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Microfacies Study of the (Late Hautervian-Early Aptian) succession Southern Iraq

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Abstract

1350 representative thin sections of (Late Hautervian-Early Aptian) succession in wells (Hf-1, Hf-2, Noor-1, Am-2and Rt-3) were examined microscopically. They revealed four patterns of facies build up represented by the following facies: lime mudstone facies buildup, lime wackestone facies build up, lime packstone-grainstone facies build up and lime grainstone facies build up. The under studied succession have been deposited within low energy environment with high energy intervals represented by fine sand grains deposits. The present depositional system may reflects deepening aboard deposition toward East Amara oilfields, while toward South and South west it reflects shallowing upward succession

دراسة سحنية لتعاقبات (الهوتريفيان المتأخر- الأبتيان المبكر) جنوب العراق

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الخلاصة

فحصت1350 شريحة صخرية ممثلة لتعاقبات (الهوتريفيان المتأخر-الأبتيان المبكر) في آبار (Hf-1, Hf-2, Noor-1, Am-2,Rt-3) الواقعة في جنوب العراق. وقد أظهرت الدراسة وجود أربعة أنماط من البناء السحني تمثلت بالبناء السحني الجيري الطيني و البناء السحني الجيري الواكي والبناء السحني الجيري المرصوص- الحبيبي والبناء السحني الجيري الحبيبي . إن التعاقبات قيد الدراسة قد ترسب ضمن ظروف بيئة هادئة تتخللها فترات من العواصف و تأثيرات التذرية المرسبة للرمال الناعمة. يعكس النظام الرسوبي للتعاقبات قيد

الدراسة تعمق نحو الأعلى باتجاه حقول شرق العمارة ، في حين يعكس تضـــحلا نحـــو الأعلـــى باتجاه جنوب و جنوب غرب منطقة الدراسة.

Introduction

The stratigraphic column of Southern Iraq is characterized by thick Cretaceous succession and important hydrocarbon accumulation. Lower Cretaceous formations form a considerable part of the Mesozoic sequence at Southern Iraq. These formations occurs below a thick cover of Palogene sediments, and most of their are reservoir rocks. The Late Hautervian – Early Aptian lithostratigraphic sequence in east Amara field consists of alternation of limestone / limestone shale Zubair Formation and the upper part of Ratawi Formation. This period was attracted the attention of many petroleum geologists and stratigraphic. AL-Naqib (1967) revealed that Zubair and Ratawi Formations replaced each other depending upon the location within the Arabian shield and the depositional basin, while (AL-Siddiki, 1966) postulated that the succession understudy represents Zubair Formation, which divided into five members on the Late Hautervian –Early Aptian succession in east related to Ratawi Formation.

Methodology:

A total of (1350) thin section were examined using binocular microscope.These thin sections were prepared from samples collected from five boreholes: HF-1,HF-2,Am-2,Noor-1, and Rt-3 (Fig. 1). The samples were unevenly distributed throughout the lithologic column because the lack of some samples in some bore holes. All the samples were supplied by the South Oil Company (S.O.C). The depth corrections of cutting samples were conducted with aid of logs. The intervals that suffer from loose samples are studied by electrofacies logging.

Microfacies study: -

Based on (Dunham, 1962;Wilson, 1975 and Flugel, 1982), the detailed examining of the available thin sections showed the occurrence of (13) essential and secondary microfacies as the following,, (Figs. 2,3,4,5,6).

1-*Lime Mudstone facies:* -

This facies is characterize by micritic groundmass, dense texture, variable occurrences of argillaceous band, moldic pyrite and partially to complete recrystallization.The percentage of grains within this facies is not more then 10% (Folk,1965). The important faunal assemblages observed are plancktonic foraminifera; *Hedbergella Trochioidea, Hedbergella spp., Hedbergella sp., Hedbergella Washitaensis Heltermani, Globogerinelloides sp.1, Globogerinelloides sp.2,* Textulariids , Calcispheres and *Oligostigana spp.*. Larger benthic foraminifera are observed, *Psudocyclimmina Greigi* , Cyclamminds , *Orbitolina sp.* , *Orbitolina discoidea- conoidea ,Orbitolina c.f. Birmanica* , *Choffatella decipeins-* smaller benthonic Foraminifera mainly *Trocholina* alpina-elongata , *Trochlina* alpina , *Trochlina sp.* . In addition to specific occurrence of red algae especially *Permocalculus spp.* e.g. *Hensonella Cyclindrica* (plate1-1). Moreover, there is a rare occurrences of *Dasycledasian* algae debris of mesallaneous which had been derived from divers Mollusca , Echinoid spins and plate, and Brachiopoda . Gastropodos ,sponge spiculs , specific occurrence of calcisphers and bitumen impregnation . This facies could be divided into three subfacies:

I-*Spar fossiliferous lime Mudstone subfacies:* -

This subfacies composed entirely of micritic ground mass texture, compact thin argillaceous bands and moldic pyrite (plate 2-1). The faunal content ranges between (2-5%), Although it reaches (10%) in some intervals reflect sea level rises within open shallow marine condition, the coexistence of planktonic-benthonic foraminifera and coralline algae confirm the open marine facies of shallow outer shelf. This facies resemble SMF (1,3) and facies zone (2)and (3).

II-*Pelagic lime Mudstone subfacies* :-

The specific occurrence of the pelagic fauna especially *Hedbergella washitaensis Heltermani, Hedbergella C.F.* Trochoidea , *Hedbergella sp.1* , *Hedbergella spp.*(Cobianchi et al.,1997,1999) , *Globigerinelloides SP1* ,

Globigerinelloides sp.2 , *Hetrohelix sp.* , Textalariids , common planktonic undetermined and Calcisphere (*Oligostigania spp.*) Plate (3-1), (4-1), highly confirm the deep outer shelf existence with the intervals represents by this microfacies , this subfacies resemble SMF(3) and facies zone (2-3) .

III-*Sandy/ Silty lime Mudstone subfacies* :-

This subfacies is characterize by angular to subrounded, poor sorted and variable size of sand/silt grains within the micritic matrix of lime mudstone facies (plate 5-1). This disseminated to agglutinated behaviors reflects the wind blown effected to siliceous shedding condition. At some intervals the fine sand or silt grain indicates the differential siliciclastic influx. This subfacies resemble SMF (1) and facies zone (2). The diagenetic builds up of over all facies mainly are restricted dissolution, cementation by both equigranular to blocky mosaic cement which the later highly blocked .The neomorphism especially recrytallization of both microsparitic to psudosparitic texture are intermitted occurrences with the over all facies build up within the studied area. Dolomitization has destroyed influence on the over all mudstone except intervals shows a well developed dolomitic rhombs (plate 6-1), these rhombs exhibit both face to face and face to edge contact within unleashed micritic matrix.

2- *Lime Wackstone facies* : -

This facies including micritic groundmass furthermore grains from about 10-50%, it comprise the following subfacies:

I- *Bioclastic lime Wackstone subfacies* :-

This submicrofacies consists mainly of micritic groundmass with more than (10%) skeletal grains (plate 1-2). The biogenic components essentially belongs to fine Mollusca shells, Echnoid plates, Gastropoda ,calcisphere and sponge specials. The bioclast debris micrite with micritic rim, fragment of larger benthonic Foraminifera and Orbitolinds, *Orbitolina sp.*, *Orbitolina Discoidea Conoidea*, *Orbitolina* debris, *Orbitolina c.f. Discoidea Conoidea* (Sampo, 1969), *Choffatella Decipiens* , Cyclamminds ,

Hemicyclamina Sigali , *Dictyconous sp.*, *Pseudocyclammina sp.*,*Pseudocyclammina Hedbergi* , *Trocolina* elongata , *Trocolina* alpina , *Trocolina alpina-elongata, Trocolina c.f. elongata* and this facies content rare planktonic Foraminifera as *Hedbergella c.f. Washitaensis Heltermani.*The effect of diagenesis processes clearly observed in this facies like dissolution of bioclast debris, moderate to highly cementation by microgranular mosaic cement and blocky mosaic cement. Neomorphism especially fine recrystallization, resembling microsparitic texture, solution microchannal partially cemented whereas in other part bituminous. The facies characterized by its very fine sandy/silty angular-subrounded and unsorted behavior -embedded in micritic matrix. This microfacies resemble SMF (10) and facies zone (2-3). The interval representing this microfacies is within the top of the slope (deep outer shelf).

II-*Bioclastic algal lime Wackstone subfacies* :-

This subfacies could be differentiated from the main facies by the presence of two different types of algae. The first is Dasycladcian algae (*Actinoporella podolica, Sulpingoprella Annulata*) (plate 2-2), while the second type represented by (*Permocalculus spp.*) algae (plate 3-2) which grow from the shallowest euphotic to the deepest oligophotic environment, and they aboundant in the forereef and shelves zones (Iryu, 1995; Pomar, 2000). Most of algae consists of high Mg-calcite (Bathurst, 1975), which played an important role in the formation of dolomite. The second type was subjected to various degree of dissolution without any sign of dolomitization. The last facies shows prominent action in the intervals of its occurrence. The first type of algae Dasycladacian observed occurs in well (Rt-3) preserved form in Ratawi formation. This facies decrease gradually to ward Amara area with increase of the second type *(Permocalculus)*. In addition to other biogenenic components, this facies contain some bioclast of benthonic Foraminifera which represented by *Orbitolina c.f. Discoidea Conoidea , Orbitolina Concava , Orbitolina sp. , Dictyconous sp., Dictyconous Avabicus , Hemicyclammina Sigali , Pseudocycllammina Hedbergi , Pseudocyclammina cf. Hedbergi*

,*Pseudocyclammina sp.*, *Cyclammina c.f.Greigi* , *Cyclammina Greigi* , *Trocholina* alpina-elongata , *Trochlina* alpina , *Trocholina sp.*. Furthermore, the planktonic Foraminifera are represented by *Hedbergella sp.*, Calcisphere , *Hetrahalix sp.*, . In addition to other biogenic components as Echnoid plate and spine, divers Mollusca, Sponge specials, Gastropoda and Brachipodas . The outstanding diagenetic processes are the dissolution of Mollusca debris and fragment of *Permocalculus* algae and cementation of micro-meso vugs by blocky granular mosaic cement in part well developed microfacies partially to completely cement in some intervals showing very fine sandy/silty texture with limited abundance. The microfacies resemble the SMF 9 and facies zone 2-3, owing to the relative occurrence between the different types of algae with the other biogenic components within the shallow deep outer shelf of open circulation condition.

III-*Benthonic Foraminifera lime Wackstone subfacies* :-

This subfacies characterize mainly by thier large benthonic Foraminifera (plate 4-2), especially *Orbitolina Discoidea-Conoidea, Orbitolina c.f. Birmanica, Orbitolina sp., Orbitolina Concava, Choffatella Decipeins, Dictyconous Arabicus, Sityconous c.f.,Arabicus, Cyclammind, Hemicyclammina Sigali, Pseudocyclammined Hedbergi,* Pseudocyclammined *sp.*, *Trocholina* alpina , *Pseudocyclammina Lituus* , *Trocholina c.f.*, elongata , *Trocholina elongata* , *Trocholina elongata-alpina* . There fauna predominate in the mesophotic and oligophotic zones in tropical to subtropical environment (Hottinger, 1997). The above faunal assemblages are well defined, whereas the other is debris and they are embedded in micritic matrix. They are completely micritized and forming peloidal texture or developed only by micritic rims reflecting algal/fungal content. The over all texture are dense, compact and argillaceous. The intermediate to planktonic foraminifera (*Hedbergella Washitaensis Heltermani, Hetrohelix sp.*) of this facies are highly confirmed that the facies deposited within open shelf lagoon with open circulation. This facies resemble to SMF (8) and facies zone (2) .The most important diagenesis

processes found in this facies are dissolution of cement, microchannel partially to completely cemented, and microstylolite.

3- *Lime Packstone-Grainstone facies* :-

This facies comprises the following subfacies :

I-*Bioclastic lime Packstone-Grainstone subfacies* :-

This subfacies characterizes by bioclasts of divers origin that represents Echinoids, Molluscs, *Permocalculus (*plate 5-2). They highly subjected to micritization process that yield peloidal texture. The over all components include more than (50%). Based on the presence of micritic ground mass and winnowing action, the most diagenesis processes are dissolution and cementation. The biogenic components that observed in this subfacies are: *Orbitolina* undetermined, *Orbitolina Discoidea-Conoidea, Trocholina sp.*,Textulariids.This subfacies resembles SMF 3 and facies zone 3 that represents the toe of slope environment.

4- *Lime Grainstone facies* :-

This microfacies is grain supported which is more then (90%). The build up of this facies represents high wave or current energy environment (Folk, 1980). Its comprise the only following subfacies:

I-*Sandy/or Silty coated grain-Oolitic Grainstone subfacies* :-

This subfacies mainly consist of ooids, peloids and partially of bioclastic within cemented ground mass (plate 6-2). There are two modes of Oolitic texture, the first one comprises two sub-type of Oolitic, the first one have some preserved their original form without nuclii, while the second have some nuclei, the second type were originally being Oolitic and change to peloid due to micritization by the action of algae and fungi (Enos,1983; Tucker,1985), those pealed were subjected to selected dissolution , following by primary cementation (equigranular) leading to development of blocky mosaic cement . This coated grain and peloid are clearly observed in this facies, they are most probably secondary in origin produced by diagenesis action on bioclasts and Ooids. More over these peloid and coated grains reflect Oolitic shoals of agitated condition that consist of narrow

channel including local tidal basin in platform margin of open circulation, this subfacies resemble SMF (5) and facies zone (6).

Result and Discussion

The facies analysis of the stratigraphic section under study showed that the lime mudstone facies build up comprises about 50%, and lime wackestone facies build up form about 35% of the over all facies build up Late Hautrevian-Early Aptiann period in east Amara field, while the lime packstone / grainstone and grainstone facies build up comprises about 10 and 5% respectively. Moreover, the Late Hautervian-Early Aptian depositional period in the study area represents carbonate-carbonate / shale section, the clastic of sandy / silty size found in many horizons throughout the studied sections having various shape and pattern of distributions it's believed that this mode of distribution indicates the winnowing action. Generally , the faunal assemblages in the studied section offer a clue for the type and depth of depositional regime, therefore, the abundance of planktonic forams especially the Genous *Hedbergella* , in addition to the appearance of pelagic lime mudstone facies suggest that the Late Hautervian- Early Aptian section in Zubair and Amara area syndeposited under two different ecological system .Based on Al-Bayati (2001) , the co-existence of planktonic together with benthonic foram in the studied bears witness that the marine current play an important role in sweeping and scavenging the near shore benthonic foram remains to the deeper part of the depositional basin (off shore) , i.e. the Late Hautervian- Early Aptian interval in Amara were deposited in shallow- deep part of the outer shelf .

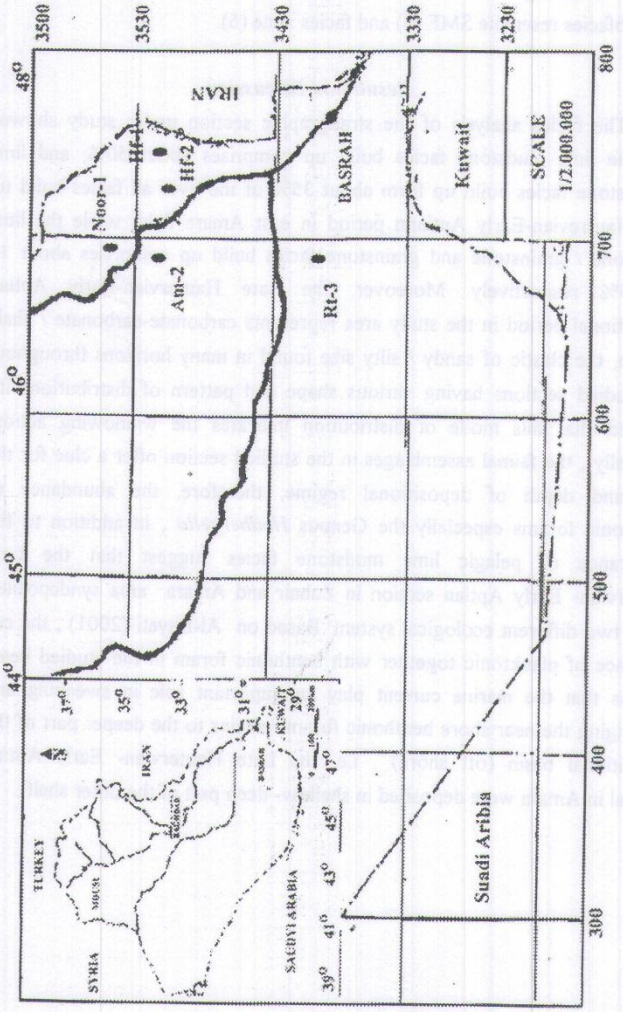


Fig. (1): Location map of study area.

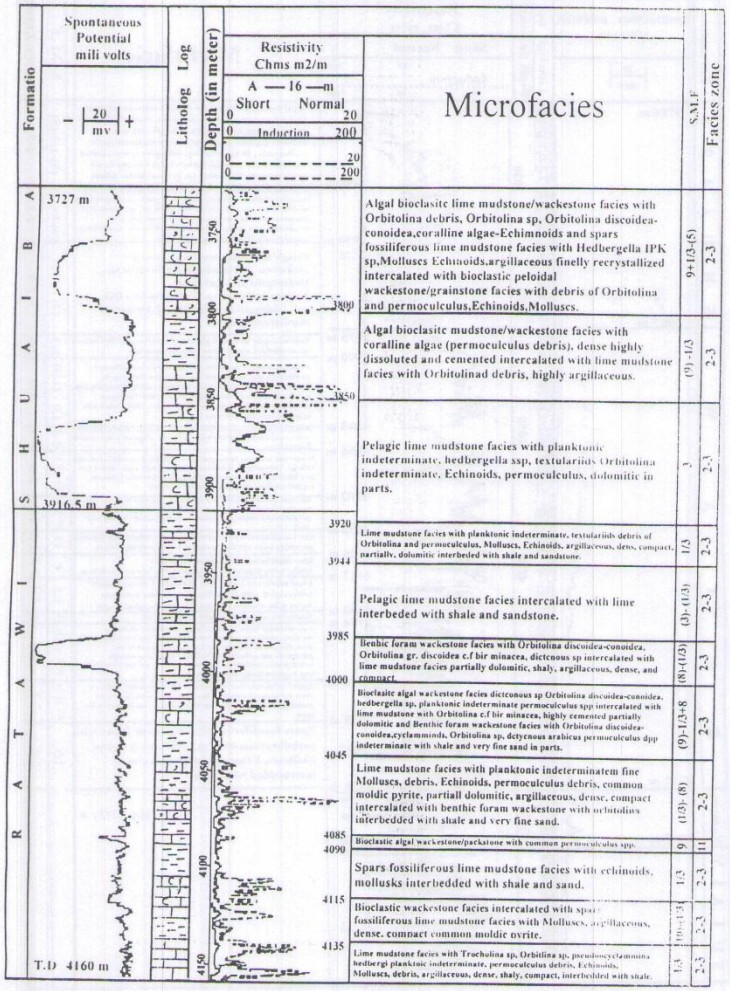


Fig. (2): Shows the vertical distribution of the lithology and microfacies of the studied section in well HF-1

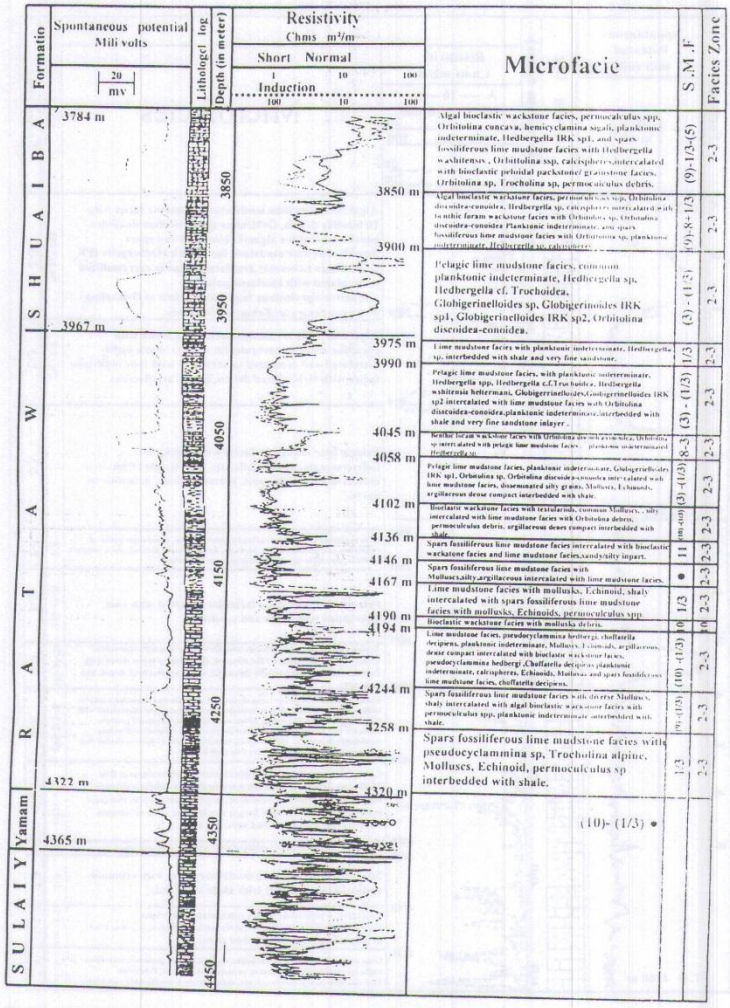


Fig.(3): Shows the vertical distribution of lithology and microfacies of the studied section in well HF-2

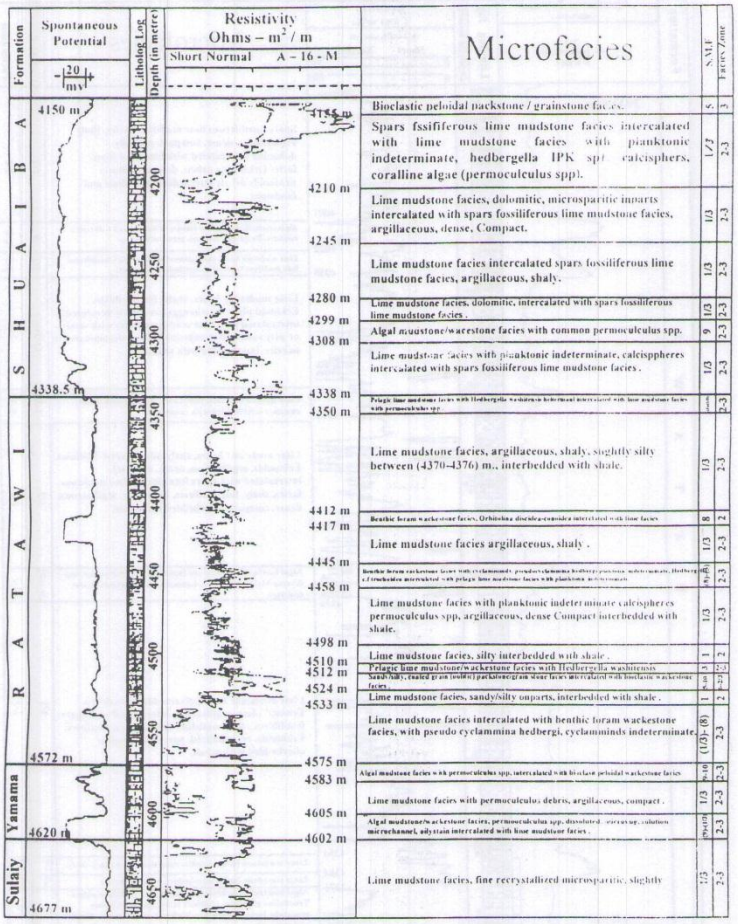


Fig. (4): Shows the vertical distribution of the lithology and microfacies of the studied section in well Noor-1

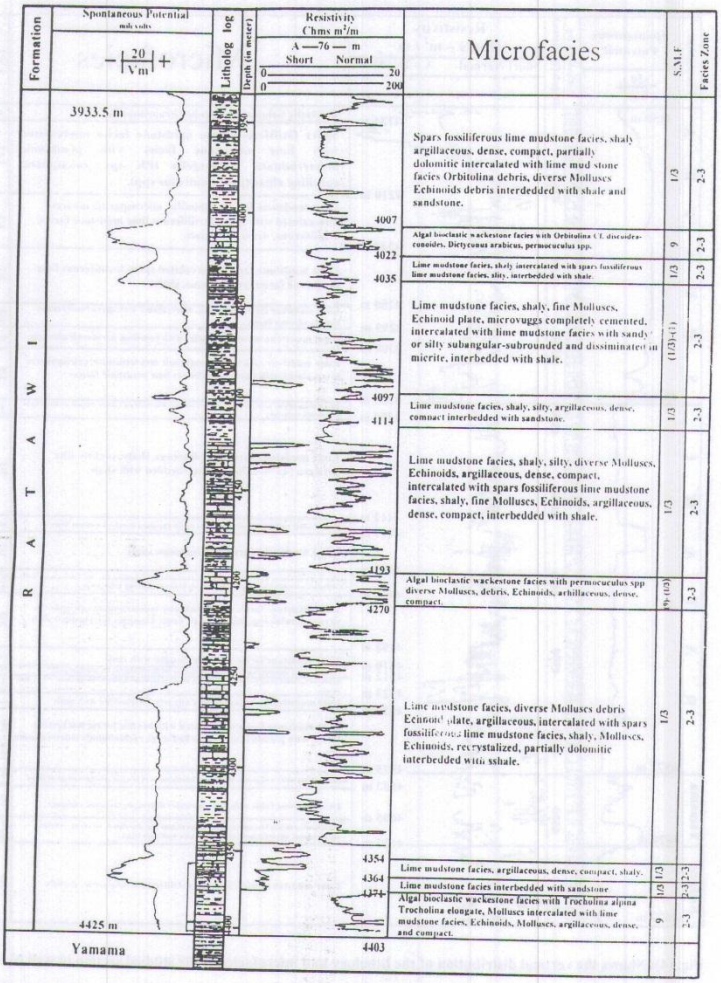


Fig. (5): Shows the vertical distribution of the lihtology and microfacies of the studied section in well Am-2

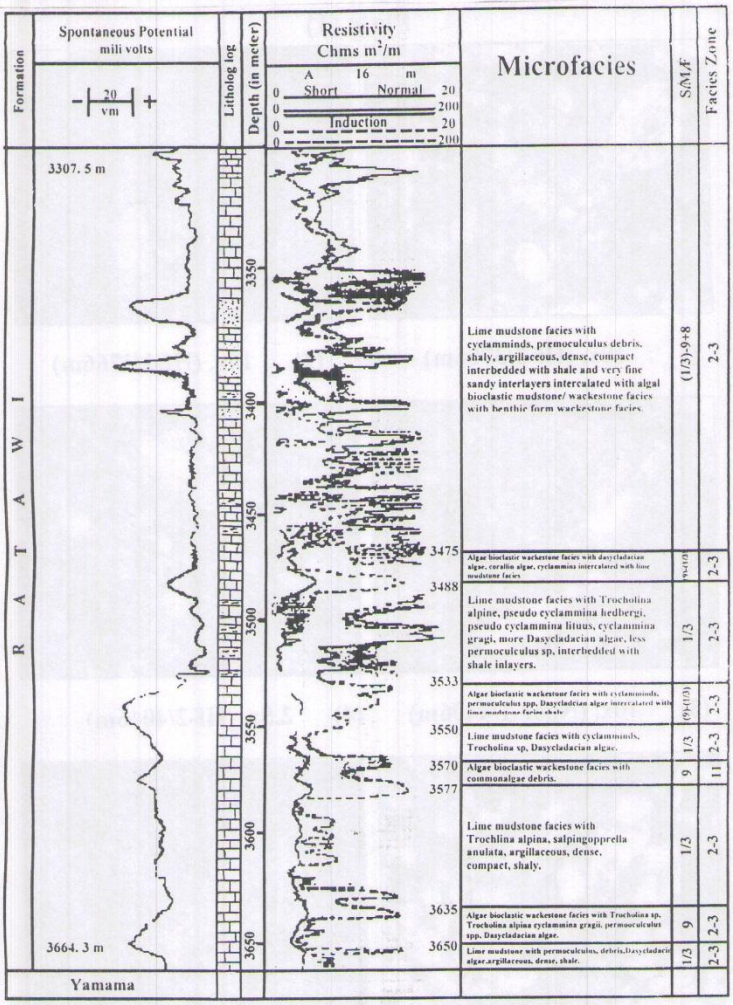
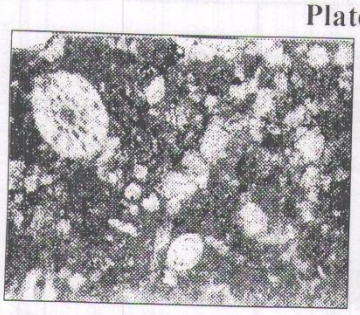


Fig. (6): Show the vertical distribution of the lithology and microfacies of the studied section in well Rt-3

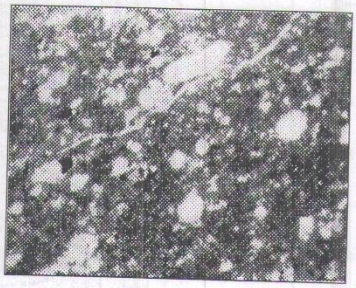
Plate (1)



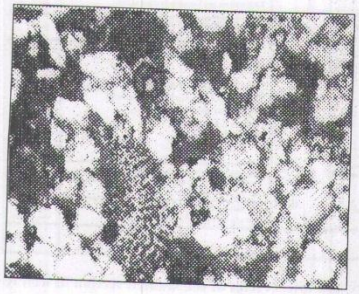
(1) 10x, (Hf-2/3706m)

(2) 10x, (Hf-1/3766m)

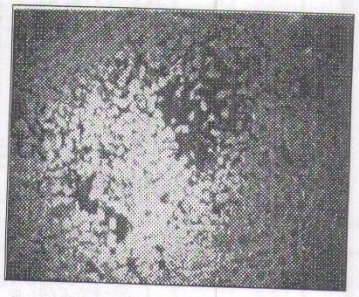
(3) 10x, (Noor-1/4406m)



(4) 2.5x, (Hf-2/4046m)

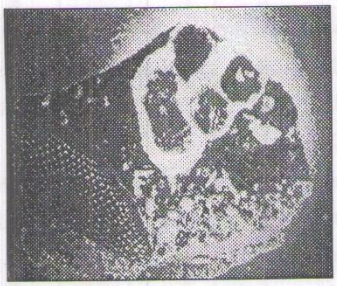


(5) 10x, (Noor-1/4382m)

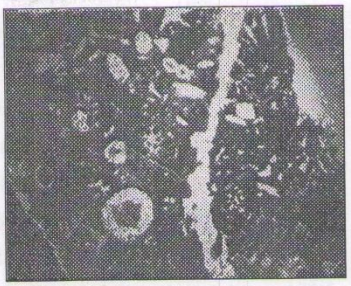


(6) 2.5x, (Am-2/4206m)

Plate(2)

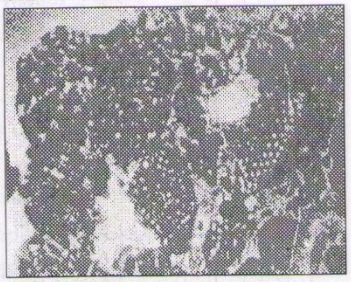


(1) 2.5x, (Hf-1/3876m)

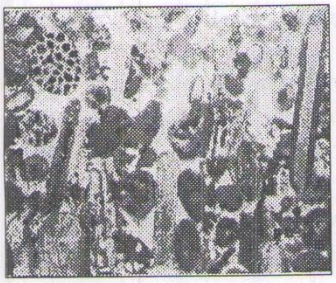


(2) 2.5x, (Rt-3/3476m)

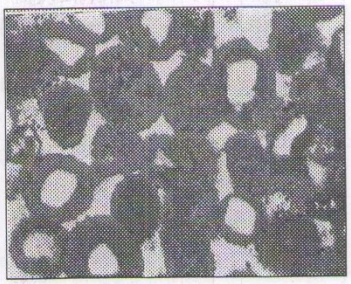
(3) 10x, (Am-2/4392m)



(4) 2.5x, (Noor-1/4170m)



(5) 2.5x, (Noor-1/4522m)



(6) 10x, (Noor-1/4510m)

Conclusions

1-The Late Hautervian- Early Aptian section in Amara area deposited under low energy environment intermitted with many period of high energy as indicated by the presence of the lime mudstone facies builds up with many horizons of lime wackEstone facies.

2-The rock under study represents either source rock or rocks through which the hydrocarbons were migrated as indicated by the presence of oil impregnation filling the microsolution channel.

3-The sedimentological system of the Late Hautervian- Early Aptian lithostratigraghic section in Amara area are deepening upward whereas, the system change to shallowing up ward south and south western Amara area.

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