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GEOCHEMISTRY OF THE RED SEA SHELF SEDIMENTS AT AL-GHARDAQA.
I - ABUNDANCE AND DISTRIBUTION OF CHEMICAL CONSTITUENTS.

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ABSTRACT

Sediment samples from the area of Al-Ghardaqa were analyzed for the following constituents: carbonate, chloride, sulphate, organic carbon, sodium, potassium, magnesium, strontium and total iron. The area could be subdevided into two distinct north and south zones. The north zone has more material from terreginous origin, compared with the south zone. However, in both areas carbonate decreases landwards and seawards.

The zonal distribution of chemical constituents indicates that chloride, sulphate and potassium decrease seawards, while organic carbon, calcium, magnesium, strontium, sodium and total iron increase seawards.

INTRODUCTION

The chemical composition of the marine sediments reflects the effect of various processes taking place into the marine environment, viz: adsorption, substitution, biological precipitation and chemical interaction. It also reflects the influence of the source material and the mineralogic constituents of the sediment. Early diagensis may also be manifested in the surface sediments of certain environments(Bathrust, 1971). However, the carbonate precipitate from sea water mainly due to biological processes (Cloud, 1965). The inorganic precipitation of carbonate from sea water is demonstrated in certain environments (Purdy, 1961).

Beltagy, (1984) and El-Sayed, (1984) studied the distribution of some sediment components in the area of Al-Ghardaqa. According to these authors, sediments of the area are mostly carbonate. However, the sample density made by them did not permit any discussion about the area distribution of the chemical component.

The sediments of Al-Ghardaqa, Red Sea are mostly carbonates. According to Schenk (1969), carbonate facies in marine environment are typically arranged from the shore zone out to the shelf-break and into the basins as follows:

In the near-shore intertidal and supratidal areas, carbonate dominates, grading landwards into evaporite deposits, salinas and clastic sediments.

In shallow to deep shelf areas, carbonate skeletal sands and muds accumulate.

The present study deals with some aspects of the chemistry of Recent sediments of Al-Ghardaqa area, Red Sea. In order to investigate the area distribution of different components carbonate, sulphate, chloride, organic carbon, Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, Sr^{+2} and total iron were determined.

MATERIALS AND METHODS

The sediments of the area under investigation were sampled during 1982. The beach samples were collected by hand, while the bottom ones were collected using a grab sampler. Fig. (1) shows the locations of the sampling stations.

The carbonate content was determined by the method described by Vogel (1953) and Alexeyev (1971), while total sulphate was determined gravimetrically according to the method mentioned by Kolthof et al., (1969). The chloride content also was determined gravimetrically following the method reported by Hillebrand et al., (1953). The organic carbon content was measured by the method described by El-Wakeel and Riley, (1957). For determining the Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, and Sr^{+2}, the samples were dissolved in H F and H Cl O_4 as described by Riley (1958) and measured using a Varian 1200 A.A.S. Standards were prepared and added to a matrix in proportions similar to the near-shore sediments. The total iron was measured colorimetrically as described by Armstrong, (1957).

RESULTS AND DISCUSSIONS

The chemical analysis of the samples are given in Lotfy (1985). 2. For the sake of the present discussions, the area under investigation was subdevided into two regions as shown in figure 2.

Carbonate

The area distribution of carbonate content is illustrated in figure 3. In the sediment of the tidal zone, the carbonate content ranges between 34.3% and 72.3% with an average of 48%. In the tidal zone sediments, the content increases seawards.

The carbonate content of the shelf sediments, however, is higher. It ranges between 73.8% and 97%, averaging 86.7%. The average carbonate content of region I is 85% which is lower than the average carbonate content of the sediment of region II (average 93%). The carbonate content of the shelf sediment increases seawards.

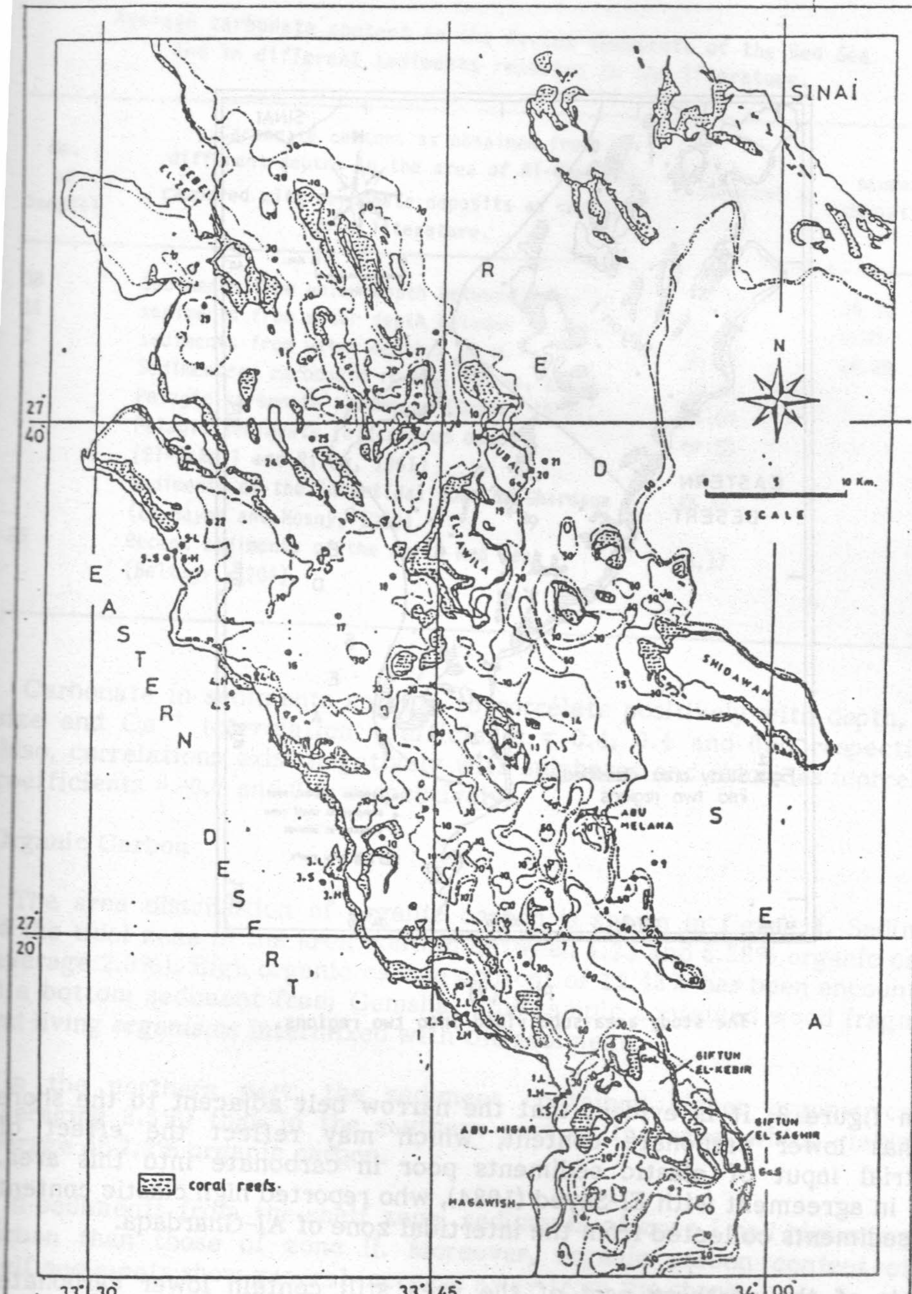

Fig. (1)
Map showing location and sampling stations, the geomorphology of the Ghardaga region and depth contours.

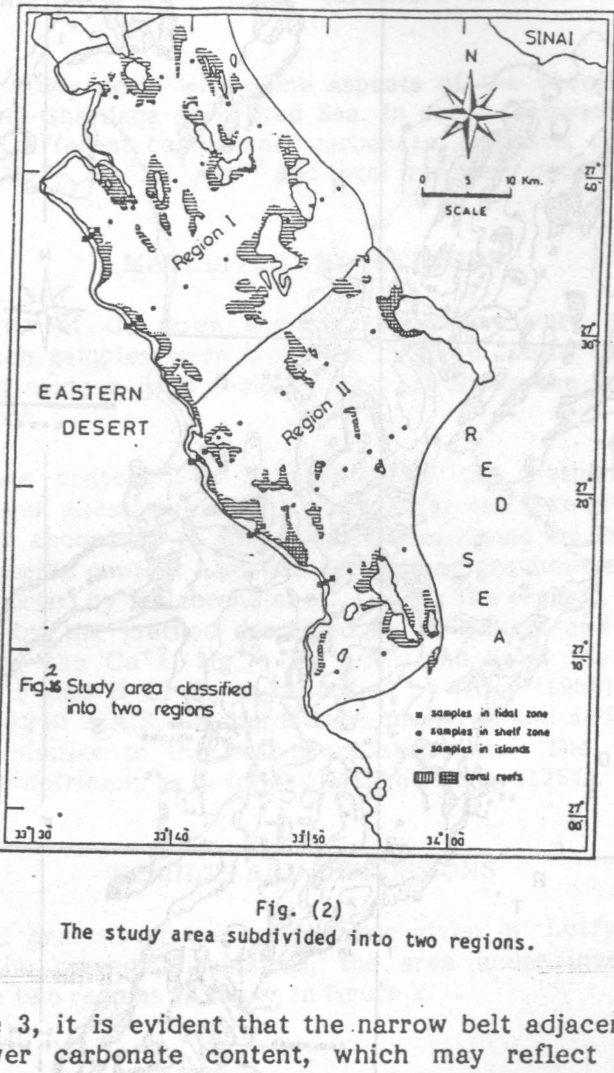

Fig. (2)
The study area subdivided into two regions.

From figure 3, it is evident that the narrow belt adjacent to the shore area has lower carbonate content, which may reflect the effect of terrestrial input of clastic sediments poor in carbonate into this area. This is in agreement with El-Sayed (1984), who reported high clastic content in the sediments collected from the intertidal zone of Al-Ghardaqa.

Islands of the northern part of the area still contain lower carbonate than the islands in the southern part of the area.

The average carbonate content in the sediments obtained from different depths in the Red Sea is summarized in table 1, together with values for different carbonate deposits reported in the literature.

The results indicate that carbonate content becomes more abundant with depth.

TABLE 1

Average carbonate content in the Recent sediments of the Red Sea and in different sediments reported in the literature.

No. of Samples	Carbonate content as obtained from different depths in the area of Al-Ghardaqa campared with carbonate deposits as compiled from literature.	Carbonat %	sandard deviation
38	Sediments from water depth between 0 and 20 m.	70.20	20.10
11	sediments from water depth between 20 and 50 m.	93.20	5.00
2	sediments from water depth > 50 m.	85.00	16.20
-	Sedimentary carbonate rocks (Green, 1972).	76.20	
-	Pelagic carbonate sediments (Green, 1972).	8[illegible].00	
-	Pelagic sediments (clacareous ooze) (El-Wakell and Riley, 1961)	69.25	
-	Sediments of the intertidal zone of Ghardaqa (El-Sayed and Hosny, 1980).	45.50	
26	Recent sediments of the north Red Sea. (Beltagy, 1984).	95.17	

Carbonate in sediments appears to correlate positively with depth, mean size and Ca^{++} (correlation coefficients = 0.4, 0.4 and 0.8, respectively). Also, correlations exist negatively with sulphates and chlorides (correlation coefficients = -0.7 and 0.5, respectively).

Organic Carbon

The area distribution of organic carbon is shown in figure 4. Sediments of the tidal zone in the area contain between 1.23 and 5.38% organic carbon (average 2.9%). High organic carbon content of 12.43% has been encountered in a bottom sediment from Gemsha. This sample contained wood fragments and living organisms intermixed with the sediment.

In the northern part, the sediment contained higher organic carbon (averaging 3.5%) than in the southern part of the area, which yielded an average of 2.2% organic carbon.

In sediments from the shelf zone, sediments of zone I had higher organic carbon than those of zone II. Moreover, organic carbon content of the shelf sediments show general increase away from the shore.

Beach sediments of islands of the northern part of the area had also higher organic carbon than sediments of the southern part of the area.

On the average, the Red Sea sediments are higher in organic carbon than pelagic sediments, (Table 2).

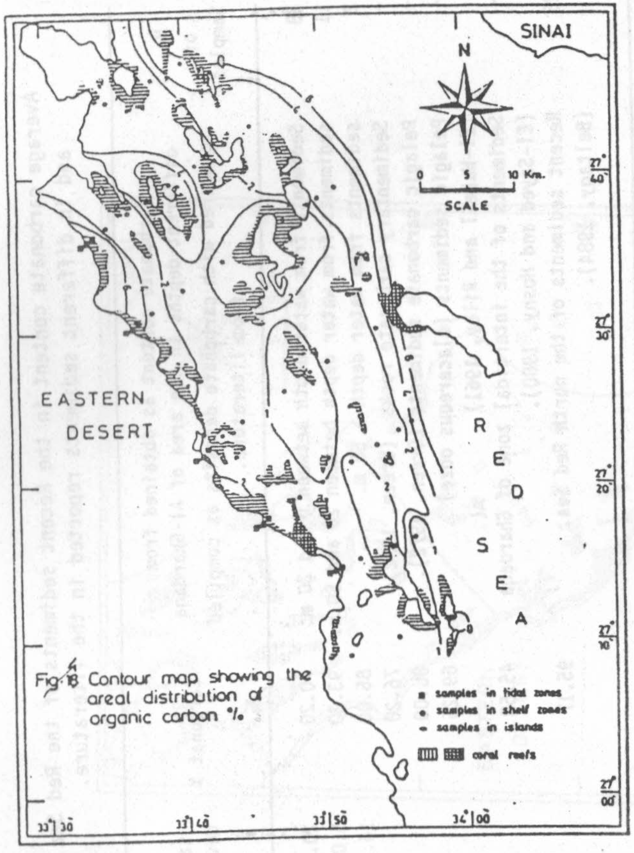

Fig. (4)
The area distribution of organic carbon (wt.%).

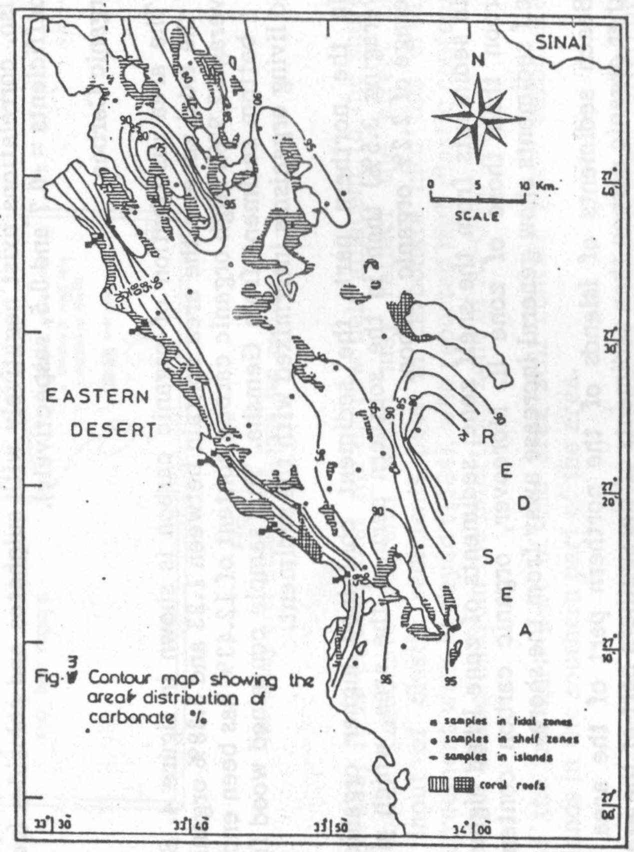

Fig. (3)
Contour map showing the area distribution of carbonate content (wt.%).

TABLE 2

Average organic carbon content in the Recent sediments of the Red Sea compared with other sediments reported in the literature.

Sample No.	Organic carbon content as obtained from different depths in the area of study, and from different rocks as complied from literature	Organic carbon %	Standard deviation
38	Sediments from water depth between 0 and 20 m.	2.60	1.80
11	sediments from water depth between 20 and 50 m.	1.74	0.80
2	sediments from water depth > 50 m.	2.81	2.20
-	Shallow water sediments, Scotian shelf (Turekian, 1965).	2.29 - 4.97	2.20
-	Pelagic sediments (calcereous ooze) (El-Wakeel and Riley, 1961)	0.31	
-	Pelagic sediments (Trask, 1955; El-Wakell and Riley, 1961).	0.50	
-	Gulf of Şuez, Red Sea (Mohamed, 1949). Belltagy and Moussa (1984)	0.06 - 0.45	
-	Sediments of the intertidal zone of Al-Ghardaqa (El-sayed and Hosny, 1980).	0.15 - 1.75	

Organic carbon showed positive correlation with mean size.

From the area distribution, it is obvious that organic carbon is closely related to reef formation, nevertheless deep water sediments contained also a high proportion of organic carbon. This may be attributed to bottom scourge by subsurface current, and subsequent deposition of organic rich material derived from the shallow zone into the deeper parts.

Sulphate

The area distribution of sulphate content is shown in figure 5. Sediments of the tidal zone in the area of study exhibit a sulphate content ranging between 1.77 and 5.40% (average 3.3%). In region I, the sediments contained a higher proportion of sulphate (averaging 4%) than the sediments of region II, which displayed an average of sulphate content of 2.5%.

Sediments of the supratidal zone contain higher sulphate than the intertidal zone sediments and the later contain still a higher proportion of sulphate than the shelf zone. The average sulphate content of the shelf sediments is 0.7%. Thus, the sulphate content of the sediments in the area decreases seawards.

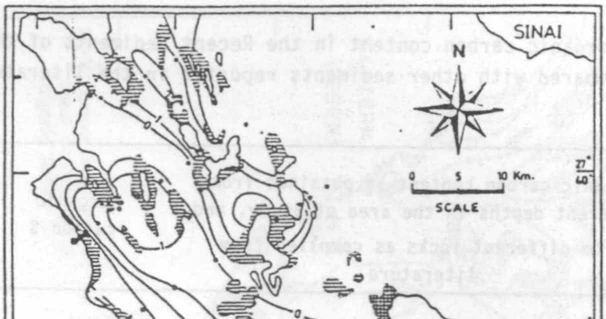

Fig. (5)
The area distribution of sulphate (Wt.%)

The average sulphate content of the island sediments is 0.95%. The northern islands contain still higher proportion of sulphate than the samples collected from the southern islands.

Generally, in this area, the sulphate content of sediments decreases seawards and southwards.

Table 3 gives the average concentrations of sulphate content in Recent sediments from different depths in the area, together with some values as compiled from the literature.

The results indicte that sulphate becomes less abundant with depth. The general pattern of precipitation of sulphate in the sediments of the area suggests that sulphate is deposited in the tidal zone.

TABLE 3

Variation of sulphate with depth in the Recent sediments of the Red Sea and the same for other materials as reported elsewhere

Sample No.	Sulphate content as obtained from different depths in the area of study, and from different rocks as compiled from literature	SO_4^{--}	Standard deviation
39	Sediments from water depth between 0 and 20 m.	1.64	1.62
11	sediments from water depth between 20 and 50 m.	0.00	0.00
2	sediments from water depth > 50 m.	0.00	0.00
-	sedimentary carbonate rocks (Green, 1972).	0.39	
-	Pelagic carbonate sediments (Green, 1972).	0.36	

For the precipitation of sulphates within deep water-filled basins, the most important factor, apart from an extremely arid climate and periodic replenishment of sea water, is the barrier which gives near-complete isolation from the main mass of sea water. The barrier may be structural, such as a fault bounded ridge, or sedimentary, such as a carbonate reef or sand bar (Shearman, 1963 and 1966; Kinsman, 1966 and 1969; and Dean, 1978). Although, barriers, exist in the area, complete isolation does not occur, since a N-S flow of the Gulf water flush the isolated deep basin from time to time (Beltagy et al., 1986 and Anwar, P.C.)

Chloride

The area distribution of chloride is shown in figure 6. Sediments of the tidal zone in the area exhibit a chloride content ranging between 0.2 and 3.8%, averaging 2.4%.

Sediments in the shelf zone had its high content of chloride in the zone between 0 and 20 m depth. As can be seen from figure 6, chloride attains its highest concentration near to the tidal zone and islands. However, the chloride content decreases seaward.

The average chloride content in the sediments obtained from different depths in the Rea Sea is summarized in table 4, togther with values reported from different formations by other workers.

The results idicate that chloride decreases with depth. Chloride content in sediment appears to correlate negatively with depth, mean size and carbonate (correlation coefficients = -0.58, -0.50 and -0.50 respectively). It seems that chloride is deposited in a much similar manner as that suggested for sulphate. Chloride content in sediments appears to correlate positively with sulphate (correlation coefficient = 0.51).

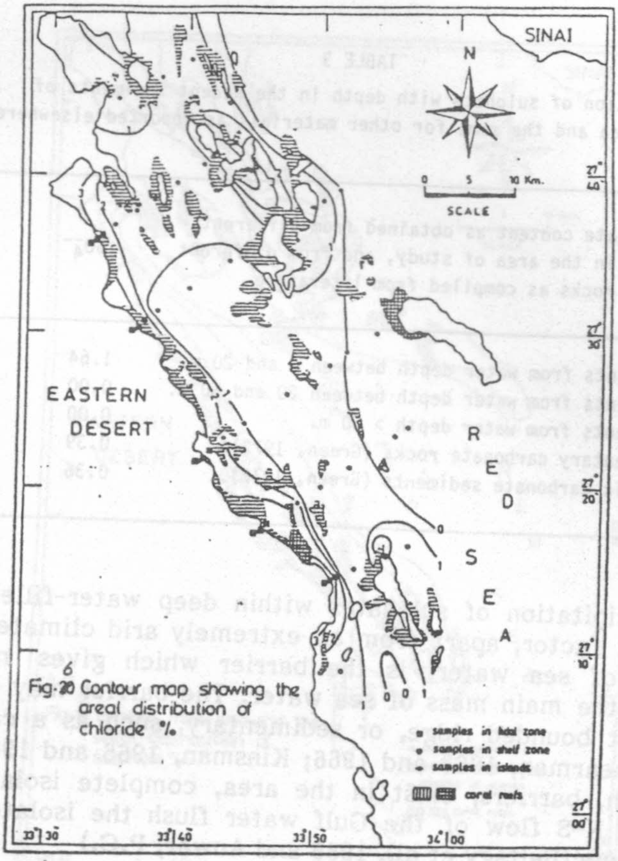

Fig. (6)
The area distribution of chloride (wt.%).

TABLE 4

Average chloride content in the Recent sediments of the Red Sea and in different geological materials reported in the literature.

Sample No.	Chloride content as obtained from different depths in the area of study, and from different rocks as compiled from literature	Chloride %	Standard deviatio
38	Sediments from water depth between 0 and 20 m.	1.93	1.25
11	sediments from water depth between 20 and 50 m.	1.02	1.0
2	sediments from water depth > 50 m.	0.0	0.0
-	sedimentary carbonate rocks (Green, 1972).	0.02	
-	Pelagic carbonate sediments (Green, 1972).	2.10	

Calcium

The area distribution of calcium content is illustrated in figure 7. In the sediments of the tidal zone, the calcium content ranges between 14.6% and 28.6%, averaging 19.3%. Sediments of the supratidal zone contain less calcium than the intertidal zone sediments, i.e. the calcium content of the tidal sediments increases seawards.

The calcium content of the shelf sediments is much higher, it ranges between 25.2% and 36.8%, averaging 33.2%. The calcium content of the shelf sediment increases also seawrads and southwards.

The calcium content of beach sediments of islands of the area ranges between 29.5 and 37.2%, averaging 32.6%. The northern islands in the area contain still less calcium than the southern islands in the area.

Generally, in this area, the calcium content of the sediments increases seawards.

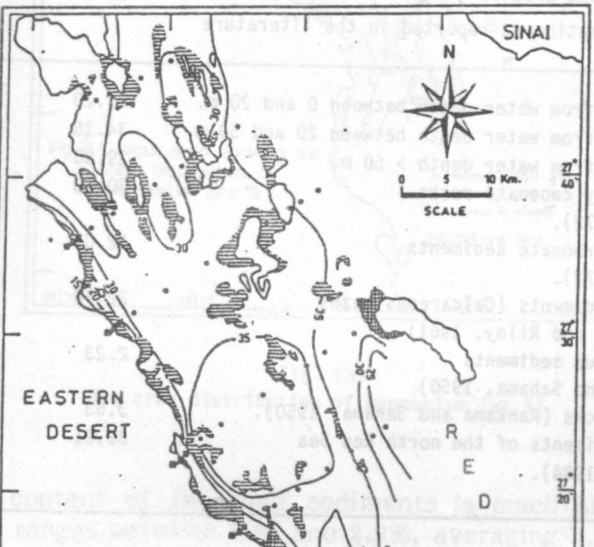

Fig (7)

The area distribution of calcium (wt.%).

The average Ca^{++} in the Recent sediments obtained from differ depths in the Red Sea is summarized in table 5, together with val reported from different formations by other workers.

The results indicate that Ca^{++} becomes more abundant with depth.

Calcium in the Recent sediments of the area under investigation appe to correlate positively with distance from shore and mean size (correlat coefficients = 0.54 and 0.54). It apperas to correlate negatively w sulphate and chloride.

TABLE 5

Average calcium content in the Recent sediments of the Red Sea and in different geological materials, as reported in the literature.

Sample No.	calcium content as obtained from different depths in the area of study, and from different rock formation, as reported in the literature	Ca^{--} %	Standard deviation
38	sediments from water depth between 0 and 20 m.	28.20	8.40
11	sediments from water depth between 20 and 50 m.	34.18	2.00
2	sediments from water depth > 50 m.	29.80	6.50
-	sedimentary cabonate rocks (Green, 1972).	30.20	
-	Pelagic carbonate sediments (Green, 1972).	32.00	
-	Pelagic sediments (Calcareous ooze) (El-Wakeel and Riley, 1961)	22.70	
-	Argillaceous sediments (Rankama and Sahama, 1950)	2.23	
-	Igneous rocks (Rankama and Sahama, 1950).	3.63	
26	Recent sediments of the north Red Sea (Beltagy, 1984).	32.21	

Magnesium

The area distribution of Mg^{++} is illustrated in figure 8. In of the tidal zone, the Mg^{++} content ranges between 0.5 and 2.. 1.6%. On the average, sediments of region I has slightly higher Mg^{+} (average 1.68%) than region II (average 1.38%). Sediments of the supra... zone contin lower Mg^{++} than the intertidal zone sediments, i.e. in th tidal zone, the Mg^{++} content increases seawrds and northwards.

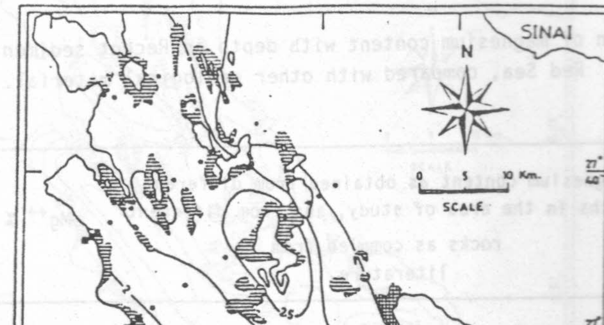

Fig. 8 Contour map showing the areal distribution of magnesium ions %

Fig. (8)
The area distribution of magnesium (wt.%).

The Mg^{++} content of the shelf sediments is much higher than in the tidal zone. It ranges between 0.65 and 2.9%, averaging 1.77%. The average Mg^{++} of region I is 2.23% and is higher than that of region II (average 1.95%). Thus, the Mg^{++} content of the shelf sediments seems to increase seawards and northward.

The Mg^{++} content of island beach sediments in the study area, ranges between 0.71 and 1.3%, averaging 0.86%. The Mg^{++} content of the island sediments increases northwards.

The average Mg^{++} content in the Recent sediments of Al-Ghardaqa is summerized in table 6, together with values compiled from literature.

The results indicate that the Mg^{++} content becomes higher with depth. However, low Mg^{++} content is found between 20 and m depth.

TABLE 6

Variation of magnesium content with depth in Recent sediments of the Red Sea, compared with other geological material.

Sample No.	Magnesium content as obtained from different depths in the area of study, and from different rocks as compiled from literature.	Mg^{++} %	Standard deviation
38	Sediments from water depth between 0 and 20 m.	1.62	0.70
11	sediments from water depth between 20 and 50 m.	1.50	0.80
2	sediments from water depth more than 50 m.	2.25	0.30
-	sedimentary carbonate rocks (Green, 1972).	0.47	
-	Pelagic sediments (crabonate) (Green, 1972).	0.40	
-	Pelagic sediments (calcerous ooze) (El-Wakeel and Riley, 1961)	0.50	
-	Silts, shales and muds (Gold scmidt, 1954).	0.90-1.51	
-	Argillaceous sediments (Rankama and Sahama, 1950).	0.89	
-	Gulf of Paria clay (Hirst, 1962 a).	1.32	
-	Igneous rocks (Rankama and Sahama, 1950).	1.26	
-	Recent sediments from north Red Sea (Beltagy, 1984).	1.45	

Mg^{++} appears to correlate positively, but not strongly, with distance from the shore, mean size and carbonate (correlation coefficients = 0.4, 0.41 and 0.31 respectively).

Generally, the Mg^{++} content becomes more abundant in fine grained carbonate sediments.

Sodium and Potassium

The area distribution of Na^{+} is shown in figure 9. Sediments of the tidal zone in the area contain a proportion of Na^{+} ranging between 0.2 and 5.6%, averaging 2.9%. On the average, sediments of region I have a higher Na^{+} content (average 3.35) than region II (average 2.05%).

In the sediments from the shelf zone, the Na^{+} content still maintains the same pattern of distribution, i.e. sediments of region I have higher Na^{+} content (average 2.2%) than region II (average 1.2%). Moreover, the Na^{+} content of the shelf sediments shows a general increase seawards.

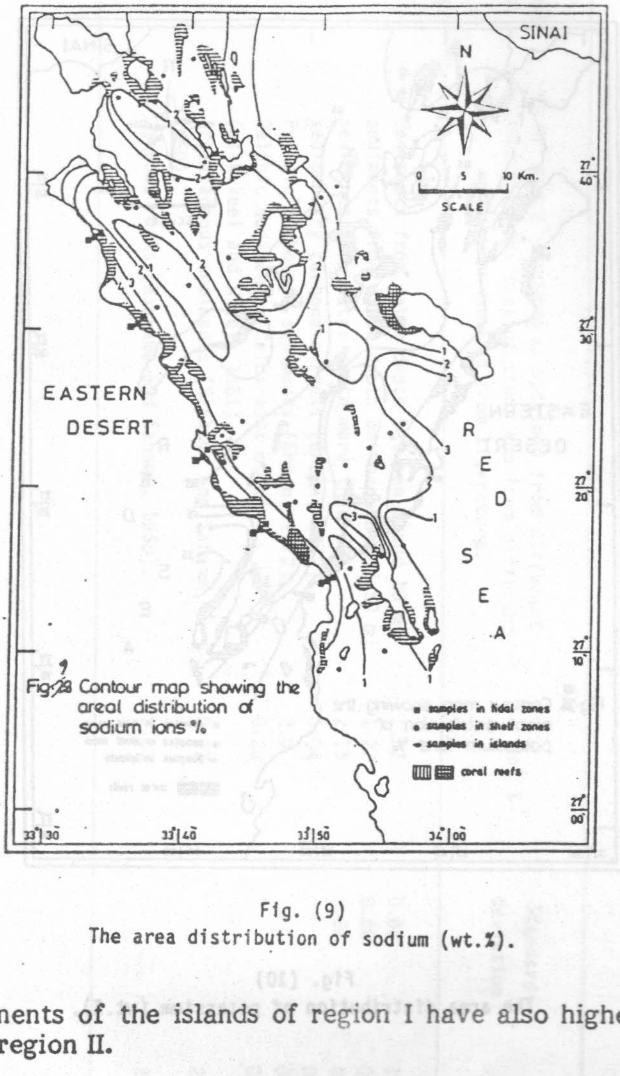

Fig. (9)
The area distribution of sodium (wt.%).

Beach sediments of the islands of region I have also higher Na^{+} content than those of region II.

The area distribution of K^{+} is shown in figure 10. In sediments of the tidal zone of the area, K^{+} content ranges between 0.7 and 2.5%, averaging 1.55%. In region I, the sediments contained on the average a relatively higher K^{+} (average 1.55%), while those of region II had an average of 1.4%.

Sediments from the shelf zone had values of K^{+} ranging between 0.08 and 3.34%, averaging 0.75%. Sediments of region I have higher K^{+} content than region II. Potassium content of the shelf sediments shows a general decrease away from the shore.

The northern island sediments of the area had also a higher K^{+} content than sediments from the southern islands.

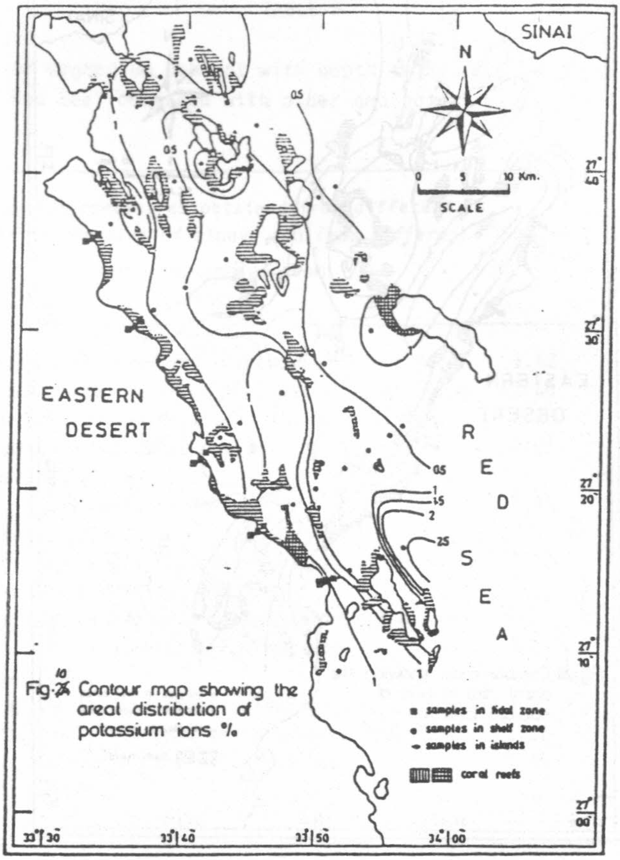

Fig. 10 Contour map showing the areal distribution of potassium ions %

Fig. (10)
The area distribution of potassium (wt.%).

Table 7 gives the average concentration of Na^+ and K^+ in Recent sediments from different depths in the area, together with some values as reported elsewhere.

The results indicate that Na^+ content decreases between 20 and 50 m depth, but K^+ content, generally, decreases with water depth.

Na^+ in the sediments did not show any strong correlation with mean size nor carbonate (r = 0.3 and -0.25, respectively).

TABLE 7

Variation of sodium and potassium with depth in the Recent sediments of the Red Sea and in different sediments as compiled from literature.

Sample No.	Na^+ and K^+ contents as obtained from different depths in the area of study and from different rocks as compiled from literature.	Na^+ %	Standard deviation	K^+ %	Standard deviation
38	Sediments from water depth between 0 and 20 m.	1.57	0.88	1.10	0.60
11	sediments from water depth between 20 and 50 m.	1.27	0.80	0.70	0.44
2	sediments from water depth more than 50.	2.15	0.86	0.41	0.21
-	sedimentary carbonate rocks (Green, 1972).	0.04		0.27	
-	Pelagic carbonate sediments (Green, 1972).	2.0		0.29	
-	Pelagic sediments (Calcareous ooze) (el-Wakeel and Riley, 1961).	0.28		0.60	
-	Argillaceous sediments (Rankama and Sahama, 1950).	0.97		2.70	
-	Igneous rocks (Rankama and Sahama, 1950).	2.83		2.59	

Strontium

The area distribution of Sr^{++} is shown in figure 11. In the sediments of the tidal zone Sr^{++} content varied between 400 and 9600 ppm, with an average of 4000 ppm. Sediments of region I have a slightly higher Sr^{++} content than sediments of region II.

Sr^{++} in the shelf sediments maintains the same pattern of other elements, i.e. the Sr^{+2} content increases northwards. Moreovore, Sr^{++} seemed to be closely related to reef formation, it decreases towards deep water and beaches away from the reef.

Beach and island sediments of the northern part of the rea, have a higher Sr^{+2} content than those of the southern part.

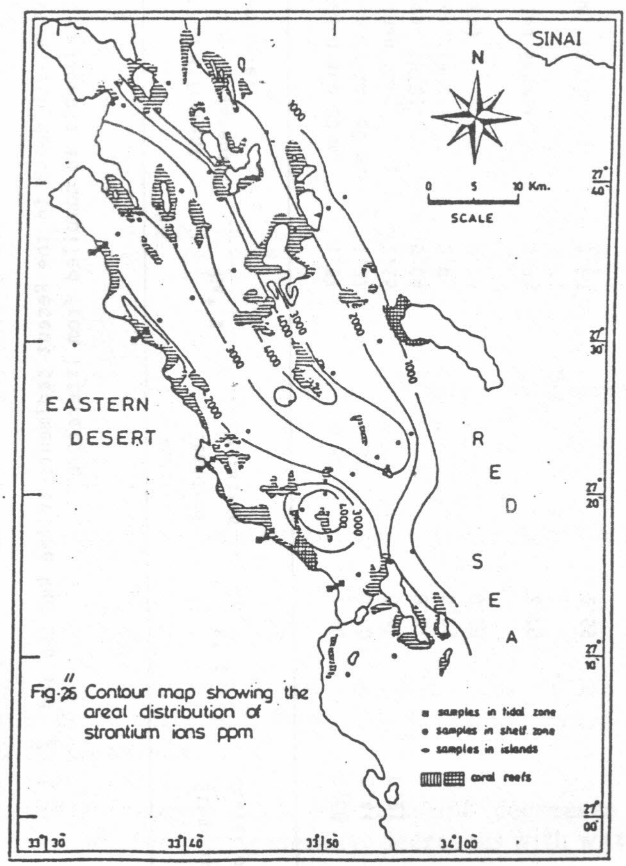

Fig. (11)
The area distribution of strontium (ppm).

The average Sr^{+} content in the recent sediments obtained from different depths in the Red Sea is summarized in table 8, together with values reported for different geologic formations as compiled from literature.

Sr^{++} content in the sediments of the area appears to correlate positively with carbonate (r = 0.21). Thus, Sr^{++} of the sediemnts of Al-Ghardaqa seems to be weakly associated with carbonate sediments. It is evident, however, that the carbonates contain high proportion of strontium in marine sediments. For example, El-Wakeel and Riley (1961) have found that the calcareous deep-sea sediments contain the highest content of Sr^{++}. Turekian (1965) and Goldberg and Arrhenius (1958) have reported high concentrations of Sr^{++} in the apatite phases of fish debris and in the calcite of planktonic fossils. It is possible that the mixed origin of carbonate in the area is responsible for this irrigularity.

TABLE 8

Variation of strontium content with depth in the Recent sediments of the Red Sea compared with other sediments as reported in the literature.

Sample No.	Sr^{++} content as obtained from different depths in the area of study, and from different rocks as compiled from literature	Sr^{+2} %	Standard deviation
[illegible]	Sediments from water depth between 0 and 20 m.	0.40	0.10
[illegible]	sediments from water depth between 20 and 50 m.	0.43	0.20
[illegible]	sediments from water depth more than 50 m.	0.50	0.30
-	Near-shore sediments (El-Wakeel and Riley, 1961)	0.03	
-	Sedimentary carbonate rocks (Green, 1972).	0.06	
-	Pelagic carbonate sediments (Green, 1972)	0.13	
[illegible]	Pelagic calcareous sediments from all major oceans (Chester, 1965).	0.10	
-	Manganese nodules (El-Wakeel and Piley, 1961).	0.10	

Total Iron

The area distribution of total iron is shown in figure 12. In the sediements of the tidal zone, the proportion of total iron ranges between 0 and 7500 ppm, averaging 3100 ppm. In region I, the sediments contain higher total iron than the sediments in region II.

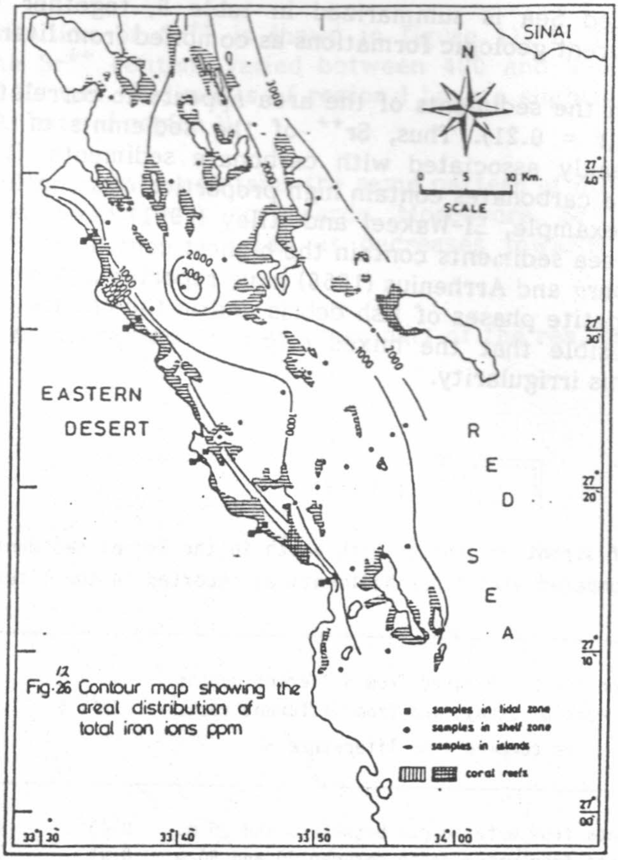

Fig. (12)
The area distribution of total iron (ppm).

Sediments from the shelf zone contain between 0 and 3200 ppm. averaging 1500 ppm. Sediments of region I have a higher iron content than sediments of region II. The iron content of the shelf sediments, however, shows a general increase towards deep water.

Beach sediments of the islands had generally lower iron content, when compared with tidal shelf sediments.

Table 8 shows the concentration of total iron content of recent sediments together with values reported for different geologic formations as compiled from literature.

The iron content of the recent sediments appears to correlate positively, but not strongly, with mean size, carbonate and organic carbon (r = 0.3,0.3 and 0.2 respectively).

TABLE 9

Average iron content in Recent sediments of the Red Sea and in different sediments as compiled from literature

Sample No.	Total iron content as obtained from different depths in the area of study, and from different rocks as compiled from literature.	Fe %	Standard deviation
38	Sediments from water depth between 0 and 20 m.	0.05	0.02
11	sediments from water depth between 20 and 50 m.	0.17	0.09
2	sediments from water depth more than 50 m.	0.09	0.05
-	sedimentary carbonate rocks (Green, 1972).	0.38	
-	Pelagic carbonate sediments (Green, 1972).	0.09	
-	Pelagic sediments (Calcareous ooze). (El-Wakeel and Riley, 1961).	3.14	
30	Pelagic calcareous sediments from all major oceans (El-Wakeel and Riley, 1961).	3.89	
25	Recent sediments of north Red Sea (Beltagy, 1984).	0.13	

CONCLUSION

The sediments of Al-Ghardaqa area are mostly carbonate sediments. Shell fragments and reefal debris seem to be a major source of carbonate to the area. Microscopic examination of some samples showed that molluscan shall fragments and foraminiferal tests are abundant in the coarse fraction of the sediments. The distribution of carbonate, however, shows a definite pattern. that is reflected on most other constituents. Sediments of the northern region has a lower carbonate content than sediments of the southern region. Also, beach sediments of the tidal zone contain a lower carbonate content.

Thus, it is evident that carbonates in the northern part are diluted by sediments from other sources. This was also shown by El-Sayed (1984) who studied sediments of the near-shore of area Al-Ghardaqa Marine Biological Station. The northern region lies near the entrance of the Gulf of Suez and receives sediments carried down to the area by outflowing currents comming from the Gulf. The transported sediments originating from the Gulf are deposited in the northern part of the area which receives very few sediments of terrestrial origin. Thus, the zonal distribution pattern of carbonate content increases southwards.

The Red Sea is a narrow inland sea that lies in a very arid zone, between the African and the Arabian plates, the source of sediments to the basin is largely autochtonous, mainly biogenic or chemical precipitation of different mud facies. However, fine sediments of the deeper water contain relatively high content of non-carbonate materials.

Organic carbon in areas like Al-Ghardaqa, has only one well defined source, that is the organic remains of marine animals and plants. Moreover, finer sediments contain higher content of organic carbon, particularly in deep water regions. The source of the organic carbon here seems to be organisms living in the water column. Dissolved organic carbon may be absorbed on the sediment particles. On the other hand, beach sediments contain the remains of benthic marine fauna of a very local nature. Because of the warm nature of the water in the area, oxidation of organic matter is an active and rapid process, the organic carbon content of sediments is rather low. But, when compared to the organic content of other regions of the Red Sea, as given by Mohamed (1949) and Beltagy and Mousa (1984), the organic carbon content in the study area is generally high.

The sulphate and chloride of the sediments are mostly derived from sea water. Minor amounts may possibly be derived from residual salts resulting from evaporation on coastal lagoons on some islands.

The distribution patterns of sulphate and chloride indicate that evaporation of sea water in shallow coastal areas is the main cause of the precipitation and distribution of sulfates and chlorides, which are present in coastal regions in higher amounts than in most other studied locations.

The calcium ion is the absolute major component in the studied samples. It is a major constituent in the carbonates, and is present in lesser amounts in most sulphates. Ca^{++} content seems to be mainly influenced by the amount of terrestrial input to the sediments. This terrestrial part is generally poor in Ca^{++}. The content of Mg^{++}, on the other hand, is not much affected by sediments from terrestrial origin.

The zonal distribution pattern of Ca^{++} is the same as that of the carbonates. Precipitation of the calcium ions seems to be mostly biogenic. However, the presence of gypsem is evident, partilularly in shollow water sediments (Lotfi, 1985).

Sodium and potassium in Al-Ghardaqa area have the same source. These elements are extracted from the rocks rich in feldspars during weathering processes, and tend to be deposited in the finer sediements. The tidal sediments rich in terrigenous feldspars near Al-Ghardaqa, affect the distribution of potassium, particularly in areas where the coarse fraction is important (as coarse fragments are likely to contain more polymineralogic grains resulting from desintegration of various igneous rocks).

The zonal distribution pattern of K^+ and Na^+ is, however, clearly related to the mean size of the sediments. The sodium content increases with the fine sediments towards the deeper water and the potassium content increases on the beach sediments.

Strontium in the studied sediments is predominant in carbonates. The Sr_{++} content seems to be highly influenced by calcareous outcrops in the vicinity of the study area, or by the occurrence of abundant accumulations of marine organisms and coral reefs.

As the distribution of strontium is strongly related to that of the carbonates, the source of precipitation of strontium seems to be mostly biogenic.

In general, the distribution of total iron in recent sediments of the Red Sea is associated with fine grained carbonate sediments. The zonal distribution pattern of iron however, is clearly related to the zonal distribution of the sediment itself, i.e. to total iron is generally higher in marine than in beach sediments.

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