Iraqi National Journal of Earth Science

www.earth.mosuljournals.com

Microfacies Analysis of Kometan Formation (Late Turonian-Early Campanian) from Dokan and Qallat Sections in Sulaymania Governorate, Northeastern Iraq

Rana A. Alhialy [1], Zaid A. Malak [2*], Omar A. Al- Badrani [3]

[1,2,3] *Department of Geology, College of Science, University of Mosul, Mosul, Iraq.*

Article information

Received: 04- Apr -2024

Revised: 18- May -2024

Accepted: 18- Jul -2024

Available online: 01- Jul – 2025

Keywords:
Kometan
Late Turonian
Early Campanian
Dokan
Sulaymania

Correspondence:
Name: Zaid A. Malak

Email: zaidmalak@unmosul.edu.iq

ABSTRACT

The Kometan Formation is studied in two exposed sections, the first is Dokan section, with a thickness of up to 118 m, and the second is Qallat section, where the formation is exposed with about 88 m thick. The formation is composed of limestone and dolomitic limestone having chert nodules. The lower contact of the formation with Gulneri Formation and the upper contact with Shiranish Formation are both unconformable. The current study relied on examining 80 thin sections that show the presence of planktonic foraminifera and a little benthonic foraminifer. Three main microfacies are identified, which are later divided into six submicrofacies. Based on the facies analysis, it is found that the environment deposition of the formation in Dokan section was marine represented by the toe of slope at the lower part, then retreated to toe of slope/slope environment, and finally slope environment at the top of the formation. While in Qallat section, the deposition of the formation was in the toe of slope/slope at the lower part of the formation, then retreated to toe of slope environment, and finally toe of slope/slope environment at the top of the formation. This means that the lower part of the formation in Dokan section resembles the middle part of the formation in Qallat section, and the middle part of the formation in Dokan section resembles the upper part of the formation in Qallat section, which means that the depositional environment of the formation in Qallat section was deeper than that in Dokan section.

DOI: 10.33899/earth.2024.148310.1258,

تحليل السحنات الدقيقة لتكوين كوميتان (التورونيان المتأخر– الكامبانيان المبكر) من مقطعي دوكان وقلات في محافظة السليمانية، شمال شرقي العراق

رنا عبدالاله الحيالي [1]، زيد عبدالوهاب ملك [*2]، عمر احمد البدراني [3]

[3،2،1] قسم علوم الارض، كلية العلوم، جامعة الموصل، الموصل، العراق.

معلومات الارشفة

تاريخ الاستلام: 04– ابريل –2024

تاريخ المراجعة: 18– مايو –2024

تاريخ القبول: 18– يوليو –2024

تاريخ النشر الالكتروني: 01– يوليو –2025

الكلمات المفتاحية:

كوميتان

التورونيان المتأخر

الكامبانيان المبكر

دوكان

السليمانية

المراسلة:

الاسم: زيد عبدالوهاب ملك

Email: zaidmalak@unmosul.edu.iq

الملخص

تمت دراسة تكوين كوميتان في مكشفين سطحيين، الأول في دوكان ويصل سمكه إلى 118 مترا، والثاني في قلات، حيث سمك التكوين 88 مترا. يتألف التكوين في كلا المقطعين من الحجر الجيري والحجر الجيري الدولومايتي حاوياً على عقد من الصوان في معظم مستويات التكوين المختلفة. سطح التماس السفلي للتكوين مع تكوين كولنيري وسطح التماس العلوي مع تكوين شرانش كلاهما غير متوافقين. اعتمدت الدراسة الحالية على فحص 80 شريحة رقيقة أظهرت وجود المنخربات الطافية والقليل من المنخربات القاعية. تم تحديد ثلاث سحنات دقيقة رئيسة، والتي تم تقسيمها لاحقا إلى ست سحنات دقيقة ثانوية. بناء على التحليل السحني، وجد ان التكوين قد ترسب في مقطع دوكان ضمن بيئة بحرية ممثلة بامام المنحدر في الجزء السفلي ثم الى بيئة امام المنحدر/المنحدر، وأخيرا بيئة المنحدر في الجزء العلوي من التكوين. بينما في مقطع قلات، ترسب التكوين في بيئة امام المنحدر/المنحدر في الجزء السفلي من التكوين ثم امام المنحدر، وأخيرا بيئة امام المنحدر/المنحدر في الجزء العلوي من التكوين. هذا يعني أن الجزء السفلي من التكوين في مقطع دوكان يشبه الجزء الأوسط من التكوين في مقطع قلات، والجزء الأوسط من التكوين في مقطع دوكان يشبه الجزء العلوي من التكوين في مقطع قلات، وهذا يعني أن البيئة الترسيبية للتكوين في مقطع قلات أعمق من مقطع دوكان.

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Introduction

Buday (1980) divided the main cycle of Kometan Formation into the Cenomanian-Early Turonian and Turonian-Early Campanian subcycles, where the formation existed in the second subcycle. The Kometan Formation was first described by Dunnington (1953; in Bellen et al., 1959) in the type section near the villages of Kometan and Ain Diza (Rania City). The formation is about 36 m thick, and it consists of thin beds of light gray to white *Globigerina-Oligostegina* limestone. Chert nodules in some beds are present, as well as the presence of glauconite in the lower part of the formation. The lower contact with the Balambo Formation and the upper contact with the Shiranish Formation in the type section represent two unconformable surfaces. Many types of foraminifera have been diagnosed within formation succession, such as: *G.sigali Reichel; G. Lapparenti Brotzen; G.lapparenti tricarinata; planoglobulina sp; and Bulimina sp, Radiolaria sponge spicules, Inoceramus (*fragments*).* According to these fossils, the age of the Kometan Formation in its type section was determined by the early Turonian-Santonian (Bellen et al., 1959).

Youkhana (1976) studied several exposed sections of the Kometan Formation in northern and northeastern Iraq and stated that the age of the formation is Turonian to Santonian.

Hammoudi (1995) pointed out that the sediments of the Kometan Formation in northern Iraq consist of a succession of limestone and dolomitic marly limestone beds, and that the formation was deposited in the outer shelf–upper slope environments, sometimes extending towards the slope or shallow shelf environment.

Al-Khafaf (2005) also described the formation in the Ain Diza area and in the type section in the village of Kometan and the Dokan section, and depending on planktonic foraminifera biozones, he divided the formation into six biozones and determined the age of the Kometan as middle Turonian-early Campanian, referred to outer shelf-upper slope depositional environments.

Malak et al. (2021) divided the formation at the Dokan Dam section in northeastern Iraq into three main facies representing environments of outer shelf, upper bathyal, and middle bathyal.

Sulaiman (2023) also studied the formation in Tabin and Smaquli sections in northern Iraq, and states that the depositional environment of the formation is outer shelf and extends to upper-middle bathyal environments.

The present study focuses on the lithostratigraphy description and microfacies analysis of the Kometan Formation in two surface sections in order to determine its sedimentary environment and imagine the depositional model of the formation.

Geological Setting

According to Buday (1980), two tectonic movements occurred during the Mid-Cretaceous (Austrian and Sub-Hercynian) that ended the previous secondary subcycle (Cenomanian-Early Turonian). These movements have affected the Unstable Shelf area significantly, and led to the separation of the Early Turonian deposits from another Turonian sediments in most regions of Iraq, except for the eastern and northeastern regions, i.e. towards the deep zones of the sedimentary basin accompanied by the occurrence of variations of thickness and facies in the sediments of the secondary subcycle (Turonian-Early Campanian). This subcycle ended with the break in sedimentation, followed by a marine transgression that occurred in the late Campanian-Maastrichtian. During the last secondary subcycle (Turonian-Lower Campanian), several formations were deposited in Iraq, namely Kometan in the northeast of Iraq, and Khasib, Tanuma, and Saadi in central and southern Iraq (Chatton and Hart, 1961; Hammoudi, 1995).

The Kometan Formation, which was deposited in the upper Cretaceous period and exposed in northeastern Iraq, represents one of the formations comprising the lower part of the large tectonostratigraphic megasequence of the Arabian Plate (AP9) (Sharland et al., 2001). The succession of the formation was deposited within the main Cenomanian-Early Campanian cycle, which is characterized by severe tectonic instability due to the influence of mountain-building movements.

Locations of the Studied Sections

The two selected outcrop sections to study the Kometan Formation, namely Dokan and Qallat, are located within Sulaymania Governorate, northeastern Iraq. The two sections fall within the High-Folded Zone according to the tectonic division of Iraq (Fouad, 2015) (Fig. 1). While they are within the Fold-Thrust Zone according to the modified divisions of Lawa et al. (2013) and Omar et al. (2015), as shown below:

Dokan section: This section is exposed 6o Km to the northwest of Sulaymania City within the southwestern limb of Sarah anticline at the intersection of longitude coordinate (44° 57′ 29″ E) and latitude (35° 56′ 32″N).

Qallat section: The Kometan Formation appears in the Dokan area, northeast of the Kosrat anticline, on the western side of Dokan Lake in Sulaymania Governorate, northeastern Iraq, specifically at the point of intersection of longitude (44° 58′ 12″E) and latitude (35° 54′ 36″N).

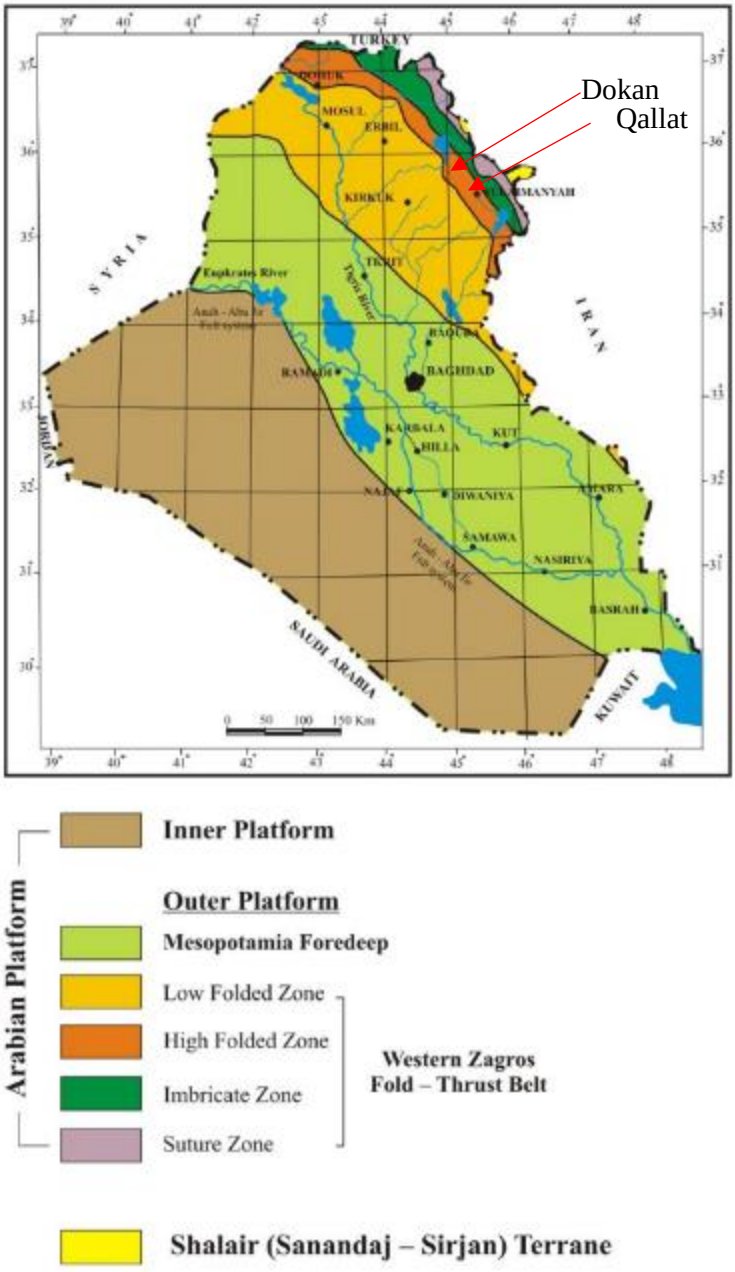

Fig. 1. Tectonic divisions of Iraq and the location of the two studied sections (Fouad, 2015).

Methods and Materials

The field description of the selected sections focuses on measuring the beds' thicknesses, determining the hardness, color, and bedding nature, as well as monitoring all sedimentary structures and stratigraphic features. The sampling process has been given a great attention, as (80) samples are collected from the formation in both Dokan and Qallat sections, and thin sections are made in the Department of Geology, Mosul University to study their components, and to be used for the classification of Dunham (1962) to describe and determine microfacies

by examining them using the polarized microscope and then to identify the affecting diagenetic processes, an finally to deduce the depositional environment of the formation.

The formation thickness in the Dokan section is 118 m; its lower contact is unconformable with the Gulneri Formation, which consists of thin beds of black shale containing glauconite grains. And the upper contact with the overlying Shiranish Formation is unconformable too, characterized by the presence of a conglomerate bed with fine pebbles of diameters less than 2 cm embedded within a sandy matrix containing green, well-rounded glauconite grains. The formation consists mainly of a medium to well-bedded succession of hard, white-light gray limestone and dolomitic limestone with a spread of calcite veins and iron oxides nodes (Fig. 2) as well as chert nodules scattered in most sequences of the formation and near the bedding surfaces (Fig. 3).

Fig. 2. Iron oxides nodes between the boundaries of the beds in Dokan section.

Fig. 3. Chert nodules between the boundaries of the beds in the Dokan section.

In Qallat section, the formation is about 88 m thick, its lower part contains hard limestone succession with a thickness of 20 m, of white to gray color, medium bedding (20 cm - 90 cm) with scattered iron oxides and chert nodules and signs of weathering (Fig. 4). The middle part is about (21.5) m thick, and it consists of hard, white, limestone, thin-medium bedding (20-40 cm) with stylolite (Fig. 5) and veins of calcite and iron oxides. Accordingly, the upper part of the formation is about 47 m thick, of hard, white to gray limestone beds (15-60 cm) with scattered iron oxides as well as traces of *Thallasinoid* that are present in most of this part and stylolite. The formation settles unconformably on the underlying Gulneri Formation, composed

of thin beds of black shale, and is characterized by the presence of glauconite. The upper contact of the formation with the Shiranish Formation is covered here.

Fig. 4. Signs of weathering in Qallat section.

Fig. 5. Stylolite surface in Qallat section.

Results and Discussion

The microfacies analysis reveals that the Kometan Formation in the two studied sections contains three main microfacies that are then subdivided into six submicrofacies according to their content of carbonate grain components, as shown in Figures 6 and 7.

Microfacies analysis of Kometan Formation

A- Lime Mudstone Microfacies (M)

This microfacies exists in the lower parts of the formation in the two studied sections, and it consists of grains less than 10% of skeletal grains, which are represented by the planktonic foraminifera and lithoclasts. The diagenetic processes include dolomitization and neomorphism. This microfacies is divided into two submicrofacies depending on the type of grains, as shown below:

1. Dolomitic Lime Mudstone Submicrofacies (M1)

This submicrofacies is represented by dolomitic limestone beds that occur at the bottom of the formation in both sections and with a thickness range between 2.5 and 4.5 m. It consists mainly of micritic matrix and is affected by dolomitization and recrystallization (Plate 1-A).

The general characteristics of this microfacies are compared with the standard microfacies of Flügel (2010), and it is found to be similar to the (SMF3) and within the Facies Zone (FZ3) of Wilson (1975), which refers to the toe of slope environment.

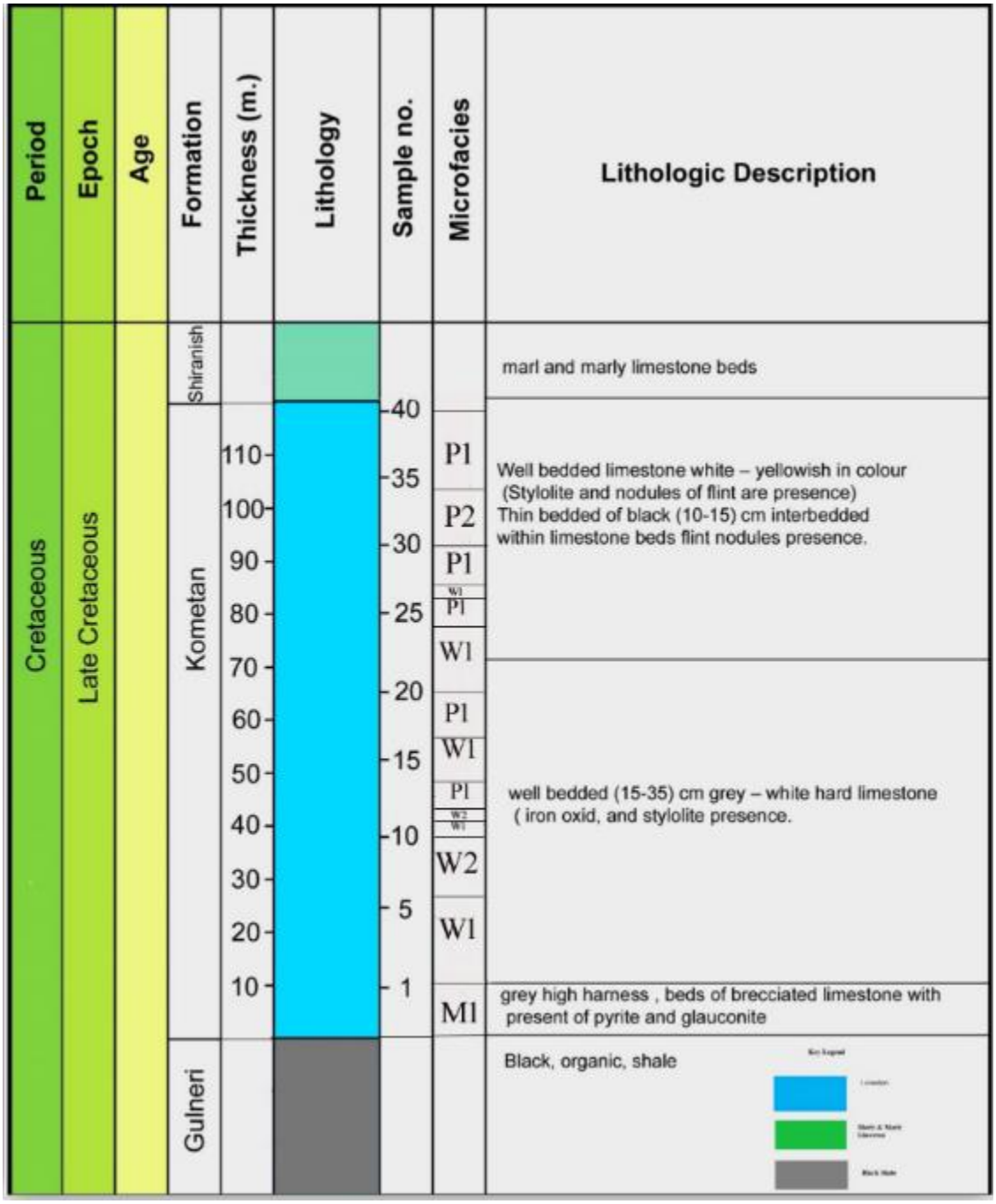

Fig. 6. Standard lithological color and microfacies of the Kometan Formation (Dokan section).

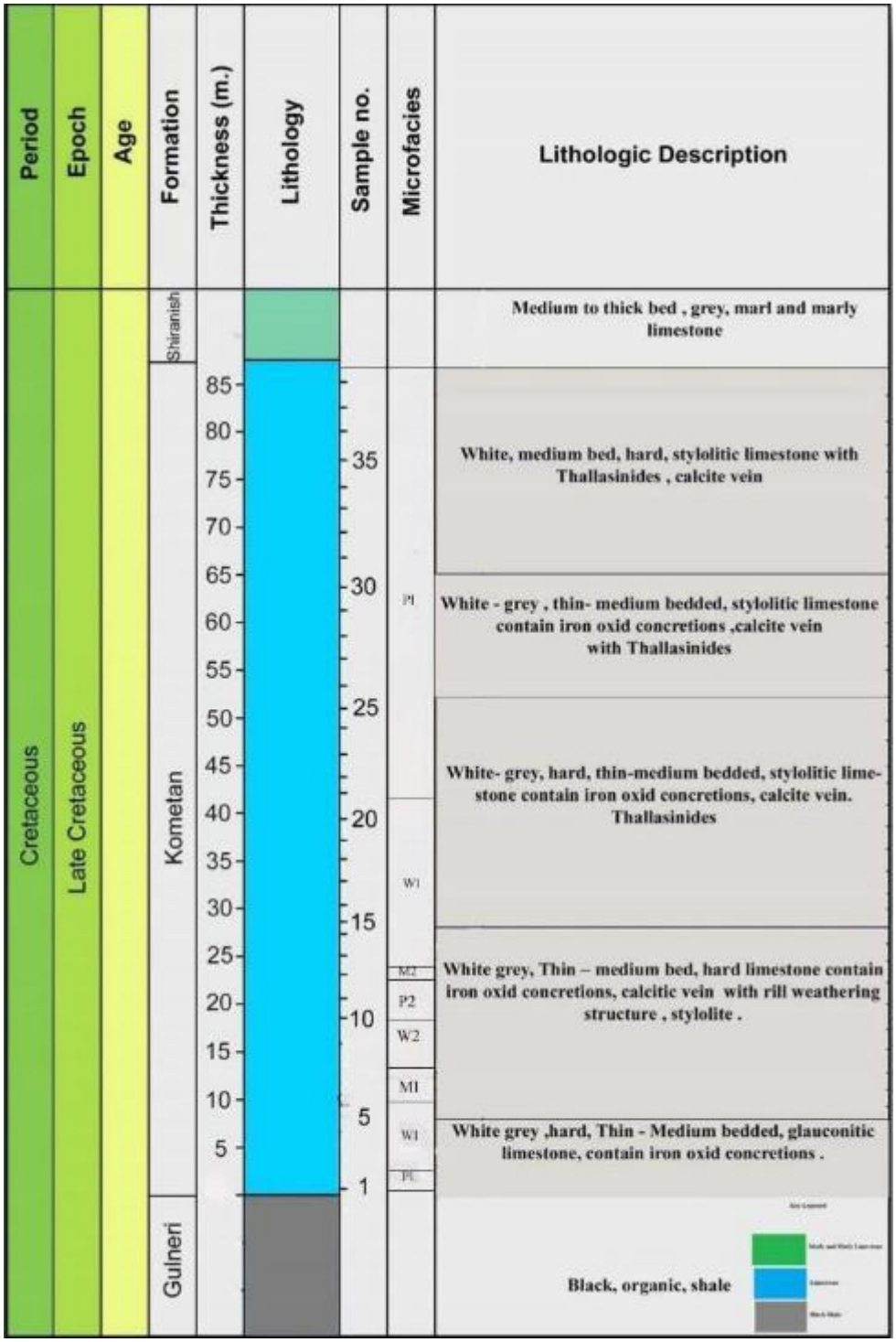

Fig. 7. Standard lithological color and microfacies of the Kometan Formation (Qallat section).

2. Planktonic Foraminifera Lime Mudstone Submicrofacies (M2)

This submicrofacies is represented by a limestone bed that has been found at the lower part of the formation in the Qallat section only. Its thickness is about 2 m. The percentage of skeletal grains in this submicrofacies is about 10%. The grains consist of planktonic foraminifera (85%), including globular chambered foraminifera such as genera (*Heterohelix, Globigerinelloides*), and keeled planktonic foraminifera such as (*Marginotruncana, Globotruncana*), in addition to benthic foraminifera represented by the genus (*Praebulimina*) (Plate 1-B), a few ostracoda shells (Plate 1-C), and calcispheres. The matrix is composed of

brown micrite in which pyrite is spread out. This submicrofacies has undergone many diagenetic processes as physical compression, chemical compaction, dissolution (mold porosity) and cementation (granular cement) (Plate 1-D).

The general characteristics are similar to (SMF3) of Flügel (2010), which was deposited within the (FZ3) and represented by the toe of the slope environment.

B. Lime Wackestone Microfacies (W)

These facies are present in both sections; it consist of skeletal grains (about 10%-40%). The skeletal components are represented by planktonic foraminifera, benthic foraminifera, ostracoda, pelecypod, echinoderms, and bioclasts, with pyrite within fossil shells and the micritic matrix. This main microfacies is then divided into two submicrofacies depending on the grain type:

1. Globular Planktonic Foraminifera Lime Wackestone Submicrofacies (W1)

This submicrofacies is widely spread or prevalent in different parts of the Dokan section and less distributed in the Qallat section. It is represented by limestone beds with a thickness between 1 to 15 m, and it consists mainly of globular planktonic foraminifera forming about 80% of the total skeletal components of the facies and represented by *(Whiteinella, Globigerinelloides, Archaeoglobigerina, Heterohelix), Hedbergella,* and a few keeled planktonic foraminifera, as well as ostracoda and benthic foraminifera represented by the genus *Pseudotextularia,* bioclasts, and intraclasts. This facies is mud-supported and contains a matrix with organic materials (Plate 1-E). This microfacies has been affected by dissolution (vugs porosity) (Plate 1-F) and (Plate 2-H). This microfacies is similar to the (SMF3-Fora) that was deposited within the (FZ3), representing the deepest toe of the slope environment.

2. Keeled Planktonic Foraminifera Lime Wackestone Submicrofacies (W2)

This submicrofacies exists sporadically in the lower parts of both sections, where it is represented by limestone beds with a thickness of (1-5) m. This facies consists mainly of the keeled planktonic foraminifera (60%) such as the genera *Dicarinella, Marginotruncana, Globotruncana, and Contusatruncana,* and the globular planktonic foraminifera (40%) (Plate 1-G), and a few bioclasts, ostracods, echinoderms, and pelecypods, all are embedded within a micritic matrix. The facies is affected by dissolution, dolomitization, cementation (granular cement), and physical compaction. This facies is also characterized by the presence of a microlamination (Plate 1-H). This facies is similar to the (SMF3) that was deposited within the landward (FZ3), representing the toe of slope environment nearest to the slope.

C. Lime Packstone Microfacies (P)

This microfacies is found in different parts of both sections, and it consists mainly of skeletal grains that range between 55 and 80% of the rock components as a whole, embedded within a micritic matrix. The skeletal grains are mainly composed of planktonic foraminifera, benthic foraminifera, bioclasts, pieces of echinoderms, ostracoda, and lithoclasts. This microfacies is divided into two submicrofacies depending on the grain content:

1. Globular Planktonic Foraminifera Lime Packstone Submicrofacies (P1)

This submicrofacies exists in both sections of the formation, and it is represented by limestone beds with a thickness between 2 and 43 m. It consists of packed grains reaching 70% of the rock components represented by the globular planktonic foraminifera, including *Whiteinella, Globigerinelloides, Archaeoglobigerina, Heterohelix, Hedbergella,* in addition to a few keeled planktonic foraminifera, and a less common proportion of benthic foraminifera belonging to the genus *Rosita, Gavelinella* (Plate 2-A), (*Nodosaria*) (Plate 2-F), and a few of extraclasts and bioclasts. Pyrite also presents within the micritic matrix and coarse-green

glauconite with more than 30%, especially at the bottom of the formation in Qallat section (Plate 2-B). The facies are affected by dissolution, neomorphism, cementation, and physical and chemical compactions represented by the stylolite (Plate 2-C) and (Plate 2-D). This microfacies is similar to properties between (SMF3 to SMF4) that were deposited in turn within the (FZ3-FZ4), representing a toe of slope-to-slope environment.

2. Keeled Planktonic Foraminifera Lime Packstone Submicrofacies (P2)

This submicrofacies is located at the bottom of the Qallat section and the top of the Dokan section. It consists of skeletal grains, which account for up to 70% of the components of the rock as a whole, represented by the keeled planktonic foraminifera, and represented by genera (*Dicarinella, Marginotruncana, Globotruncana, and Contusotruncana*). The proportion of the genera of globular planktonic foraminifera is about 20%, with a low percentage of benthonic foraminifera represented by (Nodosaria) and a few echinoderms, ostracoda, and bioclasts. The microfacies is affected by dissolution, cementation, and dolomitization (suture mosaic dolomite) (Plate 2-E).

The characteristics of this microfacies are similar to (SMF4) (Flügel, 2010), which was deposited within the deep (FZ4) (Wilson, 1975), representing the deep slope environment.

Depositional environment

Determining the sedimentary environment of the lithostratigraphic units or formation requires the deduction of field, petrographic characteristics, as well as fossils. These indicators are of paramount importance in estimating the sedimentation conditions that prevailed during the sedimentation (Selley, 2000). In the Kometan Formation, the depositional environment was marine, represented by the toe of slope at the lower part of the formation, then retreated to toe of slope/slope environments, and finally the slope environment at the top of the formation (Fig. 9).

Description of the environments of deposition

Dokan section

Facies distribution refers to a deep marine environment that prevailed in the formation of the Dokan section. The microfacies in the lower part of the Kometan Formation are dominated by dolomitic lime mudstone submicrofacies (M1), then globular planktonic foraminifera lime wackestone submicrofacies (W1), and followed by keeled planktonic foraminifera lime wackestone submicrofacies (W2). The first microfacies at the bottom of the Dokan section is characterized by the prevalence of both types of globular planktonic foraminifera (high percentage) and Keeled foraminifera (low and small in size). While the above microfacies are characterized by containing the genera *Marginotruncana, Heterohelix*, and *Hedbergella*, whose presence indicates a deep marine environment (Sliter, 1972; Hart, 1980). On the other hand, the presence of benthonic foraminifera such as *Nodosaria* and *Textularia* refers to the outer shelf environment (Sliter and Baker, 1972; Ghose, 1977). The coupling of keeled and globular planktonic foraminifera is an indicator of a relatively deep environment (Boggs, 2006). The presence of the genus *Archaeoglobigerina* refers to the outer shelf environment (Funnel, 1967; Koutsoukos and Hart, 1990; Omana, 2006). From the above fossils' distribution, the lower part of the formation in the Dokan section represents a deep shelf margin environment within (SMF3/FZ3) (Toe of slope) according to Wilson (1975) and Flügel (2010).

In the middle part of the formation (from the interval thickness 45 to 65 m), the prevalence and alternation between the globular planktonic foraminifera lime packstone submicrofacies (P1) and globular planktonic foraminifera lime wackestone submicrofacies (W1) is well known. These microfacies are characterized by the prevalence of globular planktonic foraminifera and

a little keeled planktonic foraminifer that are small in size, as well as the presence of a small amount of bioclasts and extraclasts with the presence of pyrite and glauconite.

The above microfacies are characterized by the presence of the *Rosita* and *Globigerinelloides,* which reflect a marine environment with a water depth ranging between 200 and 500 m (Koutsoukos and Hart, 1990; Sliter and Leckie, 1993). Pumice (2005) indicated that the widespread distribution of globular planktonic foraminifera and the lack of small-sized keeled planktonic foraminifera refer to a far outer shelf environment. From above, this part has been deposited in deep outer shelf environments at (SMF3/FZ3) to (SMF4/FZ4) (toe of slope-to-slope environments) according to Wilson (1975) and Flügel (2010). A similar interpretation has been indicated by Sulaiman et al. (2023).

In the upper part of the formation (from a thickness of 65 to the formation top), the deposition is characterized by the dominance of globular planktonic foraminifera lime packstone submicrofacies (P1) and keeled planktonic foraminifera lime packstone submicrofacies (P2). This part is characterized by the prevalence of both keeled and globular planktonic foraminifera and few benthic foraminifera. The presence of the genus *Nodosaria* (Plate 2-F) and the genus *Archaeoglobigerina* usually refers to the outer shelf environment (Sliter, 1972; Koutsoukos and Hart, 1990; Seyrafian, 2000). The genus *Gavelinella* (Plate 2-G) is also recorded in microfacies, which reflects a middle-upper bathyal marine environment (Seyrafian, 2000). Thus, the upper part of the formation has been deposited in a slope marine environment (SMF4/FZ4) according to Wilson (1975) and Flügel (2010).

Qallat section

The microfacies with characteristics of the deep sedimentary environment prevail in Qallat section at its lower part (till 13 m), represented by the spread of all submicrofacies. The dolomitic lime mudstone submicrofacies (M1), globular planktonic foraminifera lime packstone submicrofacies (P1), and globular planktonic foraminifera lime wackestone submicrofacies (W1) prevail.

The presence of the genera *Gavelinella, Globigerinelloides, Heterohelix, and Hedbergella* in the above microfacies reflects the conditions of a deep sedimentary environment (Sliter, 1972; Reckman and Friedman, 1982; Seyrafian, 2000).

The association of calcisphere with planktonic foraminifera has been recorded in some facies, which refers to a relatively deep marine environment (Hart, 1991) and is associated with the proliferation of glauconite, referring to the deep-sea environment (Scholle et al., 1983). Also, the diagnosed presence of some benthic foraminifera genera represented by the genera *Praebuliminaa, Rosita,* and Texularia reflects the upper bathyal (Chose, 1977; Koutsoukos and Merrick, 1985; Koutsoukos and Hart, 1990).

The widespread distribution of the globular planktonic foraminifera and the small size keeled planktonic foraminifera and the accompanying benthic foraminifera (may be transported) reflect the deposition of the lower part in the deep marine environment alternated between toe of slope and slope environments at (SMF3/FZ3) and (SMF4/FZ4) according to Wilson (1975) and Flügel (2010).

The middle part of the formation (from 13 to 22 m) has prevailed keeled planktonic foraminifera lime wackestone submicrofacies (W2) and keeled planktonic foraminifera lime packstone submicrofacies (P2). These facies are characterized by the presence of the keeled planktonic foraminifera such as *Dicarinella marginotruncana, Globotruncana, and Contusatruncana,* and globular planktonic foraminifera with a small percentage, in addition to bioclast and intraclast, and the spread of pyrite and glauconite.

The prevalence of the keeled planktonic foraminifera is indicative of a deeper marine environment (Leckie, 1987). Sliter and Premoli-Silva (1990) have indicated that the presence of genera (*Globotruncana, Contustruncana, Marginotruncana*) associated with pyrite and glauconite indicates deep sedimentary environments (Scholle et al., 1983; Master and Scott, 1978). On the other hand, the above facies contain a low percentage of benthonic foraminifera represented by (*Nodosaria*) refers to the outer shelf environment (Sliter, 1972). The above evidence indicates that the middle part of the formation is deposited in a deep outer shelf margin environment represented by (SMF3/FZ3) toe of slope environments according to Wilson (1975) and Flügel (2010).

The upper part of the formation (from 22 m to the top) consists of globular planktonic foraminifera lime packstone submicrofacies (P1), which is the most common in the Qallat section, and the globular planktonic foraminifera lime wackestone submicrofacies (W1) and Planktonic Foraminifera Lime Mudstone Submicrofacies (M2). This section is characterized by the prevalence of both globular planktonic foraminifera and benthic foraminifera, with a rare presence of keeled foraminifera.

The presence of the genus *Globigerinoides* with bioclast is usually indicative of a deep marine environment accompanied by changes in sea level (Seyrafian, 2000). And the occurrence of *Globigerinoides* in lime mudstone reflects a deep marine environment (Reckman and Friedman, 1982) (Plate 2-G). The above microfacies, that also characterized by the prevalence of benthic foraminifera (*Nodosaria*), refer to the outer shelf environment (Sliter, 1972). From above, this part has been deposited in the deep marine environment extending from toe of slope-to-slope environments or (SMF3/FZ3) to (SMF4/FZ4) according to Wilson (1975) and Flügel (2010).

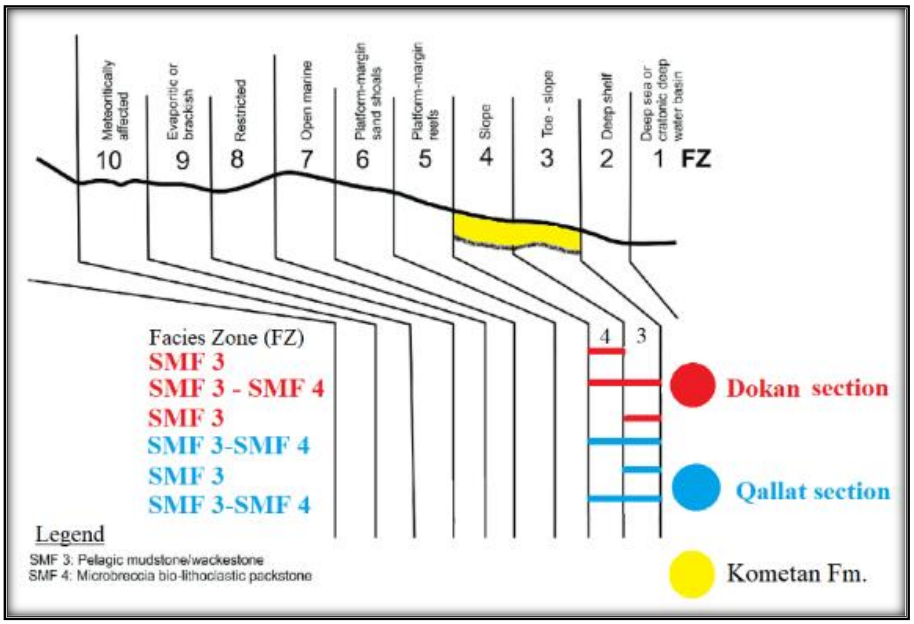

Fig. 9. Depositional model for the Kometan Formation in the studied sections.

Conclusion

The two sections show a slight difference in the types of microfacies, where the microfacies analysis of the study sections reveals the presence of three main microfacies: lime mudstone (M), lime wackestone (W), and lime packstone (P). The aforementioned microfacies, in turn, are divided into (6) submicrofacies, noting that there is a clear similarity between the specifications of these microfacies and the global standard microfacies, which indicates that the deposition of the formation in Dokan section was in a marine environment represented by the

toe of slope at the lower part of the formation, then retreated to toe of slope/slope environment and finally slope environment at the top of the formation. While in the Qallat section, the deposition of the formation is represented by the toe of slope/slope at the lower part of the formation, then retreats to the toe of slope environment, and finally, the toe of slope/slope environment at the top of the formation. That means the lower part of the formation in Dokan section resembles the middle part of the formation in Qallat section, and the middle part of the formation in Dokan section resembles the upper part of the formation in Qallat section, which means the depositional environment of the formation in Qallat section was deeper than in Dokan section.

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Plate -1-

A- Dolomitic Lime Mudstone Submicrofacies (M1) with pyrite (P.). Where is the effect of dolomitization (D.), Sample No. Kd1. X10.

B- Genus of *Praebulimina reusi* Sample No. Ks. 13. X10

C- Planktonic foraminiferal Lime Mudstone (M2) with Articulated ostracoda SP. shell Sample No. Kq11. X10

D- Planktonic Foraminifera Lime Mudstone Submicrofacies (M2) Sample No. Kq 13. X10.

E- Globular Planktonic Foraminifera Lime Wackestone Submicrofacies (W1), Sample No. Kd11. X10.

F- Fracture porosity fill with calcite cement and pyrite in Globular Planktonic Foraminifera Lime Wackestone Submicrofacies (W1), Sample No. Kd 17. X10.

G- Keeled Planktonic Foraminifera Lime Wackestone Submicrofacies (W2), Sample No. Ks9. X10.

H- Lamination fossils in Keeled Planktonic Foraminifera Lime Wackestone Submicrofacies (W2), Sample No. Ks9. X10.

Plate -1-

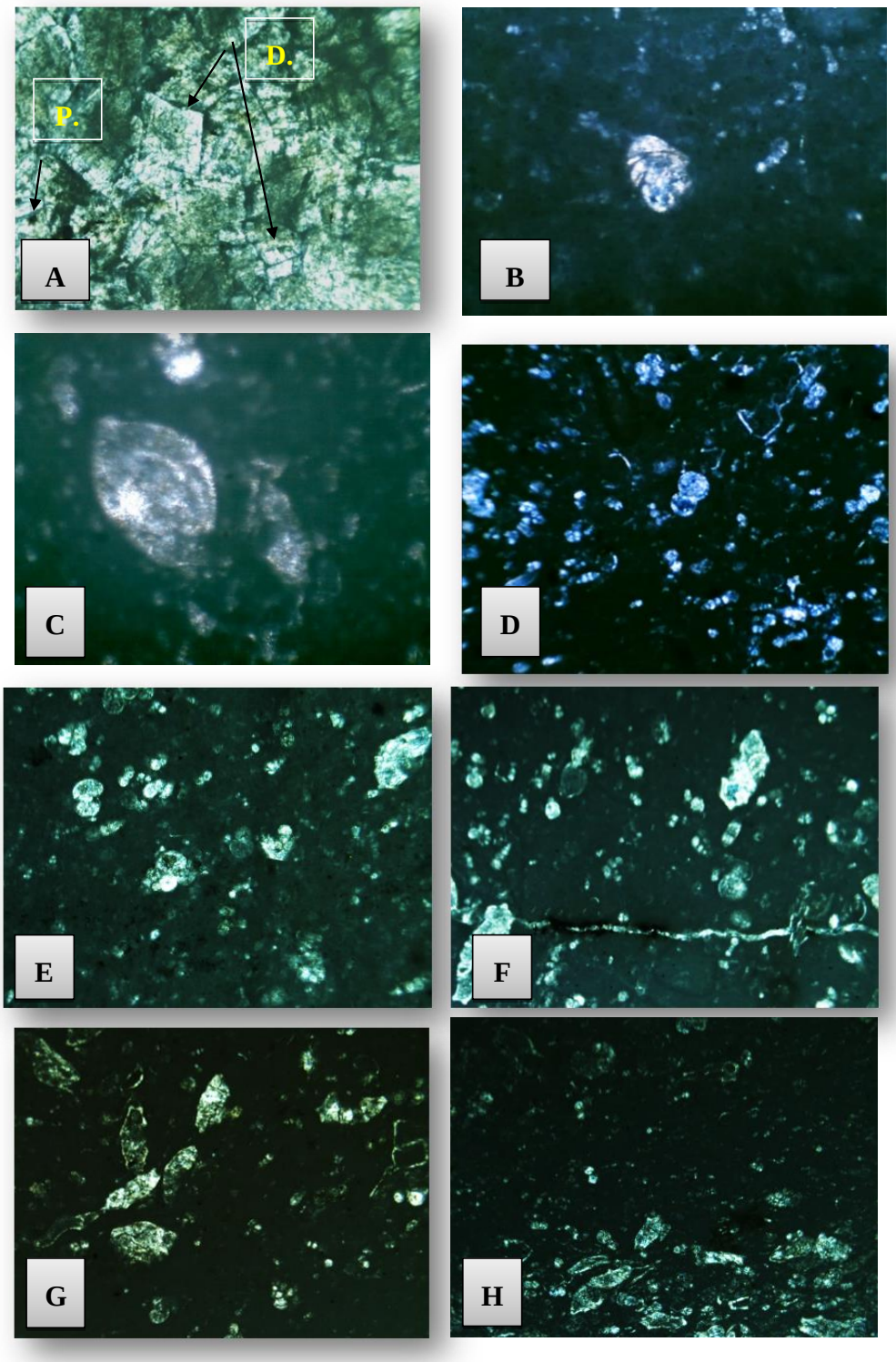

Plate -2-

A- Genus of *Gavelinella* (G.) and *Rosita* (R.) Sample No. Kd. 40 X10

B- Glauconite mineral Sample No. Ks1. X10

C- Irregular anastomosing Stylolite Sample No. Ks4. X10

D- Globular Planktonic Foraminifera Lime Packstone Submicrofacies (P1) Sample No. Kd25. X10.

E- Keeled Planktonic Foraminifera Lime Packstone Submicrofacies (P2) Sample No. Kd31. X10.

F- Genus of *Nodosaria* Sample No. Kd 12 X10

G- Planktonic Foraminifera lime mudstone with *Globigerinelloides* (Subbotina.) Sample No. Kq13. X10.

H- Pyrite within in Globular Planktonic Foraminifera Lime Wackestone Submicrofacies (W1), Sample No. Kd 19. X10.

Plate-2-