Natural Radioactivity Assessment of Kaolin and Gibbsite Rock Materials in Sinai, Egypt

Presented by:

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Abstract:

The activity concentrations of ^{238}U, ^{232}Th, and ^{40}K in the kaolin and gibbsite samples collected from various localities of Sinai, Egypt have been measured using the γ-ray spectroscopy technique. For each sample, various characterizing quantities such as Ra_{eq}, H_{ex}, H_{in}, and Iγ values are calculated. All the values lie within the worldwide range. the dose rates of the most samples varies from 48.07 to 88.27 with average 46.21 which are agreement with the recommended limits (18-93 nGy h^{-1}) except two samples are high called T.3.2 in EL Tih I location (201.04 nGy h^{-1}) and M_6 in Mussaba Salama (98.33 nGy h^{-1}). The Chemical and mineralogy analysis show that the uranium concentration ranges from 2 to 18 PPm which are agreement with the recommended limits except M1 sample equals 44 PPm.and Fe_2O_3% ranges from 0.45 to 4.20 except one sample called T.3.2 equals 15.7% and AL_2O_3 ranges from 11.7 to 37.2 %. So it is desirable to used in industrial, where Kaolin and gibbsite is host several economic metal values. Which used in many important industries such as; paper industry, ceramics, refractory bricks, white cement, textiles, Rubber, medical industries, and special types of plastics.

1. Introduction

The high geological mobility of natural radionuclides in environment allows them to move easily and to contaminate much of the environment with which humans come in contact (Faanhof, 1999 and Walley El-Dine N. et al, 2004). These materials used for manufacturing purposes. Kaolin is Known as China clay which composed essentially of the mineral kaolinite with the chemical composition $Al_2Si_2O_5(OH)_4$ and gibbsite $Al_2O_3.nH_2O$, so they consider as an important ore of aluminum which benefit to industrialists and mineralogists, the major uses of them directly related to its physical and chemical properties. This work is study the Natural Radioactivity assessment and geochemical analyses for some kaolin and gibbsite rock samples collected from locations in Sinai, Egypt.

2. Experimental methods

2.1 geological setting

The Um Bogma formation in Egypt is composed of different rock faces that are mainly represented by shale, siltstone, clay, ferruginous sandstone, calcareous sandstone and feldspathic sandstone (EL Assy et al., 2004). In Sinai, Kaolin occur interbeded with sandstones in several areas and belongs to two ages, the oldest is of early carboniferous (≈ 300 m.y.) and the youngest is of early cretaceous (≈ 60 m.y.).

The studied areas are located in central west Sinai to the east, northeast, and southeast of Abu Zeneima City (120 Km east south of Suez) as shown in fig. (1). The studied areas south Abu Zeneima includes the following sites, Mussaba Salama, El Esila, El Dehesa, El Shallal and El Tih plateau which contain (Tih I and Tih II). in gibbsite includes the following sites, Wadi El Naseib, Talet saleim, south W. Abu thor. The laterite sediments (gibbsite – bearing shale) are studied in four localities in southwestern Sinai namely, Talet Seleim (Ts), Abu Thor (Th), Abu Mogheirate (Mg) and W. Naseib (Ns) and their surroundings (Shaffer, 1975), described four modes of occurrence of laterites and bauxite materials, these are Blanket laterites, Pocket laterites, Detrital deposits and karst bauxite.

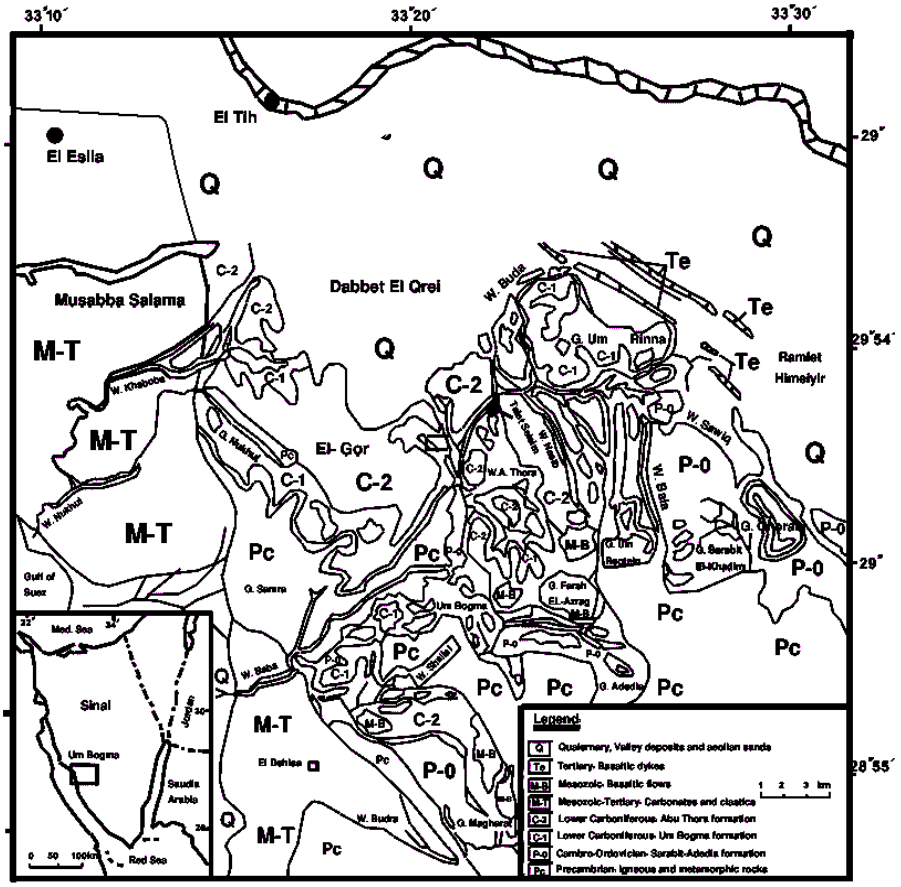


Fig. (1): Geological and Location map of the studied sites (*After EL Shahat and Kora, 1986*) with modifications.

2.2 sample collection and preparation techniques

Twenty nine types of kaolin rock samples and Twenty seven types of gibbsite are collected from locations in Sinai, Egypt. The representative collected samples were thoroughly pulverized, sieved to 200 mesh and sealed in plastic bottles marinelli beakers in 100 ml and 250 ml, dry weighted and stored for 4 weeks before counting in order to allow the reaching of equilibrium between ^{226}Ra and ^{222}Rn and its decay products for radiometric analysis using HPGe spectrometer, The activity concentration of ^{226}Ra, ^{214}Bi, ^{214}Pb (from ^{238}U decay series), ^{228}Ac, ^{212}Bi, ^{212}Pb (from ^{232}Th decay series) and ^{40}K were measured, the radium equivalent, the

external and internal hazard index, the absorbed dose and the annual effective dose were assessed. Fe and Al was analysed by spectrophotometer technique after digestion with acids, Uranium was analysed by titration against ammonium metavanadate.

2.3 Radiometric measurement

An ortec coaxial p-type HPGe (EG&G Ortec Model GEM-50210-P), crystal of 64.5 mm diameter and 69.9 mm length with 50% efficiency that of "3x3" NaI (Tl) . The detector resolution has a full width at half maximum (FWHM) of 0.9 Kev at 122 Kev and 1.9 Kev at 1330 Kev. Each sample was put into the shielded HPGe detector and measured for an accumulating time nearly 24 h. to obtain good counting statistics. The environmental gamma background at the laboratory site has been determined and subtracted in order to get net counts for the sample. The minimum detectable activity (MDA) of the present measurement system was calculated as follows:

$$MDA = \frac{LLD}{\varepsilon P t W} \qquad (1)$$

Where MDA is in Bq kg^{-1} , ε is the absolute efficiency of the used HPGe detector, P the absolute emission probability of the γ decay, t the measurement time in seconds, W the weight of the dried sample expressed in kg, and the lower limit of detection (LLD) is given by: (Curie,1968)

$$LLD = 2.706 + 4.653\sigma_{N_B}, \qquad (2)$$

Where σ_{N_B} is the standard deviation (SD) of the background in the region of interest and equals square root of the number of counts for the background spectrum. (S Turhan et al, 2007). The MDAs for ^{232}Th, ^{238}U, ^{226}Ra and ^{40}K were 0.27, 0.75, 1.00 and 1.34 Bq kg^{-1}, respectively.

3. Result and discussion

3.1 Radiometric Analysis

The specific activity A_i (Bq kg^{-1}) of radionuclide content for the measured samples was determined from the relation:

$$A_i \text{ (Bq kg}^{-1}) = \frac{C_i}{\zeta_{(E)} \times \gamma_d \times t \times M_s} \quad (3)$$

where C_i (cps) is the net peak area for each photopeak energy E, $\zeta_{(E)}$ is the absolute efficiency of the used γ-ray spectrometer, γ_d is number of γ-rays per disintegration of the nuclide at energy E, t is the time counting time in seconds, M_s (kg) the mass of the sample.(M.Ngachin et al,2007). Self-absorptions for all the present samples are similar and found in very minor. Errors arise due to a number of factors which are related to systematic and statistical errors, These errors were estimated to be in the order of 5 %.

The ranges and averages activity concentrations of ^{238}U, ^{232}Th and ^{40}K (Bq/ kg) which reported in table (1,2) for inter comparison kaolin and gibbsite for each locations . The concentrations of ^{238}U is higher than the recommended limits which are equal to 35 Bq/kg (UNSCEAR, 2000) except EL Dehessa location is 34.45±3.09 and EL Tih II location is 16.26±1.15 which belong kaolin samples. The Activity concentration of ^{232}Th is is higher than the recommended limits in kaolin samples except EL Tih I and II locations and all gibbsite locations are in agreement with the international limit which are equal to 30 Bq/ kg (UNSCEAR, 2000). The concentration of ^{40}K is lower than the international limit (400 Bq/ kg). As a whole, each locations differ clearly in U, Th and K content as shown in fig(2).

Table (1) The ranges and averages activity concentrations in (Bq/kg) of ^{238}U, ^{232}Th and ^{40}K in kaolin and gibbsite for each locations have number of samples N

Location	Activity Concentration Bq/Kg		
	U-238*	Th-232	K-40
Kaolin Locations			
Down Of El Tih Plateau(N=4)	11.96-74.52	1.62-21.52	133.00-659.56
	43.23±2.70	14.78±1.27	279.63±2.38
El Tih I (W.El Mysina(N=3)	3.11-453.58	16.71-63.86	4.49-169.83
	141.15±5.16	39.55±2.98	62.45±1.09
El Tih II(W.Ras Gharam)(N=4)	20.31-27.23	18.42-24.52	2.99-22.03
	16.26±1.15	22.26±1.15	8.50±0.27
Mussaba Salama(N=5)	42.33-184.02	28.9-62.12	5.17-46.60
	55.64±4.71	51.40±3.65	19.15±0.89
El Dehessa(N=4)	35.20-71.93	23.95-80.51	5.35-12.26
	34.45±3.09	43.19±2.59	8.33±0.50
El Shallal(N=3)	78.60-151.65	42.68-51.87	8.54-17.41
	73.29±5.71	45.85±3.63	12.71±0.74
El Esila(N=6)	33.75-107.34	32.54-82.66	9.91-61.85
	42.34±4.30	66.34±3.99	23.57±0.81
Total Average	79.27	42.29	56.85
Gibbsite Locations			
Talet Seleim(N=9)	340.99-5288.06	4.80-26.42	13.52-207.26
	2374.21±13.58	12.30±2.13	88.75±2.75
W.Naseib(N=6)	37.50-1034.80	3.04-23.38	37.67277.66
	244.95±4.40	12.04±1.52	115.59±1.85
West Abu Thor(N=10)	108.35-3856.33	7.05-22.06	48.83-411.24

Location	Activity Concentration Bq/Kg		
	U-238*	Th-232	K-40
	638.17±5.58	10.98±1.48	137.12±2.05
El Gor(N=2)	172.72-546.51	6.33-11.87	63.70-83.18
	359.61±9.54	9.10±1.39	73.44±1.86
Total Average	1108.63	11.52	111.5

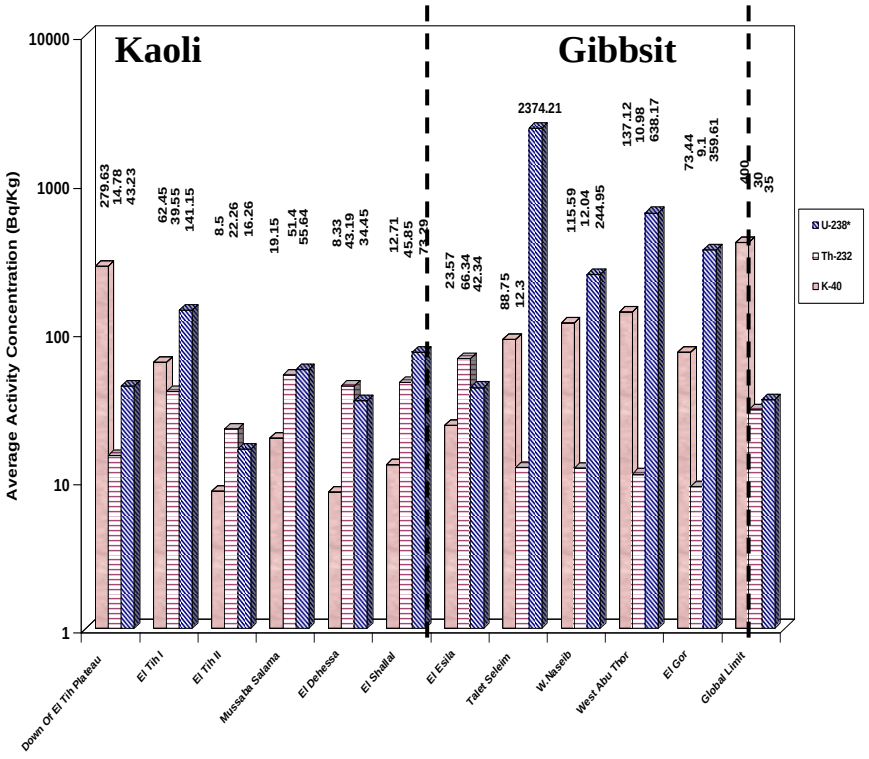
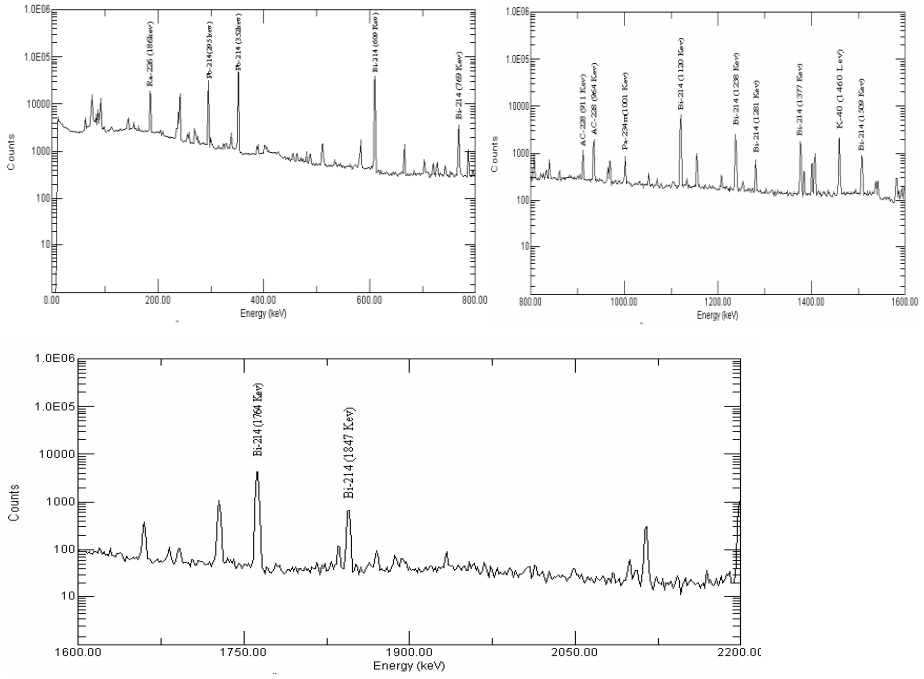
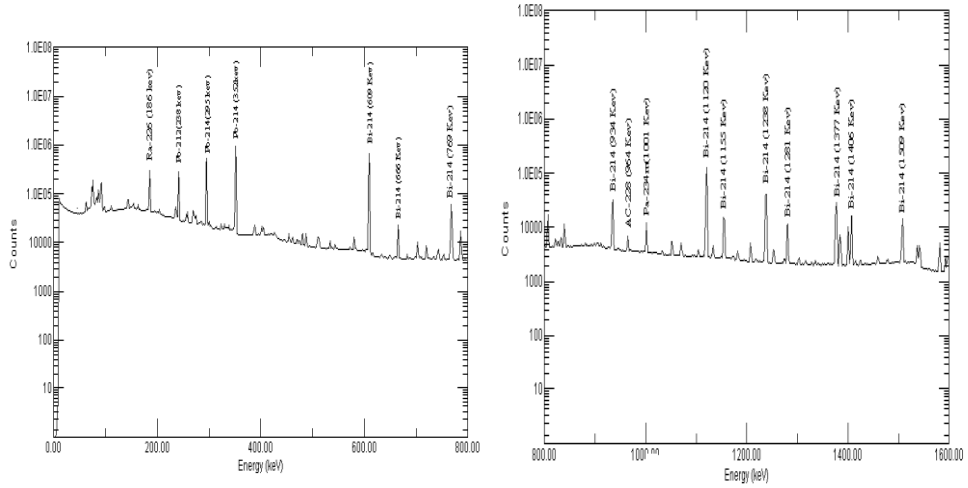


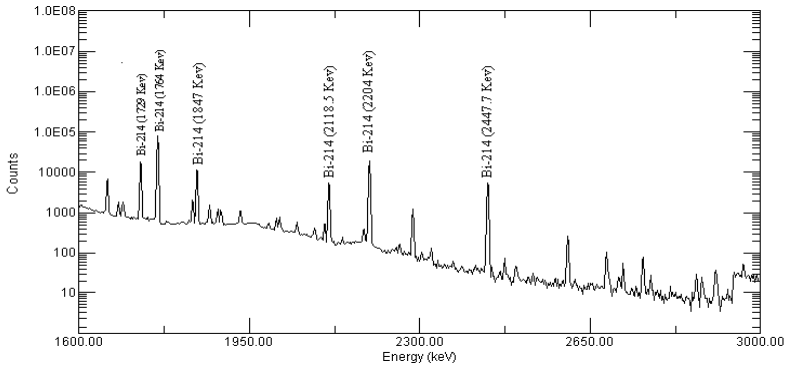
Fig. (2): U, Th and K activity concentration (Bq/Kg) for each locations

Figure (3) represent the spectrum for (T-3-2) sample taken by the used HP Ge detector.


Counts
Energy (keV)
Bi-214(1764 Kev)
Bi-214(1847 Kev)

(a)


Counts
Energy (keV)



(b)

Fig. (3): The spectrum for the highest sample for (a) kaolin and (b) gibbsite taken by HPGe detector

Table (2) show the Concentrations for ^{238}U, ^{226}Ra, ^{232}Th (ppm) , ^{40}K% , Th/U ratio and U/Ra ratio in kaolin. Values of eU, eTh and eRa in ppm, as well as K, in %, were converted to activity concentration, Bq/kg, using conversion factors given by polish central laboratory for radiological protection (Malczewski et al, 2004). The specific parent activity of a sample containing 1 ppm , by weight, of U is 12.35 Bq/kg, 1 ppm of Ra is 11.1 Bq/kg, 1 ppm of Th is 4.06 Bq/kg and 1% of ^{40}K is 313.(EL Galy et al,2008).

Table (2) Mean, max, min Concentrations for238U, 226Ra, 232Th (ppm) , 40K% , Th/U ratio and U/Ra ratio

Location		Concentration ppm			K-40%	Th/U	U/Ra
		Ra-226	U-238	Th-232			
Kaolin							
Down Of El Tih Plateau	Mean	3.83	4.62	3.66	0.88	1.52	1.17
	Min	3.21	3.25	4.25	0.42	1.07	0.70
	Max	4.23	6.01	5.37	0.59	1.85	1.87
El Tih I (W.el Mysina)	Mean	15.39	15.22	9.78	0.20	2.37	0.86
	Min	3.73	2.67	4.13	0.01	0.15	0.70
	Max	38.54	36.58	15.80	0.54	3.89	1.09
El Tih II	Mean	0.11	1.97	5.51	0.03	4.19	1.23

Location	Concentration ppm			K-40%	Th/U	U/Ra
	Ra-226	U-238	Th-232			
(W.Ras Gharam)	Min 0.89	1.64	4.56	0.01	4.03	0.92
	Max 1.51	2.20	6.07	0.07	4.36	1.57
Mussaba Salama	Mean 4.67	7.38	12.72	0.06	3.41	1.16
	Min 1.64	3.41	7.15	0.02	1.54	0.74
	Max 2.57	14.84	15.37	0.15	5.88	1.58
El Dehessa	Mean 3.15	4.10	10.69	0.03	3.72	0.89
	Min 2.39	2.84	5.93	0.02	2.08	0.84
	Max 4.16	5.80	19.92	0.04	5.67	0.95
El Shallal	Mean 6.21	9.44	11.34	0.04	2.24	1.04
	Min 2.29	6.34	10.56	0.03	1.43	0.90
	Max 8.25	12.23	12.83	0.05	3.52	1.31
El Esila	Mean 3.73	4.99	16.41	0.08	5.36	0.99
	Min 1.54	2.72	8.05	0.03	2.93	0.79
	Max 8.03	8.66	20.45	0.20	9.05	1.25
Gibbsite						
Talet Seleim	Mean 187.14	191.47	3.04	0.28	0.04	1.05
	Min 29.65	27.50	1.19	0.04	0.01	0.93
	Max 440.50	426.46	6.54	0.65	0.20	1.27
W.Naseib	Mean 21.57	19.75	2.98	0.38	0.40	1.25
	Min 1.87	3.02	0.75	0.16	0.05	0.84
	Max 8.95	83.45	5.78	0.88	1.05	2.01
West Abu Thor	Mean 14.63	157.18	3.02	0.48	0.16	1.04
	Min 5.55	8.79	1.74	0.15	0.01	0.83
	Max 283.62	310.99	5.46	1.30	0.62	1.58
El Gor	Mean 37.12	29.00	2.26	0.23	0.09	0.78
	Min 8.18	13.93	1.57	0.20	0.07	0.77
	Max 6.05	44.07	2.94	0.26	0.11	0.79

It is revealed that concentrations of ^{226}Ra varies from 0.89 (EL Tih II) to 440.50 (Talet Seleim) ppm, ^{238}U varies from 1.64 (EL Tih II) to 426.46 (Talet Seleim) ppm, ^{232}Th varies from 0.75 (W. Naseib) to 20.45 (EL Esila) ppm and for K% varies from 0.01(EL Tih II) to 1.30 (West Abu Thor) %.

The U-contents and Th/U ratios in sedimentary rocks are useful for deducing the conditions under which the highly anomalous mineralized or uraniferous types were formed [Adams and Weaver, 1958]. However, three types of sediments are differentiated according to their Th/U ratios.

The first type includes sediments of Th/U ratio value ranging between 0.012 and 0.81.These sediments are developed under conditions where uranium was migrated from its source and fixed in the sediments with continuous recharge.

The second type of sediments has Th/U ratios ranging between 1.47 and 1.49. They are characterized by their relatively high Th-content than U-content due to slightly more scavenging of U-content from continuous leaching and recharging.

The third type of sediments has Th/U ratio ranges between 1.49 and 5.47. These sediments reflect the poor weathering and rapid deposition of rock detritus. Terefore, the detrital radioactive minerals like xenotime, samarskite, thorite and euxenite usually dominate (El Galy et al., 2008). Three types of sediments are differentiated according to their Th/U ratios. The U/Ra ratios for most of the samples are exceed unity, reflecting a state of radioactive disequilibrium between uranium and its daughter, radium which reported in table(2), this state is mostly related to uranium enrichment. on the other hand, the non-mineralized sediments have U/Ra ratios generally less than unity due to their low content of uranium. The U-Ra variation indicates that uranium and its daughter are positively correlated. (El Galy et al., 2008).

Table (3) reported ranges and averages of the parameters hazard which illustrates the absorbed dose rate, effective dose rate, radium equivalent, external and internal hazards for each location in kaolin samples.

Radium equivalent activity is the most widely used radiation hazard index (Req). The radium equivalent is a weighed sum of activities of the ^{226}Ra, ^{232}Th and ^{40}K based on the assumption that 370 Bq/kg of Ra, 259 Bq/kg of Th and 4810 Bq/kg of K produce the same γ-ray dose rates. Ra_{eq} is given by (Beretka and Mathew, 1985; Tufail et al., 1992)

$$Ra_{eq} = A_{Ra} + 1.43\ A_{Th} + 0.077A_k \leq 370 \qquad (4)$$

Where A_{Ra} , A_{Th} , and A_K are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}k, respectively. The maximum value of Ra_{eq} must be <370 Bq/kg in order to keep the external dose <1.5mGy/y (Nada, 2004; Singh et al., 2005 and Huy et al., 2006).

The absorbed dose rate, D (nGyh-1) in air above the ground level owing to the concentration of ^{238}U, ^{232}Th and ^{40}K is given as (Ajayi et al., 2000; El-Arabi et al, 2006):-

$$D = 0.042\ A_K + 0.4299\ A_U + 0.666\ A_{Th} \qquad (5)$$

Where A_K, A_U and A_{Th} are activity concentration Bq kg^{-1} for ^{40}K, ^{238}U and ^{232}Th respectively. According to the recent Unscear Reports (1993, 2000),all the other values lie within the worldwide range (18-93 nGy h^{-1}), With average value (55 nGy h^{-1}). External Hazard Index is defined as:

$$H_{ext} = A_{Ra} / 370 + A_{Th} / 259 + A_k / 4810 \leq 1 \qquad (6)$$

Where A_{Ra}, A_{Th} and A_k are the activity concentration of ^{226}Ra, ^{232}Th and ^{40}K in Bq/kg respectively. The value of this index must be less than unity in order to keep the radiation hazard to be insignificant, i.e. the radiation exposure due to the radioactivity from a construction martial is limited to 1.5 mSvyr-1. The maximum value of H_{ext} equal to unity corresponds to the upper limit of Ra_{eq} 370 Bq/kg (Nada, 2004; Singh et al., 2005 and Huy et al., 2006).

There is a radiation hazard to respiratory organs due to ^{222}Rn, ^{220}Rn and their progenies. The contribution from ^{220}Rn is negligible due to its shorter half life than that of ^{222}Rn and the main contribution is of ^{222}Rn. In order to address the radiation hazard due to ^{222}Rn, the criterion formula suggested by (Krieger, 1981) for reducing the acceptable maximum concentration of ^{226}Ra to half the normal limit, has been used (Tufail et al., 2005).

$$H_{int} = A_{Ra} / 185 + A_{Th} / 259 + A_k / 4810 \quad (7)$$

Where A_{Ra}, A_{Th} and A_K are the activities of ^{226}Ra, ^{232}Th and ^{40}K. H_{int} must be less than unity (Ibrahiem et al., 2000 and Nada, 2004).

The gamma-radiation hazard index ($I\gamma$): An advisory group of experts of OECD's Nuclear Energy Agency (NEA-OECD, 1979) suggested a criterion for defining radiation risk, the gamma radiation hazard index (representative level index) defined as:

$$I\gamma = C_{Ra}/150 + C_{Th}/100 + C_K/1500 \quad (8)$$

This index can be used to estimate the level of γ- radiation hazard associated with the natural radionuclides in specific marterials. (Walley El-Dine N. et al, 2004).

Contribution of ^{238}U, ^{232}Th and ^{40}K radionuclides for the absorbed dose rate within the studied localities 0f kaolin and gibbsite are plotted in fig. (3). In kaolin samples represent fig. (3) (C, e, f, g) It is clear that the contribution of ^{238}U, ^{232}Th and ^{40}K are nearly the same for these localities. ^{232}Th plays the main and most important in dose rate contribution which represents about 60%, while ^{238}U with 30% and ^{40}K with 1% as minor contributions, While in fig. (3) (d) ^{40}K is agreement with the pervious result but ^{232}Th represent 48% and ^{238}U with 50%, in fig. (3) (a) the contribution of ^{238}U, ^{232}Th and ^{40}K represents about 45%, 25% and 30% respectively, in fig.(3)(b) the contribution of ^{238}U, ^{232}Th and ^{40}K represents about 68%, 29% and 3% respectively. In gibbsite samples represented in fig.(3)(h, i, k,l) It is clear that the major contribution is ^{238}U followed by ^{232}Th and ^{40}K is minor contribution.

Table (3) Ranges and Average of parameters hazard for each location samples in kaolin rocks

Location / No. of samples	D (nGy/hr)	Eff Dose (indoor) mSv/y	Eff Dose (outdoor) mSv/y	Ra_{eq} (Bq/kg)	H_{ext}	H_{int}	evel Index Iγ (Bq/kg)
Down of El Tih Plateau (N=4)	29.43-39.50 35.42	0.20-0.27 0.24	0.04-0.05 0.05	53.1-86 74.53	0.14-0.23 0.20	0.29-0.14 0.36	0.46-0.61 0.55
El Tih I (W.El Mysina) (N=3)	43.91-201.04 101.82	0.30-1.38 0.70	0.05-0.25 0.12	98.14-464.79 232.21	0.27-1.26 0.63	0.38-2.41 1.09	0.67-3.13 1.58
El Tih II W.RasGharam) (N=4)	18.36-23.62 20.37	0.13-0.16 0.14	0.02-0.03 0.14	44.83-40.26 52.24	0.11-0.14 0.12	0.14-0.19 0.15	0.28-0.36 0.31
Mussaba Salama (N=5)	27.13-98.33 56.98	0.19-0.68 0.39	0.03-0.12 0.07	59.95-223.02 126.81	0.16-0.60 0.34	0.21-0.98 0.48	0.41-1.52 0.87
El Dehessa (N=4)	31.62-74.82 44.18	0.22-0.51 0.30	0.04-0.09 0.05	70.97-165.24 98.08	0.19-0.45 0.26	0.27-0.58 0.36	0.49-1.14 0.68
El Shallal (N=3)	39.45-73.39 60.32	0.27-0.50 0.41	0.05-0.09 0.07	87.06-165.21 135.43	0.24-0.45 0.37	0.30-0.69 0.55	0.60-1.13 0.93
El Esila (N=6)	31.50-88.27 62.63	0.22-0.61 0.43	0.04-0.11 0.08	68.39-197.32 138.13	0.18-0.53 0.37	0.23-0.77 0.49	0.48-1.35 0.96
Talet Seleim (N=9)	164.5-2093.4 898.9	0.81-10.3 4.41	0.20-2.57 1.1	377.6-4900.9 2101.7	1.02-13.3 5.7	1.9-26.5 11.29	2.7-32.7 14.0
W.Naseib (N=6)	19.5-483.7 115.2	0.1-2.37 0.65	0.02-0.59 0.14	42.9-1128.8 265.5	0.12-3.1 0.72	0.17-6.0 1.4	0.3-7.6 1.8
West Abu thor (N=10)	58.59-1353.5 246.2	0.25-6.64 1.2	0.07-1.7 0.3	124.8-3166.5 571.98	0.34-8.7 1.6	0.50-17.1 3.0	0.91-21.1 3.84
El Gor (N=2)	93.1-277.1 185.1	0.46-1.4 0.91	0.11-0.34 0.23	215.8-645.5 430.7	0.6-1.74 1.16	1.13-3.43 2.3	1.45-4.3 2.89

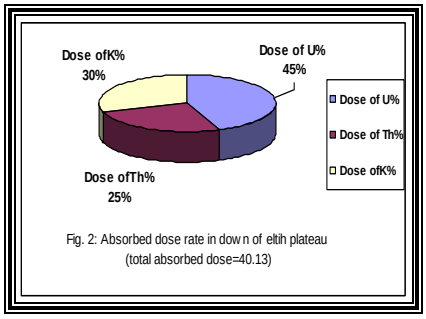


Fig. 2: Absorbed dose rate in dow n of eltih plateau
(total absorbed dose=40.13)

(a)

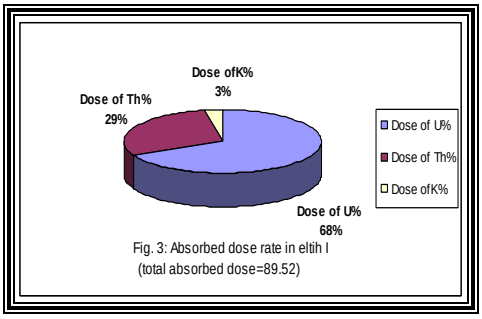
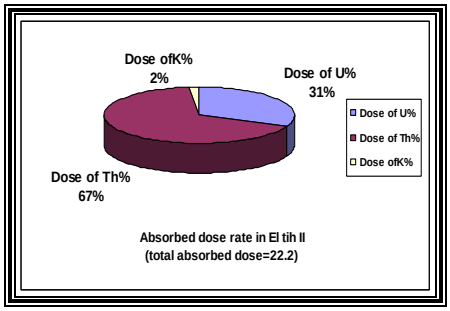
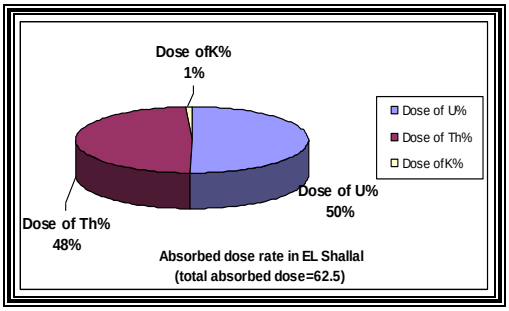


Fig. 3: Absorbed dose rate in eltih l
(total absorbed dose=89.52)

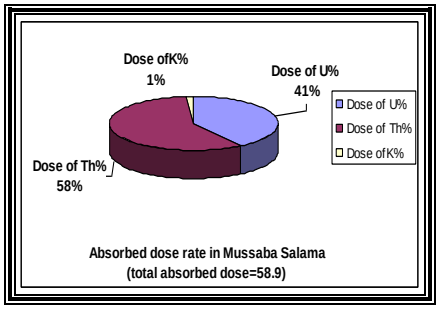
(b)



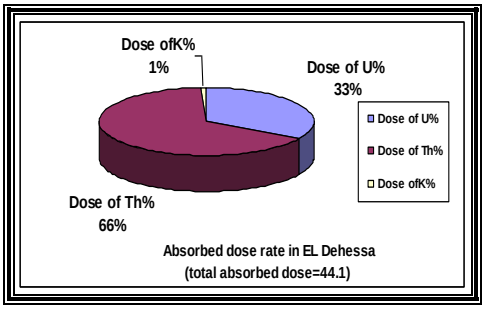
(c)



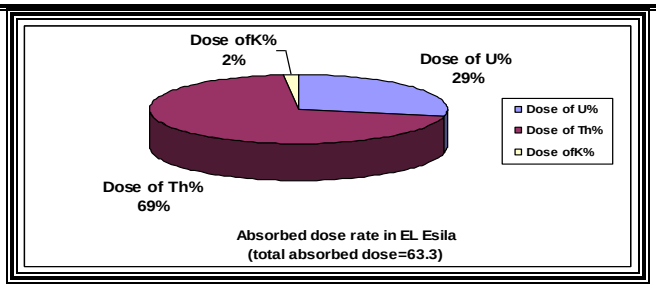
(d)



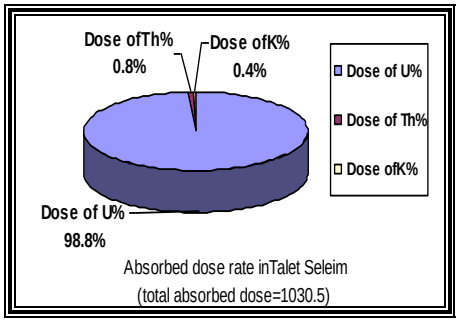
(e)

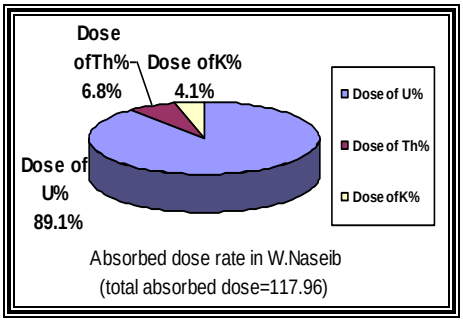


(f)

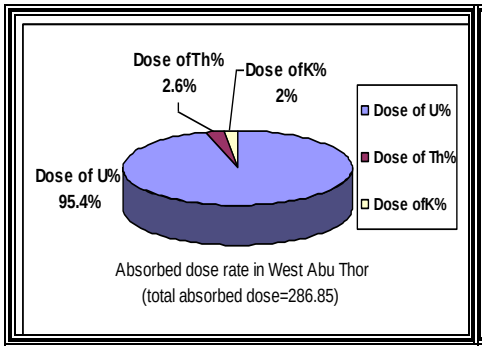


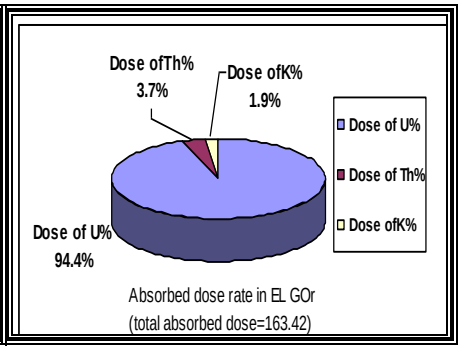
(g)





(h) **(i)**





(k) **(l)**

Fig. (3): Contribution of the different radionuclides in the absorbed dose rate in localities of kaolin and gibbsite

3.2 Chemical and mineralogy analysis

Chemical analyses were carried out for selective samples from each locality to determine the iron (Fe_2O_3) and Aluminum (AL_2O_3) concentrations using spectrophotometer and Atomic Absorption respectively. Most of the collected samples from the different localities were analyzed chemically for the determination

of the uranium concentrations (ppm) by titration method against ammonium metavanadate was used in the presence of diphenylamine sulfonate indicator. Prior to titration, proper reduction of U was performed using ammonium ferrous sulfate (El Hazek. M.N. et al, 2008). From table (4), it is very clear that the relation between the chemically analyzed uranium (U ppm) and radiometric analysed uranium (eU ppm) are deviated from unity either by decreasing or increasing. These results indicate a pronounced disequilibrium with different grades. There are three types of gibbsite according to uranium content; high uranium, moderate and low. In the present study, it is noticed that high uranium content in Talet Seleim location and moderate in EL Gor, while the low in W.Naseib and west Abu Thor.

Table (4) Average Concentrations (ppm) of chemically (U) and radiometry (eU) measurements and U/eU ratios and Fe_2O_3% and AL_2O_3%

Location/No. of samples	U ppm	eU ppm	U/eU	Fe_2O_3%	AL_2O_3%
down of Eltih plateau N=4	7.3	4.62	1.60	2.08	24.03
eltih I (W.el mysina) N=1	18.00	36.58	0.49	15.70	24.50
eltih II(W.Ras gharam) N=1	12.00	2.20	5.46	4.20	27.00
Mussaba salama N=5	16.00	7.38	2.25	2.32	23.26
El Esila N=4	2.75	4.99	0.65	3.08	31.10
Talet Seleim N=5	208.40	241/91	0.86	1.99	21.32
W.Naseib N=5	20.72	7.05	4.42	12.20	15.34
West Abu Thor N=8	14.48	25.63	0.74	15.28	16.99
El Gor N=1	62.00	14.02	4.45	21.70	5/20

3.2.1 Correlation between Uranium Chemically and Radiometry

From fig. (4), it is noticed that the correlation between average concentrations U and eU (ppm) in kaolin and gibbsite for each location are very strong positive correlation which equals R2=0.7469, we obtained this correlation after neglected four odd samples called (H-4" & T-3-2 & M6 and E9).

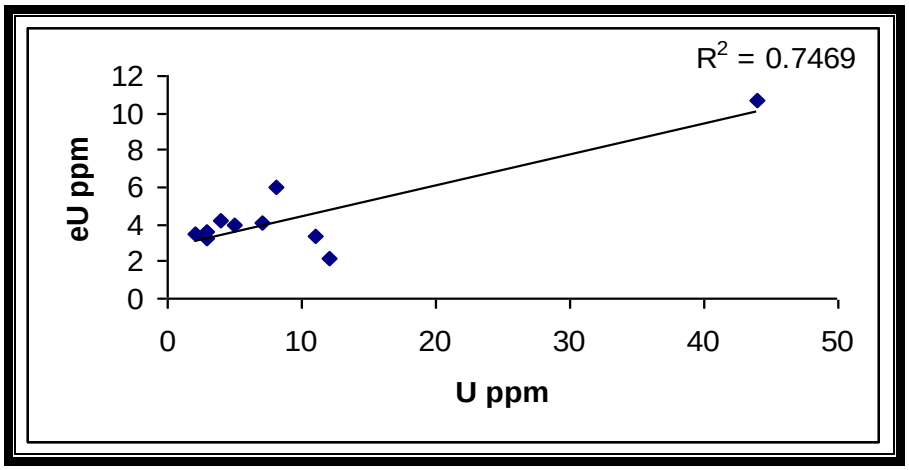


Fig. (4): Correlation in selected samples of kaolin between radiometric uranium (ppm) with chemically uranium (ppm)

3.2.2 Correlation between Uranium and iron

it is noticed that uranium (U) ppm is positive correlation with iron Fe_2O_3% in kaolin Rock samples Fig. (5)(a) (R^2 =0.3855)and all locations in gibbsite samples Fig. (5)(b) (R^2 = 0.5952) except Talet Seleim is negative correlation Fig. (5)(c) (R^2 = 0.5303). Because this location consider carbon rocks and the uranium is adsorbed a carbon and may form discrete uranium mineral.

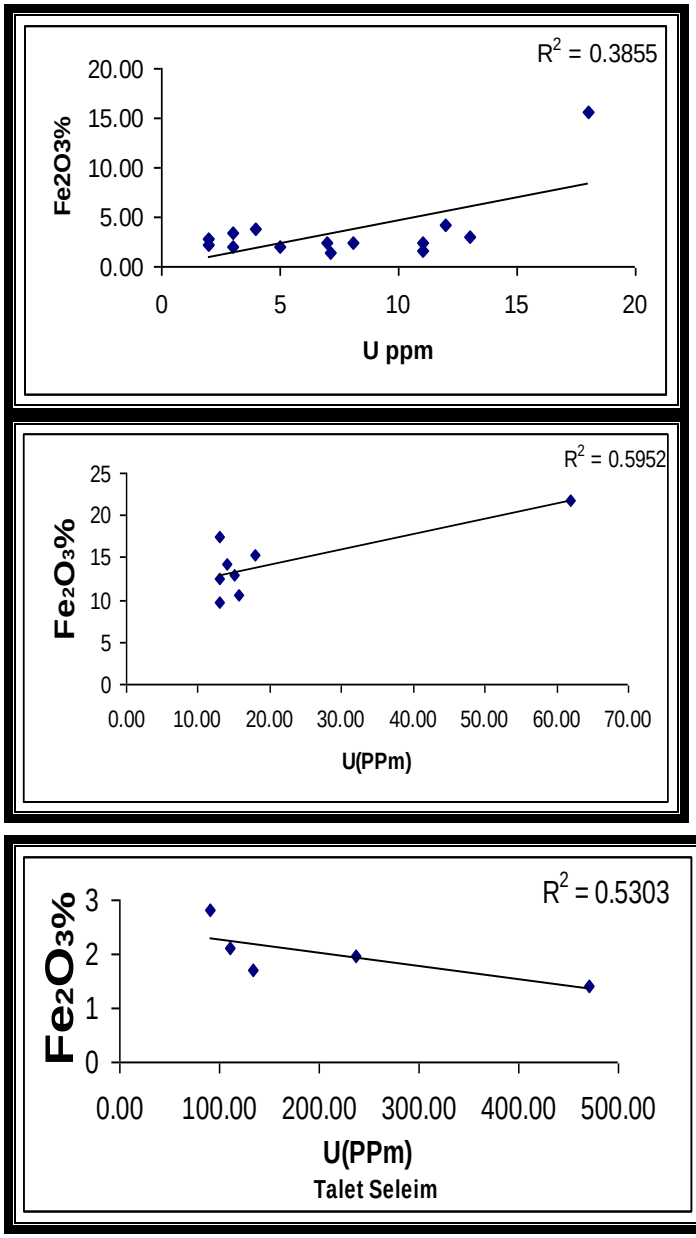


Fig. (5): Correlation between uranium(ppm) with iron (a) in kaolin samples and (b) in gibbsite samples except Talet Seleim location show in (c)

3.2.3 Correlation between Uranium and Aluminum

chemically analyzed uranium (U) ppm is very week correlation with Aluminum AL_2O_3% because iron more adsorbent for uranium than aluminum So the main relation is with iron and very low with alumina. Fig. (6)(a) represent kaolin Rock samples (R^2 =0.0.0075). and gibbsite samples (R^2 =0.0228) Fig. (6)(b) but Talet Seleim location is negative correlation (R^2 = 0.7987) Fig. (6)(c).

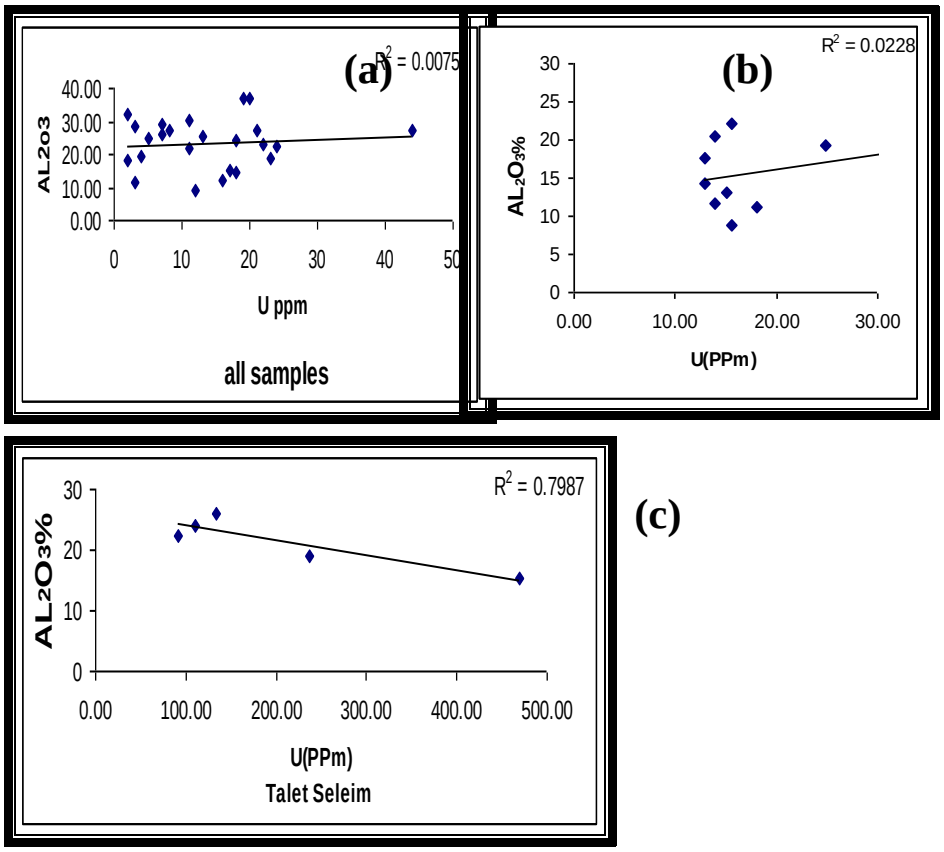


Fig. (6): Correlation between chemically uranium (ppm) with Aluminum (a) in selected samples of kaolin (b) in selected samples of gibbsite except Talet Seleim location show in (c)

To study the mineral constituents of kaolin exposed in the study area, three samples were chosen for each location and analyzed by XRD technique for the bulk samples. It is clear that the main mineral is kaolinite (clay mineral) and quartz (non- clay mineral) are present in all the studied kaolin samples (Gehan aly, 2005) but the main mineral is gibbsite (clay mineral) present in all the studied samples. (EL Aassy et al., 2004).

A comparison of the activity concentration of natural radionuclide for kaolin and gibbsite in other location is reported in table (5, 6).

Table (9) Comparison of the activity concentration

Location	Activity concentration				Reference
	Uranium	Radium-226	thorium	potassium	
Turkey	---	82.0 ± 37.3 Bq kg−1	94.8 ± 49.2 Bq kg−1	463.6±544.9 Bq kg−1	Turhan, 2009
Egypt (Tushki and Kalabsha)	479-8633 (Bq/kg)	59.8-8499(Bq/kg)	95.8-1079(Bq/kg)	8.2-269.7(Bq/kg)	Walley El Dine et al, 2003
Egypt (Sinai)	62-173.6(Bq/kg)	33.3-99.9(Bq/kg)	40.4-60.36(Bq/kg)	15.85-374.1 (Bq/kg)	Mahammed, 2005
Egypt (before bindustrial)	282.8(Bq/kg)	148.5(Bq/kg)	48.7(Bq/kg)	960.0(Bq/kg)	EL Sayed, 2000
Egypt (Sinai) (Present study)	UDL-453.58 (Bq/kg)	UDL-427.81 (Bq/kg)	1.62-82.66 (Bq/kg)	2.99-659.56 (Bq/kg)	Present work

Table (10) Comparison of the activity concentration for gibbsite samples

Location	Activity concentration				Reference
	Uranium	Radium-226	thorium	potassium	
Hungarian Bauxite	----	132-791 Bq/g	118-472 Bq/g	10-82 Bq/g	Janos S. et al, 2008
Westren Australia	120-350 Bq/g	----	450-1050 Bq/g	30-70 Bq/g	Malcolm B. Cooper, 2005
Greece	143.1-247.5 Bq/g	73.7-150 Bq/g	226.4-205 Bq/g	28.3 Bq/g	Papatheodor et al, 2005
Westren Australia	10-900 Bq/g	----	35-1400 Bq/g	10-600 Bq/g	IAEA, 2002
<u>Egypt</u> 2-Egyptian Bauxite	2516±4.83(Bq/kg)	3059±7(Bq/ kg)	39.15±2(Bq /kg)	346±5(Bq /kg)	EL Sayed S., 2000
Bauxite ore Bauxite from China Bauxite from Guyana Bauxite (typical)	0.4-0.6 kBq/g 0.46 kBq/g 0.08 kBq/g 0.5 kBq/g	---- 0.31 kBq/g 0.05 kBq/g 0.4 kBq/g	0.3-0.4 kBq/g 0.37 kBq/g 0.23 kBq/g 0.4 kBq/g	---- ---- ---- ----	UNSCEAR (1993 and 2000)
Cuba	----	92.6 Bq/g	754 Bq/g	62.6 Bq/g	Perez et al, 1993
Egypt (Sinai) (Present study)	UDL-5288.06 (Bq/kg)	UDL-4889.53 (Bq/kg)	UDL-26.92 (Bq/kg)	UDL-411.24 (Bq/kg)	Present work

4-Conclution

The present study is concerned with important economic rocks, where it is considered as raw materials for many economic industries, kaolin and gibbsite rocks were collected from different localities in Sinai, Egypt. these economic materials are used in industries such as; Aluminum constructers, paper industry, building materials as ceramics, refractory bricks, white cement, textiles, rubber, medicine, and special types of plastics and pans . The results of this study may be considered as a data base information and guide for investigators and industrial companies who used kaolin and gibbsite as raw materials for several purposes

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