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REVIEW ARTICLE

RADIOLOGICAL COMPARISON ON THE EGYPTIAN MINERAL SANDS AND SILT DEPOSITS AT THE MOUTHS OF THE NILE RIVER, ROSEITA AND DAMIETTA AREAS, MEDITERRANEAN SEA, EGYPT

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ABSTRACT

The high resolution of radioactive measurements acquired by the spectrometric gamma-ray technique were applied in the research area and subjected to statistical analysis, in order to draw valid conclusion, regarding the nature and significance of the distribution of the radioelements, that it represents each input element individually. The qualitative interpretation showed seven anomalous parts in Roseita branch and four anomalous parts in Damietta branch. The quantitative interpretation used traditional statistical treatment the calculated arithmetic mean, standard deviation, range difference (between the minimum and maximum values), standard error, Coefficient of Variation (CV%) and 95% Confidence Interval for the Mean (lower bound and upper bound). Meanwhile, the advanced statistical treatment, such as test of homogeneity Levene's Statistic, ANOVA test, K mean clustering and post Hoc of the multi comparison among the separated eleven groups. As well as they help to define their original source behaviors.

KEYWORDS

K-mean clustering, Post Hoc-test, Roseita and Damietta areas.

1. INTRODUCTION

Roseita and Damietta areas are located at the northern coast of Egypt, on the Mediterranean Sea (Figure 1), Roseita area is ranged between latitudes 31° 20′ & 31° 30′ N and longitudes 30° 15′ & 30° 30′ E, and Damietta area is ranged between latitudes 31° 27′ & 31° 32′ N and longitudes 31° 50′ & 31° 59′ E. They are stretched at the mouths of the Nile River, Egypt. The Egyptian mineral silt and sand deposits have drawn an increasing interest, since they contain different concentrations of the potentially-economic heavy minerals, that are considered as raw materials for nuclear energy, as well as their importance in many of the metallurgical industries. The most important economic minerals, that are found in relatively appreciable amounts, are the ilmenite, magnetite, zircon, garnet, rutile and monazite. Other economic minerals are present but in trace amounts, such as chromite, cassiterite, wolframite, corundum, beryl, uranothorite, gold, uranium and thorium. However, monazite and zircon are typically the main uranium and thorium hosts in the total heavy mineral suite of these deposits. In contrary, potassium measurements are not discriminable in the case of heavy mineral fraction of the coastal sand deposits.

Accordingly, aerospectrometric measurements of the surface concentrations of the total-count, potassium, uranium and thorium, using the calibrated high sensitivity gamma-ray spectrometers provide an efficient tool for exploration and quantification of the radioactive mineralization assembly of the beach sands and silts that can do comparisons among different areas.

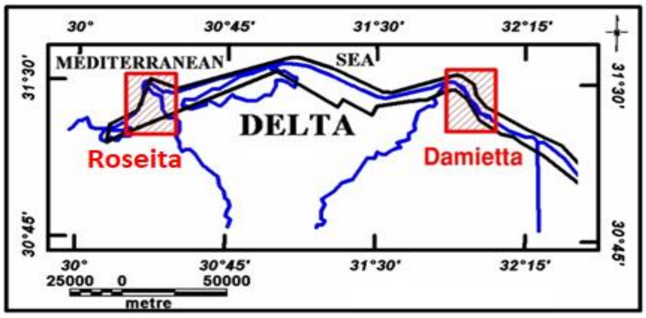

Figure 1: Egypt's map showing location of Roseita and Damietta areas, along the Mediterranean coast the northern of Egypt.

2. GEOLOGIC SETTING

The geology of the beach sand and silt deposits along the Egyptian Mediterranean coast is directly related to the continuously development of the Nile Delta and the past configuration of the Nile branches (Figure 2). Many authors the study geology of Egyptian Mediterranean coast and development of the Nile Delta, as well as the past configuration, (Shata and El Fayomy, 1970; Abo Zed and Shereet, 2005; Kaiser et al., 2014). The mineral assortments from the volcanic highland of Abyssinia (trachytes and basic rocks) have been carried by the Nile River, for a distance of approximately 4000 km, and received minor additions from other rocks along the course of the Nile; e.g., Precambrian gneisses, schists, granites and syenites in the cataract regions of the Sudan and Upper Egypt.

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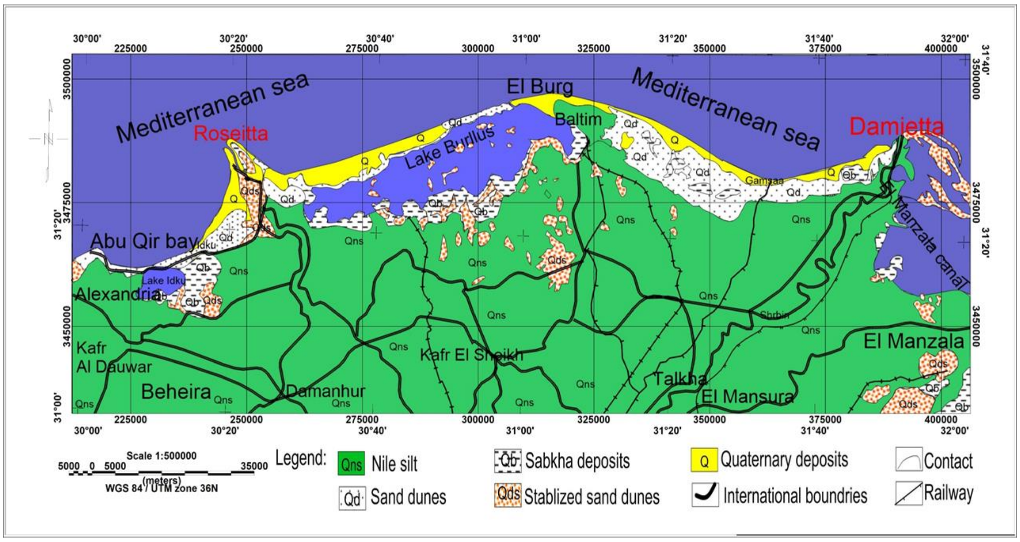

Figure 2: Geologic map of Roseita and Damietta areas, along the Mediterranean coast the northern of Egypt. (after Conoco, 1987)

2.1 Geologic Background of Roseita

The coastal plain has a convex shape with a large bay at Abu Qir, Alexandria to the west, extending to Burullus lake to the east. The plain is muddy bluesh green and partially covered with Nile silt (Qns), sand dunes (Qd), Stablized sand dunes (Qds) and Quaternary deposits (Q), and white two lakes dark colour) extending parallel to the beach. The Mediterranean Sea connects with the Burullus lake (through the inlet of Al Burj at the eastern side) and with the Idku lake (through the Alexandria inlet at the eastern side).

The coastal plain is formed of Quaternary lake deposits, sand, clay and sand dunes. Structural lines trending NNW and ENE are believed to control the shapes and trends of the lakes and the shoreline. Along and parallel to the shoreline, black sands were deposited and salts are also found in the shallow parts of the lakes. The detailed geologic map of the area (Figure 3a) is displayed and published (Conoco, 1987).

2.2 Geologic Background of Damietta

The coastal plain of Damietta (Figure 3b) is varied from yellow sandy to bluish green muddy in the Delta. It comprises Manzalah Lake, at the eastern side, then extends easterly to A1bardawil Lake. The lakes are separated from the sea by sand bars (white), that form sabkhas at A1bardawil lake, east of Damietta mouth. The sea joins the lakes and form shoreline. these lakes include bays, lagoons and head points. Islands are sandy (white to light grey) in Albardawil lake, but either sandy (near the shore) or clayey (red) in Al-Manzalah Lake (Buhayrat Al-Manzalah). East of the Suez Canal and at Tinah a plain extends southward and forms water bodies (dark brown), sabkhas (greenish brown) mud (greenish yellow), and salts (white to light yellow). East of this plain, the sand dunes accumulate in a low relief belt. The plain is muddy bluish green and partially covered with Nile silt (Qns), Sand dunes (Qd) and Stabilized sand dunes (Qds). They are formed from clay, salt, sand and sand dunes of Quaternary age. Lakes, islands, shorelines and head points are believed to be controlled by ENE and NNW linear structures. Salt deposits are located at Damietta and Port Said, gypsum at AI-Manzalah and black sands along the beach. Figure 3d shows four anomalous parts. The first, second and third anomalies are associated with stabilized sand dunes, while the fourth anomaly is associated with Nile silts.

3. Airborne Gamma-Ray Spectrometric Survey

In the period-from October, 1999 to May, 2002-the Airborne Geophysics Department of the Nuclear Materials Authority of Egypt conducted multi-channels gamma-ray survey over Roseita and Damietta area and its surroundings. They are located at the northern coast of Egypt, on the Mediterranean Sea. The present study aims essentially to utilize the acquired spectrometric data and provides valuable information about the geologic mapping and mineral exploration, especially the radioactive, as well as comparison between the radioactivity levels of different branches by different statistical methods.

The spectrometric measurements were acquired along the designed equally-spaced parallel traverse lines, that spaced at 250 meters. The direction of the traverse lines was selected approximately crossing the major features trends of the area periphery (at N20° direction). The tie lines were spaced at 2000 m perpendicular to the traverse lines (at N70° direction). The terrain clearance adopted for the aircraft during the normal survey flying was 100 m above the ground surface. The normal aircraft airspeed averaged was around 250 km/h.

The acquired spectrometric data were calibrated and processed, using the national standard procedures. The airborne gamma-ray spectrometric data were corrected for the dead time, cosmic, aircraft background and radon correction. Also, the height attenuation correction, stripping ratios and system sensitivity correction were performed. Processing of the radio-spectrometric data of the studied area contains:

- Constructing a total count (TC in Micro Rotring per hour (μR/h) map, a set of radioelements (Potassium (K in percent (%)), equivalent uranium (eU in part per million (ppm)) and equivalent thorium (eTh in (ppm)) color maps for the Roseita and Damietta branches, to show the surface distribution of these radioelements with the different lithologic units.
- Constructing three radioelements composite color image maps for the Roseita and Damietta branches in order to compare the brightness and darkness zones associated with the different branches
- Separation of the highly radio-spectrometric measurements over the lithologic units, comparison of these data for the different branches (7 parts for Roseita (Figure 3a) and 4 parts for Damietta (Figure 3b)). D1 is the first anomalous part of Damietta area, D2 is the second anomalous part of Damietta area, D3 is the third anomalous part of Damietta area, D4 is the fourth anomalous part of Damietta area, add to R1 is the first anomalous part of Roseita area, R2 is the second anomalous of Roseita area, R3 is the third anomalous of Roseita area, R4 is the fourth anomalous part of Roseita area, R5 is the fifth anomalous part of Roseita area, R6 is the sixth anomalous part of Roseita area and R7 is the seventh anomalous part of Roseita area.
- Determination of their characteristic statistics of the highly radio-spectrometric measurements, such as the arithmetic mean, 95% Confidence Interval for the Mean as the lower bound and upper bound) Standard Deviation, Standard error, range (the difference between the Minimum and Maximum) and checking the homogeneity distribution of measurements by coefficient of variation (%) (Table 1),
- Appling the homogeneity, (one-way analysis of variance), ANOVA and Levene's tests, to assess the equality of variances for a variable calculated for all the eleven groups, seven anomalous parts of Roseita and four anomalous parts of Damietta.
- Appling the K-means, creating a Number of cases in each cluster for two branches, as well as calculate their Cluster Number of Case Cross tabulations for two branches.
- Tie differences of the multiple comparisons, that will be conducted by the Post Hoc tests for the seven anomalous parts of Roseita branch and the four anomalous parts of Damietta branch, as well as the eleven anomalies of both branches.

Table 1: Statistical analysis of the variables in the different selected anomalous of the study area.

Variable	Area	N0.	Mean	Standard Deviation	Standard Error	Coefficient of Variation (%)	95% Confidence Interval for Mean		Range	
							Lower Bound	Upper Bound	Minimum	Maximum
TC	D1	129	10.7	9.3	0.8	86.4	9.1	12.3	0.01	40.6
	D2	46	9.0	2.3	0.3	25.2	8.3	9.6	4.04	13.8
	D3	52	8.0	2.4	0.3	30.1	7.4	8.7	3.17	17.3
	D4	69	10.7	2.0	0.2	19.0	10.3	11.2	5.20	14.1
	R1	1674	19.5	10.6	0.3	54.2	19.0	20.0	0.09	57.6
	R2	1077	16.7	8.2	0.2	48.9	16.3	17.2	1.26	47.9
	R3	714	10.5	1.5	0.1	14.6	10.4	10.7	5.10	16.8
	R4	1105	8.5	1.0	0.01	11.4	8.4	8.5	3.78	11.2
	R5	1942	9.8	0.5	0.01	4.8	9.7	9.8	8.34	11.5
	R6	411	9.6	1.0	0.01	10.3	9.5	9.7	7.13	12.2
	R7	329	9.2	1.2	0.1	12.9	9.1	9.4	5.80	12.3
	Total	7548	12.8	7.5	0.1	58.4	12.6	13.0	0.01	57.6
K	D1	129	1.1	0.7	0.1	68.4	1.0	1.2	0.01	2.9
	D2	46	1.5	0.5	0.1	29.8	1.4	1.7	0.78	2.7
	D3	52	1.5	0.4	0.1	27.7	1.4	1.6	0.66	2.4
	D4	69	1.8	0.4	0.1	24.8	1.7	1.9	0.80	2.9
	R1	1674	1.5	0.3	0.01	23.2	1.5	1.5	0.21	2.9
	R2	1077	1.2	0.3	0.01	20.7	1.2	1.2	0.21	2.0
	R3	714	1.6	0.3	0.01	20.3	1.6	1.6	0.69	2.2
	R4	1105	1.3	0.2	0.01	14.7	1.3	1.3	0.80	1.8
	R5	1942	1.6	0.1	0.01	7.8	1.6	1.6	1.23	2.1
	R6	411	1.7	0.3	0.01	15.2	1.7	1.8	1.23	2.7
	R7	329	1.5	0.2	0.01	10.6	1.5	1.6	1.06	1.9
	Total	7548	1.5	0.3	0.01	21.4	1.5	1.5	0.01	2.9
eU	D1	129	4.0	2.8	0.2	71.2	3.5	4.5	0.01	12.7
	D2	46	3.2	0.7	0.1	21.2	3.0	3.4	1.70	4.2
	D3	52	3.0	0.7	0.1	24.8	2.8	3.2	1.28	4.5
	D4	69	3.6	1.2	0.1	33.2	3.3	3.8	1.58	6.5
	R1	1674	11.0	5.5	0.1	49.7	10.7	11.3	1.90	29.7
	R2	1077	9.8	4.4	0.1	45.1	9.6	10.1	3.38	24.3
	R3	714	5.5	0.7	0.01	12.5	5.5	5.6	3.69	8.3
	R4	1105	5.1	0.6	0.01	12.3	5.1	5.1	3.31	6.9
	R5	1942	5.0	0.4	0.01	8.9	4.9	5.0	2.91	6.5
	R6	411	4.7	0.5	0.01	10.3	4.6	4.7	3.25	7.1
	R7	329	5.0	0.6	0.01	12.8	4.9	5.0	3.48	6.7
	Total	7548	7.0	4.1	0.01	59.2	6.9	7.1	0.01	29.7
eTh	D1	129	11.3	13.0	1.1	115.2	9.0	13.5	0.01	54.6
	D2	46	4.8	3.4	0.5	70.7	3.8	5.9	0.02	13.4
	D3	52	4.6	4.2	0.6	91.3	3.4	5.8	0.04	24.2
	D4	69	7.0	2.7	0.3	38.8	6.4	7.7	0.01	13.6
	R1	1674	21.7	13.1	0.3	60.5	21.1	22.4	3.88	60.9
	R2	1077	18.4	11.3	0.3	61.3	17.7	19.1	4.25	58.9
	R3	714	7.3	1.4	0.1	19.1	7.2	7.4	2.70	12.1
	R4	1105	6.5	1.3	0.01	19.5	6.5	6.6	2.81	9.6
	R5	1942	7.1	0.8	0.01	11.1	7.0	7.1	4.76	10.2
	R6	411	7.0	1.4	0.1	20.0	6.8	7.1	2.82	10.7
	R7	329	5.7	1.3	0.1	22.1	5.6	5.9	2.44	8.1
	Total	7548	11.9	10.2	0.1	85.9	11.6	12.1	0.01	60.9

Explanation: TC is the total count in (uR/h), K is the potassium in (%), eU is the equivalent Uranium in (ppm), eTh is the equivalent Thorium in (ppm). N. is number of samples, D1 is the first anomalous of Damietta area, D2 is the second anomalous of Damietta area, D3 is the third anomalous of Damietta area, D4 is the fourth anomalous of Damietta area, R1 is the first anomalous of Roseita area, R2 is the second anomalous of

Roseita area, R3 is the third anomalous of Roseita area, R4 is the fourth anomalous of Roseita area, R5 is the fifth anomalous of Roseita area, R6 is the sixth anomalous of Roseita area, R7 is the seventh anomalous of Roseita area.

4. Discussion and Results

4.1 Qualitative Interpretation of the Aerial Gamma-Ray Spectrometric Data

Figure (3a and 3b) show the locations of seven separated anomalous parts in Roseita branch and the four anomalous parts of Damietta branch. In Roseita branch, the strong first and second anomalies are associated with the Quaternary deposits and extend to the eastern and western banks of the Roseita branch, respectively. The third, fourth and sixth anomalies are associated with stabilized sand dunes. Meanwhile, the fifth and seventh anomalies are associated with Nile silts and Quaternary deposits, respectively. In Damietta branch, the strong first, second and third anomalies are associated with the stabilized sand dunes and recent coast deposits. While, the fourth anomaly is associated mainly with the Nile silt.

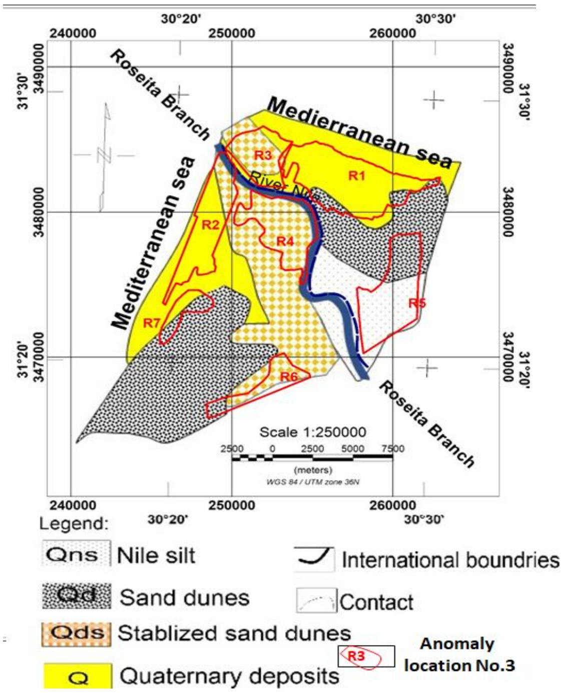

Figure 3a: Detail geologic map of Roseita branch, with seven selected anomalus locations along the Mediterranean coast, Egypt.

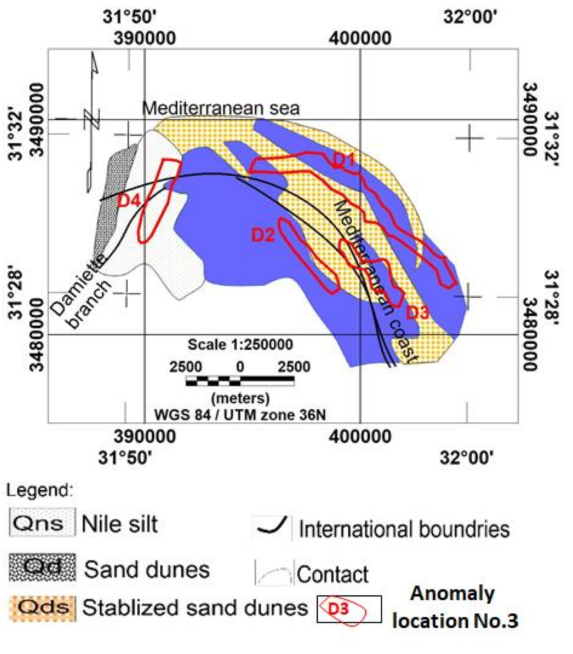

Figure 3b: Detail geologic map of Damietta branch, with four selected anomalus locations along the Mediterranean coast, Egypt.

4.1.1 *Total Count and NOR Maps*

The airborne gamma-ray spectrometric map can be of direct assistance to the exploration for many commodities (Youssef and El Khoadry, 2013; Youssef, 2020). Most obviously for the four parameters (variables) namely (TC, (Figure 4)), absolute concentrations of the three natures of radioelements (NOR), ((K, (Figure 5)), ((eU, (Figure 6)) and (eTh, (Figure 7)) show relative variation of the gamma radiations. The three main radiometric elemental concentrations mainly reflect the lateral variation of the surface elemental concentrations of the different rocks and soil types.

The major objective of the interpretation of airborne gamma-ray spectrometric survey data is to tie the similarity of the probable locations and boundaries of the anomalous provinces, in which the rocks and soils are preferentially enriched to the highly radioactivity level (Saunders and Potts, 1978); delineation of the variation composition of lithologic units and structures (Youssef and El Khoadry, 2013). Economically, important migrated uranium deposits are associated with the abnormally high eU values; in which any enrichment in uranium, sufficient to form discrete uranium minerals, is effective or locating many Mediterranean coast samples (Kaiser et al., 2014).

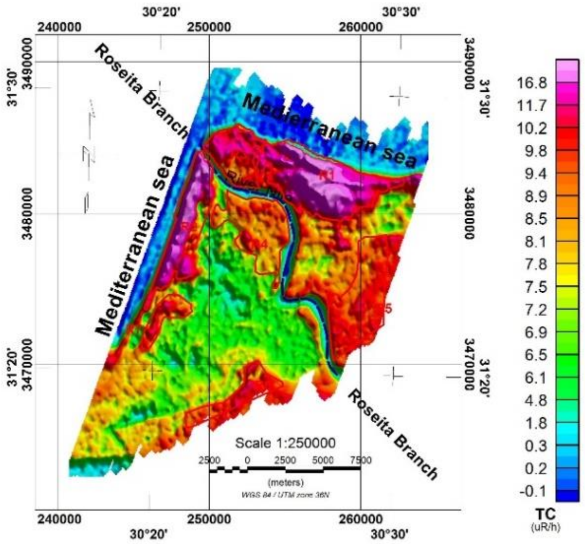

Figure 4a: Filled color map of TC, Roseita branch, along the Mediterranean coast, Egypt.

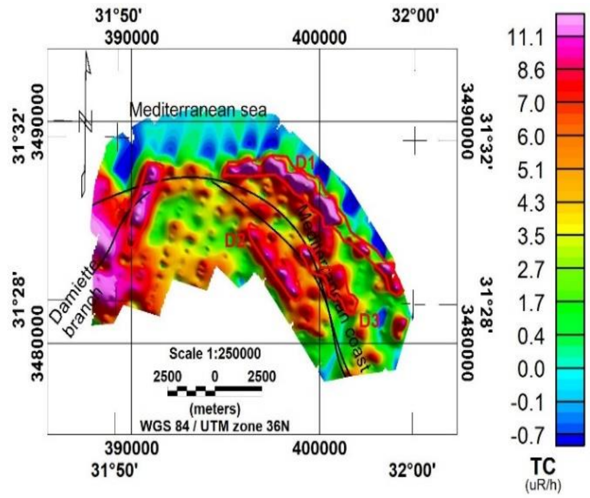

Figure 4b: Filled color map of TC, Damietta branch, along the Mediterranean coast, Egypt.

In the Damietta area, the major trends-that could be traced from the TC and NOR (Figure 4b, 5b, 6b and 7b)-are the E-W trend that traced in the northern part; the NE-SW trend could be noticed in the western part; the NW-SE that appear in the eastern part of the study area. The lowest level encountered in the four radiometric maps is conjugated with the sand dunes and Al Manzala lake is more or less having the same feature of no radiometric effect. This level could be seen as blue, green and orange colors in the four maps and have values range from 0.4 to 5 μR/h in TC, from 0.1 to 2.7 ppm in eU, from 0.4 to 3 ppm in eTh and from 0.4 to 1.1 in

K. The highest level of radiation found in Qds (stabilized sand dunes) and having magenta color of radiation values reach 29.9 μR/h in Tc, 9.2 ppm in eU, 32.2 ppm in eTh and 2.2 % in K.

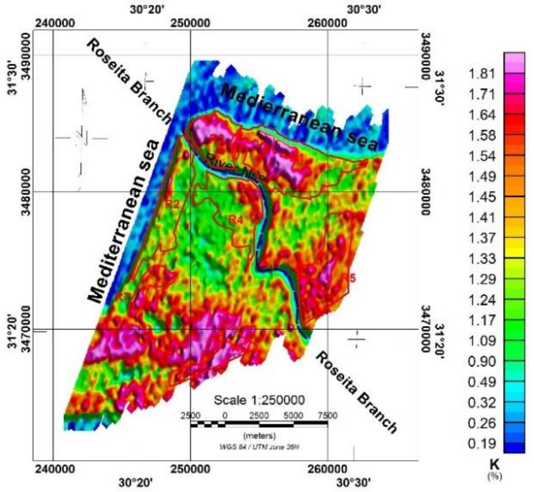

Figure 5a: Filled color map of K, Roseita branch, along the Mediterranean coast, Egypt.

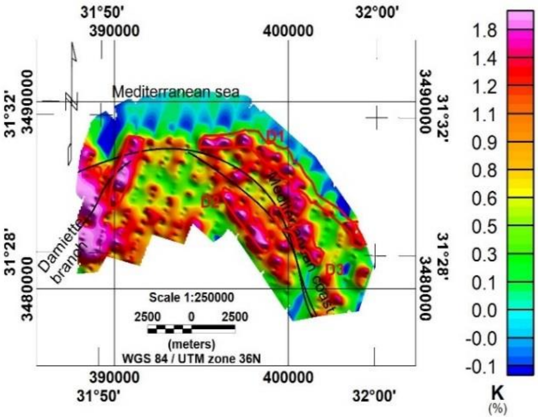

Figure 5b: Filled color map of K, Damietta branch, along the Mediterranean coast, Egypt.

In the Roseita area, the major trend notices from the TC and NOR (Figure 4a, 5a, 6a and 7a) is the E-W trend. The NNE trend could also be traced in the western part of the area. The lowest concentrations encountered in the TC and NOR maps are conjugated with the sand dunes (Qd), stabilized sand dunes (Qds) and River Nile (Roseita branch), having values of less than 8 μR/h, 1.4%, 5 ppm and 7 ppm for the TC, K, eU and eTh, respectively. This level could be seen as blue, green and orange colors in the four maps. Meanwhile, the highest values reached, having magenta color, 56 μR/h in Tc, 28 ppm in eU, 60 ppm in eTh and 2.8 % in K, and recorded over the Quaternary deposits and Nile silt.

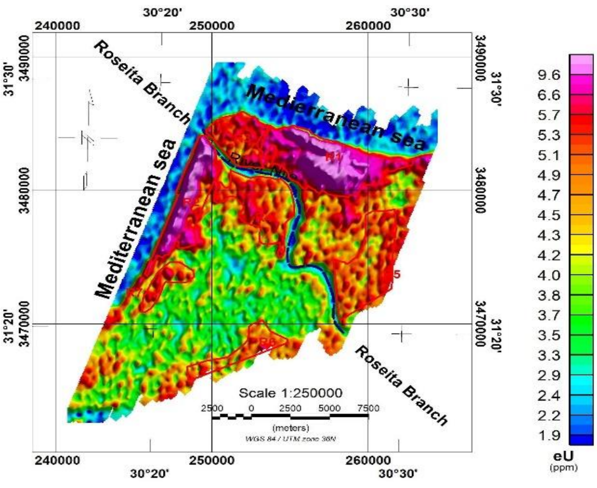

Figure 6a: Filled color map of eU, Roseita branch, along the Mediterranean coast, Egypt.

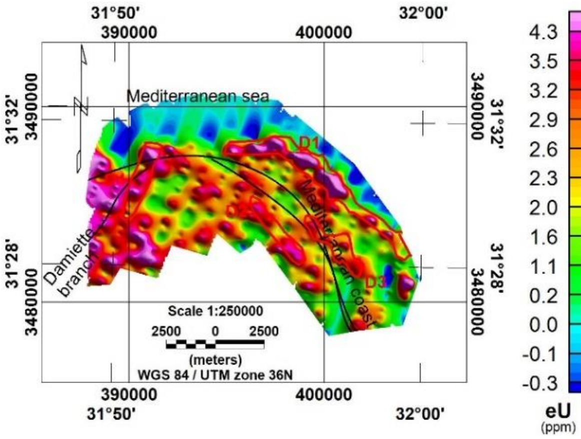

Figure 6b: Filled color map of eU, Damietta branch, along the Mediterranean coast, Egypt.

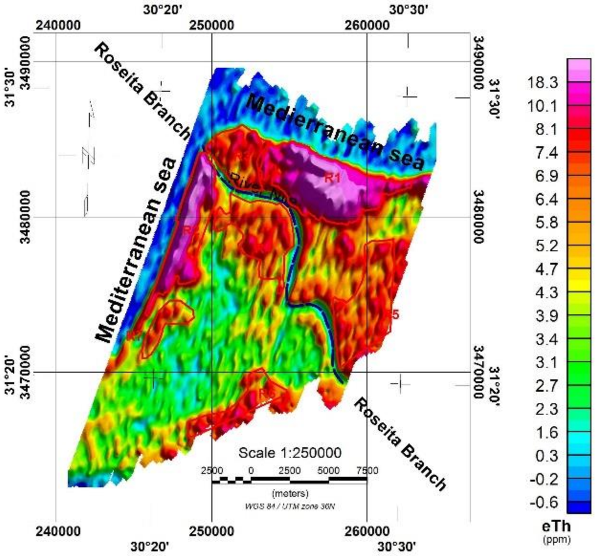

Figure 7a: Filled color map of eTh, Roseita branch, along the Mediterranean coast, Egypt.

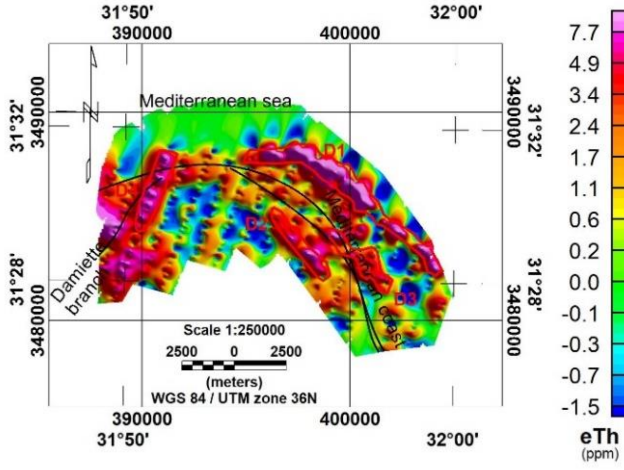

Figure 7b: Filled color map of eTh, Damietta branch, along the Mediterranean coast, Egypt.

4.1.2 Ternary or Composite Map

A ternary map, is a color composite image, generated by modulating the red, green and blue phosphors of the display device, or yellow, magenta and cyan dyes of a printer in proportion, to the radioelement concentration values of the K, eTh, eU and their ratio grids. Since particular rock types, often have characteristic ratios of the three radioactive elements, the ternary map of these ratios is a useful geological tool and mineral exploration for discriminating the zones of consistent lithologies and contacts between the contrasting lithologies (Duval, 1983). However, the radioelement composite color image displays different percentage concentrations of the three radioelements as K in % (by red color), eTh in ppm (by green color) and eU in ppm (by blue color). The radioelements composite maps of Roseita and Damietta branches (Figure 8a and 8b, respectively) show three different characters. The first is bright color parts, that are associated with the rich rocks of the three elements (K, eU and eTh), for the selected eleven anomalies; the second is dark color parts, that are associated with the poor rocks of the three elements (K, eU and eTh), for the selected eleven anomalies and single color and/or mixed two colors of RGB that mean rich in element color and/or rich in two elements.

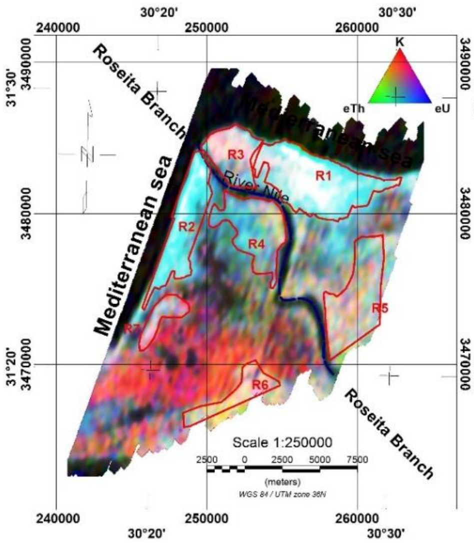

Figure 8a: Radioelements composite image of Roseita branch, along the Mediterranean coast, Egypt.

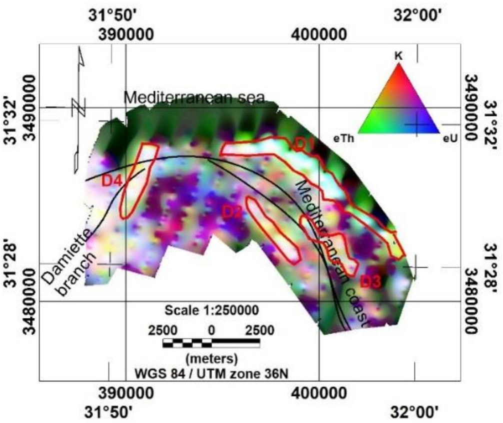

Figure 8b: Radioelements composite image of Damietta branch, along the Mediterranean coast, Egypt.

4.2 Quantitative Interpretation of The Aerial Gamma-Ray Spectrometric Data

The quantitative interpretation based on the fact that, the absolute and relative concentrations of the radioelements (K, eU and eTh) vary measurably and significantly with the lithology (Darnley and Ford, 1989). A study recommended that the statistical computation was applied to the original spectrometric data without applying any transformation (Sarma and Kock, 1980). The quantitative treatment of the spectrometric data, in the present study is discussed on the light of statistical treatment (arithmetic mean (Eq.1) , 95% Confidence Interval for Mean as lower bound and upper bound), Standard Deviation, Standard error (SEM), range (difference between the Minimum and Maximum), and checking the mean homogeneity distribution of measurements by the coefficient of variation (%).

Arithmetic Mean $\mu = \sum Xi/N$ (1)

Where: Xi and N are values of the sample and total number of samples, respectively. Standard deviation (σ) measures the spread of the data about the arithmetic mean value (Eq. 2), while the standard error (SEM) is defined as the standard deviation of its sampling distribution and the calculated ratio between the standard deviation (σ) and the total number of samples (N)

$$\sigma=\sqrt{\frac{\sum(Xi-\mu)}{N}} \quad (2)$$

95% confidence interval for the mean as (lower bound (Eq.3) and upper bound (Eq.4)) is a confidence interval, as an estimate of an interval in statistics, that may contain mean

Lower bound= μ-(95/100) SEM (3)

Upper bound =μ+(95/100) SEM (4)

The careful examination through a detailed look to the eleven area rows, it is obvious that: The highest mean concentration of TC, eU & eTh is located in R1 part and the lowest mean concentration of them is located in D3 part. But it's different for the radioelement K that, the highest average concentration of it is located in D4 part and the lowest average concentration of it is located in D1 part. From the range (Minimum and Maximum columns), the highest concentration value of TC, K, eU, and eTh was in R1 part and the lowest concentration value was in D1 part.

According to Roseita areas, it can be observed that, the highest mean concentration of TC, eU and eTh is located in R1 part and the highest mean concentration of K is located in R6 part, meanwhile, the lowest mean concentration of TC was in R4 part, K is noticed in R2 part, eU is recorded in R6 part, and eTh is located in R7 part. From the range, the highest concentration value of TC, K, eU and eTh was in R1 part and the lowest concentration value for TC and eU was in R1 part, for K was in R1 & R2 parts, and for eTh is noticed in R7 part.

It can be separately looking to Damietta area and observe that, the highest mean concentration of TC and K is located in D4 part and the highest mean concentration of eU and eTh is located in D1 part, but the lowest mean concentration of TC, eU, and eTh is located in D3 part. But it's different for the radioelement K, the lowest mean concentration of it is noticed in D1 part. From range (Minimum and Maximum columns, the highest concentration value of TC, K, eU, and eTh was in D1 part and the lowest concentration value was in D1 part.

4.2.1 Coefficient of Variation (Mean Homogeneity Test)

In probability theory and statistics, a study introduced the coefficient of variation (CV), also known as relative standard deviation (RSD), it is also known as unitized risk or the variance coefficient, is a standardized measure of the dispersion of a probability distribution or frequency distribution (McKay, 1932). It is expressed as a percentage (%) and only used as positive numbers in the calculation, Therefore, the resultant value of this formula CV = (Standard Deviation (σ) / Mean (μ)) will be multiplied by 100 (Everitt, 2003). Then, applying the CV equations on the TC and NOR data of the eleven parts for the two branches, the results of computed check normality for two branches are represented in Table (1). The careful examinations of the CV calculations were regarding the degree of data homogeneity of the distribution of the various spectrometric variables for the different branches. The lower CV% values mean the higher degree of homogeneity. In the present study, the relatively lower values of CV% for K for the two branches, in comparison to those for the TC, eU and eTh. Generally, the results of CV are less than 100 in the two parts, that were founded in the area and depend on the radioelement contents, so every part separately represents a homogeneous medium.

According to the all study area, the coefficient of variation, the highest degree of homogeneity of TC, K, eU, and eTh was in R5 part. Meanwhile, the lowest degree of homogeneity of all the radioelements was in D1 part. According to the four parts of Damietta area, the coefficient of variation, the highest degree of homogeneity for the TC, K, and eTh was in the D4 part and for eU was in the D2 part. And the lowest degree of homogeneity of all the radioelements was in the D1 part. According to the seven parts of Roseita, the coefficient of variation, the highest degree of homogeneity for the TC, K, eU and eTh was in the R5 part, and the lowest degree of homogeneity for the TC, K, and eU were in the R1part and for eTh was in the R2 part.

4.2.2 Analysis of Variance or Anova Test

Table 2: Test of Homogeneity of Variances, All Areas

Variables	Levene's Statistic	df1	df2	Sig.
TC	656.9	10	7537	.000
K	188.3	10	7537	.000
eU	685.5	10	7537	.000
eTh	805.7	10	7537	.000

Table 3: ANOVA, All Areas

		Sum of Squares	df	Mean Square	F	Sig.
TC	Between Groups	145991.9	10	14599.2	399.8	.000
	Within Groups	275168.3	7537	36.52		
	Total	421160.2	7547			
K	Between Groups	195.191	10	19.52	265.9	.000
	Within Groups	553.1	7537	.073		
	Total	748.3	7547			
eU	Between Groups	56025.1	10	5602.5	574.2	.000
	Within Groups	73534.8	7537	9.7		
	Total	129559.9	7547			
eTh	Between Groups	328991.9	10	32899.2	544.5	.000
	Within Groups	455332.1	7537	60.4		
	Total	784324.0	7547			

In statistics, the one-way analysis of variance (ANOVA and Levene's tests are inferential statistics used to assess the equality of variances for a variable calculated for two or more groups. Some common statistical procedures assume that, the variances of the groups, from which different samples are drawn are equal. Levene's test assesses this assumption 1960 Levene's. It tests the null hypothesis, that the proposes population variances are equal (called homogeneity of variance or homoscedasticity). If the resulting P-value of Levene's test is less than some significance level (typically 0.05), the obtained differences in the sample variances are unlikely to have occurred based on the random sampling from a population with equal variances. Thus, the null hypothesis of equal variances is rejected and it is concluded that, there is a difference between the variances in the population. Levene's test is often used before the comparison of means. When Levene's test shows significance, one should switch to more generalized tests that is free from the homoscedasticity assumptions. In this study, first, the eleven parts (4 parts for Damietta and 7 parts for Roseita), the test of homogeneity of variances started with Levene's test of the similarity of variances (Table 2) for the four radioelements TC, K, eU and eTh. This test shows that, there is heterogeneity between the variances of the eleven parts. The ANOVA table of all the study area is shown in (Table 3). As P-value (Sig.) <0.05, this means that, there are a statistically significant differences between the variances of the eleven parts. The geologic meaning from the ANOVA test is indicates that, the eleven areas have different compositions.

Table 4: Test of homogeneity of variances, Damietta Branch.

Variables	Levene's Statistic	df1	df2	Sig.
TC	43.743	3	292	.000
K	16.110	3	292	.000
eU	41.685	3	292	.000
eTh	36.915	3	292	.000

Table 5: ANOVA, four parts of Damietta Branch

		Sum of Squares	df	Mean Square	F	Sig.
TC	Between Groups	353.4	3	117.8	2.9	.034
	Within Groups	11775.0	292	40.3		
	Total	12128.4	295			
K	Between Groups	23.4	3	7.8	22.7	.000
	Within Groups	100.3	292	0.3		
	Total	123.7	295			
eU	Between Groups	45.2	3	15.1	3.7	.011
	Within Groups	1173.3	292	4.0		
	Total	1218.5	295			
eTh	Between Groups	2498.0	3	832.7	10.4	.000
	Within Groups	23462.5	292	80.4		
	Total	25960.5	295			

Secondly, the four parts of Damietta Branch, the test of homogeneity of variances, by Levene's test of variances (Table 4) for the TC and three radioelements (K, eU & eTh) and from the ANOVA table (Table 5) show that, there is heterogeneity between the variances of the four parts. As P-value (Sig.) <0.05, this means that, there are statistically significant differences between the variances of the four parts. The Damietta geologic meaning from the ANOVA test reveals that, the four parts have different conditions such as the composition, environments or depositions.

Table 6: Test of Homogeneity of Variances, Roseita Branch

	Levene's Statistic	df1	df2	Sig.
TC	1075.337	6	7245	.000
K	167.371	6	7245	.000
eU	1105.518	6	7245	.000
eTh	1349.023	6	7245	.000

Table 7: ANOVA, seven parts of Roseita Branch

		Sum of Squares	df	Mean Square	F	Sig.
TC	Between Groups	143207.8	6	23868.0	656.5	.000
	Within Groups	263393.3	7245	36.4		
	Total	406601.1	7251			
K	Between Groups	169.2	6	28.2	451.1	.000
	Within Groups	452.8	7245	0.1		
	Total	621.9	7251			
eU	Between Groups	52403.2	6	8733.9	874.4	.000
	Within Groups	72361.5	7245	10.0		
	Total	124764.7	7251			
eTh	Between Groups	322147.1	6	53691.2	900.7	.000
	Within Groups	431869.6	7245	59.6		
	Total	754016.7	7251			

Thirdly, the seven parts of Roseita Branch, the test of homogeneity of variances, by Levene's test of variances (Table 6) for the TC and radioelements (K, eU, & eTh) and from the ANOVA table (Table 7) show that, there is heterogeneity between the variances of the seven parts. As P-value (Sig.) <0.05, this means that, there are the statistically significant differences between the variances of the seven parts. The Roseita geologic meaning from the ANOVA test reflects that, the seven parts have different conditions, such as composition, environments or depositions.

4.2.3 K-Means Clustering

The K-Means clustering intends to partition the n objects into k clusters, in which each object belongs to the cluster with the nearest mean. This method produces exactly k different clusters of greatest possible distinction. The best number of clusters k leading to the greatest separation (distance) is not known as a priori and must be computed from the data. The main aim of K-Means clustering is to minimize the total intra-cluster variances, or the squared standard deviation.

The K-Means is relatively an efficient method. However, we need to specify the number of clusters, in advance, in which the final results are sensitive to initialization and often terminates at a local optimum. Unfortunately, there is no global theoretical method to find the optimal number of clusters. In this study, the comparison outcomes of the multiple runs, with different *k*'s and choose the best one, based on a predefined criterion. In general, a large *k* probably decreases the error, but increases the risk of overfitting.

Table 8: Number of cases in each Cluster and distances between the final cluster centers, Damietta branch

Cluster	1		268
	2		21
	3		7
Total			296
Cluster	1	2	3
1		26.7	49.3
2	26.7		22.5
3	49.3	22.5	

Table 9: Number of Counts in each Cluster and distances between the Cluster Centers, Damietta branch

Area			Cluster Number of Case			Total
			1	2	3	
Damietta	D1	Count	102	20	7	129
		%	79.1%	15.5%	5.4%	100.0%
	D2	Count	46	0	0	46
		%	100.0%	0.0%	0.0%	100.0%
	D3	Count	51	1	0	52
		%	98.1%	1.9%	0.0%	100.0%
	D4	Count	69	0	0	69
		%	100.0%	0.0%	0.0%	100.0%
Total	Count		268	21	7	296
	%		90.5%	7.1%	2.4%	100.0%

First, in Damietta area, Now, the K-Means Clustering is used to gather very large data set, so it is conducted to arrange the Damietta's cases (Table 8) in three categories. So that, the cases in each category are similar to each other and different from the cases in other categories, each category is a cluster. From Table (8), the total number of Damietta cases is 296. The following table shows the number of cases in each cluster. It can be concluded that, the second and third clusters have the smallest distance between their cluster centers (26.7 and 22.5), respectively. The largest distance is between the first and third clusters (49.3). For more details about the cluster number of cases cross-tabulation, the following table (Table 9) will be shown:

According to the first part in Damietta D1, there was 129 cases. We can conclude that, these cases were not similar, so that there distribution on the three clusters by these percentages: 79.1% of the cases went to the first cluster, 15.5% of the cases went to the second cluster, and 5.4% of the cases went to the third cluster. According to the second D2 and the fourth D4 parts in Damietta, they have 46 and 69 cases, respectively. These cases were similar and went to the first cluster. The same thing happened to the third part D3, except 1.9% of their cases went to the second cluster. Finally, it can be concluded that, for the four parts 90.5% of their cases went to the first cluster, and 7.1% of all the cases went to the second cluster, and only 2.4% went to the third cluster, which emphasis that, non-similarity was nearly between the cases (D2, D3 and D4) in the first area. There is an evidence that, the similarity was among the parts D2, D3 and D4.

Secondly, Roseita parts, the K-Means Clustering is used also, so it is conducted to arrange the Roseita cases in three categories that, the cases in each category are similar to each other and different from the cases in other categories, each category is a cluster. From table (10), the total number in Roseita is 7252, as well as, the number of cases is in three clusters.

Table 10: Number of Cases in each Cluster and Distances between final Cluster Center, Roseita

Cluster	1		6139
	2		795
	3		318
Total			7252
Cluster	1	2	3
1		24.728	50.265
2	24.728		25.604
3	50.265	25.604	

Table 11: Cluster Number of Case Cross-tabulation, Roseita branch

		Cluster Number			Total
		1	2	3	
R1	Count	961	462	251	1674
	%	57.4%	27.6%	15.0%	100.0%
R2	Count	677	333	67	1077
	%	62.9%	30.9%	6.2%	100.0%
R3	Count	714	0	0	714
	%	100.0%	0.0%	0.0%	100.0%
R4	Count	1105	0	0	1105
	%	100.0%	0.0%	0.0%	100.0%
R5	Count	1942	0	0	1942
	%	100.0%	0.0%	0.0%	100.0%
R6	Count	411	0	0	411
	%	100.0%	0.0%	0.0%	100.0%
R7	Count	329	0	0	329
	%	100.0%	0.0%	0.0%	100.0%
Total	Count	6139	795	318	7252
	%	84.7%	11.0%	4.4%	100.0%

Table (11) concluded that, the first and second clusters have the smallest distance between their cluster centers. The largest distance was between the first and third clusters. For more details about the cluster number of cases cross-tabulation will be shown in table (11). According to the first part in Rashid R1, there was 1674 cases, approximately 23% of all the cases in Rashid. It can be observed that, these cases were not similar, so that their distribution on the three clusters by these percentages, 57.4% of the cases went to the first cluster, 27.6% of the cases went to the second cluster and 15% of the cases went to the third cluster. The same thing nearly happened to the R2 part, which represents approximately 15% of all the cases in Rashid, 62.9% of the cases went to the first cluster, 30.9% of the cases went to the second cluster and 6.2% of the cases went to the third cluster. According to parts from R3 to R7 in Rashid, they have 4501 cases, approximately 62% from Rashid's cases. These cases were similar and went to the first cluster. Finally, it can be concluded that, for the seven parts 84.7% of their cases went to the first cluster, 11.0% of the cases went to the second cluster and only 4.4% went to the third cluster. There is an evidence that, the non-similarity between the cases was between in R1 and R2 parts.

4.2.4 Post Hoc Tests

Post-hoc (Latin, meaning "after this") means to analyze the results of your experimental data. They are often based on a family-wise error rate; the probability of at least one Type I error in a set (family) of comparisons. Dunnett's Test (also called *Dunnett's Method* or *Dunnett's Multiple Comparison)* compares the means from several experimental groups against a control group to see, is there a difference. When an ANOVA test has significant findings, it doesn't report which pairs of means are different. Dunnett's test can be used, after the ANOVA has been run, to identify the pairs with significant differences. Dunnett's test only compares one group with the others. One fixed "control" group is compared to all of the other samples, so it should only be used, when you have a control group (Dunnett, 1955). In this study, Dunnett's T3 Test (1980) is applied. Dunnett T3 Test (1980) is modification of Tamhane T2 multiple comparison test. It depends on pair-wise comparisons. It is priori multiple comparison tests used, to determine whether the mean of a control condition differs from that of two or more experimental conditions in ANOVA (Olejnik and Lee, 1990). This test is based on the Studentized maximum modulus. Dunnett T3 procedure is used, when the sample sizes are small i.e. n < 50 (Hochberg and Tamhane, 1987). It is used if the degree of freedom is small. This method is based upon (Sidak's, 1967) uncorrelated-t inequality, which is sharper than Sidak's (1967) multiplicative inequality.

4.5 TC Multiple Comparisons by Post Hoc Test (Dunnett's T3 test)

Table 12: Post Hoc Tests for TC dependent variable of Damietta branch

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
TC	D1	D2	1.75763	.88010	.251
		D3	2.66895*	.88119	.017
		D4	-.03665-	.85115	1.000
	D2	D3	.91133	.47226	.291
		D4	-1.79428-*	.41350	.000
	D3	D4	-2.70560-*	.41583	.000

Post Hoc test is designed, because it has obtained a significant difference between the group means. The differences among means is needed to provide specific information on, which means are significantly different from each other. Table (12) shows the results of Dunnett's T3 test in the Damietta parts, as (D1&D3), (D2&D4) and (D3&D4) have significant differences between each pair of means, which mean (D1&D3), (D2&D4) and (D3&D4) may not be formed in the same environment or in one deposition phase, While (D1&D2), (D1&D4) and (D2&D3) have no differences between these pairs in significant difference, that may mean be formed in the same environment or in one deposition phase. In Roseita parts (Table 13), all the parts have significant differences between each pair of means, which mean these parts aren't formed in the same environment or one depositional phase.

Between Damietta and Rashid parts (Table 14), these pairs are not significantly different (D3&R4), (D4&R3), (D1&R3), (D1&R4), (D1&R5), (D1&R6), (D1&R7), (D2&R4), (D2&R5), (D2&R6) and (D2&R7), that may mean be formed in the same environment or in one depositional phase or nearly similar total count concentration. The differences between these pairs are significantly different (D1&R1), (D1&R2), (D2&R1), (D2&R2), (D2&R3), (D3&R1), (D3&R2), (D3&R3), (D3&R5), (D3&R6), (D3&R7), (D4&R1), (D4&R2), (D4&R3), (D4&R5), (D4&R6) and (D4&R7), that may mean they aren't formed in the same environment or in one depositional phase, or nearly similar total count concentration.

Table 13: Post Hoc Tests for TC Dependent Variable Roseita branch.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
TC	R1	R2	2.78142*	.35926	.000
		R3	8.98555*	.26495	.000
		R4	11.05060*	.26025	.000
		R5	9.77729*	.25885	.000
		R6	9.93403*	.26319	.000
		R7	10.28430*	.26685	.000
	R2	R3	6.20413*	.25590	.000
		R4	8.26919*	.25103	.000
		R5	6.99588*	.24958	.000
		R6	7.15262*	.25408	.000
		R7	7.50288*	.25786	.000
	R3	R4	2.06506*	.06440	.000
		R5	.79175*	.05850	.000
		R6	.94849*	.07542	.000
		R7	1.29875*	.08732	.000
	R4	R5	-1.27331-*	.03088	.000
		R6	-1.11657-*	.05674	.000
		R7	-.76630-*	.07181	.000
	R5	R6	.15674*	.04994	.037
		R7	.50701*	.06657	.000
	R6	R7	.35026*	.08184	.000

Table 14: Post Hoc Tests for TC Dependent of Damietta and Roseita branches

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
TC	D1	R1	-8.81944-*	.85493	.000
		R2	-6.03802-*	.85217	.000
		R3	.16611	.81690	1.000
		R4	2.23117	.81539	.311
		R5	.95785	.81495	1.000
		R6	1.11460	.81633	1.000
		R7	1.46486	.81752	.978
	D2	R1	-10.57706-*	.42124	.000
		R2	-7.79565-*	.41560	.000
		R3	-1.59152-*	.33743	.001
		R4	.47354	.33375	.999
		R5	-.79977-	.33266	.601
		R6	-.64303-	.33605	.931
		R7	-.29276-	.33892	1.000
	D3	R1	-11.48839-*	.42352	.000
		R2	-8.70698-*	.41792	.000
		R3	-2.50285-*	.34028	.000
		R4	-.43779-	.33663	1.000
		R5	-1.71110-*	.33555	.000
		R6	-1.55436-*	.33891	.002
		R7	-1.20409-*	.34176	.045
	D4	R1	-8.78279-*	.35682	.000
		R2	-6.00137-*	.35016	.000
		R3	.20276	.25247	1.000
		R4	2.26782*	.24753	.000
		R5	.99450*	.24606	.007
		R6	1.15125*	.25062	.001
		R7	1.50151*	.25446	.000

4.6 K Multiple Comparisons by Post Hoc Test (Dunnett's T3 test)

In Damietta parts, Table (15) reflects that, all differences between each pairs of means are significant, except the differences between the second part D2 with the third part D3 or the fourth part D4. Exactly these pairs are not significantly different (D2&D3) and (D2&D4), which may be considered as an indicator, to exclude the second part D2 from this comparison or merges it with another part as the same environments or the same depositional style. In Roseita branch, all differences between each pairs of means are significant, except the differences between (R3&R5) and (R5&R7) pairs.

Table 15: Post Hoc Tests for K Dependent Variable Damietta branch.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
K	D1	D2	-.46360-*	.09379	.000
		D3	-.39141-*	.08592	.000
		D4	-.68338-*	.08348	.000
	D2	D3	.07219	.08812	.958
		D4	-.21978-	.08573	.069
	D3	D4	-.29197-*	.07705	.001

Table (17) shows Post Hoc Tests for K Dependent of Damietta and Roseita branches. There are 13 pairs significantly different. Meanwhile, the following pairs are not significantly different (D1&R2), (D1&R4), (D2&R1), (D2&R3), (D2&R5), (D2&R6), (D2&R7), (D3&R1), (D3&R3) (D3&R4), (D3&R5), (D3&R7), (D4&R3) and (D4&R6), that may be formed in the same environment or in one depositional phase, or nearly similar potassium concentration.

Table 16: Post Hoc Tests for K Dependent Variable Roseita branch.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
K	R1	R2	.27277*	.01147	.000
		R3	-.10238-*	.01483	.000
		R4	.20652*	.01023	.000
		R5	-.07766-*	.00893	.000
		R6	-.25224-*	.01563	.000
		R7	-.05180-*	.01243	.001
	R2	R3	-.37515-*	.01440	.000
		R4	-.06626-*	.00960	.000
		R5	-.35044-*	.00820	.000
		R6	-.52501-*	.01522	.000
		R7	-.32457-*	.01192	.000
	R3	R4	.30890*	.01343	.000
		R5	.02471	.01247	.640
		R6	-.14986-*	.01789	.000
		R7	.05058*	.01517	.018
	R4	R5	-.28418-*	.00635	.000
		R6	-.45875-*	.01431	.000
		R7	-.25832-*	.01072	.000
	R5	R6	-.17457-*	.01341	.000
		R7	.02587	.00949	.131
	R6	R7	.20044*	.01596	.000

Table 17: Post Hoc Tests for K Dependent of Damietta and Roseita branches.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
K	D1	R1	-.42054-*	.06542	.000
		R2	-.14776-	.06532	.727
		R3	-.52292-*	.06599	.000
		R4	-.21402-	.06511	.068
		R5	-.49820-*	.06492	.000
		R6	-.67278-*	.06618	.000
		R7	-.47234-*	.06549	.000
	D2	R1	.04306	.06827	1.000
		R2	.31583*	.06818	.002
		R3	-.05932-	.06883	1.000
		R4	.24958*	.06798	.033
		R5	-.03461-	.06780	1.000
		R6	-.20918-	.06900	.176
		R7	-.00874-	.06835	1.000
	D3	R1	-.02913-	.05699	1.000
		R2	.24364*	.05688	.004
		R3	-.13151-	.05765	.704
		R4	.17738	.05664	.134
		R5	-.10680-	.05642	.940
		R6	-.28137-*	.05786	.001
		R7	-.08093-	.05708	.999
	D4	R1	.26284*	.05323	.000
		R2	.53562*	.05311	.000
		R3	.16046	.05394	.184
		R4	.46936*	.05286	.000
		R5	.18518*	.05262	.040
		R6	.01061	.05416	1.000
		R7	.21104*	.05333	.009

4.7 eU Multiple Comparisons by Post Hoc Test (Dunnett's T3 test)

eU Multiple Comparisons between Damietta parts (Table 18), (D1&D4), (D2&D3) and (D2&D4) are not significantly different, while (D1&D2), (D1&D3) and (D3&D4) are have significantly different that aren't formed in the same environment or one depositional phase or nearly similar potassium concentration. In Roseita branch (Table 19), there is one pair only not significantly different (R5&R7), meanwhile all the pairs of mean have differences, consequently these parts have different supplementary, or formed from more than one phase of deposition and no similarity between each other. eU Multiple Comparisons Between Damietta and Roseita areas (Table 20), there is one pair not significantly different (D1&R6), that may have the same environment and depositional conditions.

Table 18: Post Hoc Tests for eU Dependent Variable Damietta branch.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
eU	D1	D2	.79541*	.26883	.021
		D3	.97731*	.27025	.002
		D4	.42809	.28735	.586
	D2	D3	.18190	.14347	.747
		D4	-.36732-	.17355	.198
	D3	D4	-.54922-*	.17574	.013

Table 19: Post Hoc Tests for eU Dependent of Roseita branch.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
eU	R1	R2	1.16377*	.18979	.000
		R3	5.46084*	.13592	.000
		R4	5.90591*	.13477	.000
		R5	6.02668*	.13382	.000
		R6	6.33358*	.13553	.000
		R7	6.02735*	.13799	.000
	R2	R3	4.29707*	.13741	.000
		R4	4.74214*	.13627	.000
		R5	4.86291*	.13533	.000
		R6	5.16981*	.13702	.000
		R7	4.86358*	.13946	.000
	R3	R4	.44507*	.03200	.000
		R5	.56584*	.02773	.000
		R6	.87274*	.03505	.000
		R7	.56651*	.04363	.000
	R4	R5	.12077*	.02139	.000
		R6	.42767*	.03028	.000
		R7	.12144*	.03989	.050
	R5	R6	.30690*	.02573	.000
		R7	.00067	.03656	1.000
	R6	R7	-.30623-*	.04238	.000

Table 20: Post Hoc Tests for eU Dependent of Damietta and Roseita branches.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
eU	D1	R1	-7.00790-*	.28313	.000
		R2	-5.84413-*	.28385	.000
		R3	-1.54706-*	.25105	.000
		R4	-1.10199-*	.25043	.001
		R5	-.98122-*	.24992	.008
		R6	-.67432-	.25084	.347
		R7	-.98055-*	.25218	.009
	D2	R1	-7.80331-*	.16648	.000
		R2	-6.63954-*	.16770	.000
		R3	-2.34247-*	.10284	.000
		R4	-1.89740-*	.10132	.000
		R5	-1.77663-*	.10005	.000
		R6	-1.46973-*	.10232	.000
		R7	-1.77596-*	.10557	.000
	D3	R1	-7.98521-*	.16877	.000
		R2	-6.82144-*	.16997	.000
		R3	-2.52437-*	.10650	.000
		R4	-2.07930-*	.10503	.000
		R5	-1.95853-*	.10381	.000
		R6	-1.65163-*	.10600	.000
		R7	-1.95786-*	.10914	.000
	D4	R1	-7.43599-*	.19498	.000
		R2	-6.27222-*	.19602	.000
		R3	-1.97515-*	.14449	.000
		R4	-1.53008-*	.14341	.000
		R5	-1.40931-*	.14252	.000
		R6	-1.10241-*	.14412	.000
		R7	-1.40864-*	.14644	.000

4.8 eTh Multiple Comparisons by Post Hoc Tests (Dunnett's T3 test)

eTh multiple comparisons between Damietta parts (Table 21), there is a pair not significantly different (D2&D3), that may has the same environment and depositional conditions. Meanwhile, (D1&D2), (D1&D3), (D1&D4), (D2&D4) and (D3&D4) have significantly different, that may haven't the same environment and depositional conditions. In Roseita branch (Table 22), there is a pair only not significantly different (R5&R6), meanwhile all the pairs of mean have difference consequently, these parts have different supplementary or formed from more than one depositional phase and are not similar between each other.

In eTh multiple comparisons between Damietta and Roseita parts (Table 23), there are 8 pairs not significantly different (D2&R4), (D2&R7), (D3&R4), (D3&R7), (D4&R3), (D4&R4), (D4&R5) and (D4&R6). These pairs have similarity in the environment, concentration and depositional conditions between each other. While, the rest pairs are significantly different, and have not similarity conditions.

Table 21: Post Hoc Tests for eTh dependent Variable Damietta branch.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
eTh	D1	D2	6.42540*	1.24843	.000
		D3	6.66625*	1.28159	.000
		D4	4.23743*	1.18819	.003
	D2	D3	.24085	.77002	1.000
		D4	-2.18797-*	.60187	.003
	D3	D4	-2.42882-*	.66794	.003

Table 22: Post Hoc Tests for eTh dependent variable of Roseita branch

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
eTh	R1	R2	3.30946*	.47083	.000
		R3	14.42944*	.32530	.000
		R4	15.18866*	.32339	.000
		R5	14.65645*	.32159	.000
		R6	14.77583*	.32833	.000
		R7	16.01072*	.32858	.000
	R2	R3	11.11998*	.34828	.000
		R4	11.87920*	.34649	.000
		R5	11.34699*	.34482	.000
		R6	11.46637*	.35111	.000
		R7	12.70126*	.35134	.000
	R3	R4	.75922*	.06478	.000
		R5	.22701*	.05510	.001
		R6	.34639*	.08610	.001
		R7	1.58128*	.08704	.000
	R4	R5	-.53221-*	.04240	.000
		R6	-.41283-*	.07858	.000
		R7	.82206*	.07961	.000
	R5	R6	.11938	.07082	.866
		R7	1.35427*	.07196	.000
	R6	R7	1.23489*	.09775	.000

Table 23: Post Hoc Tests for eTh Dependent Variable of Damietta and Roseita branches.

Dependent Variable	(I)Regions	(J)Regions	Mean Difference(I-J)	Std. Error	Sig.
eTh	D1	R1	-10.46720-*	1.18624	.000
		R2	-7.15774-*	1.19275	.000
		R3	3.96224*	1.14314	.038
		R4	4.72146*	1.14260	.004
		R5	4.18925*	1.14210	.019
		R6	4.30863*	1.14401	.014
		R7	5.54352*	1.14408	.000
	D2	R1	-16.89260-*	.59801	.000
		R2	-13.58314-*	.61081	.000
		R3	-2.46315-*	.50718	.001
		R4	-1.70394-	.50596	.076
		R5	-2.23615-*	.50481	.003
		R6	-2.11677-*	.50913	.007
		R7	-.88188-	.50929	.979
	D3	R1	-17.13345-*	.66447	.000
		R2	-13.82399-*	.67601	.000
		R3	-2.70401-*	.58406	.001
		R4	-1.94479-	.58300	.079
		R5	-2.47700-*	.58201	.005
		R6	-2.35762-*	.58575	.010
		R7	-1.12273-	.58589	.932
	D4	R1	-14.70463-*	.45917	.000
		R2	-11.39517-*	.47572	.000
		R3	-.27518-	.33234	1.000
		R4	.48403	.33047	.999
		R5	-.04818-	.32871	1.000
		R6	.07120	.33531	1.000
		R7	1.30609*	.33555	.012

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5. Conclusions

The analysis and statistical treatments of the radioactive measurements acquired by the high-resolution spectrometric gamma-ray technique applied in the search area in order to draw valid conclusions, regarding the nature and significance of the distribution of the total count radiation (TC) and the three nature of radioelements (NOR), (eU, eTh and K). In this study, there are 11 anomalous parts based on the total count radiation (TC) values (4 anomalous parts in the Damietta branch and 7 anomalous parts in the Roseita branch).

Appling ANOVA of TC and NOR for the 4 Damietta anomalous parts and the 7 Roseita anomalous parts gives a result that, there are statistically significant differences between the variances of the eleven parts. The geologic meaning from ANOVA test is that, parts have different conditions such as composition, environments or deposition.

Relation between the K-Means Clustering and the anomalous parts, K-cluster Damietta's cases and Roseita cases are in three categories for each one of them. According to Damietta area, the four parts reflects that, 90.5% of their cases went to the first cluster, 7.1% of the cases went to the second cluster and only 2.4% went to the third cluster, which emphasis that no similarity was occurred between the cases (D2, D3 and D4) in the first area. There is an evidence that, the similarity is between the parts D2, D3 and D4. So, D1 can be divided into more sub-parts and D2, D3 and D4 can be merged into one part, then more research can be done. According to Roseita area, it can be concluded that, the cases in the first part R1 and the second part R2 in Roseita, which represent approximately 38% of all cases in Roseita area, were not similar. So that, they distributed in three clusters, but the cases from the third part R3 to the seventh part R7 in Roseita were similar and went to the first cluster. Also, R1 and R2 can be subdivided into more parts and from R3 to R7 parts can be merged into an area, then more research can be done.

Relation of Post Hoc Test with the anomalous parts, first, the TC multi comparison shows that, (D1&D2), (D1&D4), (D2&D3), (D1&R3,), (D1&R4,), (D1&R5), (D1&R6), (D1&R7), (D2&R3), (D2&R4), (D2&R5), (D2&R6), (D2&R7), (D3&R4) and (D4&R3) have no differences between these pairs and significantly different, that may be formed in the same environment or in one depositional phase. Secondly, The K multi comparison shows that, (D2&D3, (D2&D4), (R3&R5), (R5&R7), (D1&R2), (D1&R4), (D2&R1), (D2&R3), (D2&R5), (D2&R6), (D2&R7), (D3&R1), (D3&R3), (D3&R4), (D3&R5), (D3&R7), (D4&R3), (D4&R6) have no differences between these pairs and significantly different, that may be formed in the same environment or in one depositional phase. Thirdly, the eU multi comparison shows that, (D1&D4), (D2&D3), (D2&D4), (R5&R7) and (D1&R6) are similar cases. Fourthly, the eTh multi comparison shows that, (D2&D3) (R5&R6) (D2&R4), (D2&R7), (D3&R4), (D3&R7), (D4&R3), (D4&R4), (D4&R5) and (D4&R6) are similar cases.

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