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PETROLOGY AND PETROCHEMISTRY OF SOME UPPER EOCENE ROCKS AT GEBEL EL-QATTAMIA, CAIRO. SUEZ ROAE, Egypt.

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ABSTRACT

The limestones and other rocks related to upper Eocene in Gebel El-Qattamia section are subjected to detailed petrochemical and petrological studies. The microfacies assocations detected include sandy dolomitic micrite, shelly Nummulitic biomicrosparite, sandy shelly biomicrite and sandy micrite. Two distinct series of beds are recognized in the studied section, a lower series which is remrkably fossiliferous and an upper series which is rarely non - fossiliferous and saliferous. X-ray analysis revealed that most of these rocks are constituted of quartz with variable amounts of calcite, halite, gypsum and dolomite. The clay minerals detected are predominantly kaolinite and illite. Chemical data indicate that the rocks under consideration are distinguished by high content of A.I.R., SiO_2, $Al2O_3$, CaO, Fe_2O_3, Na_2O, MgO, SO_3- and Cl- which reflect the sandy, marly, ferruginous and lcmy saliferous nature of these rocks.

it is suggested that the rocks of Upper Eocene at Gebel El-Qattamia section were deposited under a rather shallow marine environment. The lower beds were most probably deposited in a relatively deeper conditions compared to the upper beds. Abundance of detrital materials indicates late comparatively fresh water contribution to the basin of deposition.

INTRODUCTION

The exposed Eocene rocks in the Cairo-Suez district were the subject of several geological studies. Previous investigations include the work of Kabesh and Hamada (1954), Shukri and Ayouti (1954), Said (1962), Metwalli (1963), Soliman *et al.* (1963), Farag and Sadek (1968), Metwalli (1963), Soliman *et al* (1963), Farag and Sadek (1968), Abu Khadra (1968), Moustafa (1975) and others. Moustafa (1975) examined the Eocene rocks of El Qattamia area at Cairo-Suez road and he assigned Middle to Upper Eocene age for these rocks.

Geomorphologically, El Qattamia area is characterized by three major features : the Eocene heights, the Eocene scarpand and the low land. Moustafa (1975) stated that the Eocene heights include Gebel El Qattamia (Δ 481 m), Gebel El Qattamia west (Δ 422 m) and Gebel El Qattamia SW (Δ 400 m).

The present paper deals with a detailed petrological and petrochemical studies of some sediments in the area of Gebel El Qattamia SW (Δ 400 m) located at Cairo-Suez road (Fig. 1). Some aspects regarding the environmental conditions of deposition are discussed. Noteworthy, field observations and laboratory work supported an Upper Eocene age for these sediments.

EXPERIMENTAL TECHNIQUES

For the purpose of the present investigation, a total of 14 samples were collected from the indurated rocks of the Upper Eocene section. The microfacies associations are identified in thin sections microscopically. The mineral contents are quantitatively determined by X-ray diffractometry. Complete chemical analysis of the bulk rock samples were carried out by complexometric, gravimetric flame photometric and atomic absorption spectrophotometric methods. The following constituents have been determined : SiO_2, A.I.R., Al_2O_3, Fe_2O_3, CaO, MgO, MnO, Na_2O, K_2O, P_2O_5, H_2O^-, L. O. I., SO_3^{--}, Cl^- and Sr.

LITHOLOGIC SUCCESSION

The studied lithologic succession of Gebel El Qattamia SW (about 62 m thick) includes 11 beds. These beds are composed mostly of greyish and yellowish brown hard limestone and soft sandy shales as well as a description of the studied section is represented on Fig. (2).

MICROFACIES ASSOCIATIONS

The different petrographic microfacies associations recognized in the Upper Eocene rocks at the area of study are represented by sandy dolomitic micrite, shelly

Nummulitic biomicrosparite, sandy shelly biomicrite and sandy micrite.

1- Sandy Dolomitic Micrite :

This microfacies association is recorded in beds No. 1 and 11 which represent the lowermost and the uppermost parts of Gebel El Qattamia. The rock consists mainly of subangular to subrounded quartz grains embedded in microcrystalline calcite matrix (Fig. 3). The matrix is highly stained by iron oxides and exhibits aggrading dolomitization and recrystallization to sparry calcite. The dolomite rhombs are interlocked in some parts of the thin section.

2- Shelly Nummulitic Biomicrosparite :

This microfacies association investigated in beds No. 3 and 6. The rock is composed mainly of microcrystalline calcite. Allochems, mainly represented by abundance of Nummulitic tests and fragmented shells (Figs. 4, 5 & 6). The microcrystalline matrix shows recrysteallization to microspars. The sparite appears as distinct crystals having a mosaic texture. Occasionally, silica gel replacing the walls of some Nummulitic tests shows spherulitic texture. The broken shells are replaced by microcrystalline calcite which shows partial and complete recrystallization to sparry calcite along the shell walls. *Textularia, Globorotalia* and *Miliolid* species are enclosed inside the sparry calcite matrix. Bryozoans with perforated shape are also present. Few subhedral quartz grains are scattered within the shell fragments.

3- Sandy Shelly Biomicrite :

This microfacies association is recorded in bed No. 4. The rock consists mainly of fine angular quartz grains embedded in mosaic matrix associating fragmented shells (Fig. 7). The main fossil contents detected in this association are *Nodosaria* species with well-preserved walls, Bivalves which it is replaced by sparry calcite, *Dictyoconus* species and other shell fragments. Few crystals of gypsum are scattered throughout the section. Iron stains are present in minor amounts.

4- Sandy Micrite :

This microfacies association is represented by beds No. 7, 8 and 9. The rock is composed mainly of ill-sorted to fine disseminated, quartz grains embedded in micrite groundmass (Fig. 8). Dolomite rhombs with cloudy centres and clear rims are occasionally found. Some quartz grains are fractured, others are turbid and few grains contain minute inclusions. Also, some crystals of quartz are etched and corroded. Few crystals of calcite show recrystallization into sparite. Patches of iron oxide and some other opaques are scattered throughout the main constituents of the thin section. Very few clayey materials are found. The rock is devoid of any organic remains.

X- RAY ANALYSIS

The X-ray diffraction patterns of the studied rocks are shown in Figs. (9, 10 & 11). The vertical distribution of the different non-clay minerals recognized by X - ray analysis is shown in Fig. (12). From the data obtained it is evident that :

1 - Quartz is very common in most samples analysed and its content reaches up to 54%

2 - Halite is common and concentrated in beds. No. 5, 6, 7, 8 and 9 ranging in abundance between 2% and 27%.

3 - Calcite shows remarkable fluctuations with a range between 7% and 88% tending to be concentrated in lower beds.

4 - Gypsum is detected only in 3 samples and its amount reaches up to 24%.

5 - Dolomite is present only in two samples, one sample at the base of the studied section with a low content and the other sample is at top with a concentration reaching up to 33%.

6 - Clay minerals detected are predominantly kaolinite and subordinate illite.

PETROCHEMISTRY

The results of chemical analysis of the investigated rocks are shown in Table (1). The minium, maximum and avarage values are presented in Table (2). For comparison, average chemical analyses of carbonate rocks of Upper Eocene at different localities are given in Table (3). From the obtained data some petrochemical aspects are given in the following discussion.

The abundance of acid insoluble residue (A.I.R), SiO_2 and Al_2O_3 in most samples reflects a terrigenous nature of the sediments. The wide range of Al_2O_3 content is distinct.The relationship between Fe_2O_3 and A.I.R (Fig. 13) shows a significant positive correlation ($r = + 0.58$) which suggests that most of the iron is associated with terrigenous material.

The concentration of CaO and L.O.I decreases remarkably towards the upper beds reflecting a gradual depletion in calcite content. The relatively higher concentration of MgO particularly at the top of the studied section together with excess L.O.I than that equivalent to CaO to form calcite reveals the occasional formation of dolomite, Plotting of CaO against A.I.R. (Fig. 14) shows a strong negative correlation ($r = - 0.93$) which indicates that CaO is mostly present in the carbonate phase and it is not dependent on A.I.R.

The triangalar diagram illustrating the correlation of $CaCO_3$, $MgCO_3$ and A.I.R. (Fig. 15) shows that most rock samples studied are located between A.I.R and $CaCO_3$ line. This provides an evidence that most of these rocks are enriched in clastics and impoverished in carbonate fraction. The plot of SiO_2. Al_2O_3 and (CaO + MgO) reveals that most samples are related to highly immature sandstone category (Field C), whereas few sediments are related to the category of limestone and dolostone (Field B). One sample is related to the category of sandy shale (Field A) (Fig. 16). . .

Sulphates, calculated as SO_3^{--}, and ranging in concentration from 2.57 % to

11.63 %, together with the excess CaO than that needed to L.O.E to from calcite, give an indication that gypsum is present in reasonable amounts.

Sodium content is positively correlated with soluble chlorides as Cl^- which points to the presence of halite. The distribution of Na and Cl^- throughout the studied section reveals that there is a tendency of halite to become concentrated towards the upper beds. This is confiumed by X - ray analysis. On the other hand, K_2O is also correlatible with Al_2O_3 which indicates that filite is a dominant clay mineral in the studied rocks since potassium is needed for formation of illite as reported by Keller (1970).

Strontium content ranges from 205 ppm to 1207 ppm with an average of 418 ppm. Such average is considerably higher than those of the World shale and sandstone but lower than that of carbonate rocks as stated by Turekian and Wedepohl (1961). The relationship between Sr and Ca (Fig. 17) shows a significant positive correlation ($r = + 0.78$). It is evident that the calacite - rich rocks caontain more strontium than those low in calcite. Also, strontium forms a strong negative correlation with the acid insoluble residue ($r = - 0.83$) as shown on Fig. (18) which indicates that strontium is independent on A.I.R. and is attributed only to calcite content in the rocks. This finding is in agreement with that stated by Formaseri and Grandi (1968) and El-Hinnawi and Loukina (1977).

CONCLUSIONS

The investigated section at Gebel El Qattamia appears to be subjected to certain diagenetic processes such as recrystalilization, dolomitization, internal filling and silicification. Recrystallization is related mainly to S-phase in which grain growth of an original cryptocrystalline to microcrystalline calcite is altered to microsparite. Dolomitization involves aggrading porphyroid and coalescive neomorphism, in which the total replacement by dolomite was associated more closely with supratidal sediments and evaporites. Internal filling occurs as small veinlets of sparry calcite, representing orthosparite filling solution channels. Silicification is present as geode-like cavity.

The interrelated studies including the lithology, X-ray analysis, microfacies associations and chemical composition lead to some aspects regarding the environmental conditions of deposition of the Upper Eocene rocks studied in Gebel El Qattamia which can be summarized into the following :

1 - The deposition was mainly under shallow marine environment.

2 - The lower series of beds in the section are most probably deposited in a relatively deeper conditions. The existence of different life forms provides an indication to suitable environment with good illumination and normal water salinity .

3 - The relative concentation of halite in the higher series of beds reflects high salinity and sem restricted marine environment under arid conditions.

4 - The occasional formation of dolomite indicates a warm conditions during the depositon. Pilkey and Hower (1960) stated that $MgCO_3$ increases with the increase of temperature. Chave (1954) and chilingar *et. al.,* (1967) concluded that Ca / Mg ratio reflects the environmental temperature.

5 - The low values of manganese favours its leaching due to prevailance of even very weakly acidic medium (Goldschmidt, 1954). Since manganese migrates for more than iron, the studied section could be considered near shore shallow marine sediments from which manganese is highly leached.

6 - The abundance of land provision of clastics especially at top suggests contribution by streams or surface run-off.

7 - Sea-regression towards the top of the section is also suggested.

ACKNOWLEDGEMENT

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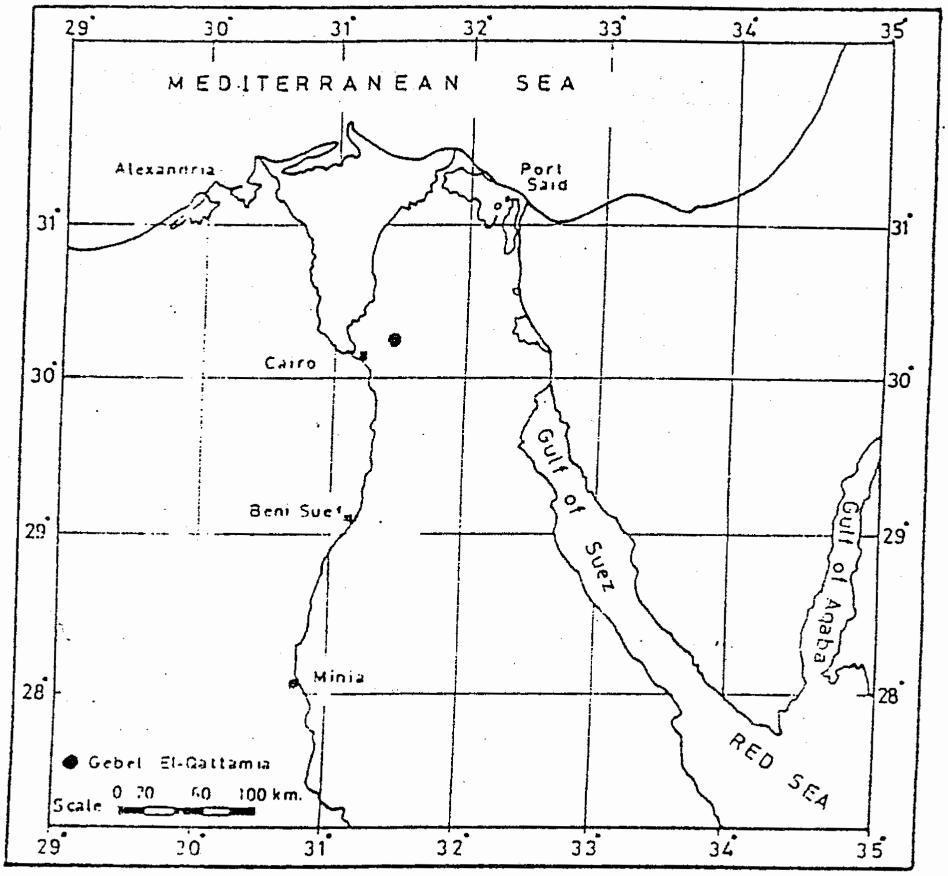


Fig. (1) : Location Map of the study area.

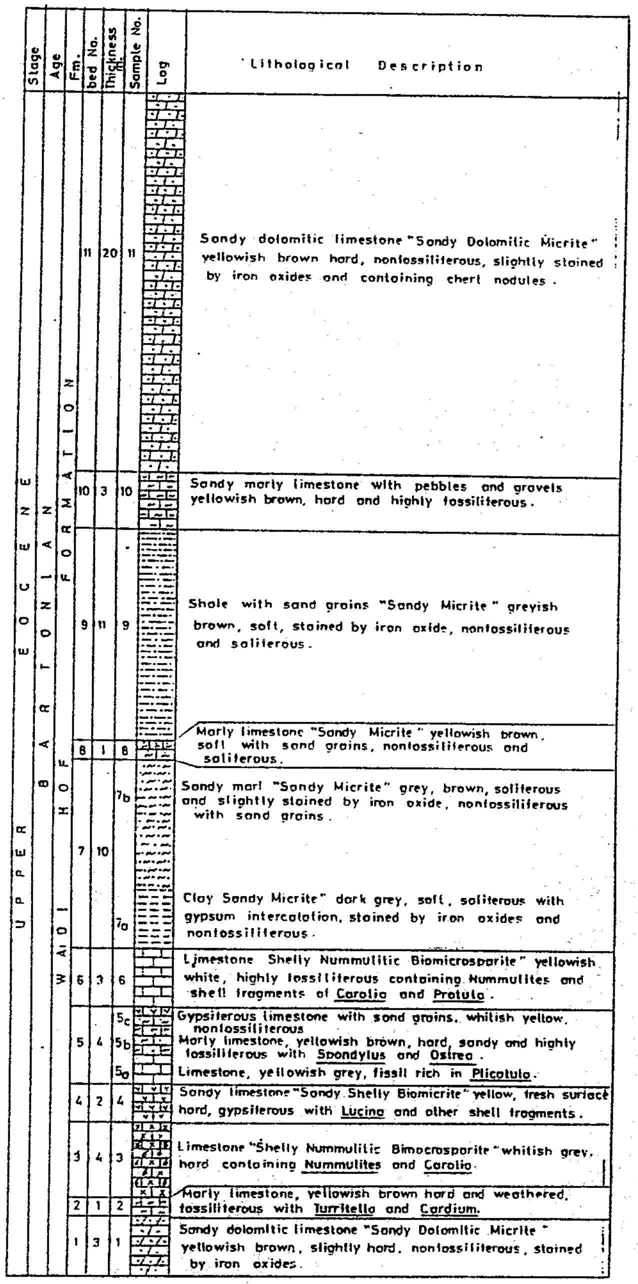
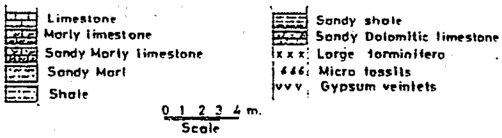


Fig. 2. Measured surface columnar section of Wadi Hof Formation at Gebel El-Qattamia



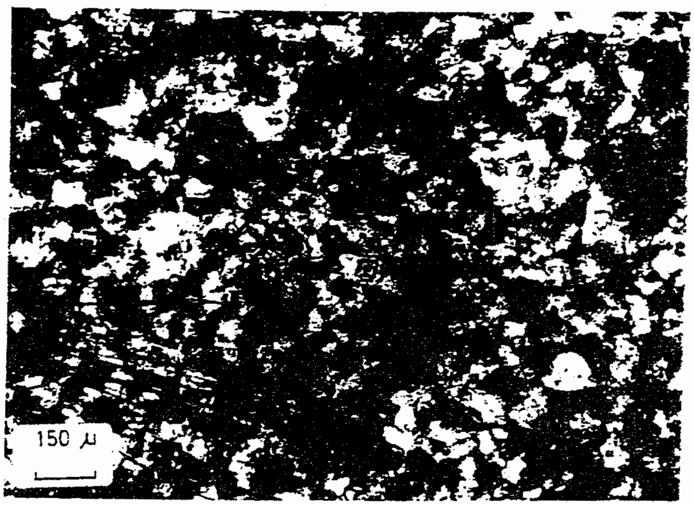


Fig. (3) : Photomicrograph of Sandy Dolomitic Micrite showing il-sorted quartz grains with dolomite rhombs embedded in micritic groundmass.
Sample No : 11 P.L.

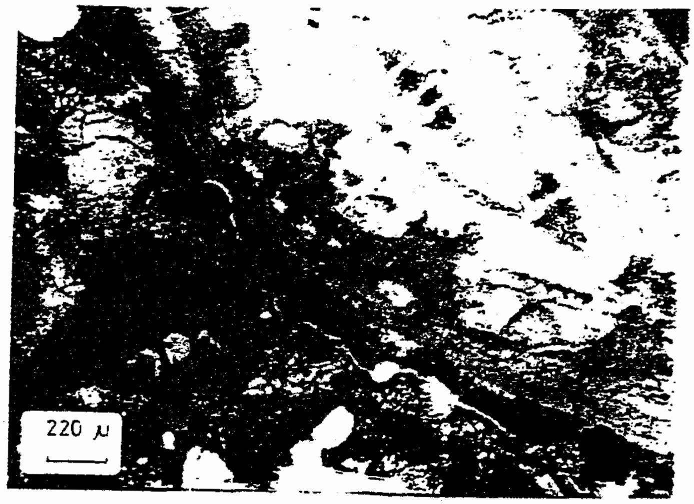


Fig. (4) : Photomicrograph of shelly Nummulitic Biomicrosparite showing well preserved Nummulite
Test. Sample No : 6 P.L.

Fig. (5) : Photomicrograph of Shely Nummulitic Biomicro sparite showing Fragmented shels embedded in sparite matrix
Sample No. 6 P.L.

Fig. (6) : Photomicrograph of Sandy Shelly Biomiorite showing fragmented shells with condensed ill-sorted quartz grains embedded in micritic groundmass.
Sample No. 4 P.L.

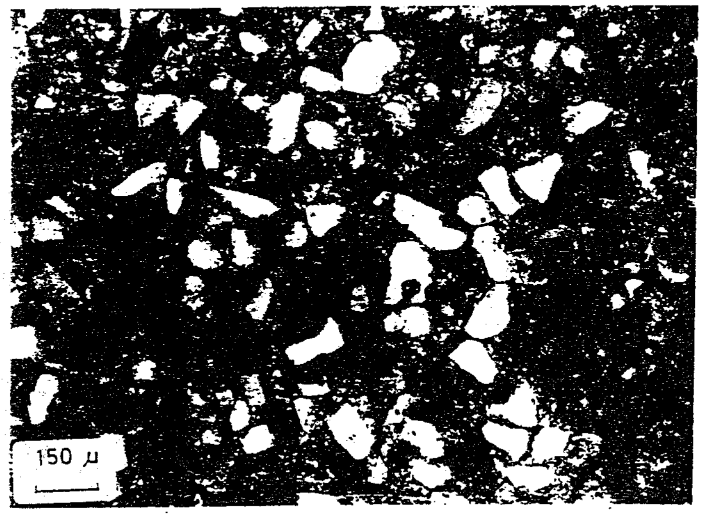


Fig.(7) : Photomicrograph of sandy Micrite showing ill-sorted quartz grains embedded in micritic groundmass.
Sample No. 8 C.N.

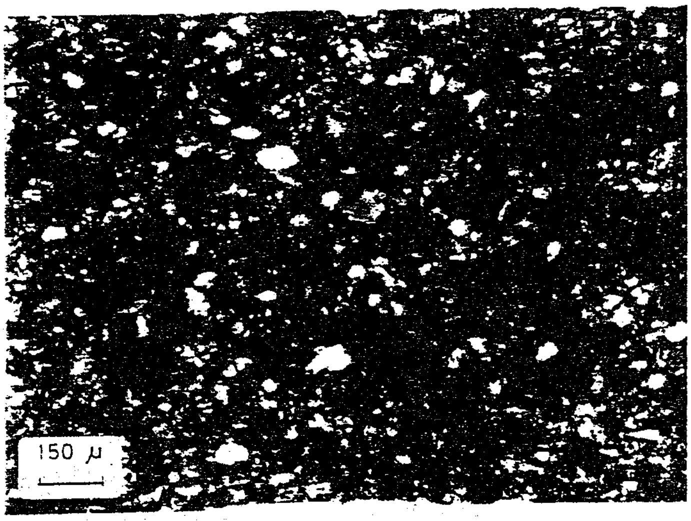


Fig. (8) : Photomicrograph of Sandy Micrite showing Fine disseminated quartz grains embedded in micritic groundmass.
Sample No. 9

C.N.

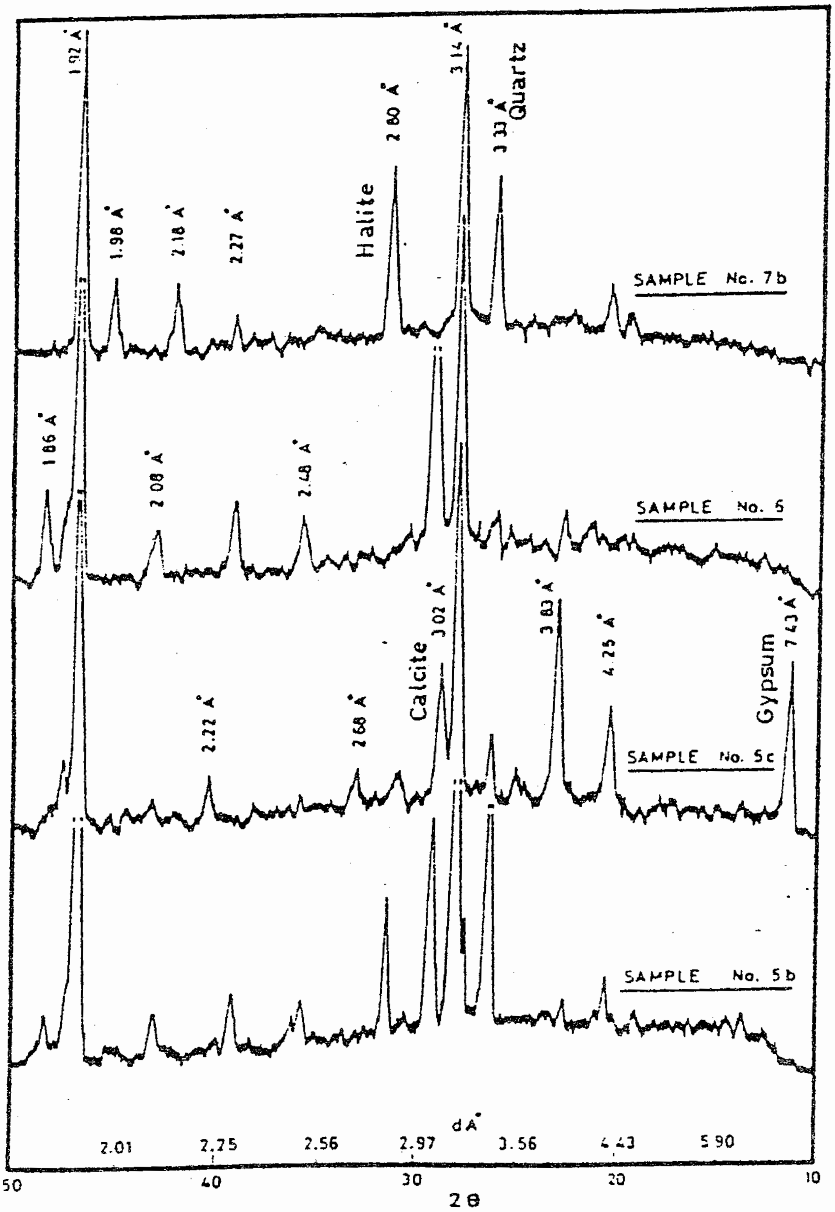


Fig. (9) : Selected X-ray diffrzction pattern of non-clay minerals of Upper Eocene rocks at Gebe El-Qattamia.

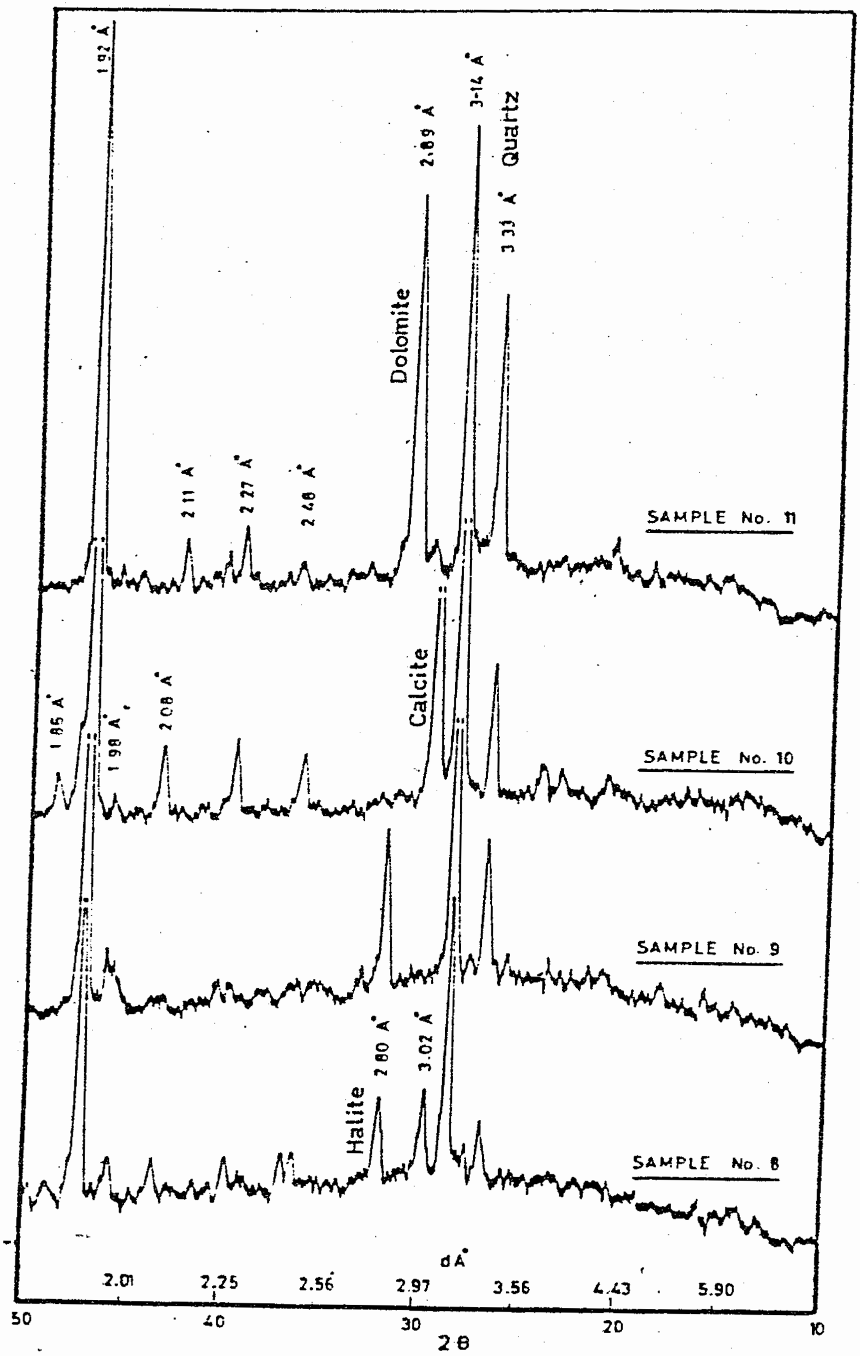


Fig. (10) : Selected X-ray diffraction pattern of non-clay minerals of Upper Eocene rocks at Gebel El-Qattamia.

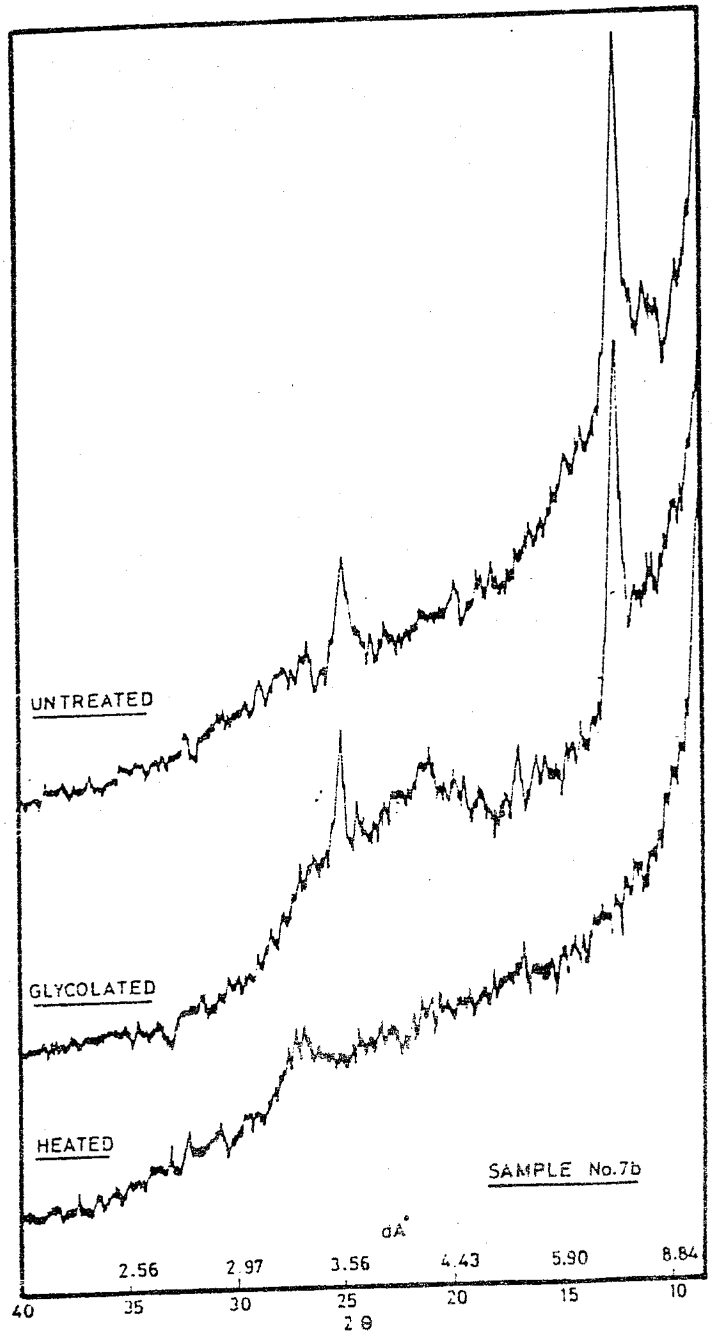


Fig.11 : Selected X-ray diffraction pattern of clay fraction of Upper Eocene rocks at Gebel El-Qattamia .

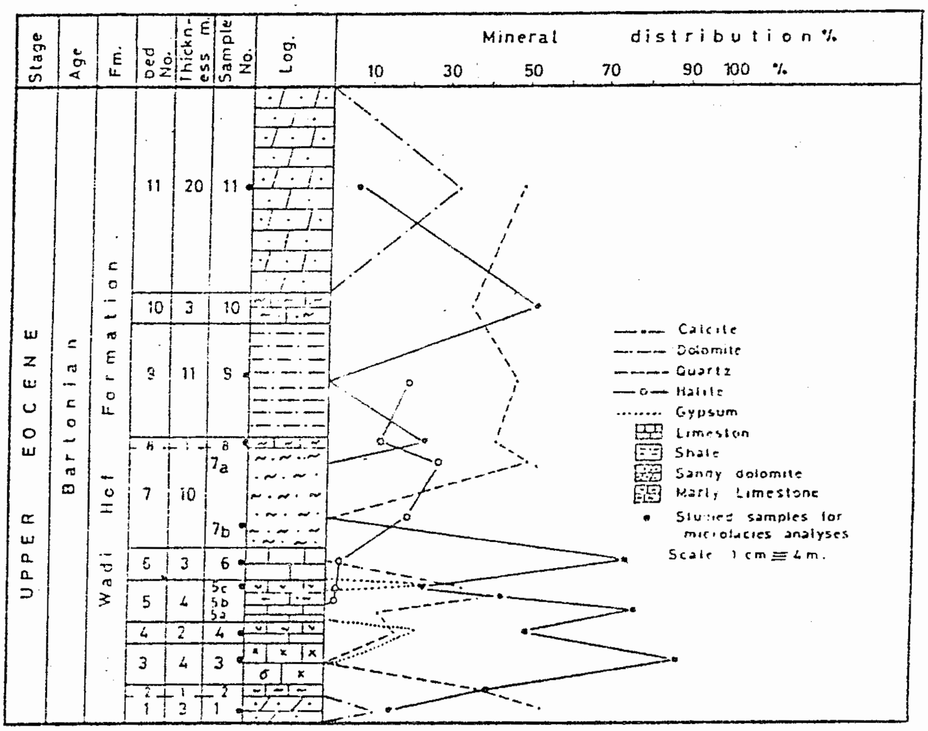


Fig. 12 : Vertical distribution of Calcite, Dolomite, Quartz, Halite and Gypsum in the rock samples of Upper Eocene rocks at Gebel El-Qattamia.

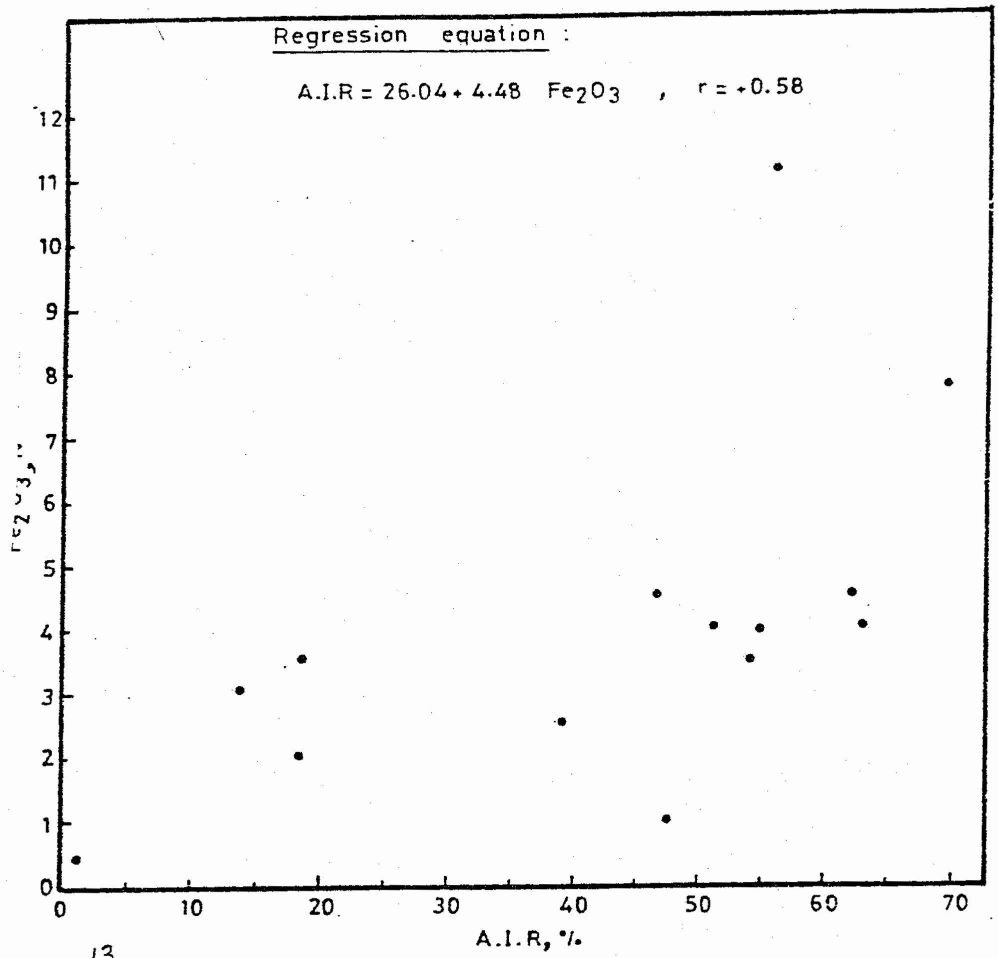


Fig. 13 : The relationship between total iron (expressed as Fe_2O_3) and acid insoluble residue (A.I.R) in the rock samples of Upper Eocene rocks at Gebel El-Qattamia.

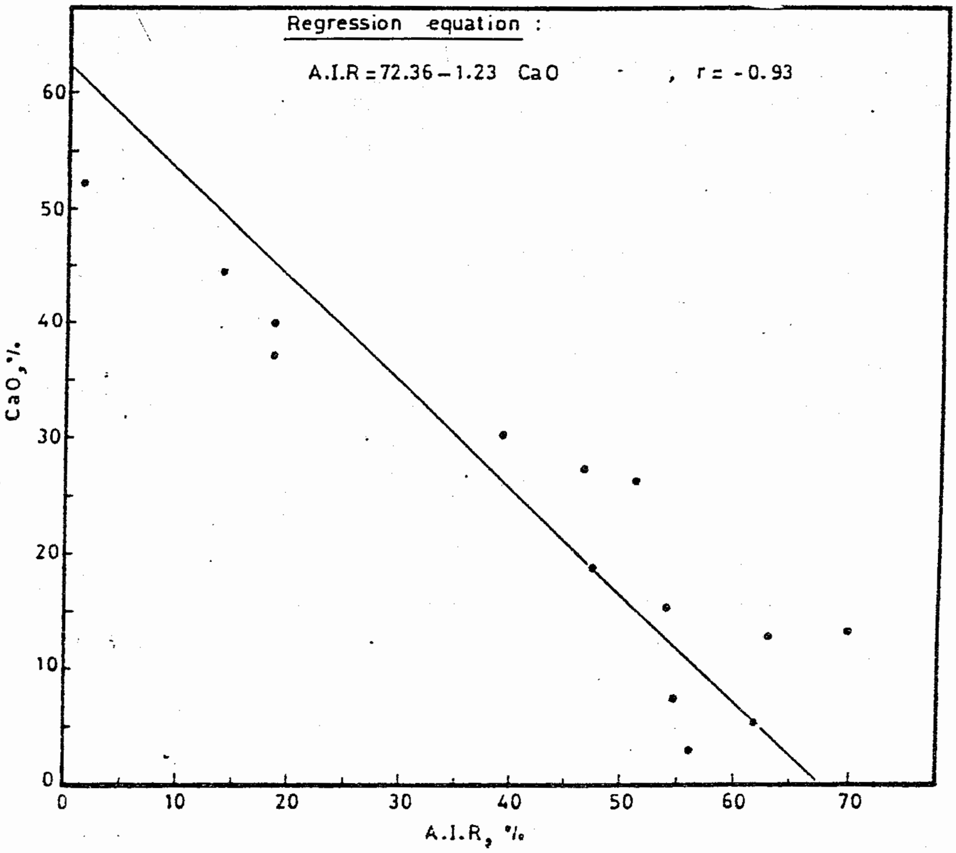


Fig. 14: The relationship between acid insoluble residue (A.I.R) and CaO content in the rock samples of Upper Eocene rocks at Gebel El-Qattamia.

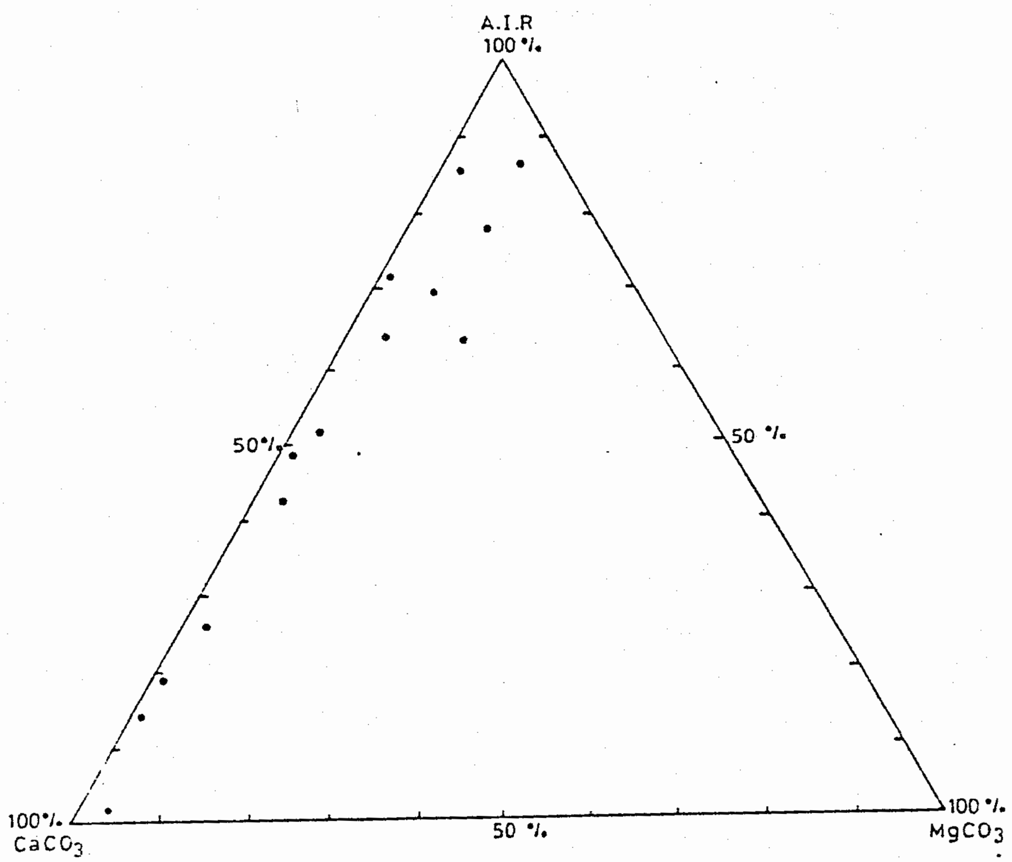


Fig.1.5: Triangular diagram illustrating the correlation of the rock samples on the basis of $CaCO_3$, $MgCO_3$ and A.I.R of Upper Eocene rocks at Gebel El-Qattamia.

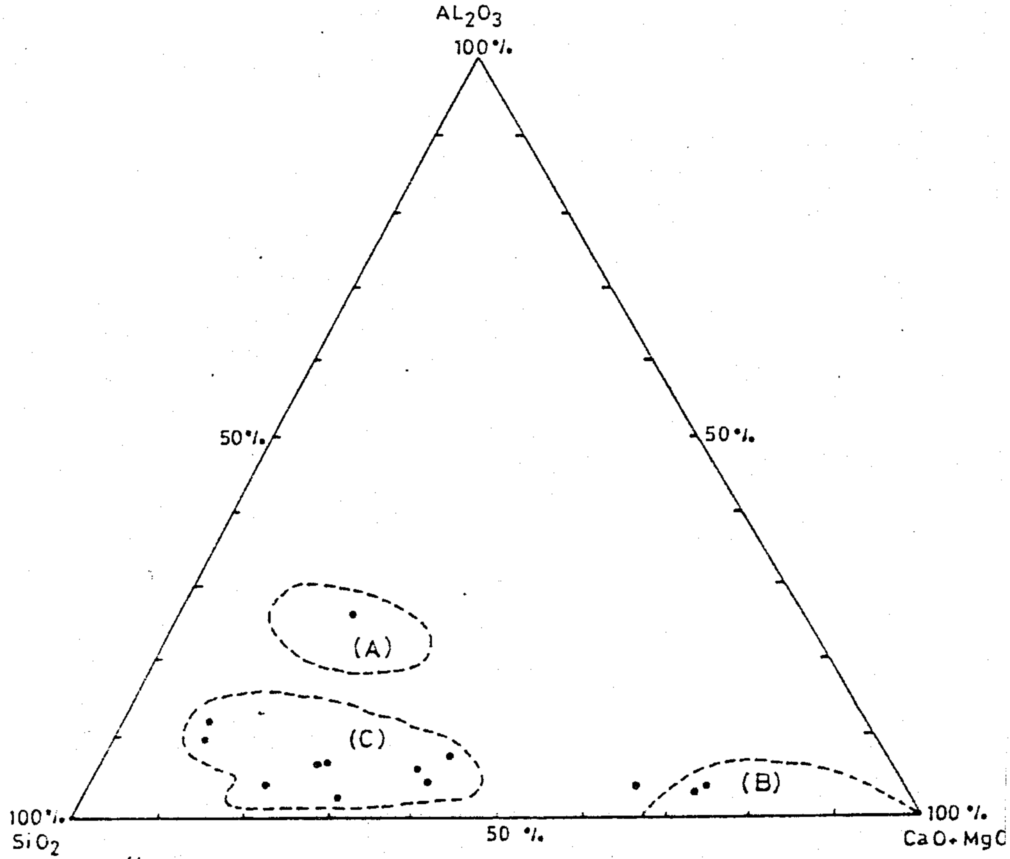


Fig. 16: Ternary diagram of SiO_2, Al_2O_3 and (CaO + MgO) in the rock samples of Upper Eocene rocks at Gebel El-Qattamia.

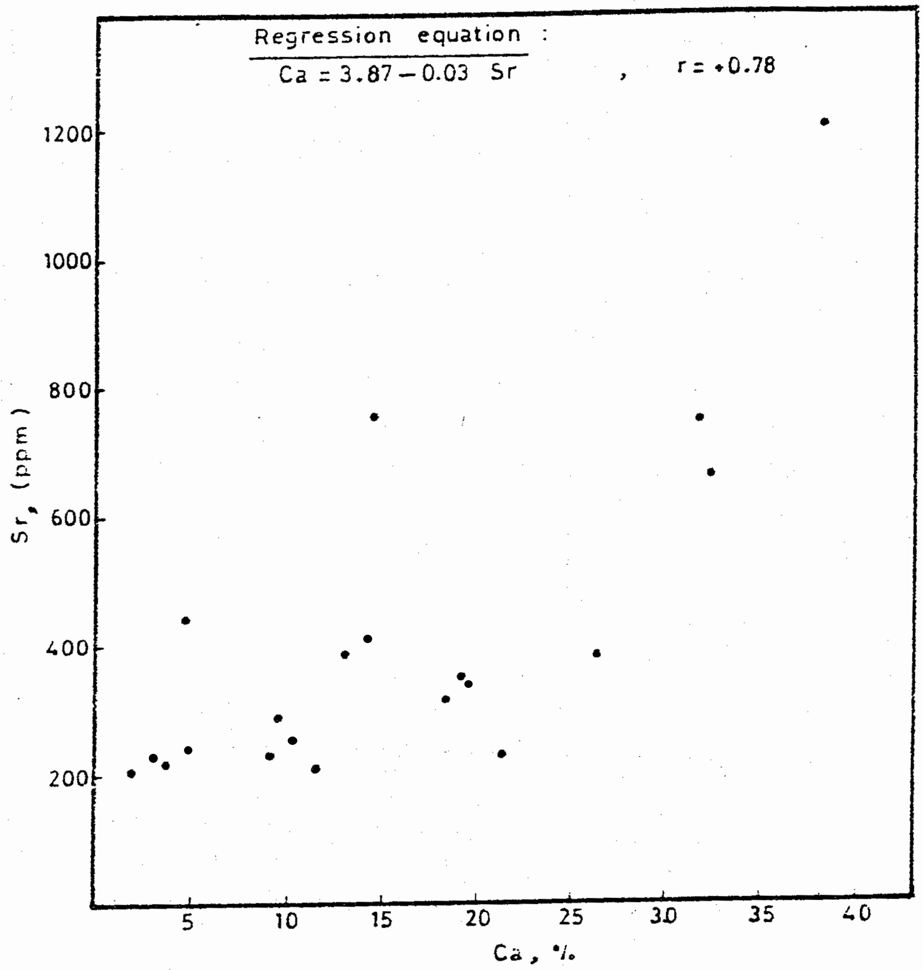


Fig. 17: The relationship between strontium content and calcium content in the rock samples of Upper Eocene rocks at Gebel El-Qattamia.

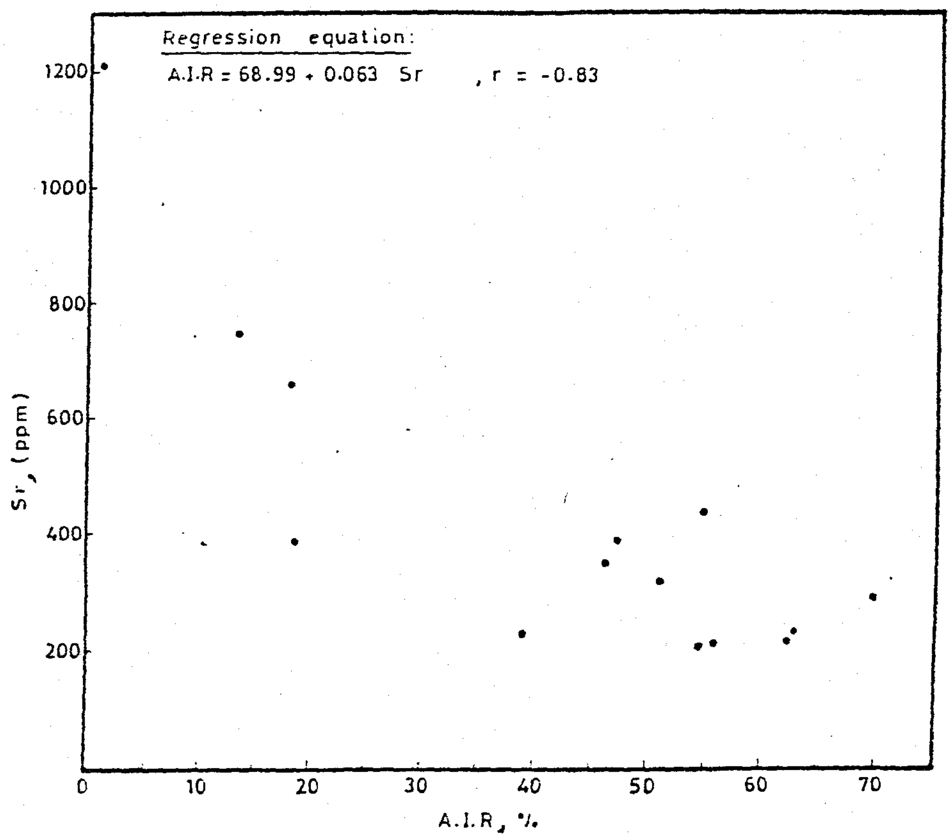


Fig. 18: The relationship between strontium content and acid insoluble residue (A.I.R) in the rock samples of Upper Eocene rocks at Gebel El-Qattamia.

Table 1 : Results of chemical Analyses.

Sample No.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	MnO %	Na_2O %	K_2O %	P_2O_5 %	H_2O^- %	L.O.I. %	SO_3^{--} %	Cl^- %	OCl^- %	A.I.R. %	$MgCO_3$ %	$CaCO_3$ %	$CaSO_4$ %	NaCl %	Ca/Mg ratio	Sr^{++} ppm
1	54.90	1.66	7.82	13.32	3.07	0.039	2.16	1.00	0.149	2.90	10.89	00.27	2.53	0.58	69.55	6.40	23.50	00.50	4.2	5.1	287
2	39.90	4.72	4.01	26.09	1.53	0.048	0.78	0.70	0.064	0.02	21.33	00.29	0.20	0.05	51.39	3.20	46.30	00.50	00,3	20.6	314
3	--	tr	00.42	52,20	1.53	0.011	tr	tr	0.024	0.19	42.63	00.95	tr	--	1.07	3.20	92.26	1.60	tr	40.3	1207
4	18.32	1.53	2.01	37,18	0.77	0.027	0.42	0.36	0.013	3.33	23.88	10.85	0.32	0.07	18.54	1.60	52.90	18.50	00.5	57.4	389
5a	15.16	1.28	3.51	44.90	0.26	0.045	tr	0.70	0.170	0.05	34.23	00.90	tr	--	18.50	00.50	79.20	1.60	tr	199,3	658
5b	40.36	3.44	4.51	27.19	0.77	0.064	0.24	0.28	0.160	0.05	21.16	00.80	0.28	0.06	46.62	1.60	47.70	1.40	00.5	42.0	349
5c	43.28	00.77	1.00	18.59	0.26	0.013	tr	0.15	0.040	5.02	19.54	11.63	tr	--	47.58	00.50	18.70	19.80	tr	82.5	389
6	12.02	1.53	3.01	44.62	0.26	0.110	1.22	0.36	0.107	0.01	35.06	00.81	1.40	0.32	13.91	00.50	78.80	1.40	2.3	198.0	748
7a	27.50	14.03	3.99	7.01	3.32	0.025	10.39	1,21	0.220	4.82	16.00	2.57	11.76	2.70	54.96	6.97	9.30	4.40	19.4	2.5	432
7b	49.18	7.90	4.51	5.44	1.02	0.030	13.50	1.56	0.140	0.30	5.93	00.41	15.43	3.55	62.32	2.10	9.20	00.70	25.5	6.3	212
8	43.82	4.46	3.51	15.73	1.53	0.057	7.59	1,13	0.047	0.19	16.07	00.26	8.67	1.99	54.29	3.20	27.80	00.50	14.3	12.1	205
9	47.60	5.86	11.09	2.86	3.32	0.040	10.38	1.06	0.430	0.71	5.40	1.62	12.43	2.86	56.06	6.97	3.10	2.80	20.5	1.0	209
10	35.48	5.48	2.51	30.10	1.53	0.062	tr	0.92	0.096	0.01	25.76	00.39	0.14	0.03	39.42	3.21	53.40	00.70	00.2	32,2	224
11	50.60	4.97	4.01	12.87	7.41	0.022	1.97	1.42	0.078	0.27	16.48	00.69	0.28	0.06	63.05	15.56	22,20	1.20	00.5	2.1	229

(-) : Not Determined   tr = Trace   (A.I.R.) : Acid Insoluble Residue

Table 2 : Average, Minimum and Maximum contents of the major and trace constituents in the studied rocks.

Constituents	Gebel El-Qattamia N = 14
SiO_2%	36.78 / 12.02 - 54.90
Al_2O_3%	4.12 / 0.77 - 14.03
Fe_2O_3%	3.99 / 0.42 - 11.09
CaO%	24.15 / 2.86 - 52.20
MgO%	1.89 / 00.26 - 7.41
MnO%	00.042 / 00.011 - 0.110
Na_2O%	4.91 / 00.24 - 13.50
K_2O%	00.83 / 00.15 - 1.56
P_2O_5%	00.110 / 00.013 - 0.430
H_2O%	1.28 / 00.01 - 5.02
L.O.I.%	21.03 / 5.40 - 42.63
SO_3^{--} %	2.31 / 00.26 - 11.63
Cl^-%	3.82 / 00.14 - 15.43
A.I.R.%	42.66 / 1.07 - 69.55
Sr^{++} ppm	418 / 205 -1207

جيوكيميائية وبترولوجية بعض صخور الايوسين الاعلي
بجبل القطامية ، طريق القاهرة - السويس - مصر

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تتكون السحنات الدقيقة الممثلة لتكوين وادي حوف بقطاع جبل القطامية من ميكريت دولوميتي رملي ، بيوميكروسباريت نيموليتي حفرى ، بيوميكروسباريت نيموليتي حفري رملي وميكريت رملي . ومن ناحية التحليل بواسطة الأشعة السينية فيتميز هذا القطاع بوجود الكالسيت والكوارتز والدولوميت والهاليت والجبس ، وتمثل معادن الطين بالكاوالين والإليت . وتدل نتائج التحاليل الجيوكيميائية علي ان معظم عينات البحث غنية في نسبة أكسيد السيليكون واكسيد الألومنيوم الذي يدل علي انتشار الكوارتز والمواد الطينية . كما أن نسبة اكسيد الكالسيوم والفاقد بالحريق فتقل كثيرا عند صخور الجيرية القياسية .

ولقد امكن التوصل الي ان بيئة الترسيب بحرية ضحلة ، وان سلسلة الطبقات السفلية لهذا القطاع قد تكونت فى بيئة عميقة نوعا . أما سلسلة الطبقات العلوية الغنية بالاملاح مثل الهاليت والجبس فتدل علي أن البحر كان ضحلا وحافا نوعا . وتدل زيادة نسبة الدولوميت علي حرارة البيئة . كما أن ترسيب الكالسيت فهو دليل علي أن هذة البيئة كانت قاعدية ، ووجود المواد الكلاستيكية بوفرة فتدل علي أن العديد من الروافد والأنهار كانت تصب في هذة البيئة .