

**GEOCHEMICAL CHARACTERISTICS OF SOME CORAL REEF CARBONATES,
SHARM EL-SHEIKH, GULF OF AQABA, RED SEA, EGYPT.**

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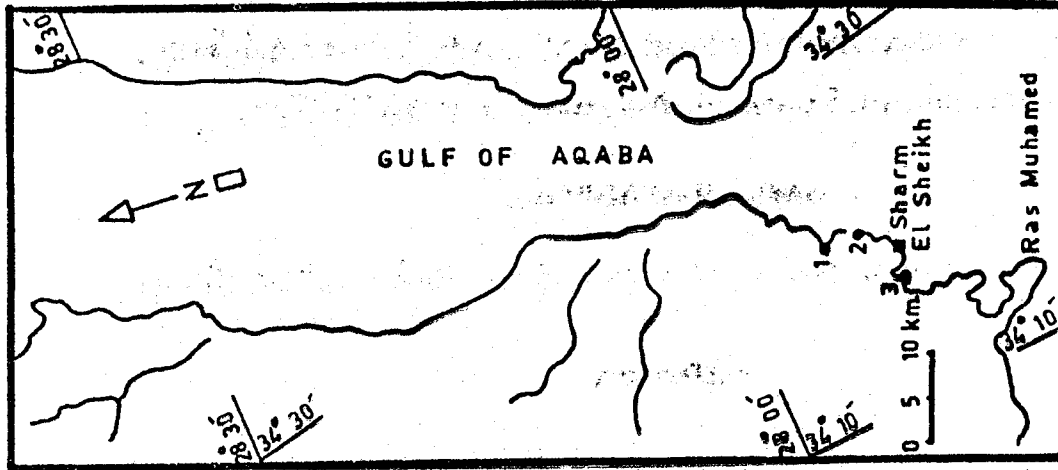
ABSTRACT

Twelve selected samples representing the coral reef carbonates and associated clastic sediments of Sharm El-Sheikh area were chemically analyzed. From the chemical data obtained, it is believed that the investigated coral reef samples vary from calcitic limestone to dolomitic limestone. The clastic sediments underlying and intercalating the coral reefs are considered as silty pebbly sand and clayey sand which has been derived from the basement complex of the country rocks in southern Sinai. The distribution of iron, copper, manganese, nickel and zinc in the detrital parts provides evidence to support the idea that these elements show a tendency to decrease in going from sandstones to samples of the reefal carbonates.

INTRODUCTION

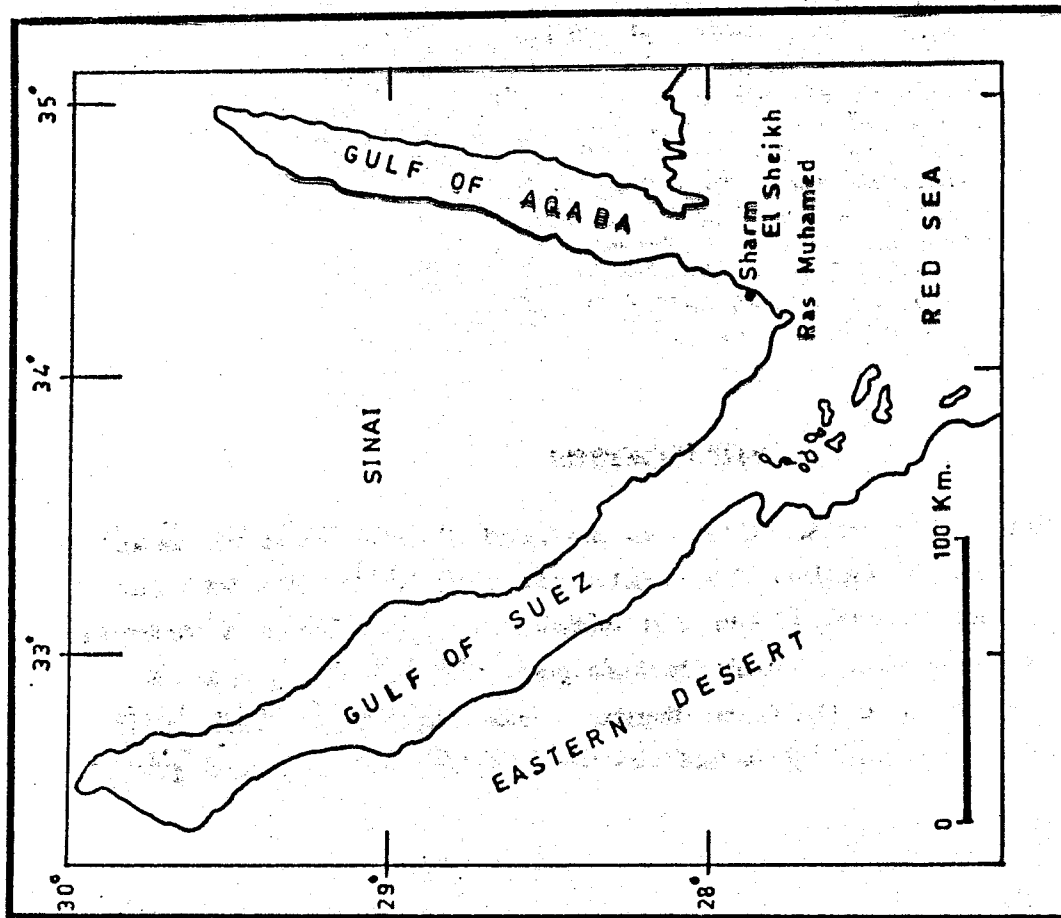
Sharm El-Sheikh area is located on the western coast of the Gulf of Aqaba, near its junction with the Red Sea (Fig. 1) Ridges of fringing coral reefs are well developed in this area where they extend parallel to the western coastline of the Gulf of Aqaba. The shores of this gulf are characterized by a narrow or absence of coastal plain.

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Fig(2):Key map showing the sampled locations.

- 1- Mersa El-At.
- 2- Ras Um Sad.
- 3- Khor Hidimiya.



Fig(1):Location map.

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The mountainous area eastward of the coral reefs is part of the Precambrian basement rocks.

Walther (1888) was the first to study modern and Quaternary reefs along the shores of the northern gulfs of the Red Sea. Hume (1906) studied the continuous fringing reefs as well as the reef terraces along the Gulf of Gulf of Aqaba. Later on, the geology of the coral reefs along the two gulfs of Suez and Aqaba has been investigated by many workers e.g. Friedman (1968), Scheer (1971), Friedman (1975), and Sneh (1978).

The purpose of this paper is to shed light on the geochemical aspects of some representative samples of the coral reef carbonates and associated clastics in front of Sharm El-Sheikh. As far as the author is aware, this study is the first trial made on major and trace element contents of these rocks.

GEOLOGICAL SETTING

Fringing coral reefs at Sharm El-Sheikh are studied at three locations namely Mersa El At, Khor El-Hidimiya and Ras Um Sad (Fig. 2) The sediments of the reef environment consist of coral and algal sands which are sometimes intermixed with quartz-feldspar grains and even pebbles and fragments of the nearby basement rocks. The basement rocks are considered as the main source of the terrigenous material mixing with the coral and algal sands cover most southern Sinai. These basement rocks near Sharm El-Sheikh mainly include amphibole granite ,

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biotite amphibole granite and pink biotite granite which belong to the younger granite group. Volcanic rocks are also present, but are less common and include andesitic flows, tuffs, and agglomerates of the Dokhan Series (Schurmann, 1966). Wadis running to the Gulf of Aqaba transport sands and detrital material produced by weathering of the exposed basement and old sedimentary rocks in central and southern parts of Sinai.

Twelve representative samples of the coral reefs were collected from the three locations. Of these samples, 10 are coral reef carbonated and 2 represent the clastic rocks underlying and intercalating the coral reefs at Mersa El At. Table (1) summarizes the field description of the samples collected from the three sites.

EXPERIMENTAL PROCEDURES

One gram of each sample was decomposed with 5 ml HClO_4 , 3 ml HNO_3 and ml HF , then dissolved in 5% HCl . CaO and MgO were estimated by EDTA titration. Samples were analyzed for Fe, Mn, Zn, Cu, and Ni on a Perkin-Elmer Model 4000 atomic absorption spectrophotometer. They were run in air-acetylene flame. Iron was detected at the 248.3 nm peak, manganese at 279.5 nm, nickel at 232.0 nm, copper at 324 nm and zinc at 213.9 nm. Detection limits were 0.005 mg/ml for iron, 0.002 mg/ml for manganese, 0.005 mg/ml for nickel, 0.002 mg/ml for copper, and 0.001 mg/ml for zinc. Based on reference carbonate materials and duplicate analyses, precision

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Table (1): Sample numbers, locations and types of sedimentary carbonates analyzed.

Locality	Sample No.	Description
Mersa El-At	Sec.II-1	Basal bed of sandstone with basement rock fragments.
	Sec.II-4	Reddish yellow sand with basement rock fragments of different grain size; clayey to argillaceous.
	Sec.II-6	Pale white carbonates with granular sands.
	Sec.II-8	Highly porous sandy carbonates with fossils of Gastropoda and Pelecypoda.
Khor-Hadimiya	Sec.V-1	White coralline limestone with shale fragment interbeds with molluscan fossils.
	Sec.V-2	White coralline limestone rich-of coral reef, shaly and contains molluscan fossils.
	Sec.V-4	Buff to pale red coralline limestone; fossiliferous.
	Sec.V-9	Dark grey coralline limestone, highly porous with pockets of iron oxides; fossiliferous.
Ras Um Sad	Sec.VI-1	White, hard coralline limestone.
	Sec.VI-2	Grey, hard coralline limestone.
	Sec.VI-4	White, hard skeletal limestone with a porous weathered surface.
	Sec.VI-7	Grey, hard coralline limestone with a dark weathered surface.

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Table (2): Chemical analyses of the reefal carbonates

Sample	CaO	MgO	Fe ₂ O ₃	H ₂ O ⁻	L.O.I	A.I.R	Calcite	Dolomite	Ca	Mn	Zn	Cu	Ni
	%	%	%	%	%	%	%	%	Mg	ppm	ppm	ppm	ppm
Sec. II-6	48.65	2.06	0.40	0.91	40.69	7.50	82.8	8.6	28.11	155	9	3	2
Sec. II-8	49.23	2.27	0.46	1.04	41.40	6.42	83.8	9.6	25.82	126	17	7	4
Sec. V-1	49.40	2.48	0.16	2.50	41.50	3.42	83.2	10.4	23.80	74	8	-	5
Sec. V-2	48.08	3.30	0.17	1.06	41.60	6.20	79.2	13.8	17.30	60	15	-	-
Sec. V-4	41.70	10.85	0.33	1.01	42.50	4.17	51.8	45.6	4.60	183	12	1	7
Sec. V-9	48.08	2.72	0.89	1.10	40.28	8.10	80.4	11.4	21.04	276	38	9	11
Sec. VI-1	51.20	2.06	0.36	1.30	41.20	3.40	87.3	8.6	29.60	136	7	-	3
Sec. VI-2	41.20	2.27	0.69	2.20	35.00	19.00	69.0	9.6	21.60	136	25	10	6
Sec. VI-4	-	-	0.21	-	-	-	-	-	-	87	18	-	6
Sec. VI-7	54.50	0.25	0.24	0.20	42.50	2.50	97.1	1	259.5	75	16	-	1

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Table (3): Statistical values for the major and trace element abundance of the studied coral reef carbonates.

Element	Coral Reef Carbonates				Sedimentary Carbonate Rocks*
	Min \bar{m}	\bar{X}	Max \bar{m}	M \underline{d}	
CaO %	41.20	48.00	54.50	48.65	42.32
MgO %	0.25	3.14	10.85	2.27	7.80
Fe ₂ O ₃ %	0.16	0.39	0.89	0.34	0.54
Mn ppm	60	134	276	131	1100
Zn ppm	7	17	38	16	20
Cu ppm	1	6	10	7	4
Ni ppm	1	5	11	5	20

\bar{X} : Arithmetic mean of detected values.

M \underline{d} : Median.

* : Average given by Turekian and Wedepohl (1961).

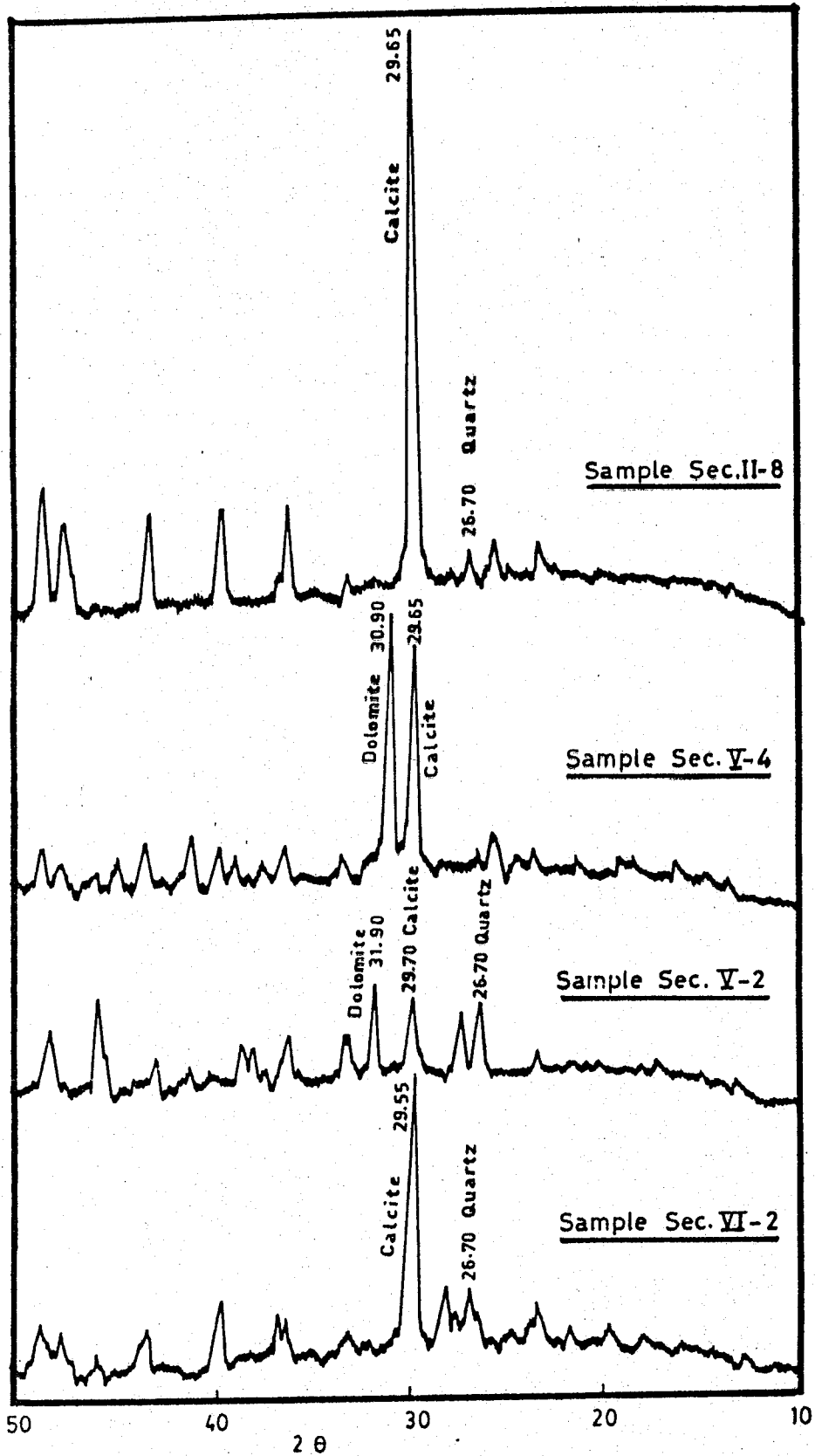


Fig.(3):X-ray diffraction pattern of representative samples from the studied reefal carbonates.

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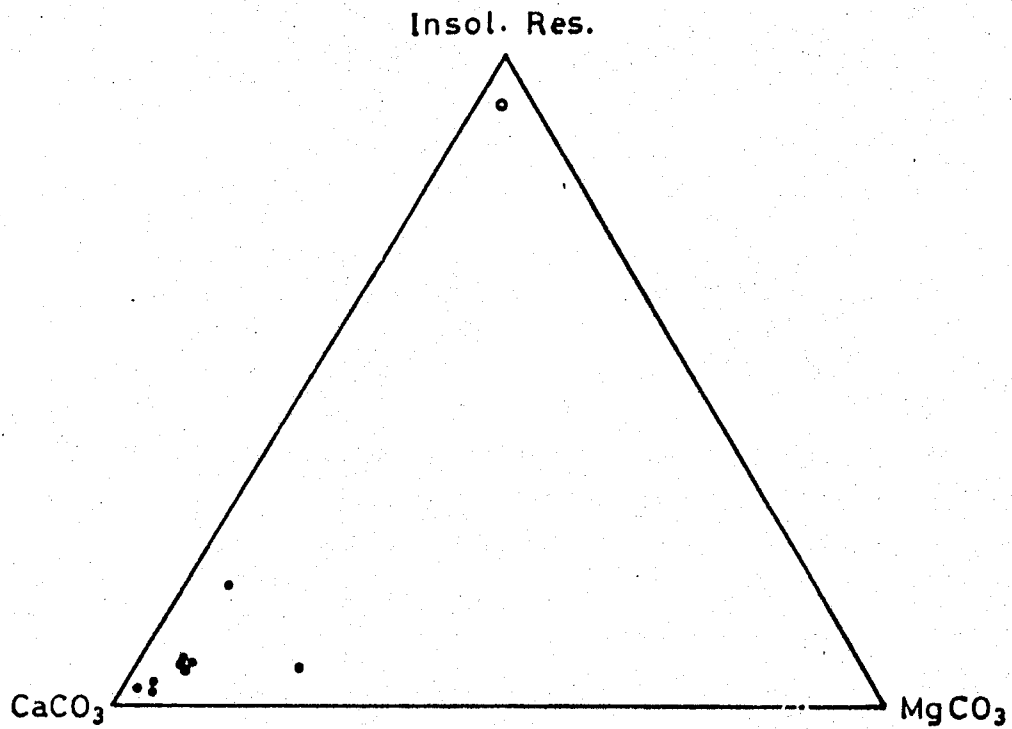


Fig.(4): CaCO_3 - MgCO_3 Insoluble Residue diagram of coral reefs of Sharm El Sheikh area.

- Coral reef carbonates .
- Sandstone (sample Sec II-1).

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and accuracy of the data were found satisfactory on the whole.

The carbonate samples were examined by X-ray diffraction technique using a Shimadzo X-ray diffractometer (type D-3). The diffraction patterns were run with Ni-filtered Cu Ka radiation at 30 Kv and 30 mA potentials.

DISCUSSION AND CONCLUSIONS

(A) Coral reef carbonates:-

The analytical data of the investigated coral reef carbonates are given in Table 2. The means, medians, and ranges of the analyzed elements in these samples are shown in Table 3 where they are compared with the mean sedimentary carbonate rocks as reported by Turekian and Turekian and Wedepohl (1961).

Form the analytical data and statistical values obtained, it is evident that the coral reef carbonates of Sharm El-Sheikh area exhibit the following main characteristics:-

- (1) The mean value of CaO in the studied coral reef carbonates is relatively higher and MgO is lower compared with the average sedimentary carbonate rocks (Turekian and Wedepohl, 1961). The relation between CaCO_3 , MgCO_3 and A.I.R. (acid insoluble residue) is illustrated in a triangular diagram (Fig. 4). The proportions of calcite, dolomite and insoluble residue provide evidence that most of the studied carbonates consist entirely of calcite. The atomic Ca/Mg

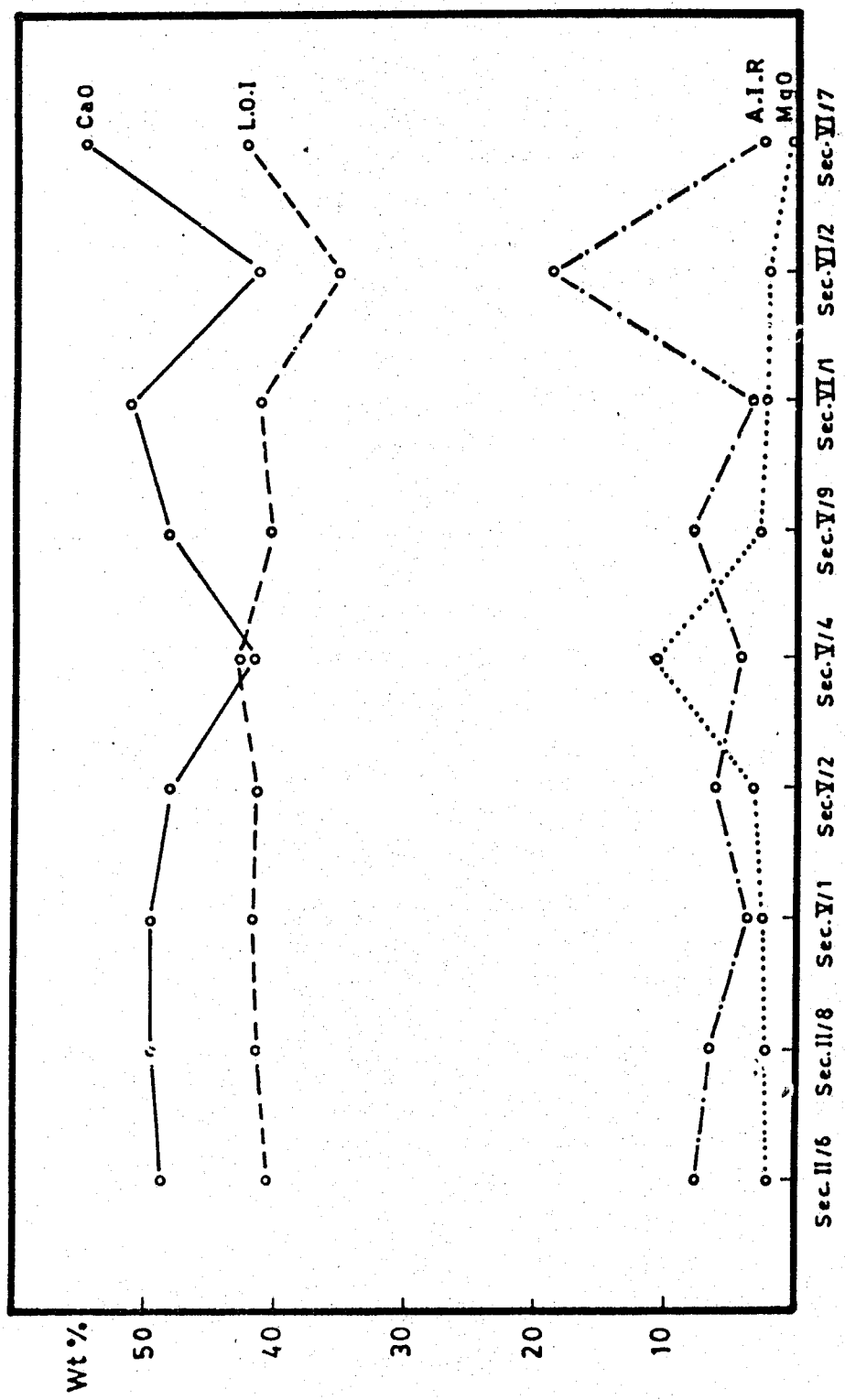


Fig.(5):Distribution of major constituents in coral reef carbonates .

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ratios within the different classes of limestones published by Bissel and Chilingar (1967) indicate that the investigated samples vary from calcitic limestone to dolomitic limestone and dolostones, since the atomic Ca/Mg ratios show a wide variation ranging from 4.6 to 259.5.

- (2) The distribution curves (Fig. 5) show that CaO, MgO and L.O.I. are consistent with each other favouring their presence as carbonates. The amount of A.I.R. or the detritus differs in each sample. The antipathetic relation of MgO and CaO contents reflects the tendency of magnesia to behave reversely with CaO, as Mg^{2+} ions (0.66 Å) are introduced into the $CaCo_3$ structure causing partial dolomitization. This is in agreement with X-ray data (Fig. 3). Dolomitization of the reefal lithofacies may be formed by the refluxing of Mg-bearing sea water through the pores and voids of the reefal limestones (Youssef and Abou Khadrah, 1984). In some instances, the carbonates were subjected to advanced dolomitization resulting in the formation of dolostone (Sample Sec. V-4, Ras Um Sad).
- (3) The contents of A.I.R. (mainly quartz; X-ray data) which represent the detrital material in the coral-algal reefs show a notable variation ranging from 2.5 % to 19.0 %. They tend to increase with the decrease of total CaO and MgO which indicate that the environmental condition prevailing during the development of the reefs does not favour the accumulation of detrital quartz grains.

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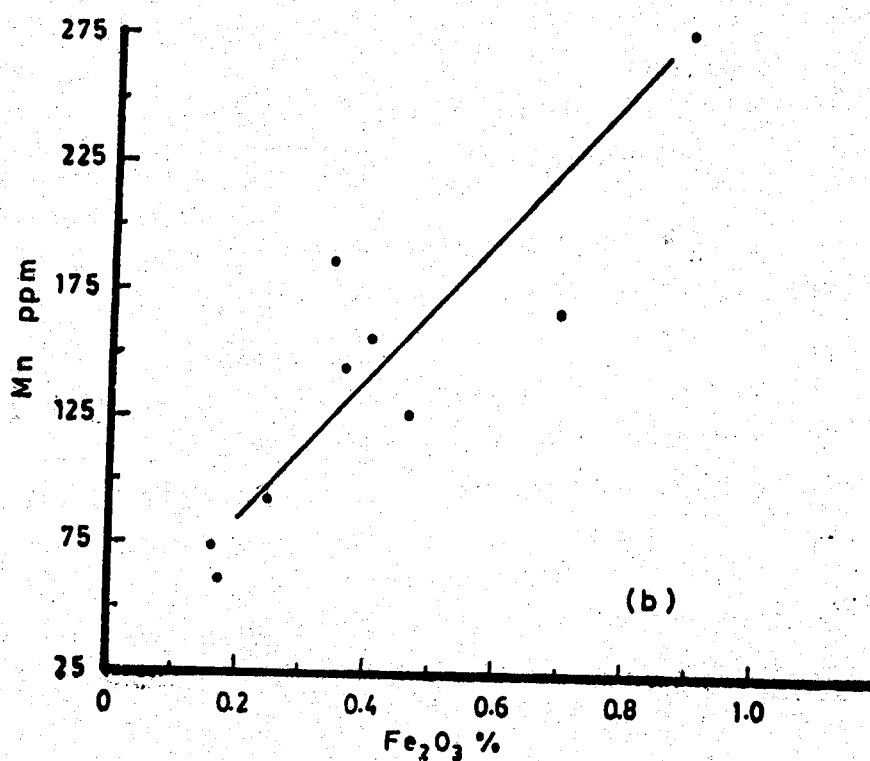
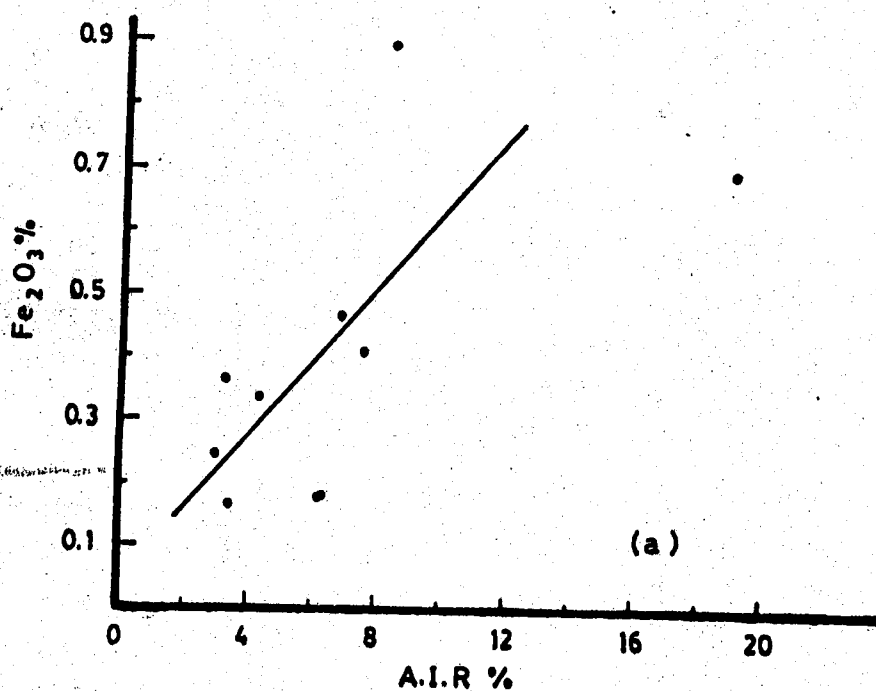


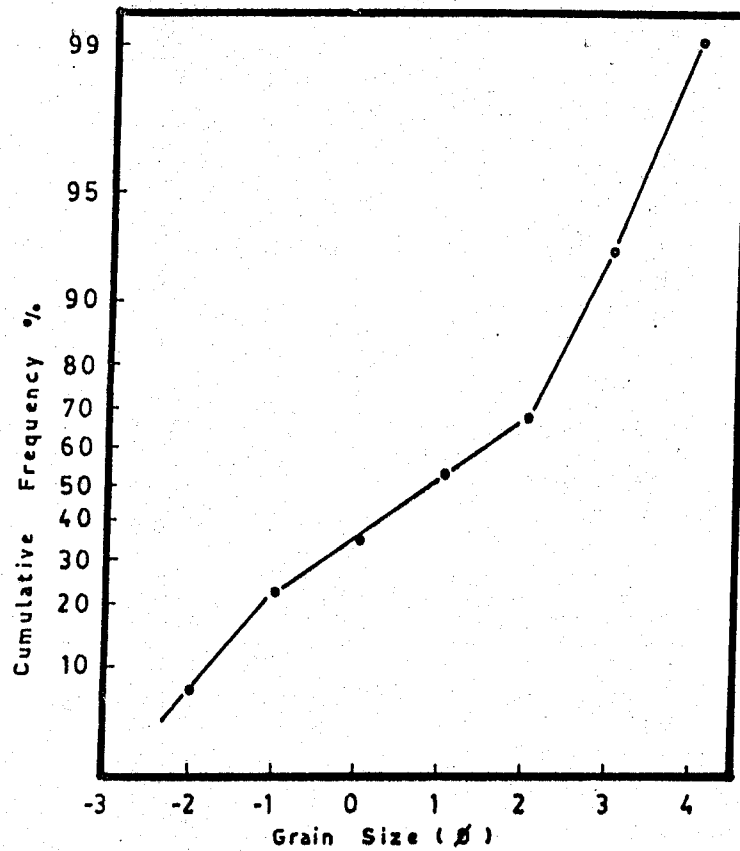
Fig. 6.(a) Correlation between A.I.R. % and Fe₂O₃ % in the reeal carbonates.

(b) Correlation between Fe₂O₃ % and Mn abundance.

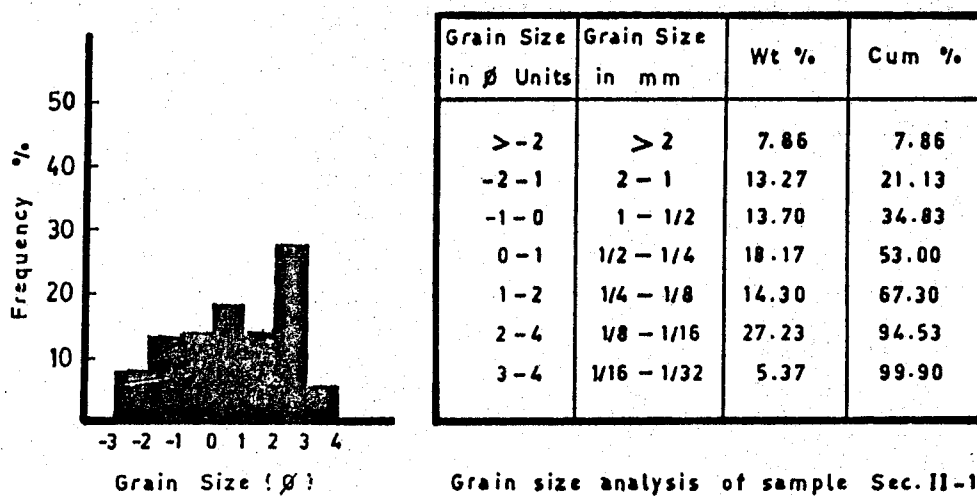
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- (4) Iron contents in the investigated coral reef carbonates vary from 0.16% to 0.89% Fe₂O₃ are slightly low as compared with the average of sedimentary carbonates. Reddish colouration of some samples due to iron content and the apparent moderate correlation of Fe₂O₃ with A.I.R. (Fig. 6) provide evidences of the possibility of the existence of iron in the non-carbonate fraction.
- (5) The investigated coral reef carbonates have a manganese content which varies from 60-276 ppm with arithmetic average of 134 ppm Mn. This is lower than the average of carbonates reported by Turekian and Wedepohl (1961) and limestones (Rankama and Sahama, 1950). The atomic radius of Mn²⁺ in six-fold coordination is 0.80 Å and for Ca²⁺ it is 0.99 Å. Mn²⁺ may substitute to 40% by weight MnCO₃ in the calcite lattice (Berry and Mason, 1959). Also, Mn²⁺ might be camouflaged by Fe²⁺ in iron minerals. From the data obtained it is clear that the highest content of manganese is usually associated with the high concentration of iron (Fig. 6).
- (6) In general, the coral reef carbonates are characterized by low concentrations of copper, zinc, and nickel. Copper content with an average of 6 ppm is lower than that of the upper lithosphere as given by Goldschmidt (1954) being 70 ppm Cu. Zinc average value is 17 ppm compared with 16 ppm for the upper lithosphere. Nickel average content being 5 ppm is considerably lower than the crustal average which is 75 ppm. Evidently, no direct relationship is detected between the amount of calcite and dolomite in the investigated reefal carbonates and each of copper, zinc and nickel. This may be due to the participation of these elements in the detritus material.

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Fig(7):Cumulative curve of the studied sandstone.



Grain size analysis of sample Sec. II-1

Fig(8):Frequency histograms.

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The variability in abundance of such elements depends on the amount of the detritus or non-carbonate material which differs in each sample.

(B) Clastic sediments:

These are represented by two samples: sample Sec. II-1, which was collected from the basal bed of sandstone underlying the coral reefs at Mersa El-At, and sample II-4 from the clayey sand intercalating the reefs in the same location. The analytical data of sample Sec. II-1 are given in the following:

SiO ₂ %	CaO%	MgO%	Fe ₂ O ₃ %	H ₂ O ⁻ %	L.O.I.%
87.32	2.86	0.62	3.94	1.27	3.00
Zn(ppm)	Cu(ppm)	Ni(ppm)	Mn(ppm)		
149	115	24	640		

Grain size analysis was carried out on sample Sec-II-1 by sieving. Sieving was performed with Ro-Tap shaker. The different fractions were weighed and their percentages were calculated. The data of the mechanical analysis were presented graphically using the log probability curve of grain size distribution (Fig. 7) and as histograms (Fig. 8).

Statistical measures for average grain size, median, sorting and skewness adopting formulae of Folk and Ward (1957) gave the following parameters:

Mean size, M	=	0.68 0
Median, Md	=	0.88 0
Sorting, o	=	1.75
Skewness, SK	=	-0.02

From the data obtained it is evident that the investigated sample is very coarse, poorly sorted and coarsely

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skewed sand. It is considered as silty pebbly sand.

On the other hand, the clayey sand sample Sec.II-4 contains 2.23% Fe O₃. The concentrations of Mn, Zn, Cu and Ni are 304 ppm, 44 ppm, 32 ppm, 10 ppm, respectively.

The author believes that this type of clastic sediments has been derived from the basement complex of the country rocks in southern Sinai. The distribution of iron, copper, manganese, nickel and zinc in the detrital parts provides evidence to support the idea that these elements show a tendency to decrease in going from sandstones such as sample No. Sec-II-1 to samples of the reefal carbonates.

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