, S.M.El-Bahi, F.Ahmed, A.S.Abdel-Haleem; Dec, Natural radioactivity and radon exhalation rate of soil in southern Egypt.Appl Radiat Isot., **55(6)**, 873-9 **(2001)**.

[8] N.N.Jibiri, A.A.Mabawoaku, Oriade, C.J.Ujugbedion; Natural radionuclide concentration levels in soil and water around a cement factory at

ewekoro, Ogun State, Nigeria, Journal of Physics.,**5,11**, 12-16 **(1999)**.

[9] Jeffrey G.Zukin1, Douglas E.Hammond1, Ku Teh-Lung1, Wilfred A.Elders2, Uranium-thorium series radionuclide's in brines and reservoir rocks from two deep geothermal boreholes in the Salton Sea Geothermal Field, southeastern California, Geochimica et Cosmochimica Acta, October, **51(10)**, 2719–2731 **(1987)**.

[10] O.O.Fasunwon, S.K.Alausa, R.K.Odunaike, I.M.Alausa, F.M.Sosanya, B.A.Ajala; Activity concentrations of natural radionuclide levels in well waters of Ago Iwoye, Nigeria, Iran, J.Radiat.Res., **7(4)**, 207-210 **(2010)**.

[11] Human health fact sheet, Natural decay series uranium, Radium, and Thorium, ANL, October, **(2001)**.

[12] Mattias Jönsson; Collimation technique for HPGe-detector gamma spectrometry in intense radiation fields, Master of Science thesis, Clinical Sciences, Lund, Lund University Spring, **(2010)**.

[13] European commission (EC), Radiation protection 112, Radiological protection principles concerning the natural radioactivity of building materials, Directorate-general environment, Nuclear safety and civil protection, **(1999)**.

[14] ICRP, Protection against Rn-222 at home and at work, Publication, Ann.ICRP, Pergamon, Oxford, **23(2)**, 65 **(1994)**.

[15] K.Khan, M.Aslam, S.D.Orfi, H.M.Han; Norm and associated radiation hazards in bricks fabricated in various locations of the North-west Frontier (Pakistan), J.Enviro.Radioact., **58(1)**, 59–66 **(2002)**.

[16] K.Komura; Challenge to detection limit of environmental radioactivity, Proceedings of the International Symposium on Environmental Radiation, Tsuruga, Fukui, Japan, October, **20**, 56–75 **(1997)**.

[17] K.Komura, A.M.Yousef; Natural radionuclides induced by environmental neutrons, Proceedings of the International Workshop on Distribution and Speciation of Radionuclides in the Environment, Rokkasho, Aomori, Japan, October, **11–13**, 210–217 **(2000)**.

[18] United nations scientific committee on the effects of atomic radiation UNSCEAR report to the general assembly, With Scientific Annexes, **(1993)**.

[19] ICRP, Annals of the ICRP, 1990, Recommendations of the international commission on radiological protection, ICRP Publication, Oxford: Pergamon Press, **60**, (1991).

[20] K.A.Zarie, K.S.Al Mugren; Measurement of natural radioactivity and assessment of radiation hazard in soil samples from, Tehama area (KSA), Isotope and Rad.Res., **42(1)**, 1- 9 **(2010)**.

[21] J.Beretka, P.J.Mathew; Natural radioactivity of Australian building materials, Industrial wastes and by-products, Health Phys., **48**, **87**, 95 **(1985)**.

[22] L.S.Quindos, G.J.Newton, M.H.Wilkening; Estimation of indoor ^{222}Rn from concrete, Health Phys., **56**, 107-109 **(1988)**.

[23] UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation): Sources and effects of ionizing radiation, (New York: UNSCEAR), **(1977)**.

[24] UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) (2000): Sources and effects of ionizing radiation, Report to Assembly with Annexes (New York: UNSCEAR).