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RADIOLOGICAL INVESTIGATION OF THE BLACK SAND REGION OF THE NORTH-EAST OF THE NILE DELTA

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Within a comprehensive radiological investigation of the Mediterranean cost of Egypt an environmental radiation survey of the black sand region of the North-East of Nile Delta was carried out. The activity concentration of the natural ^{226}Ra (of ^{238}U), ^{232}Th and ^{40}K for 18 soil samples and 25 shore sediment samples were determined using gamma spectrometers based on HpGe detector and were found to reach 193 Bq/kg for ^{226}Ra and 267 Bq/kg of ^{232}Th for some shore sediment samples. The activity concentration for the soil samples ranged between 4.2 and 49.5 Bq/kg for ^{226}Ra, 4.1 and 71.5 Bq/kg for ^{232}Th; and 95.5 and 404.0 Bq/kg for ^{40}K. Ten sea water samples were analyzed using laser fluorimetry technique after applying a radiochemical separation procedure and the determined total uranium concentration in these samples was found to be in the range (5.2-21.8) mBq/l.

Keywords: *Uranium, Radium, Laser Fluoremetry, HPGe, Nile Delta, Egypt.*

INTRODUCTION

Black sands deposits at the Mediterranean coast at the north-east of Nile Delta attracted the interest of geologists, physicists and other scientists for the last decades. The relatively high concentrations of radionuclides in these deposits were in the focus of many studies [1-4]. Mainly, these studies aimed at examination of feasibility of using these deposits as row materials in thorium and uranium mining and at investigation of radiological effects on man and environment of natural radioactivity at these locations.

One of the most important aspects of radiological studies is to provide the scientific basis for prediction of impacts to man and his environment due to different radionuclides. Radiation and radioactivity measurements are important to determine the human radiation exposure and estimate the attendant radiation dose. These data can then be linked to epidemiological studies which attempt to release human health effects to the radiation exposures.

The major objective of marine radiological investigations is to contribute in the creation of the scientific basis to predict the impact of radioisotopes (natural or anthropogenic), which may be released into rivers, lakes and seas on the marine ecosystems.

Gamma-ray spectroscopy is an essential and principal technique in almost all radioactivity measurement laboratories. Its major advantages are being multi- elements

analyses, non-destructive, applicable for almost all types of samples and very simple regarding sample preparation, i.e. no need for any chemical separation processes.

EXPERIMENTAL WORK

Site Description:

The studied area is located in the north-east of Delta on the coast of the Mediterranean Sea from New Damietta City to Porsaid. This area is described by longitudes (31^o 27` N& $31^o$ 17` N) and Latitudes (31^o 38` E& $32^o$ 19` E). This coastal area contains diverse and productive habitats important for human settlements, development and local subsistence such as four beaches (New Damietta, Damietta, Ras El Bar and Porsaid), two big seaports (Damietta seaport and Port-Said seaport), two industrial region under construction (Gammsa region and Damietta region), other two tourism villages (15-May and El-Rihab), and petroleum and natural gas production in the region extended between El-Gamil to El-Diba village.

For radiological investigation of black sand region, 18 soil, 25 shore sediment and 8 sea water samples were collected from locations shown on figure 1. The locations of sea water sample collection are indicated according to the shore sediment samples collection identification.

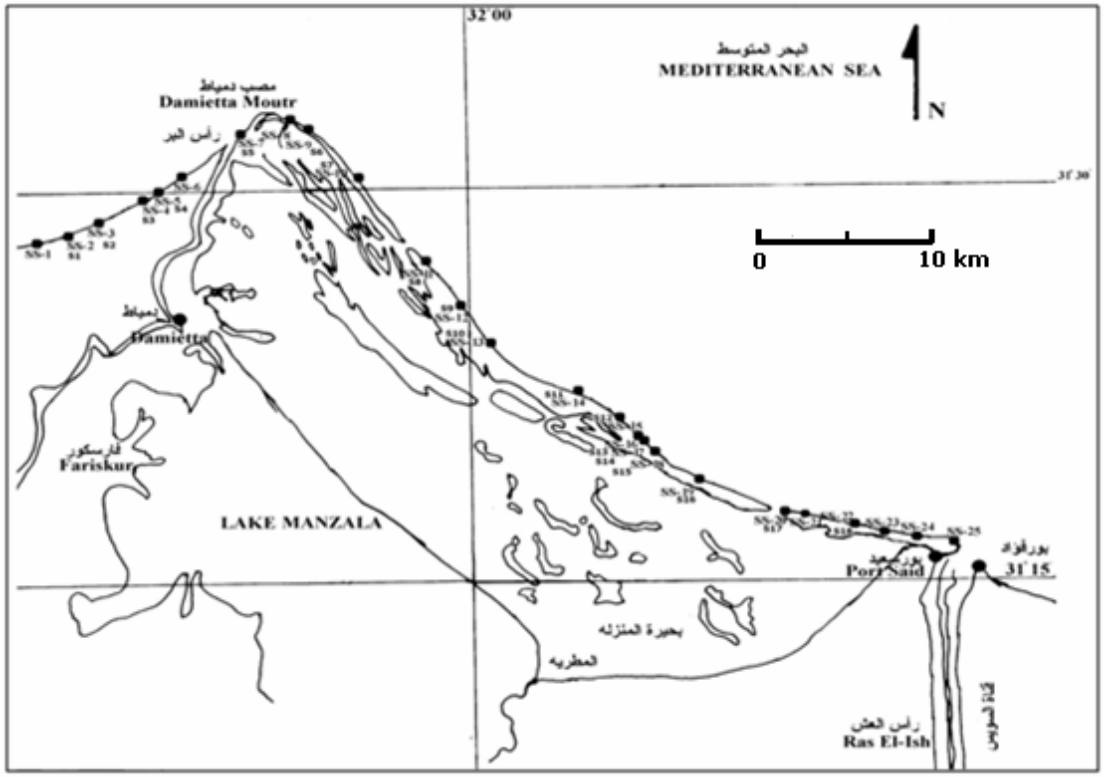

Figure 1: Map of the studied area with sampling location.

Experimental Techniques:

For gamma analysis, the collected soil and shore sediment samples were prepared according to the following procedure. The sample was dried in an oven at 115 $^{\circ}$C, mechanically cursed, and sieved through a 2 mm mesh sieve. The sieved portion of the sample was weighted. The required volume of the sample was transferred to a Marinelli beaker of 1000, 250 or 100 ml capacity, depending on the available sample size. Then the

Marinilli beakers were sealed for about four weeks to reach secular equilibrium between radium and thorium content of the sample and their corresponding daughters [5, 6].
For Laser Flouremetry analysis, the total uranium is extracted from the sea water samples according the following steps; 50 ml of the sample is evaporated to dryness in a glass beaker, 10ml.conc. HNO_3 is added to the remaining salt, the last step is repeated, 2ml 2M HNO_3 and 10ml Ca-EDTA are added then the solution is filtered. The volume of the filtered solution in the glass beaker is recorded, 4ml MIBK (Methyl Isobutyl Keton) is added. Uranium is extracted, by shaking from aqueous phase to organic phase, 2 ml from the organic solution is taken by pipette, 10 ml 0.001 $MHNO_3$ is added. The solution is shacked once more to make back extraction. The organic solution is thrown away and the aqueous solution was taken for analysis using the SCINTRIX UA-3 analyzer [7].

RESULTS AND DISCUSSION

The specific activity concentrations of ^{226}Ra (^{238}U), ^{232}Th and ^{40}K determined using gamma spectroscopy technique in Bq/kg for soil samples are given in table 1. The activity concentrations for soil samples range from 4.2 Bq/kg to 118.4 Bq/kg with average concentration 21.4 Bq/kg for ^{226}Ra (^{238}U), 4.1 Bq/kg to 176.2 Bq/kg with average concentration 26.3 Bq/kg for ^{232}Th and 95.5 Bq/kg to 420.6 Bq/kg with average concentration 270.7 Bq/kg for ^{40}K.

Table 1: Results of γ- Spectrometric Measurements for the Collected Soil Samples.

Location Identification	**Specific Activity Concentration in Bqkg^{-1} Dry Weight**			**Absorbed Dose Rate**
	^{238}U	^{232}Th	^{40}K	D(nGy/h)
S-1	7.6 ± 0.5	6.4 ± 0.5	382.5 ± 3.9	8.1
S-2	10.1 ± 0.3	10.4 ± 0.3	302.3 ± 2.1	12.0
S-3	8.1 ± 0.6	8.9 ± 0.4	270.0 ± 2.9	10.0
S-4	4.2 ± 0.3	4.1 ± 0.27	121.3 ±1.6	4.9
S-5	11.9 ± 0.9	11.9 ± 0.9	346.6 ± 6.2	13.9
S-6	31.2 ± 2.2	38.7 ± 2.1	275.5 ± 11.1	41.3
S-7	49.5 ± 1.2	71.5 ± 1.9	164.6 ± 4.0	72.2
S-8	9.3 ± 0.5	9.8 ± 0.5	283.62 ± 3.9	11.2
S-9	10.6 ± 1.0	10.4 ± 0.9	420.6 ± 5.8	12.3
S-10	15.6 ± 0.5	18.9 ± 0.9	277.2 ± 4.9	20.4
S-11	31.8 ± 0.8	28.6 ±1.2	202.2 ± 4.5	34.8

S-12	16.5 ± 0.7	17.1 ± 0.8	210.0 ± 3.6	19.6
S-13	118.4 ±1.5	176.2 ± 2.9	95.5 ± 5.2	176.0
S-14	22.9 ± 0.6	22.6 ± 1.1	210.0 ± 4.8	26.4
S-15	13.1 ± 0.3	13.6 ± 0.5	290.2 ± 3.5	15.6
S-16	9.3 ± 0.6	9.7 ± 0.6	357.3 ± 5.9	11.1
S-17	8.3 ± 0.5	8.01 ± 0.6	403.6 ± 5.3	9.5
S-18	7.5 ± 0.3	6.7 ± 0.6	259.5 ± 4.3	8.2

The specific activity concentrations of ^{226}Ra (^{238}U), ^{232}Th and ^{40}K determined using gamma spectroscopy technique in Bq/kg for the twenty five shore sediment samples are given in table 2.The activity concentrations for shore sediment samples range from 3.3 Bq/kg to 193.2 Bq/kg with average concentration 38.2 Bq/kg for ^{226}Ra (^{238}U), 2.9 Bq/kg to 267.4 Bq/kg with average concentration 54.3 Bq/kg for ^{232}Th and 67.9 Bq/kg to 425.9 Bq/kg with average concentration 265.6 Bq/kg for ^{40}K. The absorbed rates in air in nGy/y due to terrestrial gamma rays at 1m above the ground were calculated, for soil samples collection locations, according to the equation:

$$\mathbf{D= R_{Ra}C_{Ra}+R_{Th}C_{Th}+R_kC_K}$$

where; R_{Ra}, R_{Th} and R_k, are the conversion factors in (nGy/h)/(Bq/kg) of ^{226}Ra , ^{232}Th and ^{40}K. and C_{Ra}, C_{Th} and C_{40} are the activity concentrations in Bq/kg of ^{226}Ra , ^{232}Th and ^{40}. The calculate values of absorbed dose were found to be ranged between 4.9 and 176.0 nGy/h with average value 28.2 nGy/h.

Table 2: Results of Gamma Spectrometric Measurements for Collected Shore Sediment Samples.

Location	**Specific Activity Concentration in Bqkg^{-1} Dry Weight**		
ID	**^{238}U**	**^{232}Th**	**^{40}K**
SS-1	5.0 ± 0.3	5.5 ± 0.2	397.6 ± 2.7
SS-2	4.3 ± 0.45	4.5 ± 0.5	296.9 ± 4.0
SS-3	5.7 ± 0.15	5.8 ± 0.3	425.9 ± 2.6
SS-4	4.9 ± 0.4	4.6 ± 0.4	263.4 ± 2.5
SS-5	3.3 ± 0.2	2.9 ± 0.2	154.9 ± 2.3
SS-6	5.8 ± 0.3	4.9 ± 0.5	291.0 ± 4.0

SS-7	13.9 ± 0.3	16.2 ± 0.6	213.6 ± 3.1
SS-8	156.4 ± 1.5	265.4 ± 3.4	117.4 ± 5.0
SS-9	193.2 ± 6.3	267.4 ± 9.8	67.9 ± 15.7
SS-10	34.8 ± 0.8	45.8 ±1.0	157.5 ± 3.0
SS-11	6.4 ± 0.3	5.2 ± 0.4	318.5 ± 3.5
SS-12	7.4 ± 0.4	6.5 ± 0.4	219.7 ± 2.5
SS-13	19.1 ± 0.5	29.1 ± 0.53	308.7 ± 3.4
SS-14	5.5 ± 0.5	4.6 ± 0.4	217.2 ± 3.2
SS-15	170.7 ± 5.1	266.5 ± 4.6	69.6 ± 6.23
SS-16	26.4 ± 0.6	31.7 ± 1.3	138.1 ± 3.7
SS-17	140.7 ± 3.9	199.6 ± 2.7	69.6 ± 4.9
SS-18	98.3 ± 3.0	144.2 ±3.5	94.7 ± 6.2
SS-19	12.4 ± 0.6	10.6 ± 0.6	423.3 ± 4.4
SS-20	10.3 ± 0.4	7.9 ± 0.7	283.9 ± 4.2
SS-21	5.6 ± 0.3	5.6 ± 0.5	312.8 ± 5.3
SS-22	5.5 ± 0.3	4.7 ± 0.5	323.4 ± 5.1
SS-23	6.2 ± 0.1	5.8 ± 0.3	436.4 ± 2.1
SS-24	5.2 ± 0.4	5.5 ± 0.6	428.8 ± 5.5
SS-25	7.4 ± 0.4	7.2 ± 0.6	610.1 ± 5.6

The total uranium concentrations of the sea water samples are given in table 3. The specific activity concentrations range from 0.3 ppb and (3.5 mBq/l) to 1.8 ppb (21.9 mBq/l) with an average value of 0.9 μg/g (10.6 mBq/l).

Table 3: Total uranium concentration in sea water samples.

Sample ID*	**Total Uranium Concentration**	
	ppb	**mBq/g**
W1	0.58 ± 0.05	7.2±0.7
W2	0.65 ± 0.05	6.9±0.6
W13	1.01± 0.09	12.6±1.1
W14	1.04 ± 0.09	12.8±1.2
W17	1.10 ± 0.10	13.6±1.2

W19	1.76 ± 0.16	21.8±2.0
W20	0.84 ± 0.08	10.4±0.9
W22	1.10 ± 0.10	13.6±1.2

*****the digits in ID are related to the locations of shore sediment sample collection

CONCLUSION

The activity concentrations were found to be within the average world values [8]. There is good correlation between the activity concentrations of ^{226}Ra (^{238}U) and ^{232}Th. In the east Damittea mouth**,** the activity concentrations of ^{226}Ra(^{238}U) and ^{232}Th are high comparing to the west due to the black sand deposition which contains limenite, magnetite, zircon, granite, monazite, and other minerals driving originally from the disintegration of rocks especially in the upper riches of the Nile in Ethiopia. The total uranium measured in the surface sea water was found to be in the average range of the world values.

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