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MINERALOGICAL AND PETROGRAPHICAL STUDIES OF SOME SUBSURFACE LOWER CRETACEOUS (APTIAN) ROCKS IN THE NORTHERN PART OF WESTERN DESERT, EGYPT.

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ABSTRACT

The present study aimed to shed light on the mineralogical composition and the petrographic investigation of some Lower Cretaceous Aptian sediments from some wells drilled in the northern part of the Western desert, Egypt. Petrographic study has been done for different rock types for better understanding of the paleo-environment of deposition and diagenetic processes that affected the sediments. Shale samples were investigated mineralogically by means of X-ray analysis (XRD), and differential thermal analysis (DTA). The data obtaihed revealed the following conclusions :

1. The recorded clay minerals are kaolinite; illite; and mixed layer illite-montmorillonite. The genetic significant of these clay minerals suggests that the Aptian shales are most probably of marine environment and sometimes of a lacustrine origin.

2. Carbonaceous matter and carbonates commonly co-existed with the Aptian shales and greatly affected the differential thermal curves.

3. The Aptian sediments are greatly influnced by post depositional activities as evidenced by petrographic analysis.

4. Environmental interpretation and diagenetic transformation of the clay minerals are discussed.

INTRODUCTION

The Western desert has been recognized as a region of simple geological structure, covered by the northerly dipping Teretiary rocks of regional extent and reasonably lithologic uniformity (Zittle, 1883). Its northen portion froms a part of the unstable (mobile) shelf of Egypt (Said, 1962). The most extensive deposits in the unstable shelf area are those of Early Cretaceous (Aptian) revealed by deep drilling carried out by different oil companies. Petroleum exploration in the Western desert of Egypt delineated the oil potentialities of the northern part of the Western desert and decided that the reservoir prospective in this area is of Mesozoic age (Brooks, 1966; Vollen weider, 1967; El-Gezeery and Abdine, 1969; El-Banbi, 1970; Abdine and Deibis, 1972; El-Geseery *et al.*, 1972; Abdine, 974; Ezzat and Dia El-Din, 1974; O'Concor, 1975; Metwalli and Abel-Hady, 1975 .... etc.). Recently Barakat and Darwish (1987) proposed a new stratigraphic classification for the Lower Cretaceous sediments in the north Western desert dated from upper Jurassic to Lower Cretaceous as follows :

Top :	Bahariya Formation	Lower Cenomanian
	Kharita Formation	Albian
	Dahab Formation	Aptian
	Alamein Formation	Aptian
	Mediewar Formation	Aptian
	Abyad Formation	Aptian

Matruh Formation	Barramian
Alam El-Buib Formation	Barramian
Betty Formation	Neocomian
Masajid Formation	Upper Jurassic

The area under consideration is located in the northern part of the western desert of Egypt. It lies between Longitudes 28°00 and 29° 35 E and Latitude 30°00 to the Mediterranean Sea coast north wards (Fig. 1 a).

The present study is an attempt to elucidate the characters of the subsurface Lower Cretaeeous Aptian sediments (clastic and non-clastic rocks) pentrated in four wells (Fig. 1 b) drilled in the northern part of the Western desert. Theses wells are Burg el Arab-1; Alam el Buib-1; Alamein-4; El-Karita-1, and Qattra Rim-1. It is also intended to deal with the paleo-environmental deposition of these sdiments, their facies and facies change; as well as the main diagenetic processes that; affected these sediments.

ANALYTICAL PROCEDURES

I. Mineralogical Investigation of Argillaceous Samples :

A. X-ray analysis (XRD).

Seventeen representative argillaceous samples were chosen for X-ray investigation. Separation of < 2~ clay fraction has been done following methods published by (Weir *et. al.,* 1975). A phillips X-ray diffractometer has been used under the following conditions : Copper radiation, Fe-filtered, 32 Kv at 10 MA.

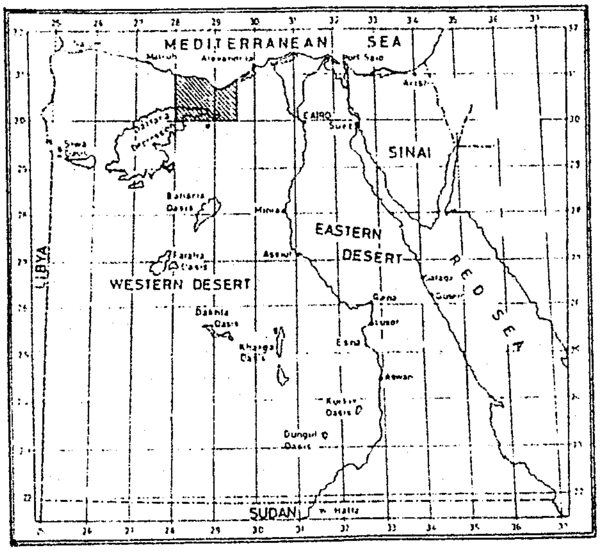


Fig. (1, a) : Location map.

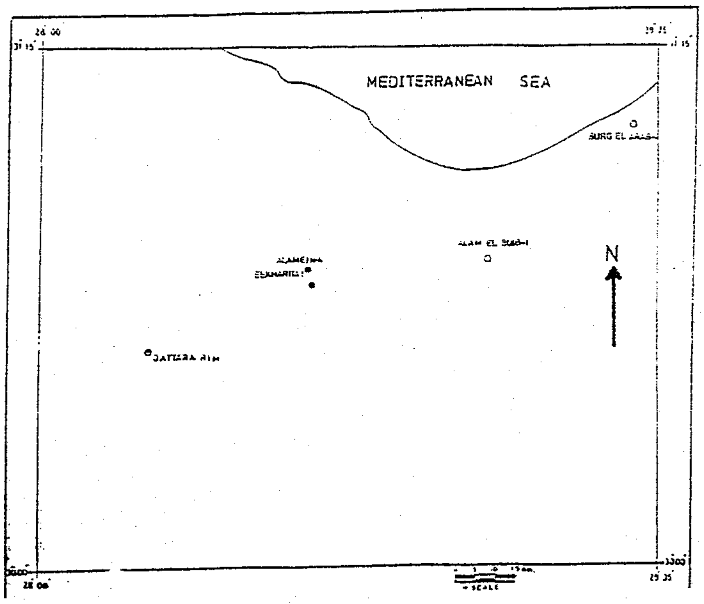


Fig. (1, b) : Location map of the studied wells.

geoinometer speed was normally at 2° 2 / min. The glass slide was X-rayed under the following conditions :

a) Untreated (Air dried); b) Glycolated; c) Heated at 500°C.

B. Differential thermal analysis (DTA)

Eleven representative argillaceous samples were examined by the differential thermal technique. The analysis was done using Shimedsu apparatus. Optimum conditions are : the heated rate is 10°C / min., starting heating at room temperature, Nitrogen atmosphere is applied at 80 mm., Calcined alumina as a reference, the end temperature is 1050°C, and chart speed is, 2.5 mm / min.

II. Petrographic Investigation

Sixty representative core samples of various rock types (Carbonates, Sandstones, Shales) were selected from five wells : Qattara rim-1; Alamein-4, El-Kharita-1; Burg El-Arab-1; and Alam El-Buib-1. The prepared thin sections were studied Petrographically. The main petrographic aspects in this study are lithological similarites, grain-size, roundness, sorting, porosity, cement-matrix relationships, mineralogical composition, main diagenetic events and the probable depositional environments.

RESULTS AND DISCUSSION

i. Lithological description of the invstigated samples :

The main rock types encountered in each well as well as their lithological description are given in Table 1, while their postition within the well are shown in Fig. 13.

Table (1) : Lithological description of the studied samples.

Age	Well name	Core No.	Sample No.	Interval (M).	Lithological description
	Qattra Rim-1	1	1-2	916.0-960.0	Dolomitic Limestone
		2	3	612.5-612.8	Dolomitic Limestone
			4-5	612.8-622.1	Sandy Micrite.
			6-7	622.4-623.9	Dolomitic Limestone
	Alamein-4	1	8	765.4-765.7	Glauconitic calcareous sandstone
			9-11	765.7-766.4	Carbonaceous shale
			12	766.9	Sandy micrite
Aptian			13-14	767.3-767.6	Sandy dolomitic limestone
			15	767.9	Dolomitic limestone
	El-Karita-1	1	16	909.6	Dolomitic Limestone.
			17	910.0	Dolomitic Limestone.
			18-21	910.3-910.9	Dolomitic Limestone.
		2	22-25	912.1-916.4	Dolomitic Limestone.
		3	26-29	918.2-922.4	Dolomitic Limestone.
		5	30-32	932.7-933.0	Carbonaceous Shale.
			33	933.3	Sandstone.
			34-35	933.9-934.5	Carbonaceous Shale.
		6	36-37	956.3-956.7	Carbonaceous Shale.
			38	956.9	Sandstone.
			39	957.3	Carbonaceous Shale.
			40	957.6	Sandstone.
	Burg el Arab-1	19	41	921.5-921.8	Calcareous Sandstone.
			42	922.4-922.5	Sandy dolomitic Limestone.
			43	922.7-922.8	Sandstone.
		20	44-50	926.0-966.4	Sandstone.
		21	51-53	966.4-966.9	Sandstone.
Aptian		22	54-55	997.9-1016.9	Sandstone.
		23	56-57	1018.2	Calcareous shale.
	Alam el Buib-1	1	58	1200-12003	Sandstone.
			59	1200.6	Calcareous shale.
			60	1200.6-1201.8	Sandstone.

ii. Mineralogical Investigation of Argilaceous Sediments:

A. X-ray analysis

Figures 2, 3, 4, 5 and 6 show five representative diffratograms for five selected shale samples. Semi-quantative estimation of the present clay minerals after schultz, 1964 was made. The clay minerals recorded are arranged according to their abundance as follow :

Kaolinite > illite-montmorillonite mixed layer > illite.

A brief description of these minerals is given below.

- ***Kaolinite :***

It is the predominated clay mineral recorded in the investigated samples. Judged from the shape of 7.1°A reflection, the recorded kaolinite in the studied samples appears to be generally moderately well crystallised (Schultz, 1960). The possible occurrence of halloysite as a result of neoformation between 1: 1 clay mineral is suggested by Millot (1970). Derivation from pre-existing kaolinite bearing sediments may be a possible source of kaolinite.

- ***Illite - montmorillonite mixed layer :***

The identification of random interstratification montmorillonite-illite has been based on X-ray data interpreted by Brown (1961). In most of the studied samples illite is present as hydrous mica associated with montmorillonite (Jackson *et al.*,

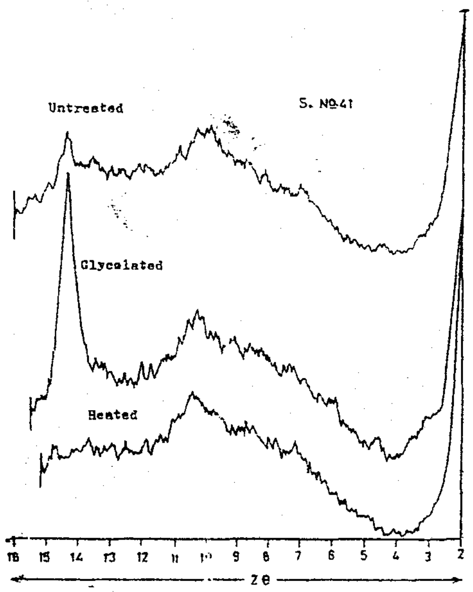


Fig. (2) : Iracing of X-ray diffractometer recordings of clay size fraction of some Aptian shale in Burg El-Arab-1 well.

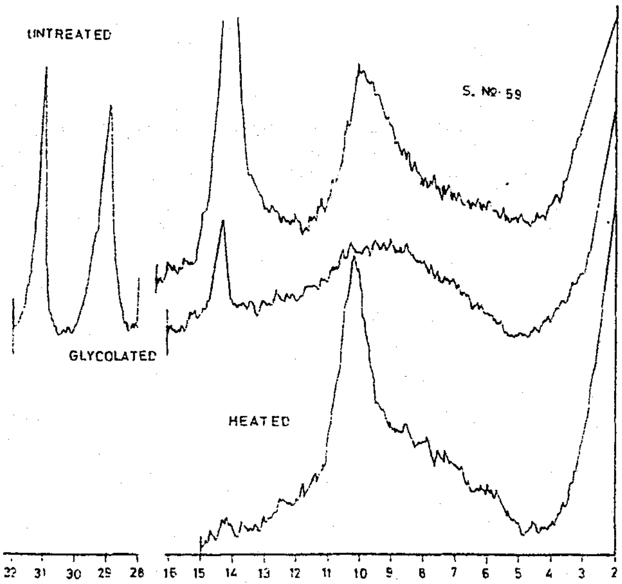


Fig. (3) : Iracing of X-ray diffractometer recordings of clay size fraction of some Aptian shale in Alam El-Buib-1 well.

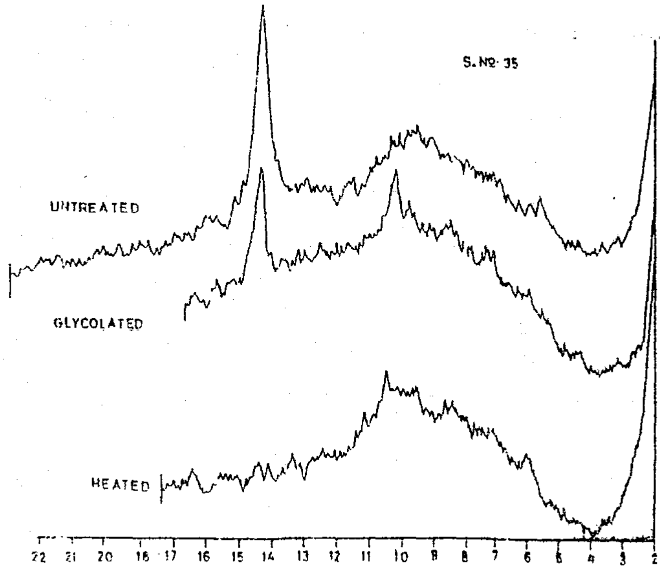


Fig. (4) : Iracing of X-ray diffractometer recordings of clay size.

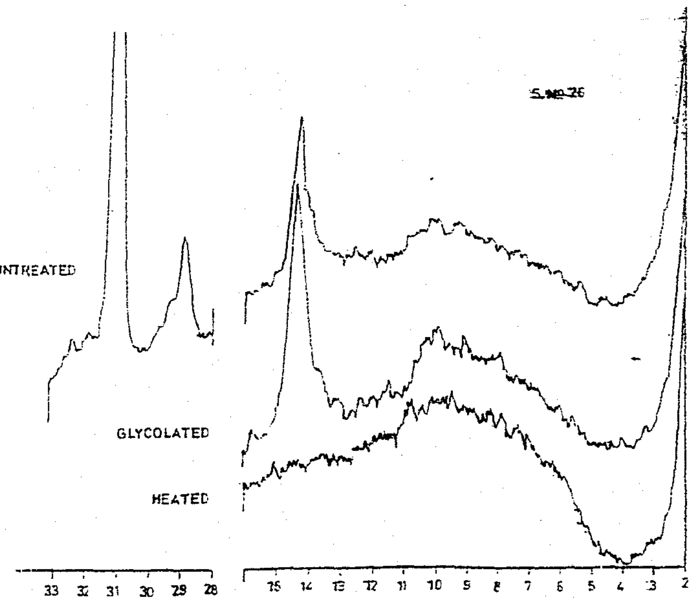


Fig. (5) : Iracing of X-ray diffractometer recordings of clay size fraction of some Aptian shale in El-Kharita-1 well

1952) at almost 12.5°A, 9.5°A and 3.3°A. Generally, illite-montmorillonite indicates a typical marine environment (Millot, 1970).

- *Illite :*

It is characterised by a series of X-ray peaks at almost 9.9°A and 3.3°A that are not afected by glycolation or heat treatment. Illite is a clay mineral which is most stable under marine environment (Millot, 1970).

B. Differential thermal analysis :

Figures 7, 8, 10, 11 and 12 show eleven representative differential thermal curves for some selected bulk samples. Generally, the data revealed that kaolinite is a predominated clay mineral followed by interstratified illite-montmorillonite. Organic matter (330°C), Goethite (404°C) as well as Quartz (600°C), Calcite (860°C) and Dolomite (780°C) are also recorded. A detrital origin is suggested due to the exo-thermic peak for kaolinite at 910-950°C (Mackenzie, 1966). On the other hand, weak endo-and exo-thermic peaks in the region 600-800°C suggest that the samples under consideration have greatly suffered from transformation effect (Jackson *et al.,* 1952).

The common occurrence of goethite and organic matter in the samples under investigation greatly affected the differential thermal curves for dolomite (788°C) and calcite (860°C). However, the first endothermic peak at 788°C is due to the decomposition of carbonate associated with the magnesium and the second one at

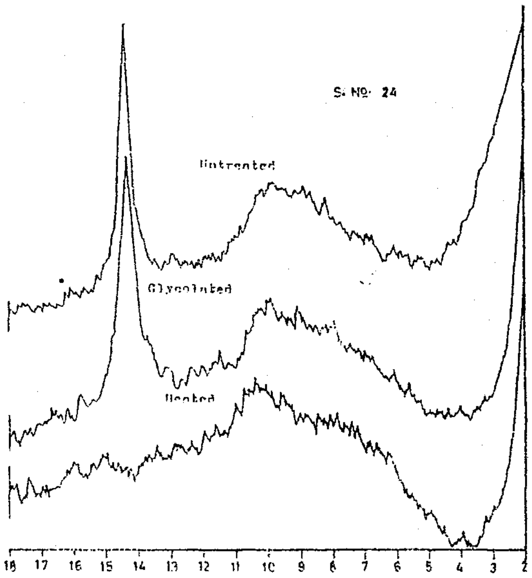


Fig. (6) : Iracing of X-ray diffractometer recordings of clay size fraction of some Aptian shale in El-Kharita-1 well

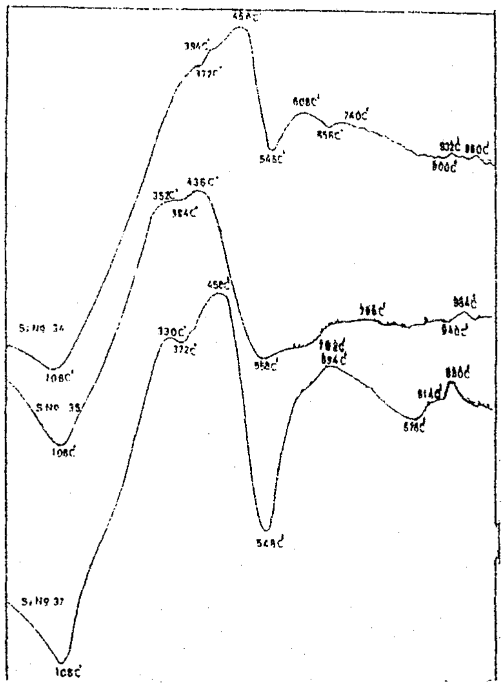


Fig. (7) : Differential thermal analysis curves of some Aptian shale in El-Kharita-1 well.

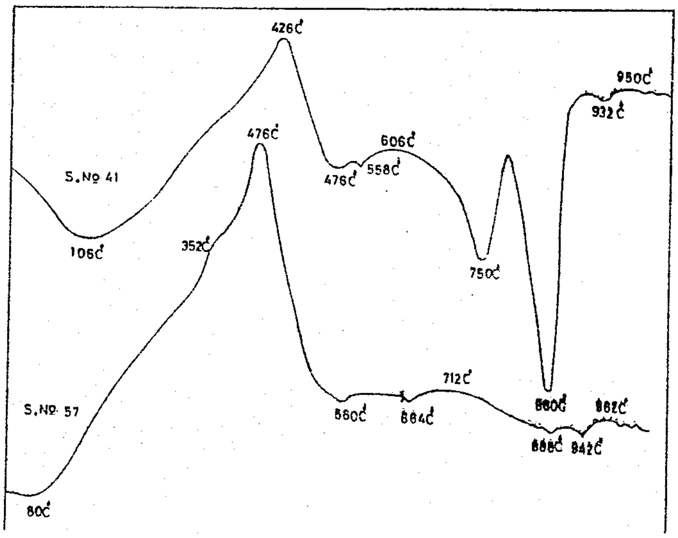


Fig. (8) : Differential thermal analysis curves of some Aptian shale in Burg El-Kharita-1 well.

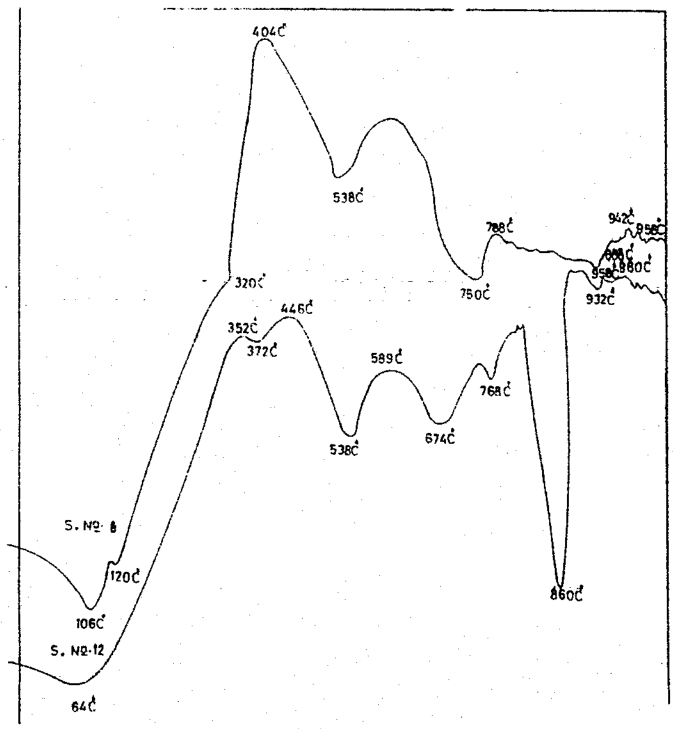


Fig. (9) : Differential thermal analysis curves of some Aptian shale in Alamein-4 well.

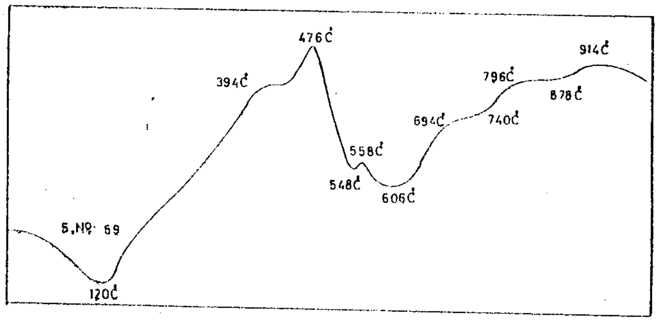
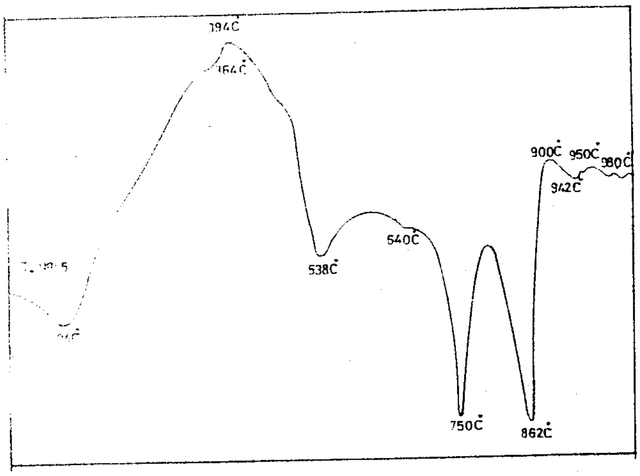


Fig. (10) : **Differential thermal analysis curves of Aptian shale in Alam El-Buib-1 well.**



(11) : **Differential thermal analysis curves of Aptian shale in Qattara Rim-1 well.**

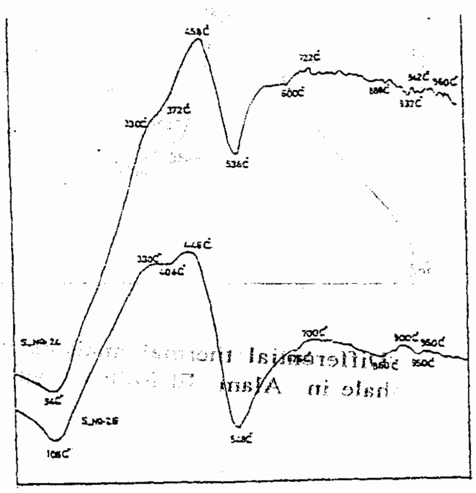


Fig. (12) : Differential thermal analysis curves of some Aptian shale in El-Kharita-1 well.

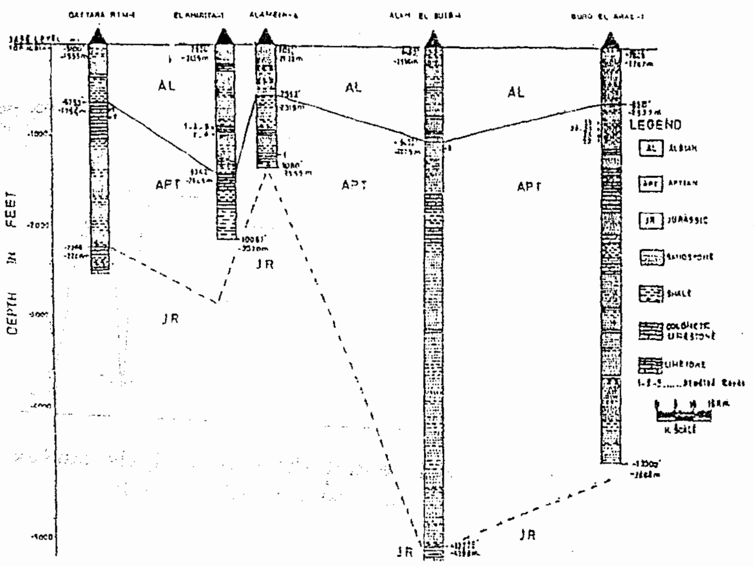


Fig. (13) : Correlation chart between the studied wells and the location of the studied core samples.

860°C due to the decomposition of the carbonate ions associate with the calcium (Mackenzie, 1966). On the other hand, high content of organic matter in the studied samples are shown by the strong exo-thermic peak at 330-476°C.

Genetic Significant of Clay Minerals :

Although the calcareous sediments are likely to have little or no kaolinite (Millot, 1970), the abundance of kaolinite in the studied shales denotes an intimate association of kaolinite and calcite. Such association implies an equilibrium condition with sea water (Zen, 1960). On the other hand, in sediments of lacustrine origin of agitate water, the dominant clay mineral is kaolinite, while in sediments of lacustrine origin of calm water, the dominant clay minerals are illite, montmorillonite, and illite (Millot, 1970). Hence, the investigated samples might be partly of lacustrine environment in which water alternate from agitate to calm characters. However, faunal studies of the samples are vital to confirm the proposed environment.

iii. Petrographic study :

Photomicrographs for the investigated thin sections are given in plates 1, 2, and 3. Nomenclature of the different rock types in the present work is based on published work by Pettijohn (1975), Selly (1976). The rock types identifed include : calcareous sandstone, Sandy dolomitic limestone, Sandstone, Carbonaceous shale, Sandy micrites and dolomitic limestone.

Petrographic study of the encountered rock types as well as their main diagenetic events and the probable depositional

PLATE.

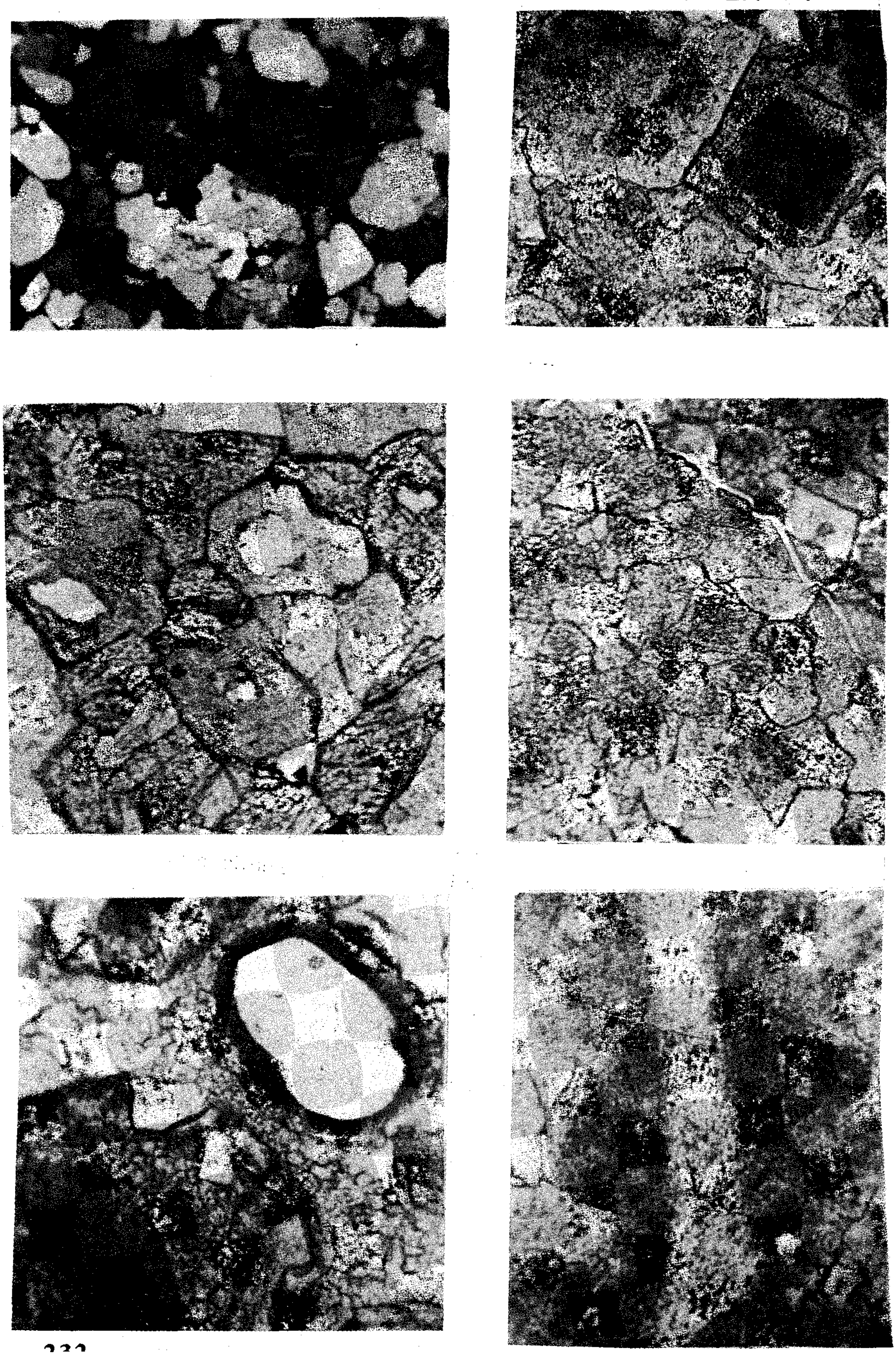


PLATE I

Fig. a : Quartzarenite Photomicrograph showing maxamium stage of deformation of poorly sorted quartz grains resulted in compact and indurated sandstone. Burg El Arab, I. well; Core 21; X 50 C.N.

Fig. b : Dolomitic limestone Photomicrograph showing elongated pores and intercrystalline porosity. Alamein-4 well; Core 1; X 50 PPL.

Fig. c : Dolomitic limestone Photomicrograph showing empty or hollow dolomite crystals and intercrystalline porosity. Alamein-4 well; Core 1; X 50 PPL

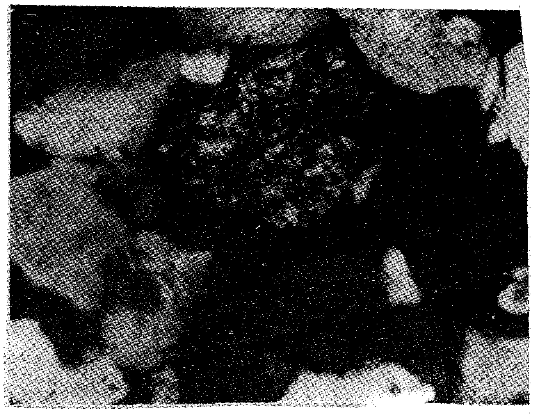
Fig. d : Dolomitic limestone Photomicrograph showing an advanced stage of diagenesis resulted in micro fissures in dolomite crystals. Qattara Rim-1; X 50 PPL.

Fig. e : Dolomitic limestone Photomicrograph showing obliteration of porosity by recrystallisation of micrites to form micro-sparite. Burg El Arab - I well; Core 19, X 100 C.N.

Fig. f : Dolomitic limestone Photomicrograph showing transformation of allochem particle into dolomite. Qattara Rim-I well; X 100 C.N.

PLATE-II

(a)



(b)

(c)

(d)

PLATE II

Fig. a : Dolomitic limestone Photomicrograph showing a single dolomite rhomb surrounded by calcite i.e. (calcitisation). Alamein -4 well; Core 1, X 50 C.N.

Fig. b : Quartzarenite Photomicrograph showing chert filling inter-pore spaces between quartz grains. Burg El Arab -1 well; Core 22, X 100 C.N.

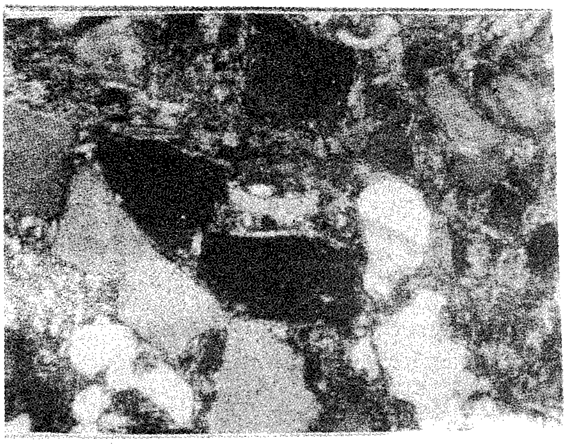
Fig. c : Sandy dolomitic limestone Photomicrograph showing precipitation of calcite engulfing much of clastic quartz grains. Burg El Arab-1 well; Core 19 X 100 C.N.

Fig. d : Dolomitic limestone Photomicrograph showing introduction of organic matter filling inter-pore spaces between dolomite crystals. Alamein-4 well; Core 1; X 50 C.N.

Fig. e : Ferruginous sandstone Photomicrograph showing iron oxides filling inter-pore spaces between quartz grains; El-Kharita-1 well; Core 5; X 50 PPL

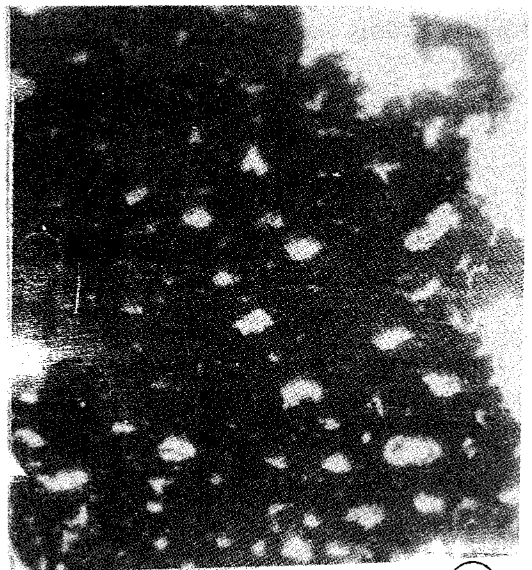
Fig. f : Dolomitic limestone Photomicrograph showing iron oxides filling inter-pore spaces between dolomite rhombs. El-Kharita -1 well; Core 5; X 50 PPL.

PLATE-II

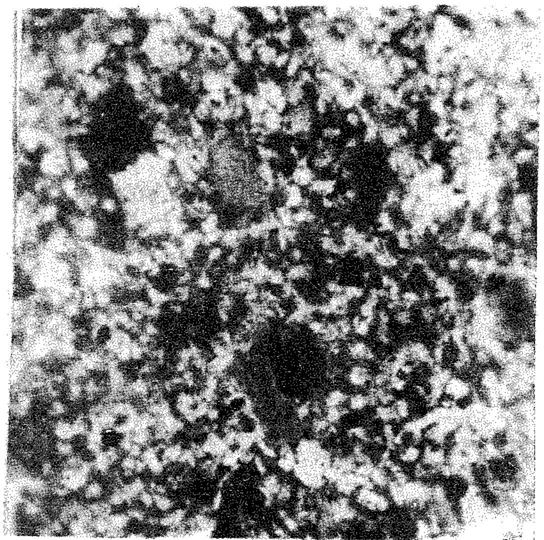


(d)

(a)



(c)



(d)

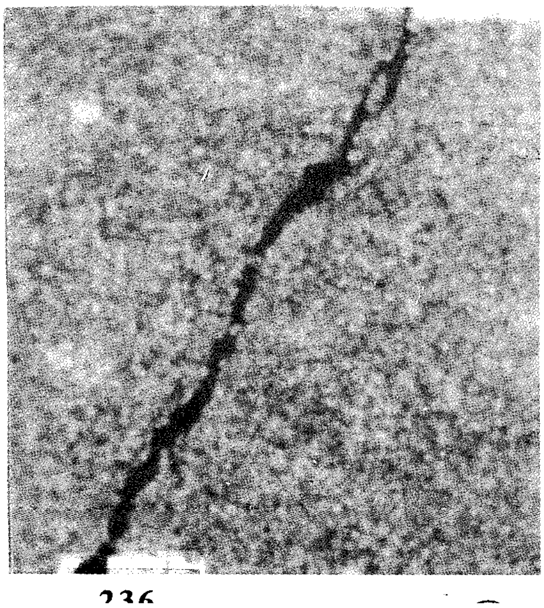


PLATE III

Fig. a : Feldspathic sandstone Photomicrograph showing abundant anhydrite fibres and laths disseminated in feldspathic sandstone. Burg El Arab-1 well; Core 23; X 50 C.N.

Fig. b : Feldspathic sandstone Photomicrograph showing altered and fresh feldspars in feldspathic sandstone. El-Kharita -1 well; Core 6; X 100 C.N.

Fig. c : Clacareous sandstone Photomicrograph showing a magnified part of vesicular plant remains. El-Kharita-1 well; Core 5, X 100 PPL.

Fig. d : Glauconitic calcareous sandstone Photomicrograph showing glauconitic pellets admixed with very fine sand, lime-mud and organic matter. Alamein-4 well; Core 1, X 50 C.N.

Fig. e : Sandy micrite Photomicrograph showing micrite (Lime-mud) and scattered very fine quartz grains. Alamein-4 well; Core 1; X 50 PPL.

Fig. f : Dolomitic limestone Photomicrograph showing phosphatic relics as a product of erosion. Alamein-4 well; Core 1; X 50 PPL.

environments are summarised in Table 2.

The previously mentioned diagenetic events are briefly discussed below :

1. Compaction and Cementation :

This is defined as the diagenetic processes affected sediments under the load of the superincumbent sediments. The recorded broken grains (Plate 1, a) represent the maximum stage of compaction with the resultant consolidation of grains and iccrease of intergranular bonding. Authigenic silica and overgrowths may be attributed to the effect of compaction (Füchtbour, 978 and Bjorlykkee, 1983).

2. Solution and Porosity :

The porosity recorded in the investigated cores are of secondary origin. In clastic sediments, higher secondary porosity is most probably due to inhomogenity in packing; intercrystalline porosity, leaching and fracturing of the rocks. Meteoric water or Sea water containing CO_2 in solution causes dissolution and weathering of limestone, creates inter-connected fissures and inter crystalline porosity (Plate 1, b). Hollow dolomite crystals are recorded in most carbonate samples (Plate 1, c) and resulted from the effect of high salinity of the deposition medium. Hollow dolomite represents an epigenetic stage of dolomitization and assists to some extent in enhancing secondary porosity in dolomitic rock, (El-Mansey, 1983). The pressure solution due to increasing overburden produces irregular sutured planes and / or broken grains

Table (2) : Main diagenetic events recorded in various rock types within Aptian rocks.

Rock Type	Main Diagenetic events	Probable depositional environment
1. Calcareous sandstone and glacuonitic Clacareous sandstone	-Leaching of the carbonate cement. -Pyrite clusters -Organic matter replacement.	Shallow shelf environment.
(2) Sandy dolomitic limestone	-Carbonate replacement on quartz grains -Recrystallization (aggradation and degradation). -Organic matter replacement.	Fairly shallow lagoon or protected shallow Shelf receiving reworked terri-genous clastics from the near by source.
(3) Sandstone	-Spheroliric silica, chertification. -Squashed, broken grains and fissures banded. -Pressure solution. Sulphate reducing. Bacteria. -Secondary replacement by secondary inclusion. -Erosional products.	A near by source rock that received a continental supply.
(4) Carbonaceous shales	-Sericitization of -Feldspars. -Simple clay bond.	Turbidity depositional basin.
(5) Sandy micrities	-Recrystallization -Organic matter replacement. -Erosional products.	Shallow marine not far from the clastic source.
(6) Dolomitic limestone	-Dolomite replaces calcite -Cementation -Replacement by organic matter. -Stylolites (pressure solution). -Hollow dolomite -Syntaxial calcite rim -Leaching	Semi-evaporitic laggon or closed basin.

(Plate 1, Fig. 1). In an advanced stage of diagenesis, pressure solution resulted in microfrartures; (Plate 1, d).

3. Recrytallization, Aggradation, and Degredation :

It involves no change in the chemical composition, it only involves changes of morphology often represented by a crystal enlargement. The micrite grains replacing the outer marigns of other components (quartz and coarse sparites) resulted in obliteration of the porosity (Plate 1, e).

4. Replacement :

It involves the alteration of chemical composition of the original rock by extraneous materials. The following main types of replacement are deduced :

a. Dolomitization :

This is the process by which the calcium carbonate in limestone is replaced by dolomite depending on Ca / mg ratio. Definite replacement (Pray and Murray, 1956) can be shown by transformation of allochem structures by dolomite (Plate 1, f). However, degree of dolomitization is highly variable in the studied samples, being partial in many rocks and complete in others (Plate 2, a). According to Folk (1968), dolomitization usually occurs in warm, shallow, more saline water and is often associated with submarine highs while limestone forms in deeper waters.

Syntaxial cement (rim-cement) :

Calcium carbonate (Calcite) can be chemically deposited as cement into particle voids and is optically continuous on dolomite rhomb or a single crystal grain with resultant non-porous fabric (Plate 2, a).

b. Silicification :

This involves partial or complete replacement of the rock by cryptocrystalline silica (Plate 2, b).

At higher pH, and temperature, silica is produced from unstable silicate minerals. The main source of silica is the dissolution of silt size quartz grains. (Fuchtbauer, 1979). Precipitation of silica in the form of chert filling inter pore spaces resulted in obliterating the original porosity of the rock (Plate 2, b). On the other hand, precipitation of calcite on large quartz crystals completely engulfing much of the original clastic material (Plate 2, c), and resulted in poor porosity.

c. Organic matter :

In latter stage of diagenesis, the introduction of organic matter leads to partial or complete replacement of the carbonate rocks through pore spaces (Plate 2, d).

d. Iron-oxides :

The recorded iron oxides, filling inter pores as a cement in clastic and carbonate rocks is responsible for the reduction in porosity in the examined rocks (Plate 2, e and f).

e. Replacement by anhydrite :

This process involes partial or complete replacement of the original clastic rocks (rarely in carbonates) by anhydrite (Plate 3, a). It takes the form of patchy dissemination. Replacement by anhydrite obliterates the original porosity.

f. Feldspar alteration (sericitization).

The recorded different stages of feldspar alteration (Plate 3, b), reflect an advancing stag of phyllomorphic diagenesis (Condie *et al.,* 1970).

DISCUSSION OF PETROGRAPHIC RESULTS

Based on lithological correlations, and Petrographic study, Figure 13 shows lateral distribution of Aptian sediments within the other geologic ages. This figure shows that an increase of thikness of the clastic sediment which deposited from a lower cretaceous sea in a north east direction.

This is accompained by a lateral facies change from sandstone to marl and carbonates. At the basal part of the stratigraphic succession, quartz arenites are the main rock component in this sequence with coarse feldspars especially in sub-grywackes intercalation. Coarsening of the main clastic components (Quartz and feldspars): higher angularity with packing sugest a regression phase during deposition and a nearby source of clastic supply (Selley 1976). The recorded interlaminated sand, silt and clay and micro structures suggest an intermittent periods of deposition below the wave base (Selley 1976). Also, the vescular plant material recorded in El-Kharita well No. 1 reflects deposition from a surface water (Gibling *et al.,* 1985) which recorded. Upwards within the stratigraphic succesion (Plate 3, c). The introduction of carbonates and glauconites with land ward, micrites and Oolites in Burg El-Arab No. 1 well with algal flats, and dolomitization reflects a transgression phase. The recorded glauconite grains in Alamein well No. 4. (Plate 3, d), reflects deeply buried conditions and show slow rate of depositin (Fairbridge, 1967). The alamein dolmite is devoid of any fossils. However, variation in the previously mentioned diagentic process which affecting textural and mineralogical composition of the Aptian sediments are due the irregular topographic feature of the northwestern desert resulted in differential uplift and erosion of the Pre-Aptian sediments. Hence some parts of the depositional basin are protected from the turbulence resulting in the formation of lime mud rock type i.e. microcrystalline limestone (micrite) (Plate 3, e). Other parts were affected by different physico-chemical conditions during the diagenetic hishtory of the Aptian sediments (clastics and carbonates) resulting in the previously mentioned diagenetic phenomena. Another regression phase was initiated after the deposition of the carbonate shale streaks above the Alamein Formation (Dahab Formation) which later subjected to erosion in the central part of the area where erosion products were deposited in the lows as evidented by the recorded phosphate and carbonate pellets (Plate 3, f). Finally, the Aptian top is difficult to determine, and the Upper carbonate unit (Alamein Formation) being the most consistent marker in the entire area.

SUMMARY AND CONCLUSIONS

Mineralogical studies of some Aptian core sediments raised from some wells drilled in the northern part of the western desert revealed the following main points:

1. Argillaceous samples were investigated mineralogically by means of X-ray analysis and differentail thermal analysis indicate that the predominate clay mineral recorded are kaolinite, mixed-layer illite-montmorillonite and illite. Goethite, carbonates and organic matter are the major non clay mineral existed. Most probably the recorded organic matter may be of a considerable amount as a source of hydrocarbon potentials.

2. The investigated shale samples are most probably of lacustrine environment in which water alternate from agitate to calm characters. Also, transformation-neoformation of one clay mineral to another is highly expected in these samples.

3. Based on lithological correlations and petrographic studies two main basin of deposition are existed. The first one located to the east and is dominated by clastic sediments with minor carbonate intercalations. The second is located to the central west part of the studied area and is characterised by marine sediments with minor shales and marl intercalations with few glauconites. The sediments show abrupt variation in lithology and thickness which reflect different magnitude of tectonic instability as revealed by bended museovite, stylolitic texture; fissures and micro-veinlets which increase porosity of the sediments and hence oil accumulation in the studied area.

4. Dtagenetic events are represented by compaction, cementation, pressure-solution, recrystallisation (aggradation-degradationa), replacement; hollow dolomlte, leaching, syntaxial calcite-rim and feldspar alteration (Sericitisation). Six rock types are distinguished which denote different probable depositional environments i.e. Shallow shelf environment, protected shelf environment; nearby source rock that received a continental supply; turbidity depositiobal basin, shallow marine that not far from the clastic source, and semi-evaporitic lagoon or closed basin.

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دراسات معدنية وبترولوجية على صخور تحت سطحية لعصر الأبتيان للجزء الشمالى الغربى لصحراء مصر الغربية

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*** هيئة المواد النووية – القاهرة

يهدف هذا البحث الى دراسة بيئة الترسيب القديمة والتحولات المعدنية التى طرأت على رواسب عصر الابتيان لعينات تحت سطحية (اسطوانية) جمعت من بعض الآبار بصحراء مصر الغربية . وقد أجريت الدراسة باستخدام الميكروسكوب المستقطب والتحاليل باستخدام جهاز الأشعة السينية والتحليل الحرارى التفاضلى .

وقد أمكن التوصل الى النتائج الآتية:

١- تتكون معادن الطلفة اساسا من الكاولينيت والاليتيت ومعادن مختلطة اهمها الاليت – مونتمورلونيت وقد ترسبت هذه المعادن فى بيئة متقلبة بين بحرية وملحية.

٢- معادن الكربونات الممثلة بمعدنى الكالسيت والدولومايت بها نسبة عالية من المواد العضوية .

٣- تمت مناقشة التحولات المعدنية المختلفة التى آثرت على هذه الصخور وقد ساعد ذلك على تفسير بيئة واحواض الترسيب وكذلك على درجة المسامية لهذه الرواسب.