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Biostratigraphy and Facies Analysis of Ibrahim Formation in Balad oil field and Zurbatiya outcrop sections center and east of Iraq

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ABSTRACT

The investigation of two selected section, stratigraphy, physical properties, petrographic, and biostratigraphic, which leads to the interpretation of the microfacies and environment for Ibrahim Formations. Ibrahim Formation has six distinct carbonate microfacies (Planktonic foraminiferal lime mudstone, Planktonic foraminiferal wackestone, Echinoderms foraminiferal wackestone, Planktonic foraminiferal wackestone – packstone, Planktonic foraminiferal Packstone, Glauconitic and dolomitic foraminiferal packstone).

Ibrahim Formation has three Planktonic foraminiferal zones (*Globigerina ciperoensis ciperoensis* Partial-Range Zone (P22 A), *Paragloborotalia pseudokugleri* partial- Range zone (P22B) and *Globorotalia kugleri* partial-Range Zone (P22 C).

According to different types of microfacies and Biozones described from Ibrahim Formation, the Formation is deposited in slope - basinal depositional environments.

Introduction

Because of its economic and geological importance in terms of hydrocarbon occurrences, this Search focused on the Ibrahim upper Oligocene, which is composed of carbonates. The formation, which is described in the type locality in well Ibrahim-1 and is located within the Ibrahim structure at the Low folded zone, is cropped out with 56.5 m (8). The thickness of the formation in the current study area (Zurbatiya) is about 160 m near the Iraq-Iran border; it is unconformable with the underlying Jaddala Formation (Late Eocene) and the overlying Euphrates Formation (Early Miocene). While the thickness of the formation in the current study area (Ba.9) is about 25 m, the lower boundary of the Ibrahim Formation is conformable with Tarjil Formation, while the upper boundary unconformable with overlying Serikagni Formation (Early Miocene).

The large thickness of the formation in the study area, which is approximately three times its thickness in the type locality, attracts geologists' attention and

suggests that it be considered as a type locality rather than the current one. The current study will discuss the depositional environment of the Ibrahim Formation based on lithofacies interpretation from a biostratigraphic and petrographic standpoint.

Location of the study area

The study area is located within the Low Folded Zone in the Zurbatiya sub-district (Wasit Governorate) (23). It is located 80 km to the north east the centre of Wasit governorate toward the Iraq-Iran border in eastern Iraq. While the Ba.9 well section is located within the Outer Platform (Mesopotamia Fore deep) (23), represents a strip of 10 kilometers wide and 16 kilometers long located between the Samara Field in the north and east Baghdad Field in the south. It lies on the western bank of Tigris and it is about 9 kilometers south of Balad District and 40 kilometers north of north stretches of East Baghdad Field. (Fig.1), (Table 1).

Table 1: The coordinates of the study section

no	Studied section	Thickness (m)	Formation	Number of sample	Coordinates
1	Balad oil field Ba. 9 well	25 m	Ibrahim	9	N 34° 02' 20.7832"
				Thin section	E 44° 12' 3.8164"
2	Zurbatiya	160	Ibrahim	31	N 33° 15' 35"
				Collected sample	E 46° 10' 33"

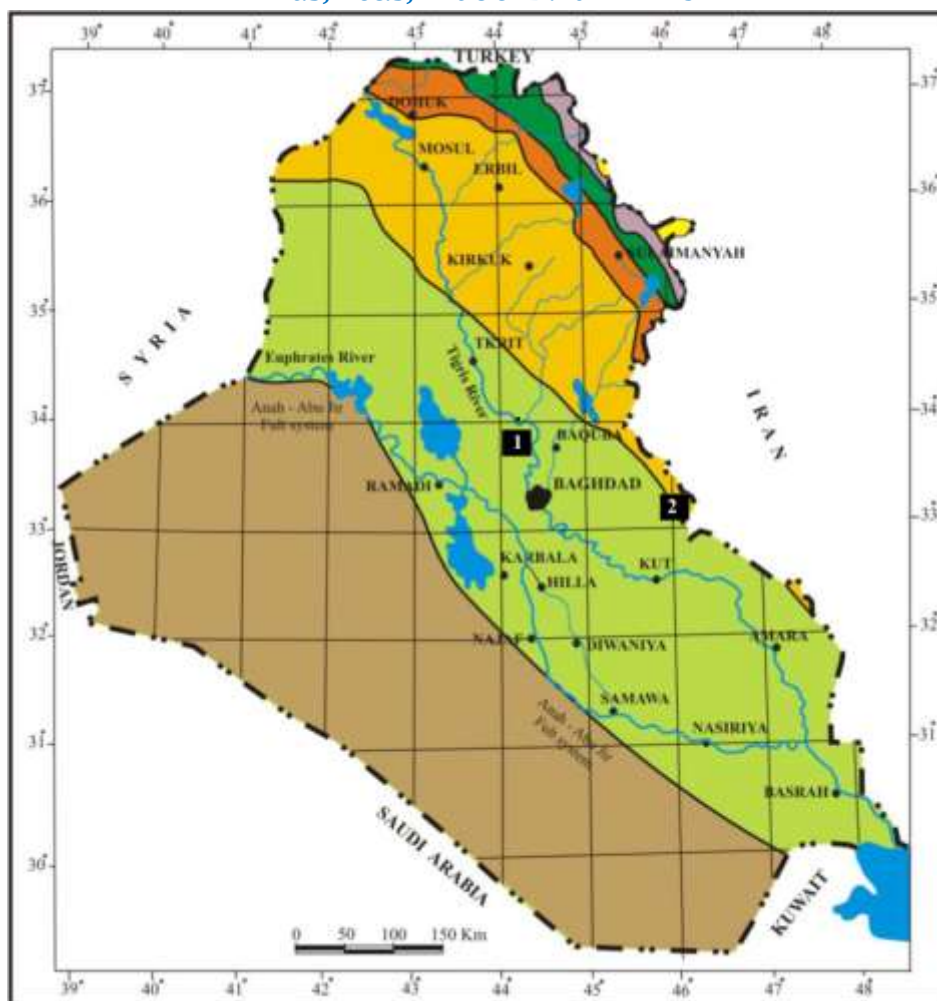


Fig. 1: Location map modified (23) showing the section studied in the Ibrahim Formation.

1- Balad oil field Ba. 9 well 2- Zurbatiya Previous work

(1) Described the Oligocene sequence and the depositional and microfacies of the Ibrahim Formation. He also mentioned to the marker bed of 4m composed of basal anhydrate exposing in the study area as a boundary of Oligocene-Miocene age.
(2) studied the Oligocene-Miocene boundary between the Tarjil and Ibrahim formations identified 24 planktic foraminiferal species and subspecies, and recognized four biostratigraphic zones
(3) studied the Oligocene stratigraphy in northwestern Iraq and he considered the age of the Ibrahim Formations is Early Miocene.
(4) mentioned the unconformability of the Oligocene – Miocene boundary in the succession of the Sinjar anticline north of Iraq.
(5) proved the age of Oligocene in the Mamlaha anticline through field surveys in Kurdistan region. Field survey and stratigraphic study with microfacies analysis showed that nearly 37 m of the rock units from Mamlaha anticline are represented these formations; Bajwan Formation (Middle Oligocene), Anah and Ibrahim formations (Late Oligocene), Serikagni, Euphrates and Dhiban formations (Early Miocene). Ibrahim Formation is not exposed as well

beds of marly limestone; it shows as pocket of marly limestone, but it sandwiched between Bajwan and Anah formations and shows no clear boundary.

(6) studied the Oligocene–Lower Miocene carbonate sequence in the Golan Mountain near Derbandikhan Town, Kurdistan region. The Oligocene -Miocene strata is ranging of about 27m thick overlying the Pila Spi Formation (Late Eocene) and underlying the Fatha Formation (Middle Miocene).

Results and discussion

1-Stratigraphy

Author: The Ibrahim Formation was first identified as *Globigerina* marly limestones with pyrite and glauconitic traces by (7), from well Ibrahim-1 in the Sheikh Ibrahim structure of the Foothill Zone, northwest of Mosul, the formation is about 56m thick.

Age: According to (8) the Formation is in late Oligocene.

Arial distribution and thickness: The Ibrahim Formation is extended on the surface and sub-surface. In the present study, the Ibrahim Formation is existed on the sub surface in the Ba.9 with thickness 25m, on the surface in Zurbatiya with thickness 160 m.

Lithology: In the well Ba.9 the Ibrahim Formation composed of argillaceous limestone whose color is light gray with rich planktonic foraminifera. The

Formation in the Balad Field does not contain any hydrocarbons, and has been separated through lithologic thin sections and logs in all the wells of Balad Field, (Fig. 2).

In the Zurbatiya the Ibrahim Formation composed of 20 m of Marl olive in color ,medium,medium tough,massive, slope forming, 15 m Interbedded marl and marly limestone pale gray in color, tough , thick bed. 10 m Limestone: pale gray in color, tough , thinly bedded ,sharp boundary. 5m Sandy limestone:brownish grey in color tough, sharp boundary.15 m Marly limestone, gray in color, tough, thick bed ,sharp boundary.15 m Marly limestone, olive in color ,medium tough, thick bed, sharp boundary. 50 m Shally limestone, dark grey, friable,

thinly bedded, sharp boundary.15 m Alternation of marl and marly limestone :green to dark grey in color , friable to medium tough , medium bedded. 15 m Marl: greenish gray, medium tough, thick bed , sharp boundary, (Fig. 3).

Stratigraphic boundaries: In the Ba.9 the lower boundary of the Ibrahim Formation is conformable with Tarjil Formation, while the upper boundary unconformable with overlying Serikagni Formation (Early Miocene).

In Zurbatiya the lower boundary is It is unconformable with underlying Jaddala Formation (Eocene), and unconformable with the overlying Euphrates Formation (Early Miocene).

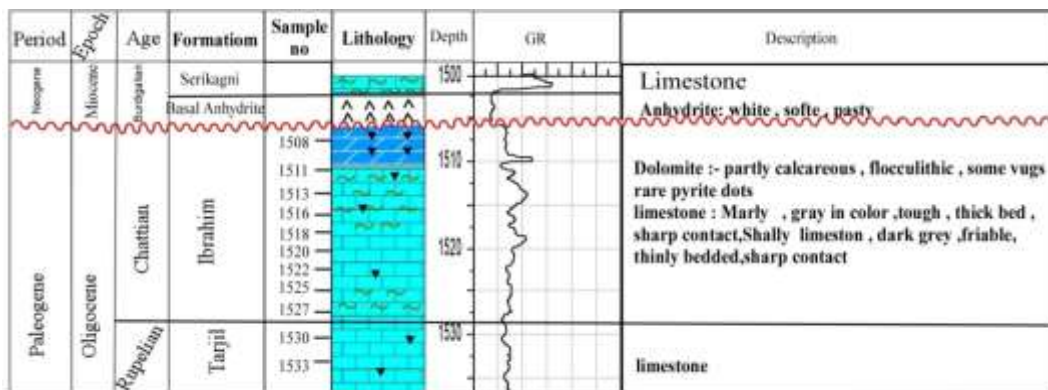
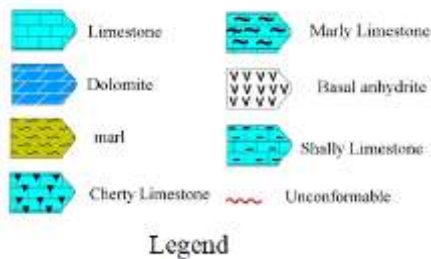


Fig. 2: Stratigraphic column of the Ibrahim Formation in Ba.9 well.



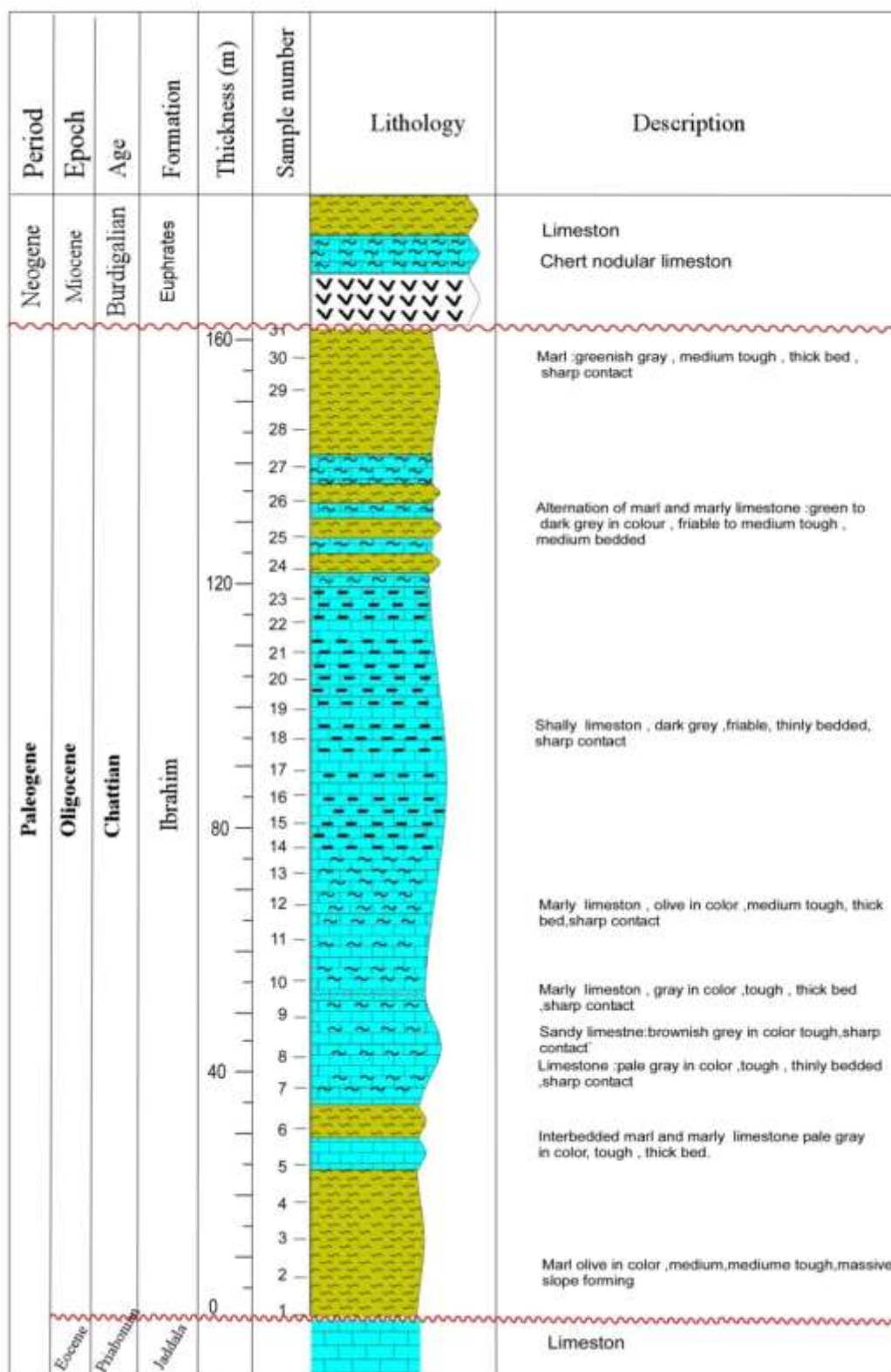


Fig. 3: Stratigraphic column of the Ibrahim Formation Zurbatiya section.

2-Biostratigraphy

Deep-marine carbonates make up the Oligocene rocks exposed in the Zurbatiya area. Washed residues from these rocks were examined for common diverse planktonic foraminifera that could be used as biostratigraphic tools to investigate the Ibrahim

formations' deep-marine setting. There are three planktonic foraminifer's biozones that described in Ibrahim Formation.

A- *Globigerina ciperoensis ciperoensis* Partial-Range Zone (P22 A)

Age: Upper Oligocene (Chattian)

Definition: Biostratigraphic interval characterized by the partial-range of the nominate taxon, under *Paragloborotalia pseudokugleri* (9), (Plate 2 (C)).

Thickness: This zone is recorded from the Ibrahim Formation and attains 30 m thick at Zurbatiya, (Fig. 4). and 25 m in Ba.9 well, (Fig.5)

Discussion: The Zone is characterized by the presence of small planktonic foraminifera, such as, *Globigerina ciperoensis ciperoensis*, *G. ciperoensis angustiumbilitata*, *G. venezuelana*, *G. praebulloides praebulloides*, *G. praebulloides leroyi*, *G. tripartita*, *G. galavisi*, *Globorotalia opima nana*, and *Globorotalia obesa*, the upper most zone of Oligocene age.

B- *Paragloborotalia pseudokugleri* partial- Range zone (P22B)

Age: Late Oligocene (Chattian).

Definition: Biostratigraphic interval between the last occurrence of nominate taxon *Globigerina Ciperoella Ciperoensis* and the last occurrence of *Paragloborotalia kugleri* (10), (Plate 2(D)).

Thickness: This zone is recorded from the Ibrahim Formation and attains 30 m thick at Zurbatiya, (Figs. (4)).

Discussion: The Zone is characterized by the presence of small planktonic foraminifera, such as, *Globigerina ciperoensis ciperoensis*, *G. ciperoensis angustiumbilitata*, *G. venezuelana*, *G. praebulloides praebulloides*, *G. praebulloides leroyi*, *G. tripartita*, *G. galavisi*, *Globorotalia opima nana*, and *Globorotalia obesa*, the upper most zone of Oligocene age.

C- *Globorotalia kugleri* partial- Range Zone (P22 C)

Age: upper Oligocene (Chattian).

Definition: Biostratigraphic interval at the last occurrence of *Paragloborotalia pseudokugleri* partial Range Zone (11), (Plate 2 (E)).

Thickness: This zone is recorded from the Ibrahim Formation and attains 100 m thick at Zurbatiya, Figs. (4).

Discussion: The zone is defined as the portion of the *Globorotalia kugleri* range that occurs prior to the appearance of *Globigerinoides trilobus* and *Globigerinoides immaturus*, *Globigerinoides primordius* and *Globigerina binaiensis* are important species in this zone.

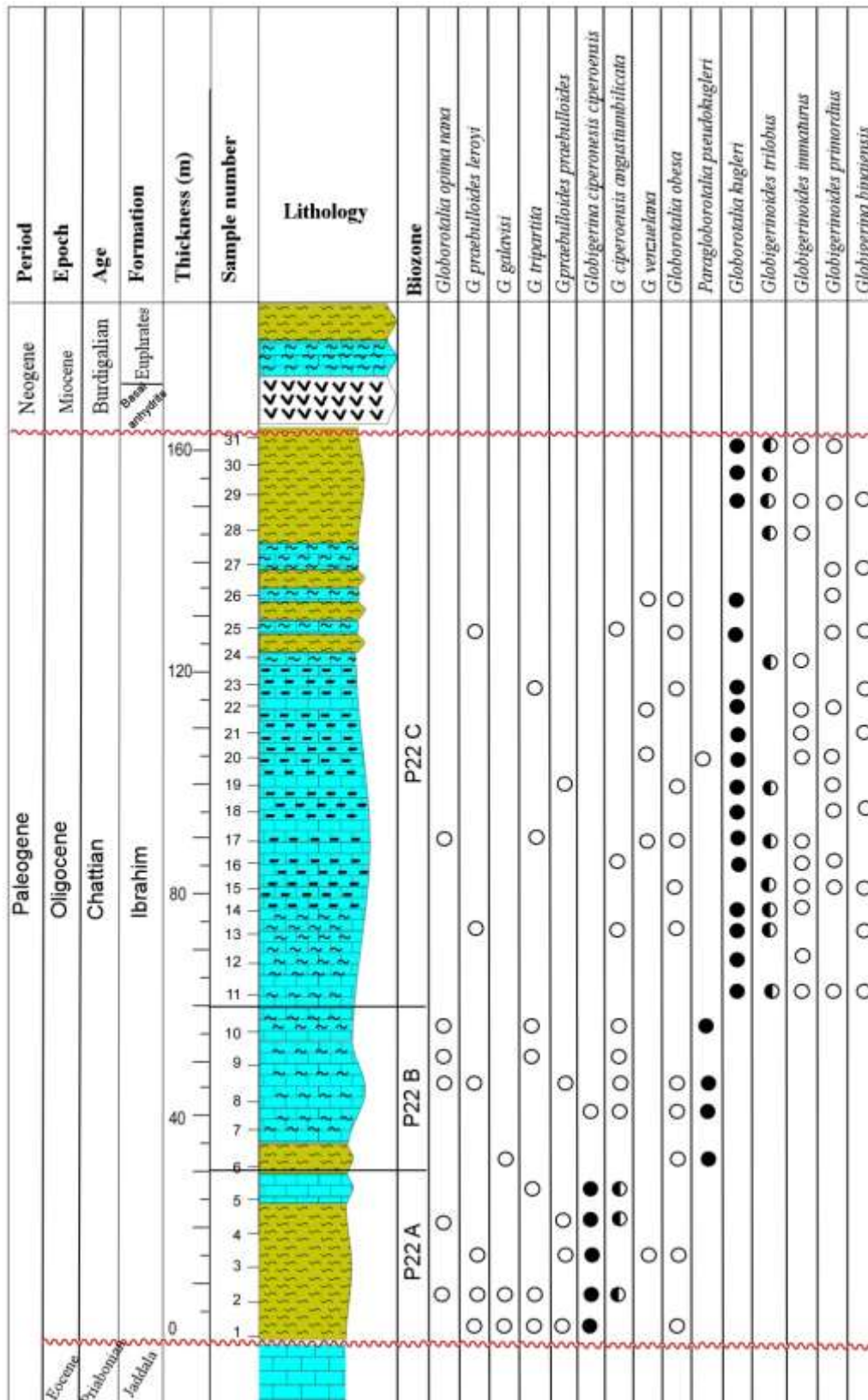


Fig. 4: Distribution of planktonic foraminifera in the Zurbatiya section

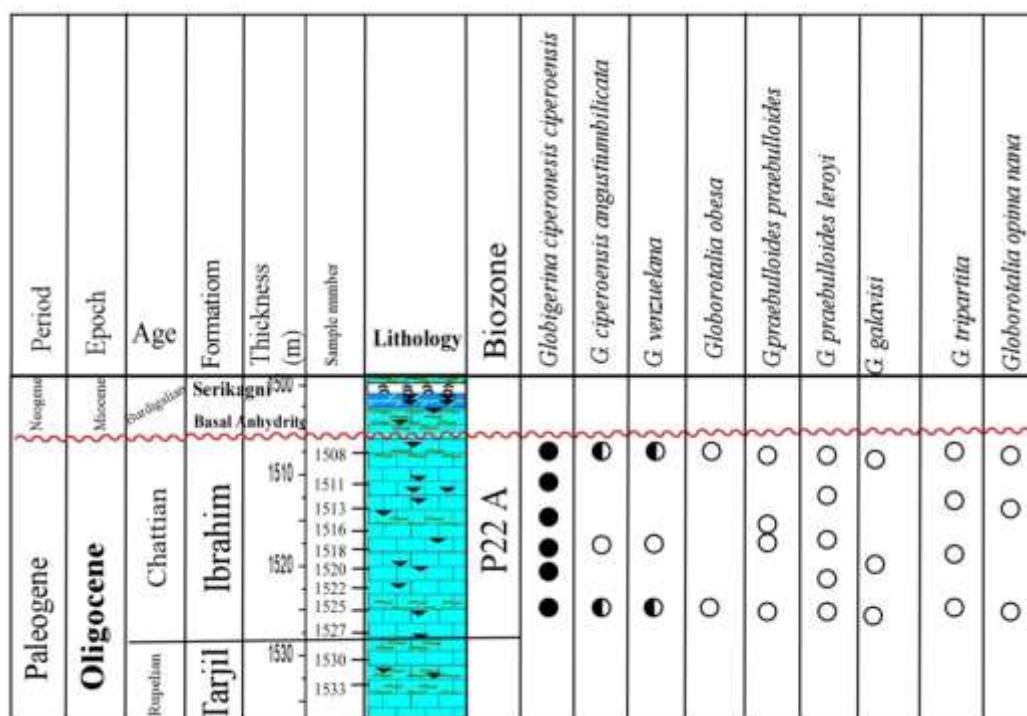


Fig. 5: Distribution of planktonic foraminifera in the Ba.9 well

3- Microfacies of Ibrahim Formation

Ibrahim Formation consists basically of six microfacies easily recognizable throughout in the thin section. The microfacies are:

A. Planktonic foraminiferal lime mudstone microfacies

This microfacies is described from the upper part of the Ibrahim Formation in Zurbatiya outcrops section about (45 m), (Fig. (7)).

Petrographically, the foraminiferal lime-mudstone is composed of small amounts of skeletal particles floating in a dense lime mud matrix. Foraminiferal tests (e.g., *Globigerina* sp., *Globorotalia* sp.), (plate 1 (A,B) . Representing the main component of these skeletal particles, are fragmented and medium preserved. These tests are available in both complete and fragmented format; they come in a variety of sizes, from very fine to medium sand. Fine glauconitic grains are also recorded randomly disseminating in the lime mud matrix. The matrix is partially recrystallized into pseudospar.

The facies was deposited in an outer shelf basal environment, depending to (12), upon planktonic foraminifera in micritic matrix with completely absences of other shallower bioclastics, had flourished in the water column off shore and reflect relatively deeper water basal environment (outer ramp), and low energy.

B. Wackestone microfacies

It represented by two sub microfacies

a- Planktonic foraminiferal wackestone sub microfacies

This microfacies described from the Ibrahim Formation in upper part of the Ba-9 well about (2 m)

at the depth (1519 -1521) (Fig.6), and upper part in Zurbatiya outcrops section about (11 m), (Fig. 7).

The foraminiferal wackestone is mainly made up of foraminiferal and other fossils tests mainly of planktonic with some smaller benthonic which form together about 10% - 40% of the rock constituents. The fossils tests are embedded in a dense grey lime mud matrix and present in a complete form and in a fragmented manner. These fossils tests variable in size ranging from very fine to medium sand size.

The main components are reworked Planktonic, the foraminifera are characterized by a relatively diverse assemblage of *Bolivina*, *Globigerina* sp., *Globorotalia* sp, (Plate 1(C, D). The combination of micritic matrix and abundance of basal skeletal fauna are exclusively marine planktonic organisms, they can be found in all current ocean depths and live in open marine environments, with a sharp decline in abundance in deeper waters, the majority of species and individuals are found in the first few hundred meters, (13).

Depending to this fauna the facies was deposited in basal (outer ramp) environment .

b- Echinoderms foraminiferal wackestone sub microfacies

This facies types described from the Ibrahim Formation in upper and lower part of Ba.9 well about (2m) at the depth (1527-1529), (1513-1515) (Fig.6).

The main characteristic of this microfacies is abundant of echinoderms and Planktonic foraminifera, (Plate 2 (F, G).

The presence of echinoderm and Planktonic foraminifera in this microfacies indicates normal marine conditions, and suggested that these sediments were deposited in moderate to low energy whilst

muddy fabric indicates low energy conditions (22). As the echinoderms have a shallow environment and the Planktonic foraminifera have a deep environment, so this facies are deposited in the slop environment.

C- Planktonic foraminiferal wackestone-packstone microfacies

This microfacies is described from the Ibrahim Formation in upper part of the Ba-9 well about (2 m) at the depth (1512- 1514) (Fig.6), and in Zurbatiya outcrops section about (8 m), (Fig. 7).

A diverse assemblage of poorly to moderately sorted, fragmented and whole fossils in lime mud is characteristic of this microfacies. Composed with Planktonic *Globigerina* sp., *Globorotalia* sp, textures range from wackestone to packstone, (Plates 1 (E,F). Planktonic foraminifera float in the water column and occupy a range of depths, the species of *Globigerina* are some of the intermediate water species living in 50–100 m depths, the deeper species living below 100 m include *Globorotalia* (15).The occurrence of large number of Planktonic *Globigerina* foraminiferal tests may point to the depositional environment being basinal (outer ramp) environment, (14).

Depending on this fauna the Planktonic foraminiferal wackestone - packstone sub microfacies was deposited in basinal (outer ramp) environment.

D- Packstone microfacies

It represented by two sub microfacies

a- Planktonic foraminiferal Packstone sub microfacies

This microfacies described from the Ibrahim Formation in middle and lower parts of the Ba-9 well about (18 m) at the depth (1511-1528m) (Fig.6), and Zurbatiya outcrops section about (38 , 17 , 10 m), (Fig. 7).

This microfacies, is mostly composed of planktonic foraminifera such as Bivalve shell fragment, Radiolaria, Rotalid, *Globigerina* sp., *Globorotalia* sp., with small benthonic bioclasts, (Plates 1 (G, H) . These planktonic foraminifera with small benthonic bioclasts which are numerous in the micrite matrix reflect relatively deeper water Toe of Slope environment and low energy, had flourished in the water column off shore (15).

Depending to this fauna the P4 was deposited in slope (outer ramp) environment.

b- Glauconitic, dolomitic foraminiferal packstone sub microfacies

This microfacies is described from the Ibrahim Formation in Ba-9 well about (7, 5 m) at the depth (1515-1522),(1507-1512), (Fig. 6), and in Zurbatiya outcrops section about (10 m), (Fig. 7). (Plate 2 (A, B) .

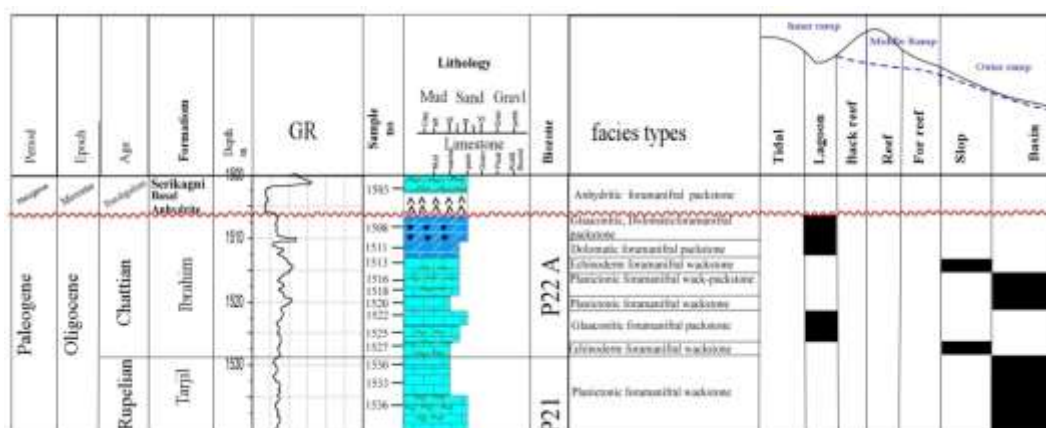


Fig.6: Microfacies and environmental distribution column of the Ba.9 well

The term glauconite is commonly used by geologists to refer to a dark green mineral that is found quite commonly in marine sediments. In correct usage the use of this term should be restricted to a potassium rich mica, which has the mineral name glauconite, because this is in fact only one member of a group of

potassium and iron-rich phyllosilicate minerals that are closely related (16).

Glauconitic is most commonly formed in inner shelf environments during times of relatively slow sedimentation, some wave or current activity, and mildly reducing conditions especially during transgressive events (17).

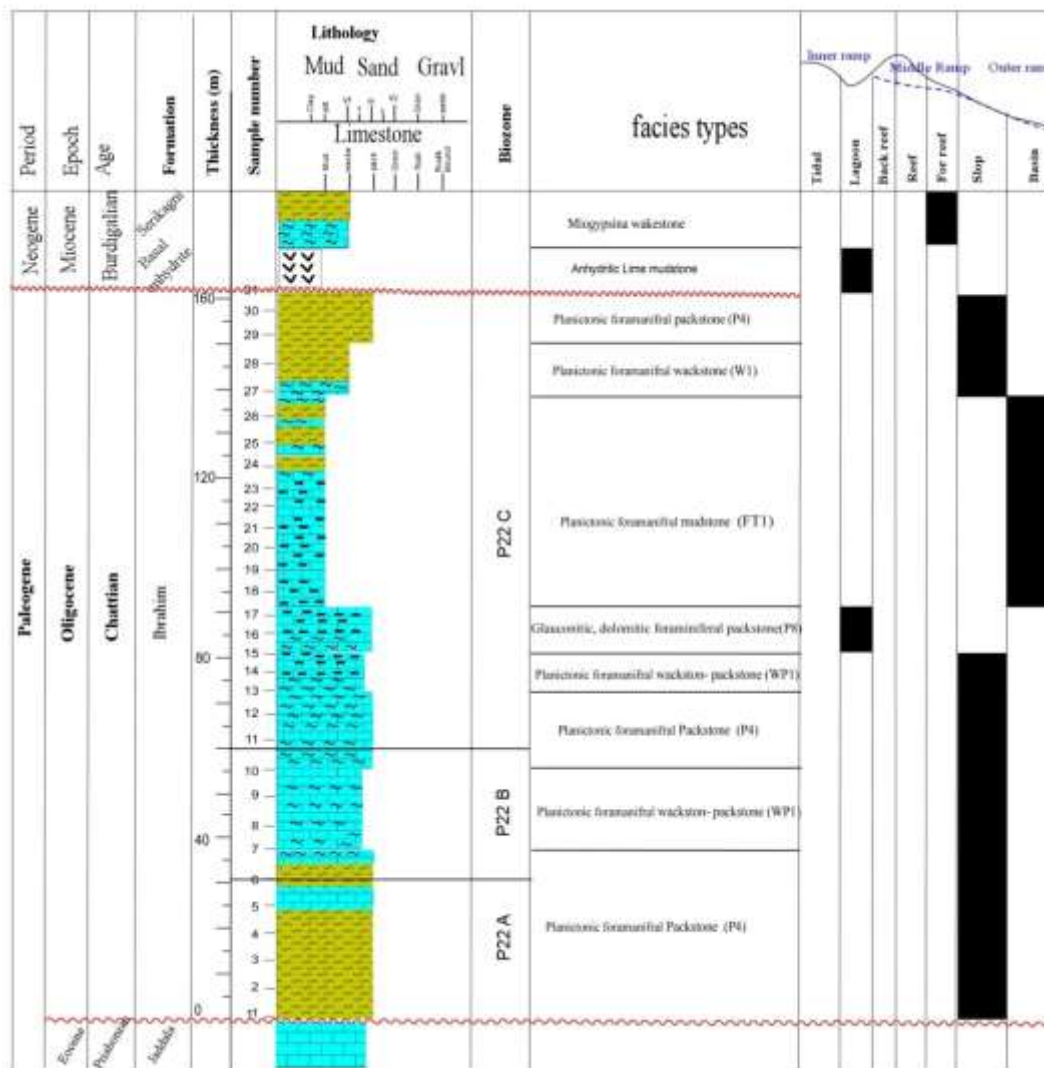


Fig.7: Microfacies and environmental distribution column of the Zurbatiya section.

4- Depositional Environment of Ibrahim Formation

The Ibrahim Formation most dominant microfacies are (Planktonic foraminiferal lime mudstone, Planktonic foraminiferal wackestone, Echinoderms foraminiferal wackestone, Planktonic foraminiferal wackestone – packstone, Planktonic foraminiferal Packstone, Glauconitic, dolomitic foraminiferal packstone), the main components of which are Planktonic foraminifera Radiolaria, Bivalve, Globorotalia sp., and Globigerina sp. The combination of micritic matrix and abundance of typical Radiolaria, Globorotalia, Globigerina and Bivalve living in the modern oceans eight shallow - water and seven deep water provinces have been defined (18, 19, 20). Because these species are adapted to cooler, denser, more eutrophic water masses, they have fewer buoyancy issues and, as a result, a lower test porosity than species from warmer or shallower waters. Deep-water planktonic forms, on the other hand, must contend with the effects of CaCO₃ solution (due to

higher pressure, lower pH, and other factors), which may explain the extra crust of radial, hyaline calcite seen in some forms. It is thought that species living below the photic zone scavenge the sinking phyto detritus (21).

The microfacies (Planktonic foraminiferal mudstone,) was deposits in basal environment, while (Planktonic foraminiferal wackestone, Echinoderms foraminiferal wackestone, Planktonic foraminiferal wackestone – packstone, Planktonic foraminiferal Packstone) was deposits in slope environment, and Glauconitic, dolomitic foraminiferal packstone was deposits in inner shelf environments.

The biozones that recorded from the Ibrahim Formation is *Globigerina ciperoensis ciperoensis* Partial-Range Zone (P22 A), *Paragloborotalia pseudokugleri* partial- Range zone (P22B) and *Globorotalia kugleri* partial- Range Zone (P22 C), as it indicates a deep (basinal) deposition environment. Overall the Ibrahim Formation deposit in slope - basinal environment.

Plate 1

A, B: Planktonic foraminiferal lime mudstone sub microfacies with micrite matrix; bearing *Globigerina* sp., Ibrahim Formation; Zurbatiya outcrops section.

C, D: Planktonic foraminiferal Wackstone sub microfacies with micrite matrix; bearing *Globigerina* sp., Ibrahim Formation; Zurbatiya outcrops and Ba-9 well about (2 m) at the depth (1519 -1521).

E, F: Planktonic foraminiferal wackstone - packstone sub microfacies with micrite matrix; bearing

Globigerina sp Ibrahim Formation; Zurbatiya outcrops and Ba-9 well about (2 m) at the depth (1512- 1514)

G, H: Planktonic foraminiferal Packstone sub microfacies with micrite matrix; bearing *Globigerina* sp., Ibrahim Formation; Zurbatiya outcrops section and Ba-9 well about (18 m) at the depth (1511-1528).

Plates 1

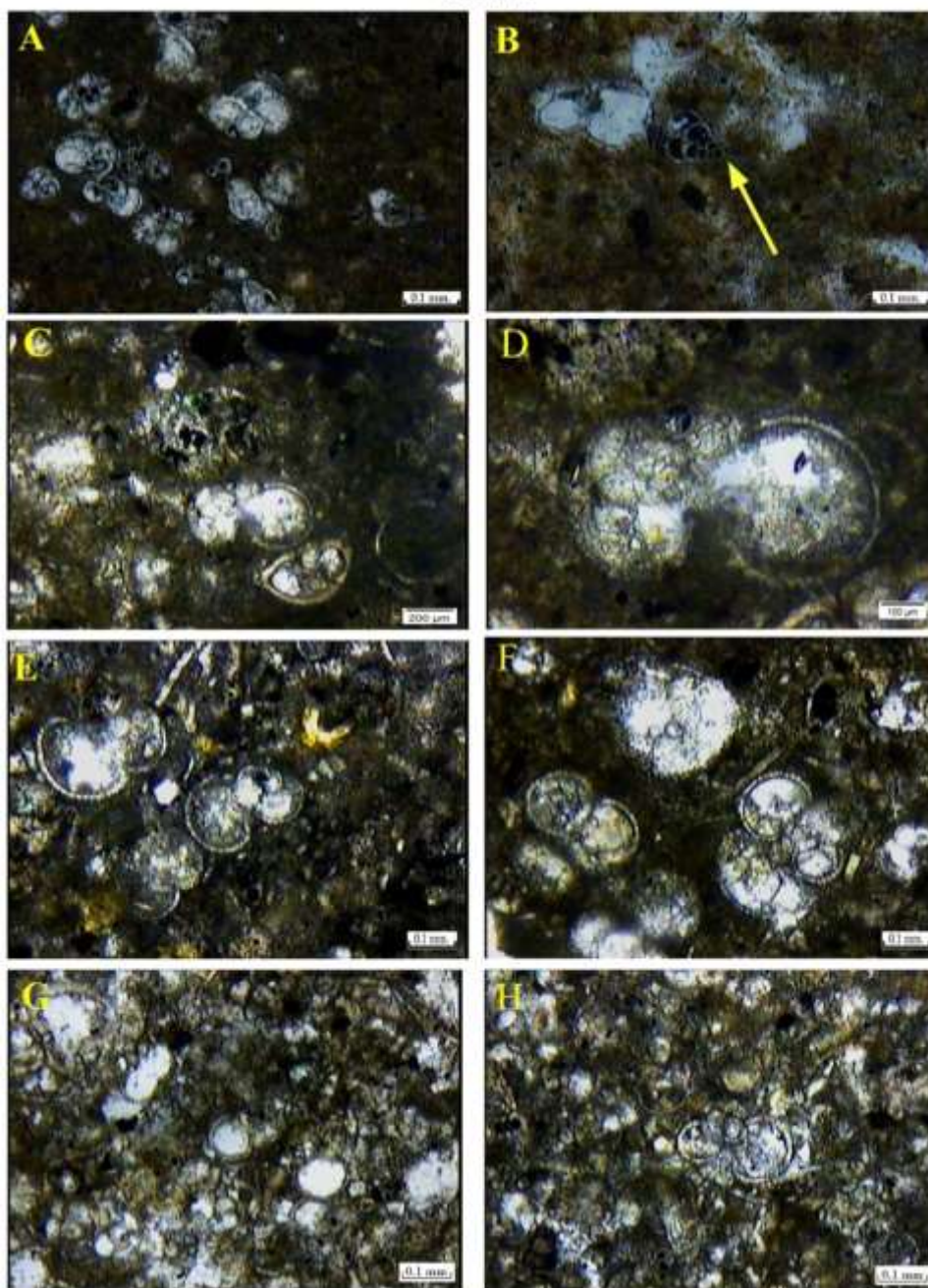


Plate 2

A, B- Glauconitic, dolomitic foraminiferal packstone sub microfacies; Ibrahim Formation; Zurbatiya outcrops section about (10 m) and Ba-9 well about (7, 5 m) at the depth (1515-1522),(1507-1512).

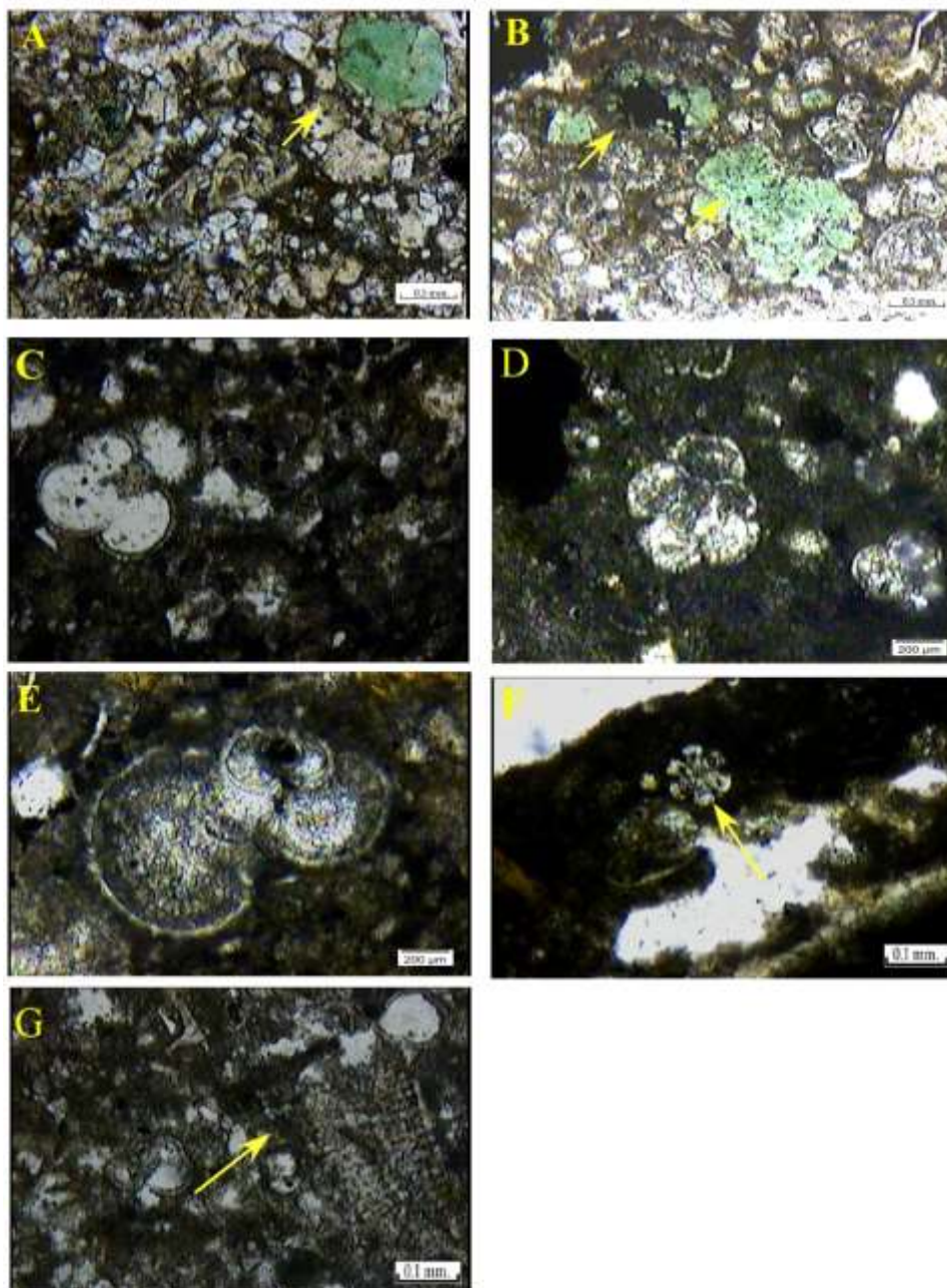
C- *Globigerina ciperoensis ciperoensis* Partial-Range Zone (P22), recorded from the Ibrahim Formation at Zurbatiya section and Ba.9 well.

D- *Paragloborotalia pseudokugleri* partial- Range Zone (P22) recorded from the Ibrahim Formation at Zurbatiya section.

E- *Globorotalia kugleri* partial- Range Zone (P22) recorded from the Ibrahim Formation at Zurbatiya section.

F,G- Echinoderms foraminiferal wackestone sub microfacies; Ibrahim Formation ; Ba.9 well about (2m) at the depth (1527-1529), (1513-1515).

Plates 2



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الطباقية الحياتية والتحليل السخني لتكوين ابراهيم في حقل بلد ومكشف زرباطية في وسط وشرق العراق

ياسر كريم جاسم ، سوسن حميد الهزاع

قسم علوم الأرض التطبيقية ، كلية العلوم ، جامعة تكريت ، تكريت ، العراق

الملخص

شخصت في المقطعين المختارين بئر بلد 9 ومكشف زرباطية، الطباقية والخواص الفيزيائية والبتروغرافية والطباقية الحياتية لصخور تكوين ابراهيم حيث ان هذا التشخيص ادى الى تفسير السحنات الدقيقة والبيئة الترسيبية لتكوين ابراهيم، حيث تم تشخيص ستة سحنات دقيقة والتي هي سحنة الحجر الطيني الحاملة للفورامنيفرا الطافية وسحنة الحجر الجيري الواكي الحاملة للفورامنيفرا الطافية وسحنة الحجر الجيري الواكي الحاملة لشوكيات الجلد وسحنة الحجر الجيري الواكي - المرصوص الحاملة الحاملة للفورامنيفرا الطافية وسحنة الحجر الجيري المرصوص الحاملة للفورامنيفرا الطافية وسحنة الحجر الجيري المرصوص الحاملة للفورامنيفرا الطافية.

شخص في تكوين ابراهيم ثلاثة انطقة حياتية والتي هي

Globigerina ciperoensis ciperoensis Partial-Range Zone (P22 A) -1

Paragloborotalia pseudokugleri partial- Range zone (P22B) -2

Globorotalia kugleri partial- Range Zone (P22 C). -3

اعتمادا على نتائج السحنات الدقيقة والطباقية الحياتية حيث ان تكوين ابراهيم ترسب في بيئة عميقة