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NATURAL RADIOACTIVITY LEVELS IN SURFACE SOIL OF KITCHENER DRAIN IN THE NILE DELTA OF EGYPT

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In order to initiate a radiological assessment program and to establish a baseline map of radioactivity background levels in the surrounding environment, the activity concentration of radionuclides in surface soil samples around Kitchener Drain area in the North Nile Delta at the coast of Mediterranean Sea were measured by using γ- ray spectroscopy. The activity concentrations was found for ^{40}K ranged from 17.05 to 99.15, for ^{232}Th series ranged from 1.23 to 32.15 and for ^{238}U series ranged from 1.61 to 50.90 (Bq/kg). The Contents in (ppm) of these radionuclides were obtained. The absorbed dose rate in (nGy/hr) due to the natural radioactivity of the samples under study was found to be in the range of 1.73 nGy/hr to 47.03 nGy/hr.

***Key Word*:** *Natural Radioactivity, Environmental Radioactivity, Radiation.*

INTRODUCTION

Several measurements in Bahr El Baqar Drain, Sand Islands in the East of Nile Delta [1], other methods and techniques have been applied in the determination of the naturally occurring radionuclide in the geological, biological [2] and environmental media such as rocks, soil, air and natural wastewate r. Quantitative gamma- ray spectroscopy is a powerful technique available for the nondestructive analysis of samples from such media [3]. Radionuclides have been present in the natural environment the main natural contributors to external exposure to gamma radiation are the uranium and thorium series, together with ^{40}K. This study aimed to determination of the distribution of natural radionuclides in the beach samples from the region around Kitchener Drain in the North of Nile Delta between Baltum and Gamms a on the coast

of Mediterranean sea, most of the drainage of the highly polluted Kitchener Drain which contains both sewage and industrial effluent run directly into the sea and not into the lake [4], see Figures 1., 2.

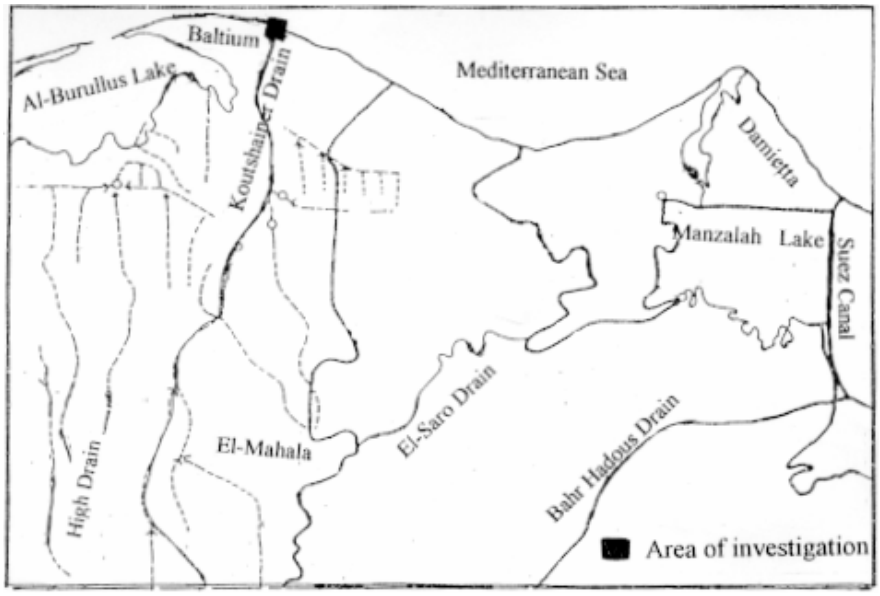

Figure 1. The location map of the area under study and sample locations

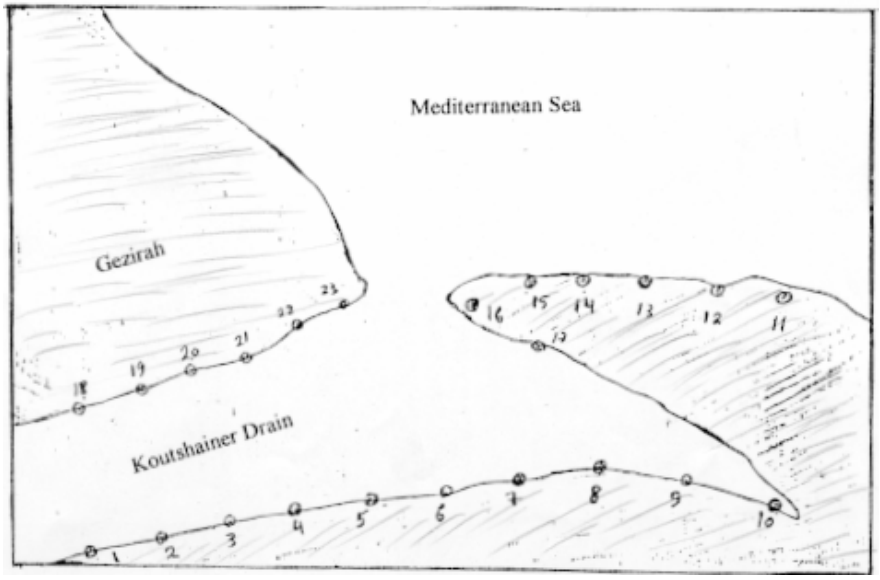

Figure 2. The location map of the area under study and sample locations

EXPERIMENTAL PROCEDURE

The detection system is a low-level gamma-ray spectrometer having 3in x 3in NaI (Tl) detector and the associated electronics, including PCA3, 2048 MCA, and data system. The detector is surrounded by cylindrical lead shield with a mov able cover in order to suppress the soft component of cosmic rays and the background due to the building materials and air. The shield contains an inner concentric cylinder of copper , this Cu-liner is used to attenuate the x-rays stimulated in the lead shield itself. The counting geometry was selected in order to minimize the backscattering radi ation [5]. The spectrometer was adjusted, calibrated and the background was carefully measured and subtracted similar to the procedure given before by the authors' [6]. The gamma spectra of the collected samples were measured and the activities of ^{238}U series, ^{232}Th series and ^{40}K in each sample were determined by measuring the characteristic γ-peaks of their daughters. The line at 1764 keV of ^{214}Bi was used to determine ^{238}U series activity, and the line at 2614 keV of ^{208}Tl for ^{232}Th series. Also the peak at 1460 keV was used for ^{40}K activity [7].

SAMPLING AND SAMPLE PREPARATION

Twenty-two shore sediments samples were collected from the beach of Kitchener Drain about 2 km long at equal distance about 100-meter as shown in the Figure 3. which represents the locations of the collected samples.

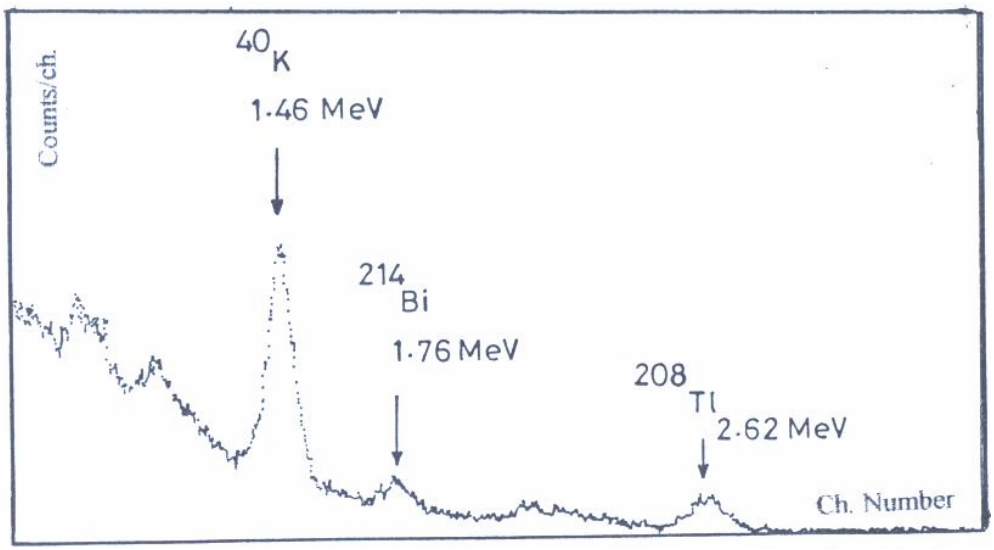

Figure 3. Example of the gamma spectra for one of the samples under investigation (sample No. 3)

The sediment samples were collected by using core method of 10 cm diameter and 20 cm depth, packed in plastic bags and then transported to the laboratory. The collected samples were dried for 4 days in air, minced, crushed, dried in oven, sieved by 1 - mm mesh, homogenized and mixed well by shaking [8]. Each sample was then weighed and carefully sealed in a cylindrical container (3in diameter and 2in height), and stored for 4 weeks to reach secular equilibrium [9,10]. Figure 3. shows example of the gamma spectra for one of the samples under investigation (sample No. 3).

RESULTS AND DISCUSSION

The activity concentrations of the samples under investigation in Bq/kg were determined from the photopeaks of the gamma spectra corresponding to ^{40}K, ^{238}U series and ^{232}Th series. Table 1. shows that ^{40}K activity concentration values which, ranged from 17.05-99.15 Bq/kg. For ^{238}U series, the results ranged from 1.61 -50.90 Bq/kg. For the ^{232}Th series, the results ranged from 1.23 -32.15 Bq/kg. It is clear that the activity concentration values for ^{40}K are higher than that of both the ^{238}U series and ^{232}Th series. Which is an acceptable result due to the presence of potassium salts in the surface soil because the sediments disgorged by the river into the sea were reduced due to recent Nile control projects [11]. And the shore contents transport the Nile sediments along the shore of Mediterranean sea in the north this type of coastal sand is relatively high in concentration of ^{40}K and poor in ^{238}U series and ^{232}Th series [12]. The difference in the concentrations of radionuclides is attributed to the difference in the rate of precipitation along the two banks of the drain particularly at the downstream in the conjunction with the sea. The study shows that the precipitation at the west is larger than the east side, is attributed to the motion of water currents in the region.

The radiation exposure rate (I) was estimated by using relation (1) [13]

$$I = 1.90\ C_u + 2.82\ C_{Th} + 0.179 C_k, \quad (1)$$

and the absorbed dose rates (D) for each samples were calculated one meter above the ground surface using the relation (2) [14]

$$D = 0.427\ C_u + 0.662\ C_{Th} + 0.043\ C_k, \quad (2)$$

also the radium equivalent activities (Ra_{eq}) were estimated according to the relation (3) [15]

$$Ra_{eq} = C_{Ra} + 1.43\ C_{Th} + 0.077 C_k. \quad (3)$$

The above values are presented in Table 2 . from which we can notice that they are in the following ranges respectively: (D) ranged from 1.73 to 47.03 nGy/hr, (I) ranged from 0.20 to 5.50 μR/hr and (Ra_{eq}) ranged from 3.58 to 103.90 Bq/kg. The contents in (ppm) of the above radionuclides are given in Table 3. by using equations:

$$^{40}K\ (ppm) = \text{Activity concentration (Bq/kg)} \times 3.862 \times 10^{-3}, \quad (4)$$

$$^{238}U\ (ppm) = \text{Activity concentration (Bq/kg)} \times 80.33 \times 10^{-3}, \quad (5)$$

$$^{232}\text{Th (ppm)} = \text{Activity concentration (Bq/kg)x247x10}^{-3}, \quad (6)$$

Which can be easily deduced from knowing the half life time, mass num ber and Avogadro's number.

Table 1. The activity concentrations (Bq/kg) for the samples of Kitchener Drain.

Sample code	K-40	U-238	Th-232
1	17.05 ± 2.08	1.60 ± 0.76	0.46 ± 0.40
2	20.67 ± 1.07	3.35 ± 1.34	1.23 ± 0.68
3	28.00 ± 3.21	0.79 ± 0.32	2.20 ± 0.76
4	30.67 ± 3.00	1.78 ± 1.20	3.60 ± 1.32
5	30.77 ± 2.91	2.11 ± 1.65	2.37 ± 0.72
6	31.50 ± 2.97	13.04 ± 1.30	2.17 ±1.00
7	33.35 ± 2.72	5.80 ± 1.05	3.94 ± 0.66
8	35.93 ± 3.05	4.00 ± 1.23	4.08 ± 0.72
9	37.64 ± 3.47	2.22 ± 1.35	2.64 ± 0.81
10	39.80 ± 3.23	7.36 ± 1.32	4.54 ± 0.78
11	40.70 ± 2.96	2.31 ± 1.20	1.00 ± 0.74
12	42.57 ± 2.24	1.80 ± 0.72	0.80 ± 0.44
13	44.25 ± 3.75	5.50 ± 1.61	3.60 ± 0.94
14	51.00 ± 3.68	8.00 ± 1.50	5.21 ± 1.15
15	51.97 ± 3.47	6.37 ± 1.28	6.13 ± 0.86
16	53.00 ± 2.83	15.09 ± 1.15	8.91 ± 0.72
17	54.73 ± 3.96	9.70 ± 1.72	4.25 ± 0.99
18	29.00 ± 2.74	14.00 ± 1.60	8.51 ± 0.93
19	59.20 ± 2.82	12.24 ± 1.13	7.50 ± 0.70
20	74.82 ± 2.11	4.81 ± 0.82	4.40 ± 0.30
21	80.16 ± 3.39	26.75 ± 1.33	18.62 ± 0.98
22	99.15 ± 2.55	50.32 ± 1.15	32.15 ± 0.75

CONCLUSION

Measurement of natural radioactivity in soil is very important to determine the amount of change in natural background with time as a result of any radioactive release. Monitoring of any release of radioactivity to the environment is important for environmental protection. The important radiological concentration consequence of natural radioactivity in soil is the effects of γ- rays on the human body. The measurements show that the values of the absorbed dose rates in air in the investigated area are lower than the recommended limit by the United Nation Scientific Committee on the Effect of Atomic Radiation (UNSCEAR,2000) [16]. From the previous

discussion, we can see that there is no radioactiv e hazard for human beings working and living in this area.

Table 2. The radium equivalent activities, radiation exposure rates, and absorbed dose rates for the samples of Kitchener Drain

Sample code	Radium equivalent activities (Bq/kg)	Exposure rate (μ R/hr)	Absorbed dose rate (nGy/hr)
1	3.58 ± 0.96	0.20 ± 0.05	1.73 ± 0.43
2	6.70 ± 1.66	0.36 ± 0.08	3.13 ± 073
3	6.09 ± 1.15	0.34 ± 0.06	3.00 ± 0.54
4	9.28 ± 2.23	0.51 ± 0.11	4.50 ± 1.02
5	7.87 ± 1.96	0.44 ± 0.10	3.80 ± 0.92
6	18.57 ± 2.12	1.00 ± 0.11	8.36 ± 0.87
7	14.00 ± 1.43	0.76 ± 0.07	6.52 ± 0.64
8	12.60 ± 1.62	0.70 ± 0.08	6.00 ± 0.72
9	8.90 ± 1.80	0.50 ± 0.09	4.31 ± 0.80
10	16.92 ± 1.74	0.92 ± 0.09	7.86 ± 0.78
11	6.87 ± 1.62	0.40 ± 0.08	3.40 ± 0.76
12	6.22 ± 0.97	0.35 ± 0.05	3.12 ± 0.43
13	14.06 ± 1.88	0.77 ± 0.11	6.63 ± 0.94
14	19.38 ± 2.24	1.05 ± 0.12	9.06 ± 1.01
15	19.14 ± 1.79	1.04 ± 0.09	9.02 ± 0.80
16	31.91 ± 1.56	1.71 ± 0.08	14.62 ± 0.69
17	20.00 ± 2.25	1.08 ± 0.12	9.31 ± 1.11
18	30.71 ± 2.09	1.51 ± 0.11	14.15 ± 0.93
19	27.52 ± 1.52	1.49 ± 0.08	12.74 ± 0.72
20	16.86 ± 1.06	0.94 ± 0.03	8.18 ± 0.44
21	59.55 ± 1.94	3.18 ± 0.10	27.20 ± 0.96
22	103.90 ± 1.58	5.50 ± 0.08	47.03 ± 0.74

Table 3. The content in (ppm) for the samples of Kitchener Drain

Sample code	K-40	U-238	Th-232
1	0.07	0.13	0.11
2	0.08	0.27	0.30
3	0.11	0.06	0.54
4	0.12	0.14	0.89
5	0.12	0.17	0.60
6	0.12	1.05	0.54
7	0.13	0.47	0.97
8	0.14	0.32	1.00
9	0.15	0.18	0.65
10	0.15	0.60	1.12
11	0.16	0.19	0.25
12	0.16	0.14	0.20
13	0.17	0.44	0.89
14	0.20	0.64	0.13
15	0.20	0.51	1.50
16	0.20	1.21	0.62
17	0.21	0.78	1.05
18	0.23	1.12	2.10
19	0.23	1.00	1.85
20	0.30	0.39	1.09
21	0.30	2.15	4.60
22	0.38	4.04	7.94

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مستوى النشاط الإشعاعي الطبيعي في مصرف كتشينر بدلتا النيل فى مصر

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تم دراسة النشاط الإشعاعي الطبيعي بمصرف كتشينر الواقع على ساحل البحر المتوسط بالقرب من مدينة بلطيم في شمال دلتا النيل وهو مصرف مياه متوسط العمق والإتساع وذلك للمساهمة في وضع خريطة لمستويات النشاط الإشعاعي في البيئة المحيطة. وتم ذلك باستخدام مطياف أشعة جاما لقياس النشاط الإشعاعي المنخفض المستوى. وهذه المنطقة التى تم دراستها تقع عند نقطة اتصال المصرف مع البحر المتوسط من خلال لسان طوله تقريبا ١كم و قد تم قياس تركيزات النويدات المشعة طبيعيا وهى اليورانيوم-٢٣٨ والثوريوم-٢٣٢ والبوتاسيوم-٤٠ بوحدات (Bq/Kg) ووجد أن تركيز اليورانيوم يتراوح بين ١,٦١ إلي ٥٠,٩٠ والثوريوم من ١,٢٣ إلي ٣٢,١٥ والبوتاسيوم من ١٧,٠٥ إلي ٩٩,١٥ (بيكريل/كجم) وكذلك بوحدات (ppm) بالإضافة لتعين النشاط الإشعاعي المكافئ (Ra_{eq}) ومعدلات التعرض الإشعاعي (I) ومعدلات الجرعة الممتصة على بعد واحد متر من سطح الأرض. ومن نتائج الدراسة تبين إن معدلات الجرعة الإشعاعية الممتصة (D) تتراوح بين ١,٧٣ إلى ٤٧,٣ نانوجراى/ساعة وهى في حدود المعدل الآمن عالميا واقل من القيمة المسموح بها من الهيئة العلمية بالأمم المتحدة للحماية من أثر الإشعاع الذرى (UNSCEAR).