IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 7, Issue 6 Ser. I (Nov. – Dec. 2019), PP 32-42
www.iosrjournals.org

Nature and geochemistry of surface marine sediments of Abu-Soma Bay along the Egyptian Red Sea Coast

Hashem A. Madkour[1], Mohamed R. Osman[2*], Abbas M. Mansour[2], Atef El-Taher[3], Kwasi Adu Obirikorang[4] and Hussein N.M. Hussein[5]

[1] Geology Department, National Institute of Oceanography and Fisheries, Red Sea Branch, 84511 Hurghada, Egypt
[2] Geology Department, Faculty of Science, Qena, South Valley University, 83523 Qena, Egypt*
[3] Physics Department, Faculty of Science, AL- Azhr University, Assuit Branch, Egypt
[4] Biology Department, Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[5] Hydrobiology Department, National Institute of Oceanography and Fisheries, Red Sea Branch, 84511 Hurghada, Egypt

Abstract:
Now several hotels and tourist villages are being built around the bay. These tourism projects including what is virtually working and others still under construction of Abu-Soma Bay. Granulometric and geochemical analyses have been carried out on 30 surface marine sediment samples collected from Abu-Soma area along the Egyptian Red Sea coast. The textural characteristics of marine sediments show that the mean size decreases in sediments of coastal areas while increase in offshore sediments and the sediment type generally changes from sand to slightly gravelly muddy sand. But, generally, sand fraction is prevalent among the other constituents. The sediments are composed mainly of poorly sorted, negatively nearly symmetrical and leptokurtic fine sands. Cluster analysis showed that, distribution of gravel, sand and mud fractions is related to bottom facies and type of sediment source and depth more than distance of the beach. Geochemically, the factor controlling the carbonate content of studied sediments includes material supply of biogenic and terrigenous components. However, the carbonate content of marine sediments ranges from 14.21% to 97.91% with average 71.21%. In general organic matter is higher in these sediments relative to adjacent areas. Organic matter recorded high values in some samples with increasing depth. The high organic matter in the present surface marine sediments is primarily due to the high supply from primary productivity, terrestrial and reworked sediments. Texture is the main controlling factor for the organic matter enrichment. Spatial variations in earth element contents in the study area are related to the sources of marine sediments to the area. The investigation of distribution of the earth element contents in surficial sediments of the study area indicated that the degree of elements pollution is caused by natural inputs of adjacent wadies and/or by anthropogenic activities. This study provides knowledge about nature and geochemistry of sediments and the extent to which the region is affected by external influences of human activities and/or natural inputs by wadis.

Date of Submission: 04-11-2019 Date of Acceptance: 20-11-2019

I. Introduction

Soma Bay and its surrounding regions are a major recreational area sea bird and marine-mammal rookery and important commercial fishing ground. Now several hotels and tourist villages are being built around the bay. These tourism projects including what is virtually working and others still under construction of Soma Bay (Figures 1 & 2). Geochemical studies of marine sediments have been extended in the last few decades due to the growing awareness of environmental pollutions and their impacts on the marine, tidal flat and coastal habitats. The bed sediments are not only a sink for trace metals, but also a source of re-suspended sediment; and under changing environmental conditions, sediment bound pollutants may be chemically remobilized and enter the water column or food chain[1].

Despite of several studies were carried out on the surface marine sediments along the Egyptian Red Sea coast. However, only some of these studies have focused on the effects of the human activities due to tourism development on the Egyptian Red Sea environments or habitats (such as: [2-14]).

The objective of this study is to examine the nature and geochemical signature and spatial distribution patterns of bed sediments at Abu-Soma Bay, achieving to determine the changes of sediment nature by environmental impacts, resulted from the tourism development activities during the past twenty years at this area. The environmental impact at Abu-Soma Bay was evaluated by surveying and analyzing the surface marine sediments. The main goal of this paper, is the perception of the authors to mitigate the negative effects may be resulted from tourism development on the Egyptian Red Sea coast.

Environmental and Geomorphic setting of Abu-Soma Bay:

Abu-Soma area is one of the famous Egyptian Red Sea coasts and tourist areas. Abu-Soma Bay is a wide embayment located in the western side of the Red Sea, about 50 km south of Hurghada City (Figures no 1 & 2). The coastal area around the bay has relatively low populations compared to the relatively dense human activities in somewhat small coastal area. The activities including mining, maritimes shipping, fishing and ship maintenance yards, tourism activities and the related industries. In the last three decades, the entire shoreline of Abu-Soma Bay was earmarked for tourism development. Accordingly, the following impacts have been recorded; dredging, coastal infilling, marina construction, alteration of inshore current patterns as a result of breakwater construction and eutrophication[15].

Figure no 1: Location map of the study area.

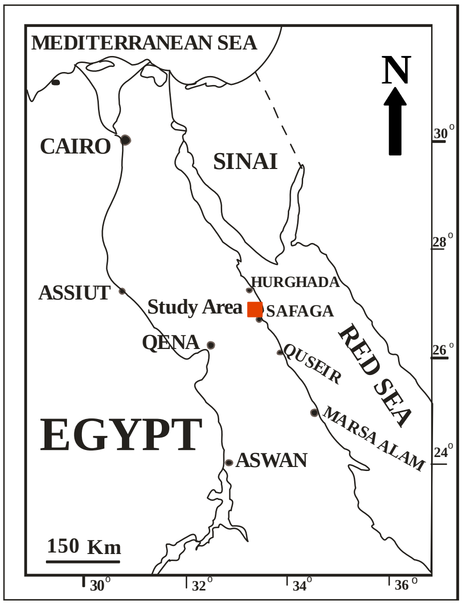
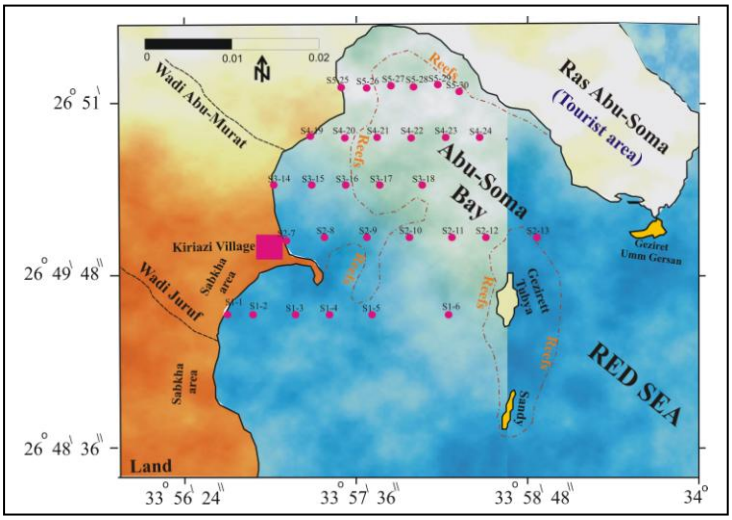


Figure no 2: Distribution of surface marine sediment samples at Abu-Soma Bay.



II. Material and Methods

Sampling Technique: In the present study, surface marine sediment samples were collected from the uppermost layer of the bottom sediments (0-25 cm) in thirty stations covering Abu-Soma Bay (Figure no 2). The location, depth and description of bottom characteristics of the collected samples are given in table no.1. The collected samples from the studied area represent three different environmental features; sabkha area, beach, intertidal zone and offshore zone until 14m water depth. The samples were taken by a grab sampler and Scuba diving. The later method was used in areas rich with corals where grab sampler failed to collect samples. After anchoring the boat at each station, the grab sampler was lowered to the sea floor and left a few seconds before being pulled back to the surface. The sediments caught in the sampler or collected by Scuba diving were placed in labeled plastic bags and returned to the laboratory.

Table no 1:. Shows sample location, depth and bottom facies at Abu-Soma Bay.

Sample no	Position		Depth	Bottom facies
	Lat.	Long.	(m)	
	o / // N	o / // E		
S1-1	26 50 12	33 57 12	1	Fine sand
S1-2	26 50 07	33 57 16	2	Fine sand
S1-3	26 50 07	33 57 1	4	biogenic sand
S1-4	26 50 07	33 57 23	6	biogenic sand
S1-5	26 50 07	33 57 28	5	biogenic sand with seagrasses
S1-6	26 50 06	33 57 33	4	biogenic sand with seagrasses
S2-7	26 50 17	33 57 06	beach	very Fine sand
S2-8	26 50 14	33 57 12	0.4	very Fine sand
S2-9	26 50 16	33 57 13	4	sandy mud
S2-10	26 50 14	33 57 20	5	biogenic sand
S2-11	26 50 12	33 57 25	6	biogenic sand with seagrasses
S2-12	26 50 11	33 57 31	7	biogenic sand
S2-13	26 50 10	33 57 35	3	biogenic sand
S3-14	26 50 33	33 57 04	beach	Sand
S3-15	26 50 50	33 57 08	0.3	Fine sand
S3-16	26 50 26	33 57 26	3.5	biogenic sand with algae
S3-17	26 50 22	33 57 32	5.5	biogenic sand
S3-18	26 50 21	33 57 36	2.5	biogenic sand
S4-19	26 50 45	33 57 04	beach	medium sand
S4-20	26 50 44	33 57 15	0.4	Fine sand
S4-21	26 50 48	33 57 33	3	Fine sand
S4-22	26 50 45	33 57 41	9	biogenic sand
S4-23	26 50 41	33 57 49	11	biogenic sand
S4-24	26 50 40	33 58 03	8	biogenic sand
S5-25	26 51 43	33 58 00	beach	Sand
S5-26	26 51 43	33 58 01	2.5	Sand
S5-27	26 51 30	33 58 03	4.5	biogenic sand
S5-28	26 51 15	33 58 12	14	biogenic sand
S5-29	26 51 06	33 58 21	12	biogenic sand
S5-30	26 50 54	33 58 26	14	biogenic sand

Laboratory Methods and Treatment of Data

Granulometric Analysis: The granulometric analysis of sediment samples was performed by wet sieving, using ASTM sieves placed at one Phi interval from -1ϕ (2mm) to 4ϕ (63μm) following the technique given by[16]. The carbonate content and the organic matter of all sediment samples were determined in the National Institute of Oceanography and Fisheries, Red Sea Branch. Carbonate content was determined by treating the samples with (1N HCL acid). The remaining insoluble residue after acid washing, was determined and the carbonate percentage was calculated. Determination of organic matter was made by sequential weight loss at $550^{o}C$ following [17].

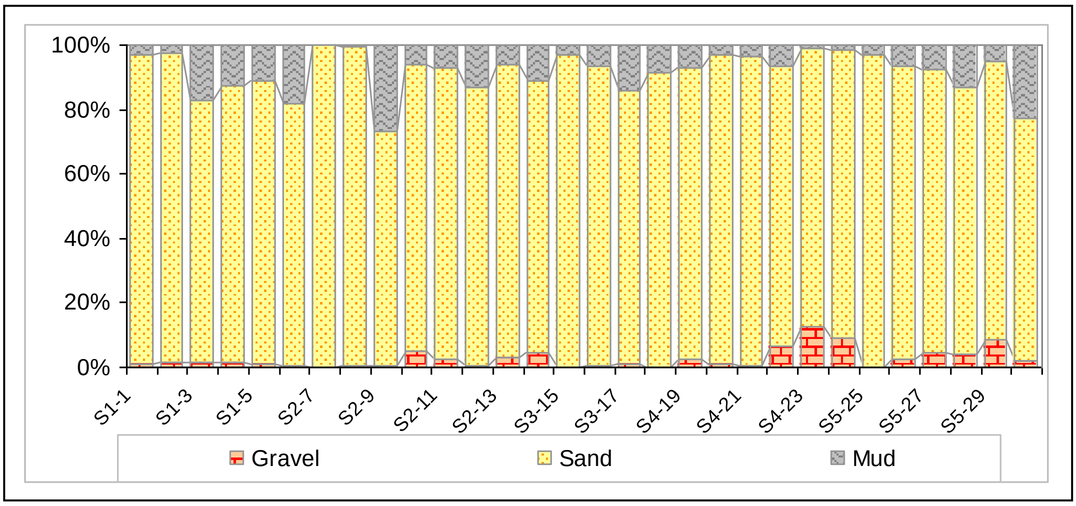
ED-XRF Experimental procedure: The XRF data in the present study are quantitative, since they are derived from "filtered" intensity values rationed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system. All analyses were conducted on a Thermo Scientific *Quant'X* Energy-Dispersive X-ray Fluorescence (ED-XRF) spectrometer, located in the Department of physics, Qassim University, Saudi Arabia. It is equipped with a thermoelectrically Peltier cooled solid-state Si (Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 µm beryllium (Be) window (air cooled), runs on a power supply operating 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with Edwards's vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition was identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background. The samples were ground into a fine powder (< 63µm) using an electric agate mill. All powdered samples were dried at 105 ^{0}C and stored in desiccators until they were analyzed. Fill up ¾ parts of the cup with the sample analyzed. Then, cover the cup with the film. Fix the slim ring by sliding it down and fix the thick ring on the top of the cup. When the cups are prepared, place them on the sample stage inside the spectrometer chamber with the side to be analyzed facing down toward the X-ray tube by using[18]. To insure that the maximum accuracies were obtained, three replicates of each measurement were applied and the differences among these replicates were always less than 3% and the average of data was determined. The resultant data of elements were expressed in (%).

III. Results and Discussion

Grain size analysis and Sediment distribution: The bottom nature of Abu-Soma Bay was divided into eight sediment facies; rock bottom, sand with coral patches, sand, coral carpet, sand with seagrasses, seagrasses, muddy sand and mud according to[19]. Gravel percentage was varied between 0.00% and 12.8% with an average of 2.67%. Sand content was fluctuated between 72.7% and 99.8% with mean content is 89.0% and mud fraction was ranged between 0.21% and 26.9% with an average of 8.33% (Table no 2; Figure no 3). Generally, the sediments of the investigated area were found to consist of a wide variety of textural classes, from coarse sand to very fine sand. Coarse sand (ϕ_1) recorded the highest average content of the investigated samples, while the very fine sand (ϕ_4) recorded the lowest average. The relatively high gravel percentages were observed as spots in northwestern horizon. This distribution reflects the effect of wave winnowing, long-shore currents and wind induced waves. This may indicates that the waves and long-shore currents drift the medium and fine sediments southward to the bay center as well as some of the fine fractions were retained within the seagrass carpets (Plate 1). Sand with coral patches were widely distributed on shallow, sand-covered hard grounds, particularly in the north-western part of the bay and around the offshore reefs on its eastern fringe as indicated by[20]. According to[21], the distribution of coarse sediments indicated that these sediments occupy the shallow nearshore areas in the northern, northwestern and western sides of the bay and some hinterlands inside the bay as well as around Tubia and Safaga Islands. Generally, the mud contents seems to be increase with increasing water depth and distance from the shoreline. The reason for this high mud content is due to the landfill operation in the last two decades during the construction of one of the tourist villages . In Abu-Soma Bay itself, grain size distribution of the sediments depends mainly on the depth, type of facies and distance from the shore line.

However, the studied sediments vary from very poorly sorted (2.18 ϕ) to well sorted (0.4 ϕ) with an average value 1.41 ϕ (poorly sorted). They are ranging from very coarse skewed (-0.6 ϕ) to very fine skewed (0.26 ϕ) with mean value -0.03 ϕ (near-symmetrical skewed). Also, they oscillate between platy kurtic (0.87 ϕ) to very leptokurtic (1.92 ϕ) with an average value 1.22 ϕ (leptokurtic) (Table no 3).

Figure no 3: Shows the average distribution of sediments texture in Abu-Soma Bay.



Cluster analysis of sediment grain size: Using Ward's method, all the analyzed samples (30 samples) of Abu-Soma Bay area, based on their content of gravel, sand and mud are divided into six main clusters according to the abundance of size fraction (Table no 2; Figure 4). Of these clusters only three have a high number of samples. Clusters 1, 3 and 6 constitute 77% of the total samples and are characterized by very high sand fraction (97%), (90%) and (85.3%) respectively. Most samples of clusters 1, 3 and 6 are located in shallow marine environment and offshore area (Figure 2). Cluster 2, 4 and 5 represent 23.4% of the total samples and are distinguished by the highest content of mud content, especially clusters 4 and 5 (24.7%) and (17.7%)

respectively. While cluster 2 is distinguished by the highest content of gravel content compared with the other clusters. Sediment samples of clusters 2, 4 and 5 are belonging to the supratidal and beach areas and some samples from offshore area (Figure 2). It is believed that the fine grains are transported by sea waves to the offshore.

Plate 1: General view of the southern part of Abu-Soma Bay and the southern part of beach and intertidal area of Abu-Soma Bay (a & b), the nature of bottem sediments near the beach and interaction between biogenic setiments with seagrasses (depth 6-12m) of Abu- Soma Bay (c & d).

Geochemical parameters:

Carbonate content: Generally, the total carbonate content in Abu-Soma Bay sediment samples ranges between 14.21 and 97.91% with an average 71.21%. The high carbonate content was recorded in samples away from offshore areas (Table no3; Figure no5). [21]classified sediments based on carbonate content to high carbonate (>80%), impure carbonate (80-60%), transitional (60-40%), terrigenous (40-20%) and high terrigenous (<20%). Following this classification most sediment samples of Abu-Soma Bay area belonging to impure carbonate (with an average content is 71.21%) (Table no 3, Figure 5). However, the carbonate content shows high positive correlation with Ca, Sr, Nb, Mo and TOM. On the other hand, it shows negative correlation with Mg, Al, Si and sand content (Table no 4). It also shows low positive correlation with gravel and mud contents (r = 0.35, and 0.38). This indicates that the biogenic carbonate constituents are less influenced by terrigenous constituent.

Total Organic Matter content (TOM): The total organic matter content of sediment samples of Abu-Soma Bay varies from 0.2% to 5.69%, with an average 3.51% (Table no 3; Figure 6). The variation in organic matter content of the bottom sediments is primarily due to local hydrodynamic influence which transport and scatter the particulate organic materials and brought them from inside the sea. On the other hand, the variation in organic matter content of the sampled sediments, especially beach samples is mostly due to local contamination by hydrocarbons, such as; tar balls thrown to the beach by waves. It is noticed from table no 4 the presence of high positive correlation between TOM and carbonate, Ca, Sr, Nb, Mo. Meanwhile, TOM shows negative correlation with Mg, Al and Si . This is due to the total organic carbon content in the surface sediments of the study area appears to be controlled primarily by variations in lithogenic and biogenic admixtures of sediments.

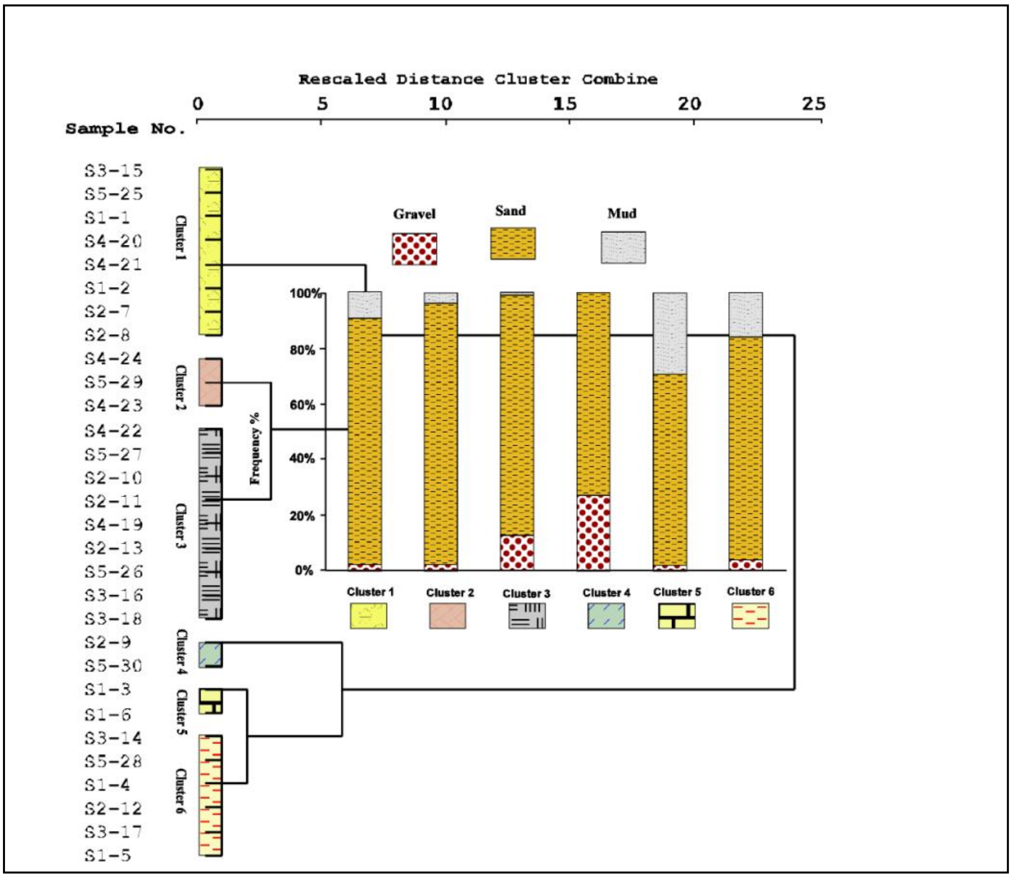
Spatial distribution of elements: The collected samples of marine sediments of the considered area were analyzed to detect the concentration and distribution of nine elements; Calcium (Ca), Magnesium (Mg), Strontium (Sr), Aluminum (Al), Silicon (Si), Vanadium (V), Rubidium (Rb), Niobium (Nb) and Molybdenum

(Mo) in order to understand the effect of natural inputs and human action on the quality of marine sediments. Overall average concentrations of elements percentage are cited in Table no 3 and Figure 7.

Table no 2: Some statistical parameters of the main grain size categories of the cluster computed by (Ward's method) cluster analysis

	Gravel	Sand	Mud
Cluster 1 (8 samples)			
S3-15	0.04	97.06	2.90
S5-25	0.06	97.11	2.83
S1-1	1.17	95.58	3.25
S4-20	1.17	95.71	3.12
S4-21	0.34	95.88	3.79
S1-2	1.75	95.97	2.28
S2-7	0.00	99.79	0.21
S2-8	0.74	98.72	0.55
Min.	0.0	95.6	0.2
Max.	1.7	99.8	3.8
X	0.7	97.0	2.4
Cluster 2 (3 samples)			
S4-24	9.26	89.15	1.59
S5-29	8.54	86.56	4.90
S4-23	12.79	86.17	1.05
Min.	8.5	86.2	1.0
Max.	12.8	89.2	4.9
X	10.2	87.3	2.5
Cluster 3 (9 samples)			
S4-22	6.53	86.75	6.72
S5-27	4.75	87.43	7.82
S2-10	4.95	88.95	6.11
S2-11	2.42	90.43	7.15
S4-19	2.50	90.44	7.06
S2-13	2.78	90.95	6.27
S5-26	2.74	90.62	6.64
S3-16	0.54	92.66	6.81
S3-18	0.01	91.58	8.41
Min.	0.0	86.8	6.1
Max.	6.5	92.7	8.4
X	3.0	90.0	7.0
Cluster 4 (2 samples)			
S2-9	0.38	72.70	26.92
S5-30	1.96	75.34	22.57
Min.	0.4	72.7	22.6
Max.	2.0	75.3	26.9
X	1.2	74.0	24.7
Cluster 5 (2 samples)			
S1-3	1.48	81.45	17.07
S1-6	0.58	81.15	18.27
Min.	0.6	81.2	17.1
Max.	1.5	81.4	18.3
X	1.0	81.3	17.7
Cluster 6 (8 samples)			
S3-14	4.31	84.46	11.23
S5-28	4.13	82.62	13.25
S1-4	1.31	85.85	12.83
S2-12	0.70	86.01	13.29
S3-17	0.86	85.01	14.13
S1-5	1.20	87.84	10.96
Min.	0.7	82.6	11.0
Max.	4.3	87.8	14.1
X	2.1	85.3	12.6
min.= minimum, max.= maximum X= average			

Figure no 4: Dendrogram from cluster analysis (ward's method) exhibiting cluster of grain size texture of Abu-Soma Bay.



The concentration of Calcium varies from 4.2 to 91.1% with an average is 62.91%. This content is extreme high than the average content of Ca in the Upper Continental Crust (UCC=3.00%) according to [23]. Also, Ca concentration exhibits high positive correlation (r = 0.76) with carbonate content (Table no 4). This implicates that the enrichment of the analyzed samples with Ca content is due to the high supply of biogenic carbonates to the sediments of the Abu-Soma Bay. The mean content of Mg is 5.87, which is higher than the average value of Mg in the Upper Continental Crust (UCC=1.33%). However, Mg shows high positive correlation with Si and Al (r=0.85 and 0.81 respectively) indicating that it is probably incorporated together with Si and Al in the lattice of the terrigenous aluminosilicate minerals resulting from the weathering of the source rocks in the neighbouring area. Meanwhile, it shows high negative correlation with Ca, Sr and carbonates (r = -0.9, -0.87 and - 0.7 respectively), implying that it is not included within the carbonate minerals. The average content of Si and Al are 12.63% and 6.74% respectively. These values are less than their average content recorded in the Upper Continental Crust (UCC=30.8% for Si, and 8.04% for Al). The average concentration of Sr is 0.81% (= 8100 ppm).This value is much higher that of Sr in UCC (350ppm). Also, Sr shows very high positive correlation with Ca content and carbonate content (r=0.95 and 0.75 respectively). This attests the incorporation of Sr with Ca in the carbonate minerals. Vanadium is ranging between 0.00 % and 0.15% with an average concentration is 0.04% (= 400ppm). This value is much higher than the average value of V in the Upper Continental Crust (UCC= 110ppm). [24]stated that magmatic and pyrometasomatic ore deposits associated with mafic igneous rocks are commonly enriched in vanadium and most titaniferous magnetite deposits contain nearly 0.3% vanadium or 3,000 ppm). Also, vanadium is commonly the principal trace element in petroleum, especially asphalt-base oils[24]. Therefore, it could be suggested that the enrichment of the analyzed sediment samples with vanadium is due to the frequent inputs of the terrigenous particles of mafic igneous rocks by the two active wadis namely, Abu-Murrat and Abu-Juruf wadis from the nearby basement rocks to the southern part of Abu-Soma Bay, as well as the tar balls, which occasionally thrown to the beach by waves. The maximum concentration of Rb attains 0.01% or 100 ppm. This value is concordant with its average concentration in the UCC (= 112ppm). The mean contents of Nb and Mo are 0.05% (= 500 ppm) and 0.03% (300 ppm) respectively. However, their mean values in UCC are 12.5 ppm for Nb and 1.5 ppm for Mo[23]. Also,

Table no 3. The results of grain size, geochemical analysis of element contents of surface marine sediments of Abu-Soma Bay.

Sa.	Sediment types			Grain size parameters (Folk&Ward,1957)				Geochemical analysis										
No.	Gravel	Sand	Mud	Mz	σI	SkI	KG	Carb.%	TOM%	Ca%	Mg%	Sr%	Al%	Si%	V%	Rb%	Nb%	Mo%
S1-1	1.2	95.6	3.3	2.4	1.1	-0.2	1.1	27.1	2.2	87.8	1.5	1.1	5.5	4.5	0.00	0.01	0.06	0.04
S1-2	1.7	96.0	2.3	1.8	1.1	-0.1	1.1	29.5	2.0	83.8	2.0	0.9	5.5	6.6	0.00	0.01	0.04	0.03
S1-3	1.5	81.4	17.1	2.8	1.7	0.0	1.6	82.8	3.6	68.5	9.2	0.8	7.7	12.4	0.06	0.00	0.03	0.02
S1-4	1.3	85.9	12.8	2.3	1.6	0.1	1.3	92.0	2.3	29.2	9.1	0.2	11.2	26.2	0.02	0.01	0.02	0.02
S1-5	1.2	87.8	11.0	2.4	1.5	0.1	1.3	94.4	4.6	84.8	2.7	1.1	5.4	4.7	0.00	0.00	0.07	0.07
S1-6	0.6	81.2	18.3	3.0	1.7	0.1	1.4	93.9	5.0	86.5	1.9	1.1	5.3	4.0	0.08	0.00	0.06	0.05
S2-7	0.0	99.8	0.2	2.5	0.4	-0.1	1.8	40.4	2.0	15.1	10.2	0.2	10.1	28.5	0.08	0.00	0.02	0.01
S2-8	0.7	98.7	0.5	2.1	0.9	0.0	1.0	29.4	1.0	11.3	15.2	0.1	9.4	27.4	0.02	0.00	0.01	0.01
S2-9	0.4	72.7	26.9	3.6	1.7	0.2	1.9	68.9	3.7	52.9	6.4	0.5	11.1	26.5	0.00	0.00	0.03	0.02
S2-10	4.9	88.9	6.1	1.8	1.6	0.0	1.1	91.6	4.6	69.1	9.4	0.9	9.0	10.1	0.02	0.01	0.05	0.03
S2-11	2.4	90.4	7.1	2.2	1.5	-0.6	1.1	92.8	4.8	86.5	0.0	1.2	5.0	5.9	0.04	0.00	0.06	0.04
S2-12	0.7	86.0	13.3	2.4	1.6	0.1	1.3	94.8	3.3	90.8	1.8	1.0	3.8	3.4	0.00	0.00	0.06	0.05
S2-13	2.8	91.0	6.3	1.9	1.5	0.0	1.0	97.9	4.6	88.6	1.1	1.2	5.0	4.1	0.03	0.00	0.07	0.06
S3-14	4.3	84.5	11.2	2.4	1.8	-0.1	1.6	23.4	3.2	8.7	9.8	0.1	6.9	24.1	0.05	0.00	0.02	0.01
S3-15	0.0	97.1	2.9	3.0	0.6	-0.2	1.3	34.7	3.0	17.4	11.4	0.2	10.8	28.7	0.03	0.00	0.01	0.00
S3-16	0.5	92.7	6.8	2.2	1.3	0.1	1.1	83.5	2.9	84.2	1.1	1.1	5.9	7.6	0.00	0.01	0.06	0.04
S3-17	0.9	85.0	14.1	2.6	1.6	0.1	1.4	91.3	4.5	77.8	2.0	1.0	3.4	6.9	0.00	0.01	0.05	0.03
S3-18	0.0	91.6	8.4	2.5	1.3	0.0	1.2	95.0	5.1	89.4	3.1	1.3	2.2	2.9	0.04	0.00	0.06	0.05
S4-19	2.5	90.4	7.1	2.1	1.6	-0.1	1.0	25.0	3.7	5.6	23.0	0.1	12.7	26.2	0.06	0.00	0.01	0.01
S4-20	1.2	95.7	3.1	2.2	1.1	-0.1	0.9	30.7	2.1	16.1	14.6	0.2	9.7	26.9	0.02	0.00	0.02	0.01
S4-21	0.3	95.9	3.8	2.4	1.0	-0.1	0.9	69.8	4.3	73.9	3.3	1.0	7.6	12.8	0.07	0.01	0.06	0.04
S4-22	6.5	86.8	6.7	1.7	1.7	0.0	1.2	93.5	5.7	87.0	0.6	1.2	4.6	5.9	0.01	0.00	0.08	0.06
S4-23	12.8	86.2	1.0	0.9	1.4	-0.1	0.9	95.8	4.6	80.6	0.0	1.4	5.2	3.1	0.14	0.01	0.07	0.05
S4-24	9.3	89.2	1.6	0.9	1.4	0.0	0.9	94.2	3.6	84.8	2.3	1.6	5.6	4.2	0.11	0.01	0.07	0.04
S5-25	0.1	97.1	2.8	2.8	0.7	-0.1	1.2	14.2	0.2	4.2	19.6	0.0	11.3	29.3	0.01	0.00	0.01	0.01
S5-26	2.7	90.6	6.6	1.9	1.5	0.0	1.2	79.8	3.6	64.0	10.2	0.7	9.0	14.7	0.00	0.00	0.04	0.02
S5-27	4.8	87.4	7.8	1.7	1.8	0.1	1.1	91.5	4.8	83.1	0.0	1.1	6.6	7.8	0.01	0.00	0.05	0.04
S5-28	4.1	82.6	13.2	2.1	1.9	0.0	1.4	91.0	2.4	91.1	1.0	1.2	0.6	6.0	0.02	0.00	0.09	0.05
S5-29	8.5	86.6	4.9	1.3	1.6	0.0	0.9	94.6	4.4	84.8	3.7	1.0	3.2	3.7	0.15	0.00	0.07	0.05
S5-30	2.0	75.3	22.6	3.0	2.2	0.3	1.5	92.8	3.9	79.8	0.2	1.0	3.0	3.7	0.05	0.01	0.05	0.03
Min.	**0.00**	**72.7**	**0.21**	**0.86**	**0.40**	**-0.60**	**0.87**	**14.21**	**0.20**	**4.20**	**0.02**	**0.02**	**0.56**	**2.91**	**0.00**	**0.00**	**0.01**	**0.00**
Max.	**12.8**	**99.8**	**26.9**	**3.56**	**2.18**	**0.26**	**1.92**	**97.91**	**5.69**	**91.10**	**23.03**	**1.60**	**12.71**	**29.29**	**0.15**	**0.01**	**0.09**	**0.07**
Avg.	**2.67**	**89.0**	**8.33**	**2.22**	**1.41**	**-0.03**	**1.22**	**71.21**	**3.51**	**62.91**	**5.87**	**0.81**	**6.74**	**12.63**	**0.04**	**0.00**	**0.05**	**0.03**

Mz = mean size, σI = sorting, SK_I = skewness, K_G = kurtosis, Carb. = Carbonate content , TOM = Total Organic Carbon, Ca = Calcium, Mg = Magnesium, Al = Aluminium, Si = Silicon, Sr = Strontium, V = Vanadium, Rb = Rubidium, Nb = Niobium, Mo = Molybdenum, Min. = Minimum, Max. = Maximum, Avg. = Average.

Table no 4. Correlation coefficients between sediment types, grain size parameters and geochemical analysis of surface marine sediments at Abu-Soma Bay.

	Gravel	Sand	Mud	Mz	6I	SkI	KG	Carb.%	TOM%	Ca%	Mg%	Sr%	Al%	Si%	V%	Rb%	Nb%	Mo%
Gravel	1																	
Sand	-0.21	1																
Mud	-0.26	-0.89	1															
Mz	-0.82	-0.23	0.62	1														
6I	0.31	-0.87	0.71	-0.04	1													
SkI	-0.10	-0.48	0.53	0.18	0.40	1												
KG	-0.43	-0.48	0.68	0.73	0.16	0.28	1											
Carb.%	0.35	-0.55	0.38	-0.25	0.61	0.31	-0.03	1										
TOM%	0.36	-0.46	0.29	-0.21	0.55	0.05	-0.07	0.73	1									
Ca%	0.29	-0.35	0.21	-0.28	0.47	0.13	-0.16	0.76	0.61	1								
Mg%	-0.28	0.35	-0.22	0.21	-0.39	-0.09	0.03	-0.70	-0.55	-0.90	1							
Sr%	0.45	-0.29	0.07	-0.43	0.40	0.05	-0.27	0.75	0.62	0.95	-0.87	1						
Al%	-0.29	0.31	-0.17	0.24	-0.44	-0.11	0.12	-0.59	-0.44	-0.81	0.81	-0.79	1					
Si%	-0.38	0.30	-0.12	0.38	-0.47	-0.09	0.27	-0.71	-0.62	-0.96	0.85	-0.94	0.87	1				
V%	0.60	-0.09	-0.20	-0.42	0.00	-0.10	-0.24	0.18	0.27	0.04	-0.06	0.19	-0.11	-0.15	1			
Rb%	0.21	0.12	-0.21	-0.25	-0.11	0.04	-0.32	0.13	0.03	0.19	-0.25	0.27	-0.12	-0.23	0.30	1		
Nb%	0.45	-0.31	0.10	-0.41	0.45	0.10	-0.26	0.76	0.62	0.93	-0.86	0.93	-0.84	-0.92	0.15	0.14	1	
Mo%	0.38	-0.31	0.14	-0.36	0.46	0.12	-0.24	0.77	0.66	0.90	-0.82	0.89	-0.79	-0.89	0.10	0.07	0.97	1

Figure no 5: Average distribution of carbonate (Carb.) of surface marine sediments at Abu-Soma Bay.

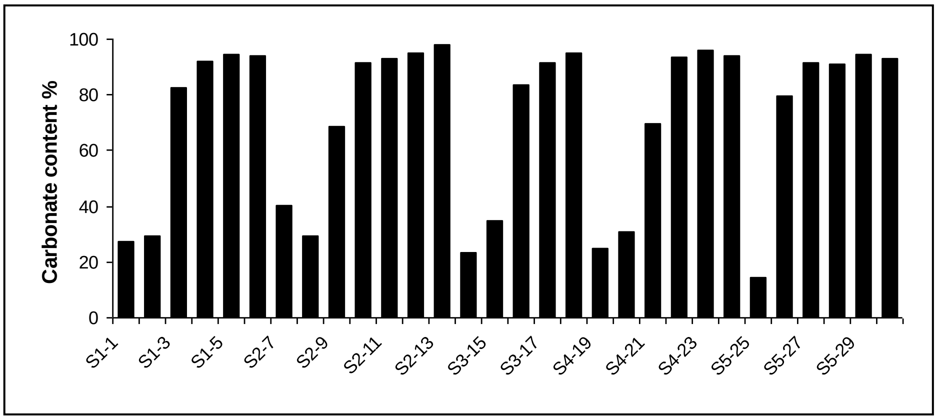


Figure no 6: Average distribution of total organic matter (TOM) of surface marine sediments at Abu-Soma Bay.

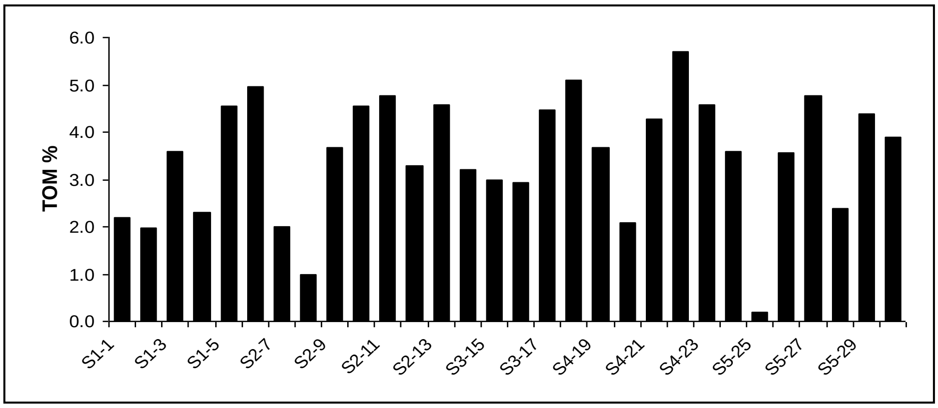
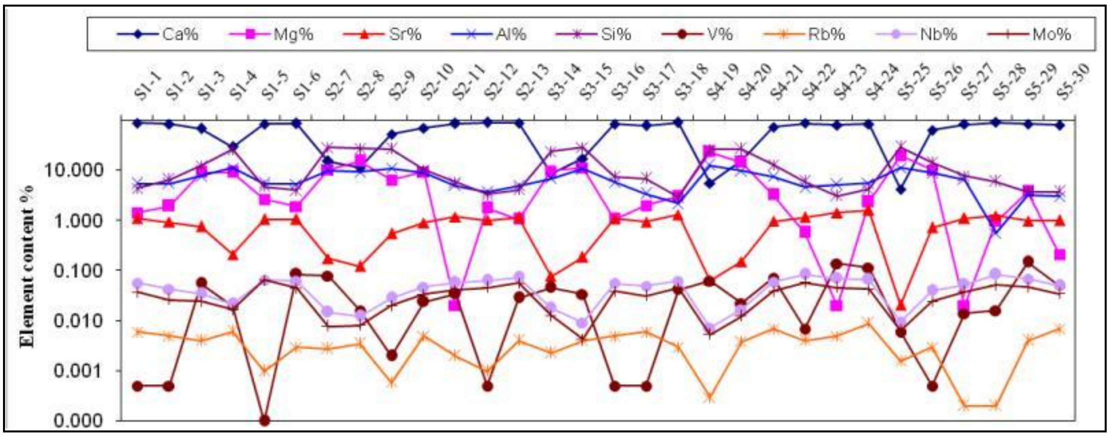


Figure no 7: Distribution of element contents of surface marine sediments of Abu-Soma Bay.



it is noted that the concentrations of Nb and Mo are extremely high than their average contents in the Upper continental crust. This is also attributed to the terrigenous inputs of the same two wadis from the nearby basement rocks. Furthermore, Nb and Mo exhibit a strong positive correlation with Calcium, Strontium, Aluminum and silicon contents (Table no 4). This may be indicate that both of Nb and Mo are incorporated with these elements (Ca, Sr, Al and Si) in the lattice of the aluminosilicate minerals that probably originated due to the weathering of the silicate minerals constitute the fragments of basement rocks coming to Abu-Soma Bay by Abu-Murrat wadi and Abu-Juruf wadi . Also Nb and Mo show a good positive correlation with carbonate, total organic matter.

From the aforementioned distribution of the earth elements in the studied sediments, It could be assume that any significant increase in the content of these elements were noticed in the marine sediment samples of Abu-Soma Bay area is due to two main factors. The first one is related to the anthropogenic activities, as a result of landfilling of some parts of the coastal area by terrestrial sediments from the adjacent wadis. That took place in the last two decades during the construction of one of the tourist villages within the area of the bay. The second factor is natural due to the frequent contribution of the continental sediments by the two active wadis (wadi Abu-Murrat and wadi Abu-Juruf) to the southern part of Abu-Soma Bay area, through estuary in front of the study area. It is worth to mention that, the present study data represent primary base line data to assist the responsible governmental authorities to follow any anthropogenic impacts, and making better assessing the needs for remediation by detecting any changes in future.

IV. Conclusions and Recommendations

The results of the mechanical analysis performed in this work indicate that, the particle size of the sediments changes from coarse sand near the beach to very fine sand with increasing distance from the beach towards the deeper water. Grain size characteristics reflect that the study area receives sediments from two different sources; the terrigenous rock fragments from the hinterland mountains and the skeletal carbonates from the sea. Therefore, the occurrence of a mixed detrital and biogenic origin of sediments in the investigated area indicates a fluctuating energy and different sources of supply, so that the sorting is generally worse. The distribution of coarser sediments may reflects the abundance of terrigenous sediments in the beach and biogenic fragments in the reef areas. The carbonate contents in the samples of Abu-Soma Bay area were recorded relatively high average, because this area is rich in biogenic materials form in situ. The organic matter plays vital role in the marine environments. It tends to be accumulated and fixed in the highly reducing environment. The organic carbon content increases as particle size decreases. Therefore, the organic materials are present essentially in the mud fraction. The elements of biogenous constituents determined in the area under study include Ca, Mg and Sr. They are likely to be derived from either modern or fossil biogenic sources. On the other hand, elements of mixed origin constituents (biogenic and terrestrial) include Al, Si, V, Rb, Nb and Mo which determined in the sediment samples of study area. The highest content of earth elements is attributed to the contribution of terrigenous fragments including mafic minerals. The gathered information will be useful in management and suitable development of the area under study. In addition, it represents database in the future.

Acknowledgment

The samples were collected through the National Institute of Oceanography and Fisheries plan, Red Sea Branch, Hurghada, Egypt. The authors wish to thank the team, participating in the present work.

References

[1]. Dickinson WW, Dunbar GB, McLeod H. Trace element history from cores in Wellington Harbour, New Zealand. Environmental Geology. 1996; 27:59–69.
[2]. Mansour AM, Nawar AH, Mohamed AW. Geochemistry of coastal marine sediments and their contaminant metals, Red Sea, Egypt: A legacy for the future and a tracer to modern sediment dynamics. Sedimentology of Egypt. 2000; 8:231-242.
[3]. Dar AM. Geological basis to study the environmental defect in the marine ecosystem as a result of tourist activities in Hurghada area and surroundings, Red Sea, Egypt. Ph.D. Thesis, Suez Canal University, Egypt. 2002; 218.
[4]. Madkour HA, Dar MA. The anthropogenic effluents of the human activities on the Red Sea coast at Hurghada Harbour (Case study). Egyptian Journal of Aquatic Research. 2007; 33(1):43-58.
[5]. Madkour HA. Impacts and mitigation of anthropogenic factors on terrestrial Red Sea environment. Review article, National Institute of Oceanography and Fisheries, Red Sea Branch, 2009; 72p.
[6]. Mohamed AM, Madkour HA, El-Saman MI. Impact of anthropogenic activities and natural inputs on oceanographic characteristics of water and geochemistry of surface sediments in different sites along the Egyptian Red Sea coast. African Journal of Environmental Science and Technology. 2011; 5(7):494-511.
[7]. Madkour HA , El-Taher AM, Abu El-Hagag NA, et al. Contamination of coastal sediments in El-Hamrawein Harbour , Red Sea Egypt. Journal of Environmental Science and Technology. 2012; 5(4):201-221.
[8]. Mansour AM, Nawar AH, Madkour HA. Metal pollution in marine sediments of selected harbours and industrial areas along the Red Sea coast of Egypt. Annalen des Naturhistorischen Museums in Wien, 2011; A113:225-244.
[9]. Mansour AM, Askalany MS, Madkour HA, et al. Assessment and comparison of heavy-metal concentrations in marine sediments in view of tourism activities in Hurghada area, northern Red Sea, Egypt. Egyptian Journal of Aquatic Research. 2013; 39:91–103.
[10]. El-Taher AM, Madkour HA. Environmental and radio-ecological studies on shallow marine sediments from harbour areas along the Red Sea coast of Egypt for identification of anthropogenic impacts. Isotopes in Environmental and Health Studies. 2014; 50(1), 120–133.
[11]. Madkour HA. Detection of damaged areas due to tourism development along the Egyptian Red Sea coast using GIS, remote sensing and foraminifera. State of the Art, National Institute of Oceanography and Fisheries, Red Sea Branch. 2015; 148p.
[12]. Uosif MAM, Shams I, Zakaly HM, Madkour HA, Mahmoud T. The Status of Natural Radioactivity and Heavy Metals Pollution on Marine Sediments Red Sea Coast at Safaga, Egypt. Journal of Nuclear Physics, Material Sciences, Radiation and Applications. 2016; 3(2):191–222.
[13]. Badawy WM, El-Taher AM, Frontasyeva MV, et al. Assessment of anthropogenic and geogenic impacts on marine sediments along the coastal areas of Egyptian Red Sea. Applied Radiation and Isotopes. 2018; 140:314–326.

[14]. Madkour HA, Mansour AM, Mohamed WM, et al. Observation of Changes in Sediment Nature by Environmental Impacts of Abu-Makhadeg Area, Red Sea. Egyptian Journal of Environmental Technology. 2019; 12(2):55-64.
[15]. Riegl B, Piller WE. Mapping of benthic habitats in northern Safaga Bay (Red Sea, Egypt): a tool for proactive management. Aquatic Conservation Marine and Freshwater Ecosystems. 2000a; 10:127-140.
[16]. Folk RL, Ward WC. Brazos River bar: a study in the significance of grain size. Journal of Sedimentary Petrology. 1957; 27(1):3-26.
[17]. Dean WE, Jr. Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss in ignition: comparison with other methods. Journal of Sedimentary Petrology. 1974; 44:242-248.
[18]. UniQuant software, version 6 for QUANT'X ED-XRF. Thermo Fisher Scientific Inc. 2008.
[19]. Piller WE, Mansour AM. The northern Bay of Safaga (Red Sea, Egypt): an actuopalaeontological approach II. Sediment analyses and sedimentary facies. Beitr. Palantologie Oestrreich. 1990; 16:1-102.
[20]. Rasser M, Piller WE. Depth distribution of calcareous encrusting associations in the northern Red Sea (Safaga, Egypt) and their geological implications. Proceedings of the 8th International Coral Reef Symposium, Panama. 1997; 1:743-748.
[21]. Dar AM. Distribution patterns of some heavy metals in the surface sediment fractions at northern Safaga Bay, Red Sea, Egypt. Arabian Journal of Geoscience. 2014; 7:55–67.
[22]. Maxwell WGH. Atlas of the Great Barrier Reef. Elsevier Publishing Company. 1968; 268p.
[23]. Taylor SR, McLennan SM. The continental crust: Its composition and evolution. Blackwell Scientific, Oxford. 1985; 312p.
[24]. Fischer RP, Jane PO. Bibliography on the Geology and Resources of vanadium to 1968. American Geological Survey Bulletin 1316, 168p.

IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) is UGC approved Journal with Sl. No. 5021, Journal no. 49115.

Hashem A. Madkour. " Nature and geochemistry of surface marine sediments of Abu-Soma Bay along the Egyptian Red Sea Coast. "IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) 7.6 (2019): 32-42.