IRAQI BULLETIN OF GEOLOGY AND MINING (IBGM)\
IRAQ GEOLOGICAL SURVEY (GEOSURV-IRAQ)

*IBGM (**2025**, Vol; 21 Issue 2)* *347-364*

MICROFACIES AND BIOSTRATIGRAPHY OF THE MIDDLE TURONIAN-MIDDLE CAMPANIAN SUCCESSION IN THE HIZOP SECTION OF THE DOKAN AREA, NORTHEAST IRAQ

Zahid M. Gardy[1*], Mushir M. Baziany[1], Sirwan H. Ahmed[1]

[1] Department of Geology, College of Science, University of Sulaimani, Sulaimani, Kurdistan Region, Iraq
* Corresponding email: Zahidgardy@gmail.com

Type of the Paper (Article)
Received: 02/ 08/2024
Accepted: 11/ 09/2025
Available online: 27/12/2025

Abstract

The carbonate sequence at the Hizop section was investigated using microfacies and biostratigraphic analyses. Lithostratigraphically, the succession comprises hard, stylolitic limestone beds rich in chert nodules and iron oxides, characteristic of the Kometan Formation. These overlie light brown marly limestone and shale assigned to the Shiranish Formation. Petrographic analysis identifies two dominant microfacies in the Kometan Formation: bioclastic packstone and glauconitic bioclastic lime packstone to grainstone. In contrast, the Shiranish Formation exhibits three distinct microfacies: Globigerinelloides packstone, Globigerinelloides wackestone, and foraminiferal packstone-grainstone. Biostratigraphic investigation delineates four key biozones: The *Globotruncanita elevata* Partial Range Zone, *Globotruncana ventricosa* Interval Zone, *Dicarinella hagni* Partial Range Zone, and *Muricohedbergella holmdelensis* Interval Zone. These biozones indicate a Middle Turonian to Early Santonian age for the Kometan Formation and an Early to Middle Campanian age for the Shiranish Formation. The age gap implies the presence of a Middle to Late Santonian hiatus, marking an unconformity between the two formations at the Hizop section in the Dokan area.

Keywords: Shiranish; Microfacies; Dokan; Iraq

1. Introduction

This research focuses on Turonian – Early Maastrichtian deposits at the Hizop section (36°10′19″ N, 44°41′14″ E), located about 82 km east of Erbil, Kurdistan Region, Iraq (Figures 1 and 2). Here, the Kometan and Shiranish formations represent distinct marine carbonate sequences spanning the Middle Turonian to Middle Maastrichtian. Originally defined by Bellen et al. (1959), these formations belong to the Arabian Plate's AP9 megasequence (Jassim & Goff, 2006; Aqrawi et al., 2010; Sharland, P.R. et al., 2001). Planktic foraminiferal assemblages show increased diversity and complexity from the Turonian to Early Maastrichtian

ISSN 1811-4539, EISSN 3005-3714
https://doi.org/10.59150/ibgm2102a18
IBGM: http://ibgm-iq.org/
Academic Scientific Journals: www.iasj.net

(Silva & Sliter, 1999; Hart, 1999; Ghafor, 1988; Al-Shaibani, et al., 1993; Bakkal, K.K., Ghafor, I.M., and Kassab, 1993. The Kometan Formation unconformably overlies the Cenomanian Balambo and Qamchuqa formations in northeastern Iraq (Bellen et al., 1959; Sharland, P.R. et al., 2001; Ghafor I.M., Sharbazeri K. M., and Al-Said Ahmed, 2004; Ameen & Gharib, 2014; Buday, 1980; Ghafor et al., 2012; Faris et al., 2019).

The dating of the Kometan Formation varies across different regions and studies. Initially, Bellen et al. (1959) established its age as Turonian at the type locality near Kometan village, Endezah. Subsequent research by Abawi, T.S. & Hammoudi (1997) and Haddad & Amin (2007) extended the formation's age range from the Late Turonian at the base to the Early Campanian at the top, based on analyses of benthic foraminifera. (Ghafor et al., 2012) studied the Kometan Formation in the eastern part of Sulaimaniyah and determined that the age ranges from Turonian to the beginning of Upper Campanian. Recent findings have identified the index planktic foraminifer *Helvetoglobotruncana helvetica*, leading to a revision of the Kometan Formation's base age to the Early Turonian (Jaff et al., 2015).

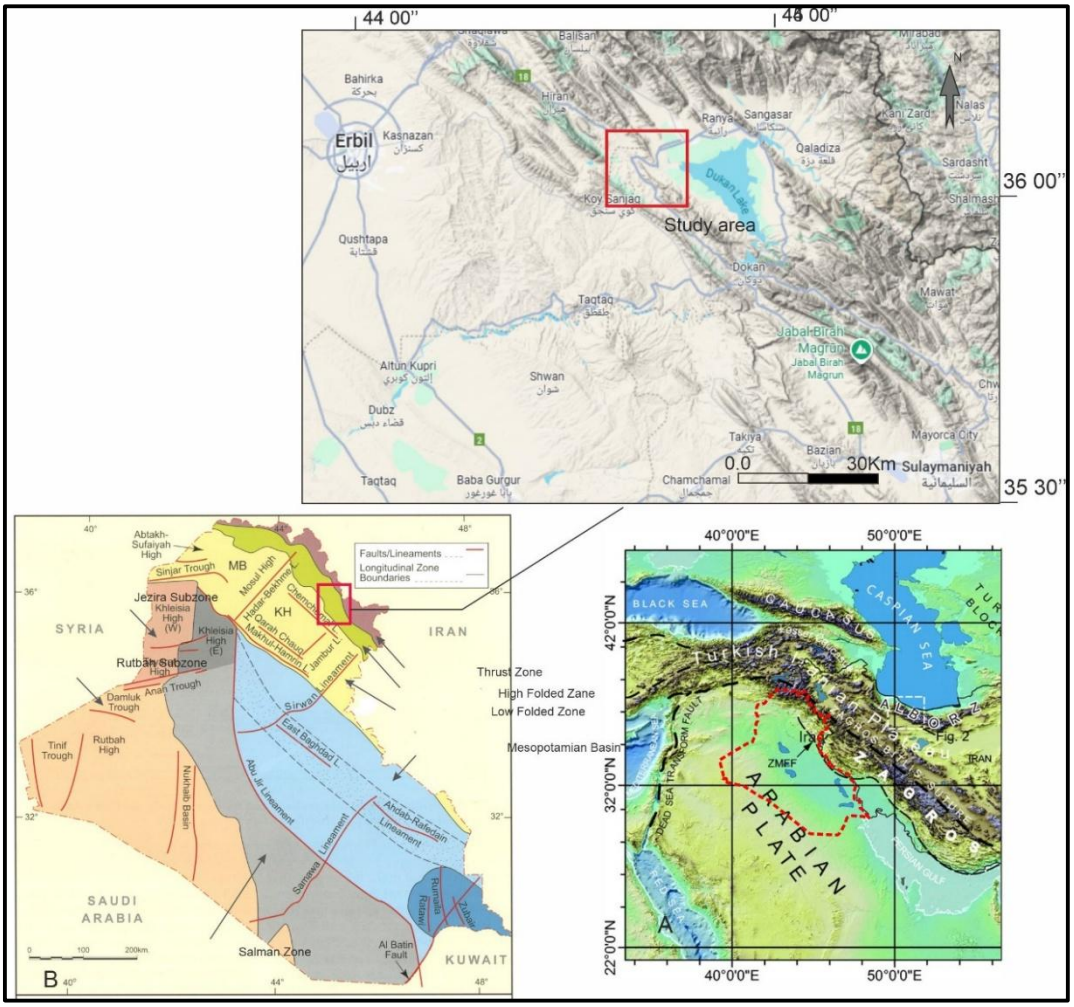

Figure **1.** The location map of the Middle East and Iraq shows the location of the study area. The upper map is a Google Terrain map showing the Dokan-Rania area. The red rectangle indicates the study area.

Figure 2. a) Tough and iron oxide-rich, milky to light grey limestone with stylolyitic bedding planes. **b)** Iron oxide nodules can be found within the Kometan Formation at the Hizop section.

In the Dokan and Sulaymaniyah regions, the Shiranish Formation unconformably overlies the Kometan Formation, while to the north, in areas such as Soran, it is on the Bekhme Formation in areas such as Soran, Aqra, and Duhok. Studies by Aqrawi et al. (2010), Jaff et al. (2015), Farouk et al. (2018), Jaff & Lawa (2019), and Nuaimy et al. (2020) have determined the age of the Shiranish Formation to span from the Late Campanian to the Maastrichtian; however, it does not extend into the Late Maastrichtian (Table 1).

Table 1: Shows the previous biostratigraphic studies of Kometan and the Shiranish formations in the area under consideration.

Authors	Formation	Age	Section
(Bellen, et al., 1959)	Kometan	Turonian	Kometan
(Abawi T. S., Hammoudi R. A., 2006)	Kometan	M. Turonian -Early Campanian	Dokan Section
(Jassim & Goff, 2006)	Kometan	Late Turonian - Early Campanian	Northern Iraq
(Haddad & Amin, 2007)	Kometan	Turonian -Early Campanian	
(Jaff et al., 2015)	Kometan	Early Turonian -Early Campanian	Dokan Section
(Kaddori N., 1982)	Kometan	Early Turonian -Early Campanian	NE Iraq
(Ahmed et al., 2015)	Kometan	Early Turonian	Dokan Section
(Sissakian et al., 2016)	Kometan	Turonian – Early Campanian	Dokan Section
(Malak, 2015)	Shiranish	Campanian-Early Maastrichtian	Dokan Section
(Ahmed et al., 2015)	Shiranish	Early – Late Campanian.	Dokan Section
(Farouk et al., 2017)	Shiranish	Late Campanian-Early Maastrichtian	Dokan Section
(Jaff & Lawa, 2019)	Shiranish	Late Campanian-Maastrichtian	Azmar and Dokan sections

2. Geological setting and tectonic subdivisions of the Kurdistan Region

The age of the Kometan Formation varies depending on the region and the study conducted. Originally, (Bellen, R.c.van, Dunnington, H.V., Wetzel, R., and Mortone, 1959) dated it as Turonian at its type locality near Kometan village in Endezah. Later research by Abawi, T.S. & Hammoudi (1997), Abawi T. S., Hammoudi, R. A. (2006), and Haddad & Amin (2007) expanded this age range, indicating a span from the Late Turonian at the base up to the Early Campanian at the top, based on benthic foraminiferal evidence. In eastern Sulaymaniyah, Ghafor, I.M., Karim, K.H., and Baziany (2012) reported that the formation's age ranges from Turonian to the Early Late Campanian. More recent studies, including those by Jaff et al. (2015), discovered the index planktic foraminifer Helvetoglobotruncana helvetica, which led to revising the base age of the Kometan Formation to the Early Turonian.

In the Dokan and Sulaymaniyah regions, the Shiranish Formation unconformably overlies the Kometan Formation, whereas in northern areas like Soran, it rests unconformably on the Bekhme Formation. The Bekhme, Aqra, and Duhok formations also underlie it in some locations. Several investigations, including those by Aqrawi A. A.M., Gof, J.C., Horbury, A.D., and Sadooni (2010), Jaff et al. (2015), Farouk et al. (2018), Jaff & Lawa (2019), and Nuaimy et al. (2020), have dated the Shiranish Formation from the Late Campanian to the Maastrichtian, although it does not appear to extend into the Late Maastrichtian (Table 1).

3. Materials and Methods

A field study was conducted in the Hizop area near Rania (36°10'19" N, 44° 41'14" E). Fourteen samples were collected from the Kometan Formation over a span of 21.96 meters, and thirty samples from the Shiranish Formation over 58.2 meters. To extract calcareous microfossils from the lithified limestone, a method developed by Lirer (2000) was employed. The samples underwent thorough washing with water, followed by sieving through ASTM standard sieves (60, 80, 100, 120, and 230 mesh). After sieving, the samples were dried at room temperature. The resulting residue was carefully examined to ensure it was free of inorganic materials, leaving the foraminifera clean and suitable for examination under a reflecting binocular microscope.

4. Lithostratigraphy

The lithostratigraphy of the Hizop Section is documented during field observations and is characterized by a total thickness of 21.96 meters for the Kometan Formation and 58.2 meters for the overlying Shiranish Formation. The lithological composition of the Kometan Formation at this section exhibits distinct vertical changes.

The lowermost 6.16 meters comprise thinly bedded, tough limestone enriched with iron oxides, ranging in color from milky to light grey, and featuring stylolite bedding planes with individual bed thicknesses between 20 and 50 cm. This is followed by a 5-meter interval of similar limestone, distinguished by a greater abundance of iron oxide nodules and the occurrence of ammonite fossils associated with bitumen.

Above this, a 2.8-meter-thick layer of hard, light grey marly limestone appears, also exhibiting stylolite structures. This is followed by a 6.4-meter sequence of alternating thin beds of light grey to brown limestone interlayered with shale layers approximately 3 cm thick.

The uppermost 1.5 meters consist of light grey to pale blue limestone interbedded with thin shale layers, noticeably rich in iron oxide. This unit represents the top of the Kometan Formation and marks its contact with the overlying Shiranish Formation (see Figures 2 and 3).

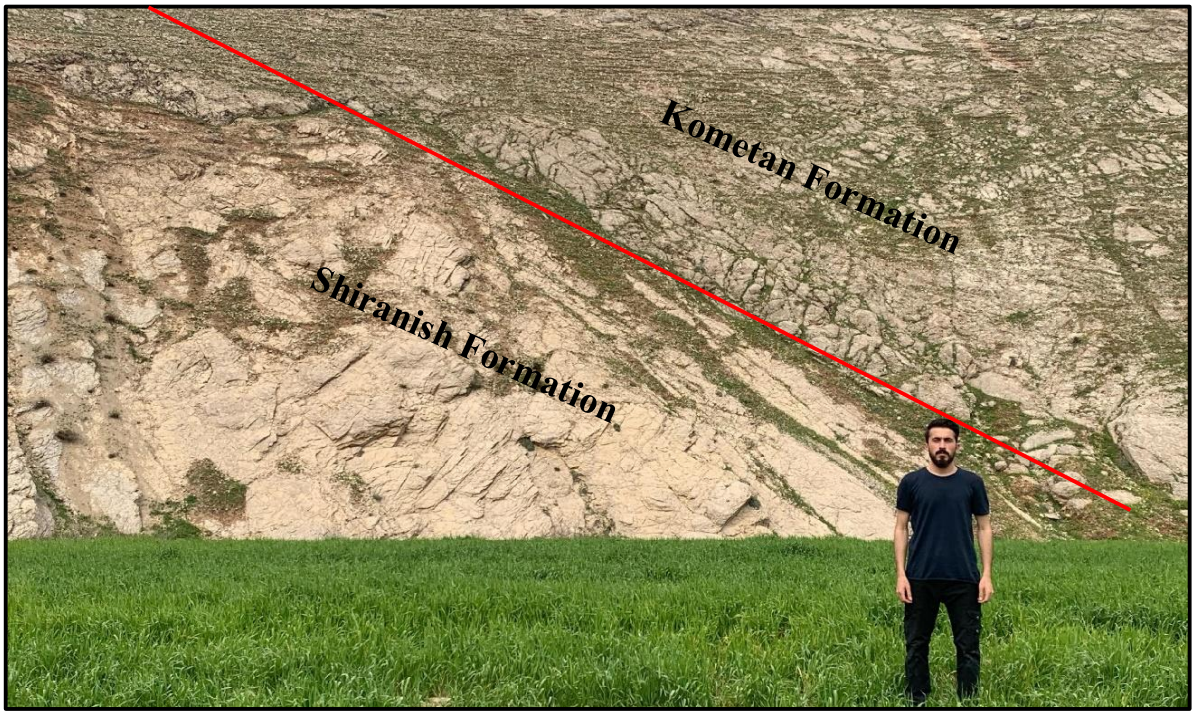

Figure 3. The contact between the Kometan and Shiranish formations is marked by a transition from milky to light grey limestone of the Kometan Formation to marl, marly limestone, and shale of the Shiranish Formation.

The Shiranish Formation at the Hizop section exhibits a diverse range of lithologies from base to top. It begins with 0.3 meters of light brown marly limestone, followed by 0.9 meters of marly limestone interbedded with dark grey shale and showing intense fracturing. This is succeeded by 8 meters of blue to dark grey shale interbedded with marly limestone, and then 6 meters of dark blue shale alternated with marly limestone (Figure 4).

Above this interval, 2 meters of dark grey shale are present, followed by 2 meters of marly shale and another 2 meters of dark grey marly limestone. Next is a 4-meter interval of marly limestone interbedded with shale, capped by a hard limestone bed measuring 40 cm in thickness.

This is overlain by 6 meters of light grey marl rich in iron oxide, followed by 10 meters of light grey shale interbedded with grey marl. The sequence continues with 2 meters of dark grey shale, then 2 meters of bituminous hard marl and shale, and 2 meters of shale interbedded with thin beds of tough marl.

The upper portion includes 6 meters of marl alternating with marly limestone, 4 meters of soft dark grey shale interbedded with marl and marly limestone, and 3 meters of shale interbedded with marl that is grey in color, iron oxide-rich, and locally contains sand.

The uppermost bed of the Shiranish Formation is composed of bitumen-rich pelagic marl, notably lacking bioturbation structures such as burrows, as well as glauconitic sandstone, breccia, or conglomerate. This absence indicates a conformable transition into the overlying Tanjero Formation. The lithological boundary is defined by a shift from the pale blue to dark grey pelagic marl of the Shiranish Formation to light green and red shale interbedded with sandstone and thin limestone beds characteristic of the Tanjero Formation (Figure 5)

Figure 4. Marl, marly limestone, and shale of the Shiranish Formation.

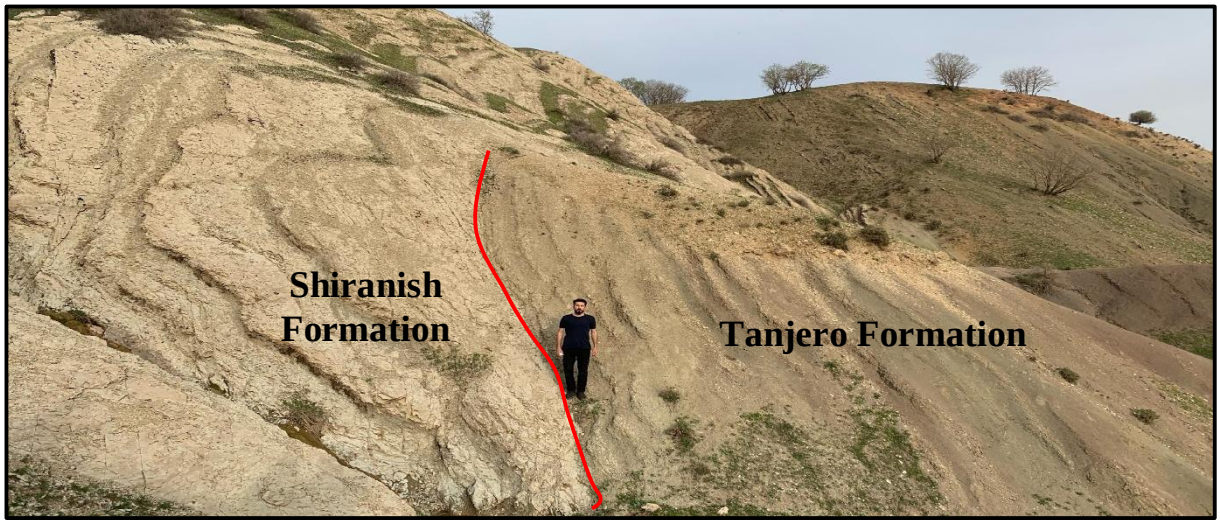

Figure 5. The contact between the marl, marly limestone, and shale of the Shiranish Formation and the green and red shale layers of the Tanjero Formation was observed at the Hizop section.

5. Biostratigraphy of the Hizop section

To establish the ages of the Kometan and Shiranish formations and analyze the nature of their contact, a detailed biostratigraphic investigation was conducted at the Hizop section. This location was chosen due to the full exposure of both formations, making it an ideal site for such a study. Systematic sampling was undertaken in the lower part of the Hizop section to collect planktic Foraminifera. Through this process, four distinct biozones were recognized, covering the upper portion of the Kometan Formation and the lower portion of the Shiranish Formation. The thickness and distribution of these biozones varied throughout the studied section. The classification of these biozones follows the framework proposed by Petrizzo et al. (2011) and includes the following:

5.1. *Globotruncana ventricosa* Interval Zone, (M. Campanian)

The *Globotruncana ventricosa* zone was first described by Dalbiez (1955) and later confirmed by Wonders (1980), Bolli, H.M., Saunders, J.B., and Nielsen (1985). Wonders (1980) and Bolli, H.M., Saunders, J.B., and Nielsen (1985) identified this zone as extending from the later part of the Early Campanian to the Late Campanian, while Sari (2006) placed it in the Middle Campanian. The *Globotruncana ventricosa* zone matches the upper part of the *Globotruncana elevata* zone as outlined by (Postuma et al., 1972) and (Sigal, 1977). It is also synonymous with the *Globotruncana stuartiformis* zone described by Obradovich (1993) and the *Globotruncana calcarata* zone identified by Bolli, H.M., Saunders, J.B., and Nielsen (1985). Furthermore, it corresponds with the *Globotruncana fornicata* zone recognized by Youkhana (1976).

This biozone is assigned to approximately 28.5 m of stratigraphy in the Hizop section, specifically within the upper part of the Shiranish Formation. It spans from the initial presence of *Globotruncana ventricosa*. The most noteworthy microfossils within this biozone are: *Globotruncana rosetta, Globotruncanita falsostuarti, Pseudoguembelina costulata, Laeviheterohelix glabrans, Rugoglobigerina rugosa, Heterohelix globulosa, Heterohelix reussi, Pseudotexlaria elegans, Rugoglobigerina hexacamerata, Globotruncana rosetta, Globotruncana linneiana, Globotruncanita stuartiformis, Globotruncana bulloides, Rugoglobigerina rugosa, Heterohelix globulosa, Heterohelix reussi, Globotruncana fornicata, Globotruncana rosetta, Rugoglobigerina hexacamerata, Pseudotextularia elegans, Pseudoguembelina costellifera, Rugoglobigerina hexacamerata, Globotruncanita elevata Muricohedbergella holmdelensis, Heterohelit reuissi, Laeviheterohelix glabrans, Planoglobulina acervulinoides, Globotruncana linneiana* (d' Orbigny), *Globotruncanita stuartiformis* (Dalbiez), *Globotruncana ventricosa* (White), *Globotruncanita elevata* (Brotzen), and *Pseudotextularia* sp. (Figures 7 & 8). Therefore, the age of this zone is determined as Middle Campanian **(**Figure 6).

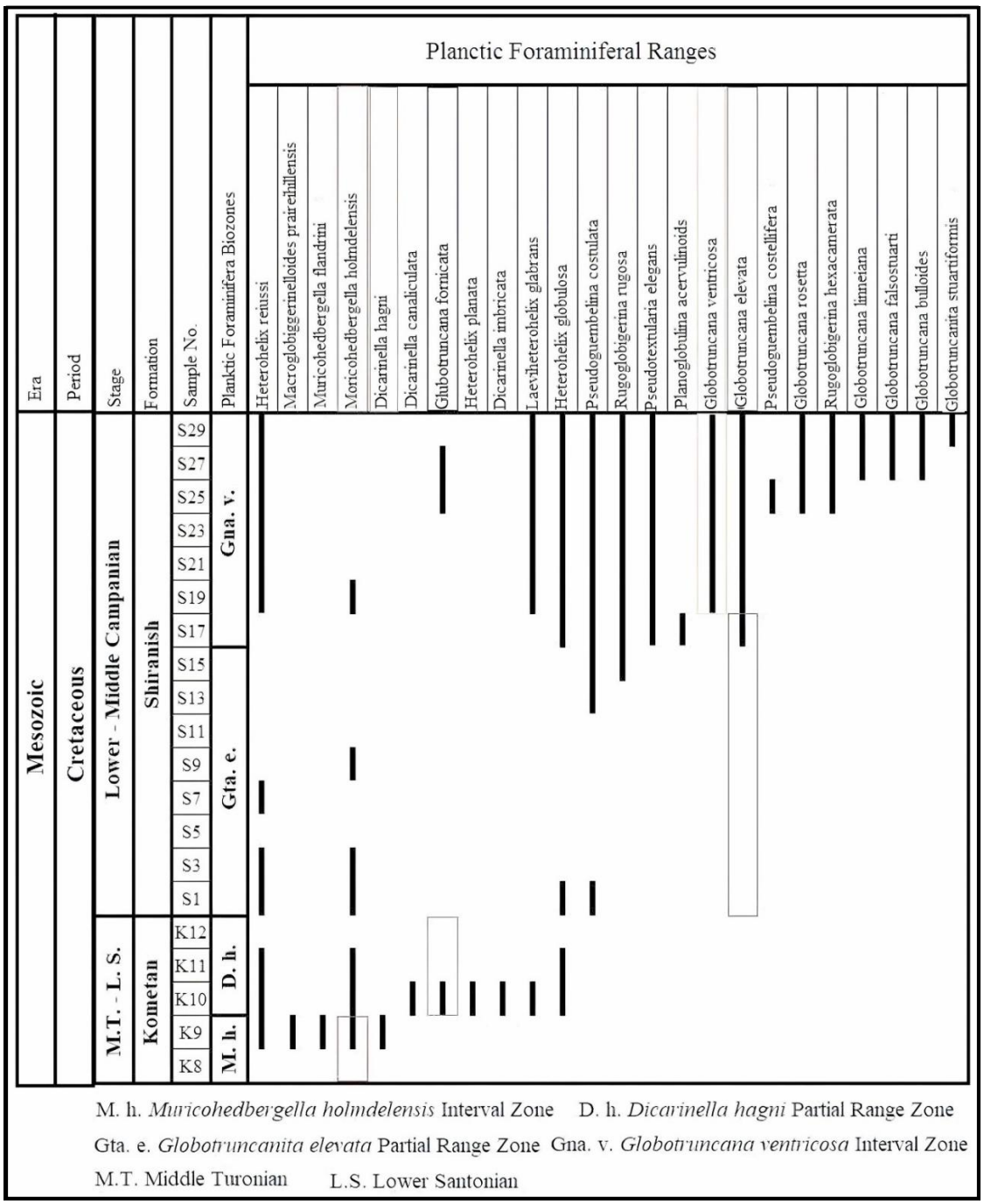

Figure 6. The range chart displays the biozonation of planktic foraminiferal ranges and their datums to identify the age of the Kometan and the Shiranish formations in the Hizop section.

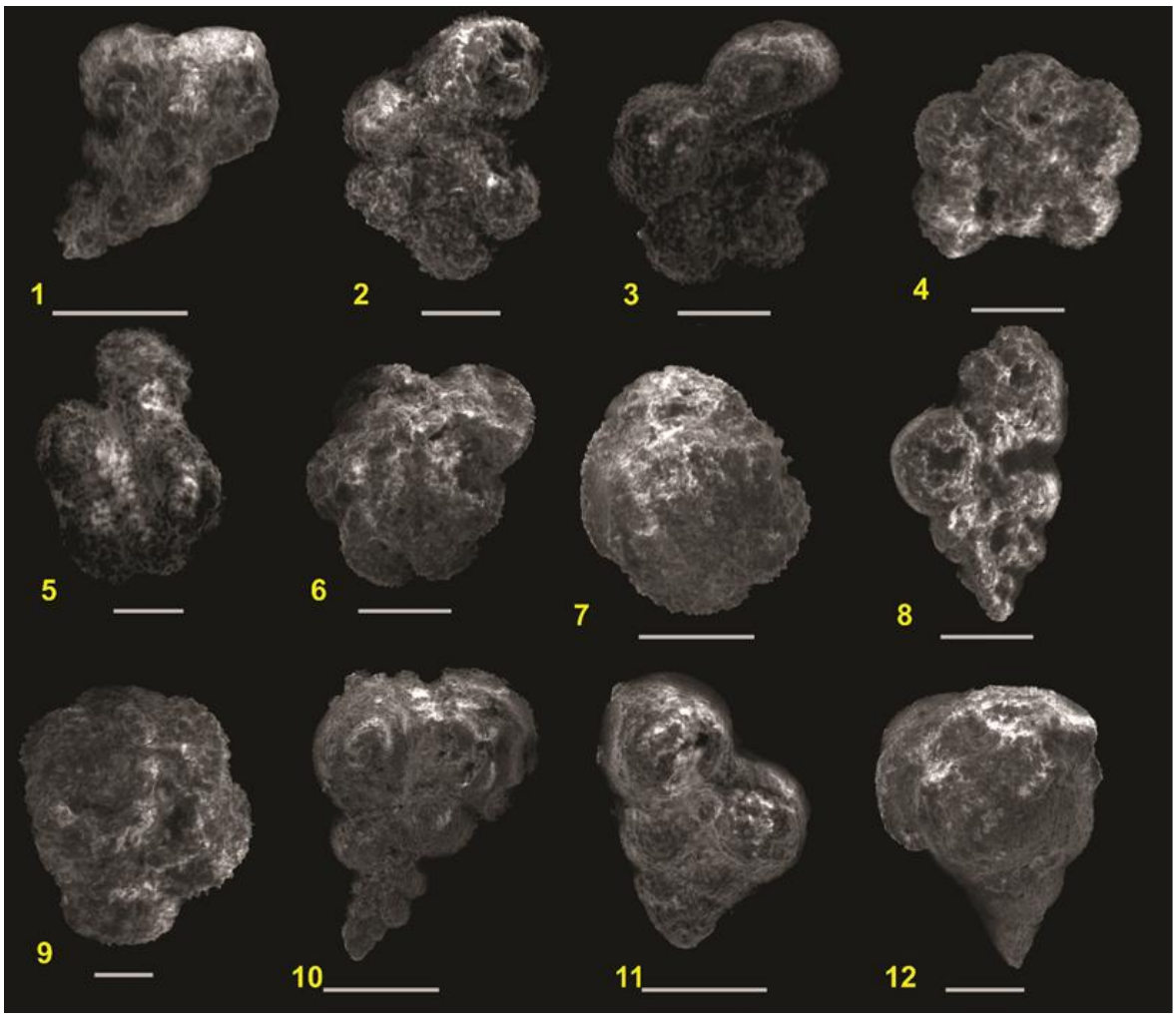

Figure 7. Zonal Species of Planktic Foraminifera from this study. 1) *Heterohelix reussi,* scale bar: 50µm. 2) *Macroglobigerinelloides praireihillensis* (Pessagno, 1967), scale bar: 50µm. 3) *Muricohedbergella flandrini* (Porthault, in Donze et al., 1970), scale bar: 50µm. 4) *Muricohedbergella holmdelensis* (Olsson 1964), scale bar: 50µm. 5) *Dicarinella hagni* (Scheibnerova, 1962), scale bar: 50µm. 6) *Dicarinella canaliculata* (Reuss 1854), scale bar: 100µm. 7) *Globotruncana fornicate* Plummer 1931, scale bar: 100µm. 8) *Heterohelix planata* (Cushman, 1938), scale bar: 100µm. 9) *Dicarinella imbricate* (Mornod, 1950), scale bar: 50µm. 10) *Laeviheterohelix glabrans* (Cushman, 1938), scale bar: 100µm.11) *Heterohelix globulosa* (Ehrenberg, 1840), scale bar: 100µm. 12) *Pseudotextularia elegans* (Rzehak, 1891), scale bar: 100µm.

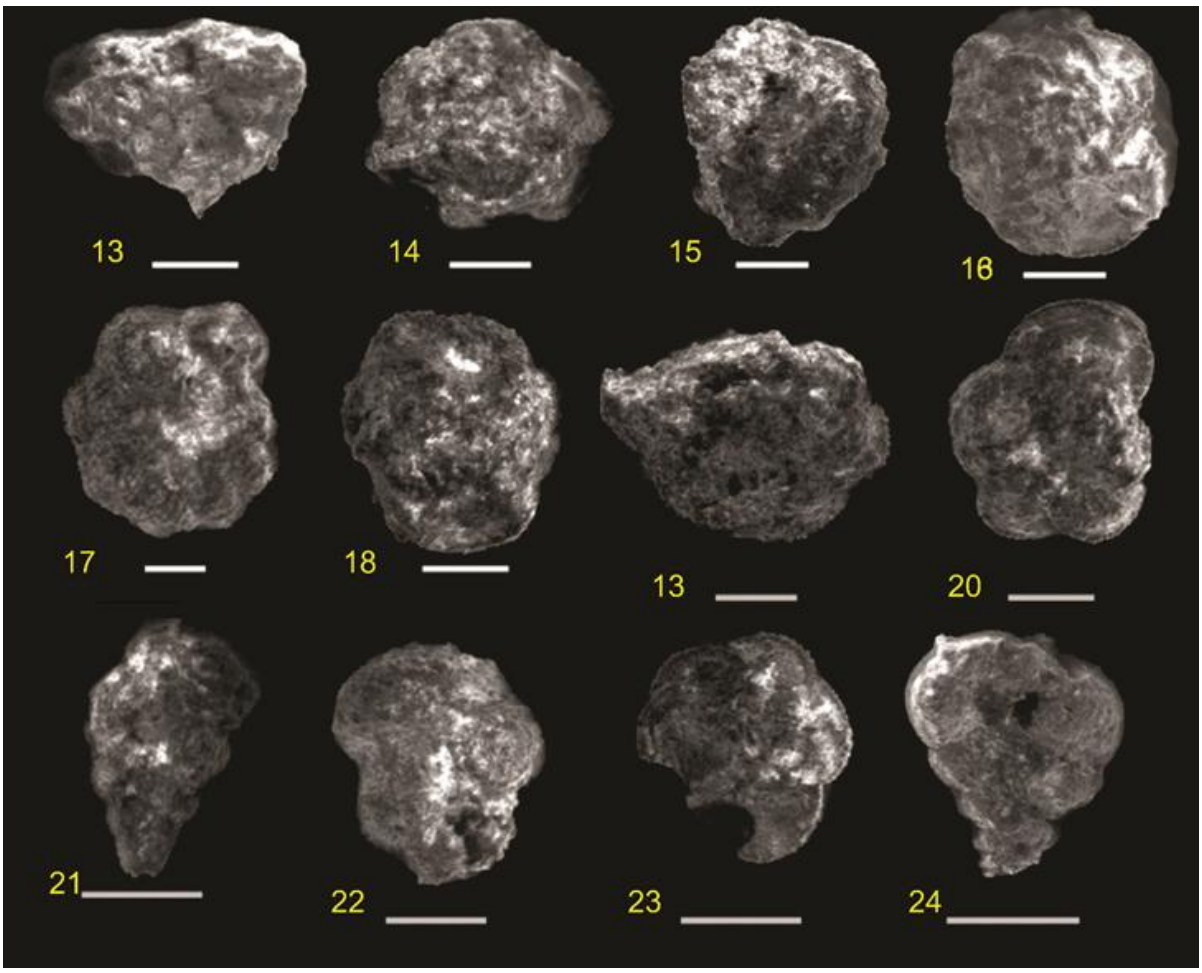

Figure 8. Zonal Species of Planktic Foraminifera from this study. 13) Planoglobulina acervulinoides (Egger, 1900), scale bar: 100µm, 14) Globotruncana ventricosa (White, 1928), scale bar: 100µm, 15) *Globotruncanita elevata* (Brotzen, 1934), scale bar: 100µm, 16) Globotruncana falsostuarti Sigal, 1952, scale bar: 100µm, 17) Rugoglobigerina hexacamerata Brönnimann, 1952, scale bar: 50µm, 18) Globotruncana rosetta (Carsey, 1926), scale bar: 100µm. 19) Globotruncana linneiana (d'Orbigny 1839), scale bar: 100µm. 20) Globotruncana bulloides Vogler, 1941, scale bar: 100µm. 21) Pseudoguembelina costellifera Masters 1976, scale bar: 100µm. 22) Rugoglobigerina rugosa (Plummer, 1927), scale bar: 100µm. 23) Globotruncanita stuartiformis (Dalbiez, 1955), scale bar: 100µm. 24) Pseudoguembelina costulata (Cushman, 1938), scale bar: 100µm.

5.2. *Globotruncanita elevata* Partial Range Zone, (E. Campanian)

The *Globotruncanita elevata* biozone is characterized by a significant presence of *globotruncanids* and *heterohelicids*, which are the predominant and abundant species defining this zone. Within the Hizop section, this biozone spans approximately 29.5 m of strata, encompassing sample numbers S-1 to S-15 in the Shiranish Formation. The assemblage in this zone primarily includes *Globotruncana elevate*, with rare occurrences of *Rugoglobigerina rugose*, and very rare instances of *Pseudoguembelina costulata*. Additionally, rare benthic

foraminifera and very rare *Muricohedbergella holmdelensis, Heterohelix reussi, Heterohelix globulosa,* and *Pseudoguembelina constulata* are found (Figures 7 & 8).

This zone corresponds to the *Globotruncana elevata* Zone as defined by J. Hardenbol, T. Jacquin (1997), Bolli, H.M., Saunders, J.B., and Nielsen (1985), and Sliter (1989 and 1995). It is also consistent with Al-Khafaf's findings on the stratigraphy of the Late Cretaceous Kometan Formation in the Dokan-Endezah area, northeastern Iraq (Hammoudi R.A., 1995; Abawi, T.S. & Hammoudi, 1997). Furthermore, it correlates with the assemblage zones of *Globotruncana fornicata, G. elevata, and G. stuartiformis,* as described by Al-Temmemy (1986) in northern Iraq. Therefore, this zone is assigned an Early Campanian age (Figure 6).

5.3. *Dicarinella hagni* Partial Range Zone, (L. Santonian)

The *Dicarinella hagni* zone was originally described by Scheibnerov (1962). This zone is described by the initial presence of *Dicarinella hagni* to the initial appearance of *G. Ventricosa*. *G. Ventricosa* is present from the lower part to the upper part of the measured section. In the Hizop section, this biozone spans approximately 4 m of stratigraphy and extends from K-8 to K-9 within the Kometan Formation. The prominent microfossils found in this biozone include *Muricohedbergella holmdelensis, Heterohelix globulosa, Heterohelix reussi, Dicarinella canaliculata, Globotruncana fornicata, Heterohelix planata, Dicarinella imbricata,* and *Laeviheterohelix glabrans* (Figure 7). This biozone's age has been identified as Early Santonian (Figure 6).

5.4. Muricohedbergella holmdelensis Interval Zone, (M.Turonian)

The *Muricohedbergella holmdelensis* zone was originally defined by Olsson (1964). This zone is characterized by the initial appearance of *Dicarinella hagni* to the initial appearance of *Globotruncana fornicata*. It spans about 4 meters of stratigraphy in the Hizop section, ranging from K-23 to K-24. Key microfossils observed in this biozone include *Heterohelix reussi, MacroGlobigerinelloides praireihillensis, Muricohedbergella flandrini, Muricohedbergella holmdelensis, Macroglobigerinelloides prairehillensis, and Dicarinella hagni* (Figure 7). The age attributed to this biozone is the Middle Turonian (Figure 6).

By merging these four zones and establishing a biostratigraphic zonation in the Hizop region, the upper portion of the Kometan Formation is most likely Middle Turonian-Early Santonian in age. Furthermore, the age of the lower part of the Shiranish Formation was Early-Middle Campanian in age (Figure 6). There is a gap during the Middle-Late Santonian time, indicating that the Shiranish Formation lies on top of the Kometan Formation in the Hizop section, which is a disconformable conformity.

6. Microfacies Analysis

Microfacies analysis plays a vital role in identifying depositional environments, establishing correlations, and understanding the formation itself. In this study, the microfacies of the

Kometan and Shiranish formations were examined using a polarizing microscope. To classify the microfacies and interpret their depositional settings, we applied the Dunham classification system for carbonate rocks. This system facilitated the identification of specific microfacies, which were then compared to the standard microfacies defined by Flugel (2010a).

Through detailed examination and accurate identification of the components in the thin sections, two microfacies were identified in the Kometan Formation (K1 and K2). In the Shiranish Formation, three microfacies were observed (S1, S2, and S3) as detailed below:

6.1. Microfacies Analysis of the Kometan Formation:

The following microfacies have been recognized within the Kometan Formation:

6.1.1. Bioclastic packstone sub-microfacies (K1)

This submicrofacies is observed in the upper part of the Kometan Formation, close to its boundary with the Shiranish Formation at the Hizop section. It is primarily composed of bioclasts and various foraminiferal forms (Figure 9a, b, c, d, e, & f), all set within a micritic matrix. Diagenetic alterations present in this submicrofacies include micritization, silicification, cementation, and fractures filled with blocky cement. The abundance of bioclasts and the diversity of foraminifera suggest deposition in open marine environments such as deep shelf, slope, and basin settings, as outlined by Flugel (2010). This submicrofacies corresponds to SMF (3) of (Wilson, 1975), associated with basinal environments (FZ 1) and toe-of-slope settings (FZ 3) based on (Flugel, 2010a).

6.1.2. Bioclastic Glauconitic Lime Packstone to Grainstone submicrofacies (K2)

This submicrofacies is recognized in the lower part of the Kometan Formation at the Hizop section. It consists of around 30% bioclastic material, approximately 25% subrounded to rounded coarse sand-sized glauconite grains, and a range of benthic foraminifera (Figure 9g, h, & i). Some grains are surrounded by micritic envelopes, which have led to partial dissolution. All components are embedded within sparry calcite cement. Diagenetic features commonly observed include micritization, compaction, and recrystallization. The combination of bioclastic fragments, glauconite grains, and diverse benthic foraminifera indicates deposition in basinal settings, as described by Flugel (2010a). This submicrofacies corresponds to SMF 14 of (Wilson, 1975), associated with deep shelf and basinal environments (FZ 2 and FZ 1) according to (Flugel, 2010).

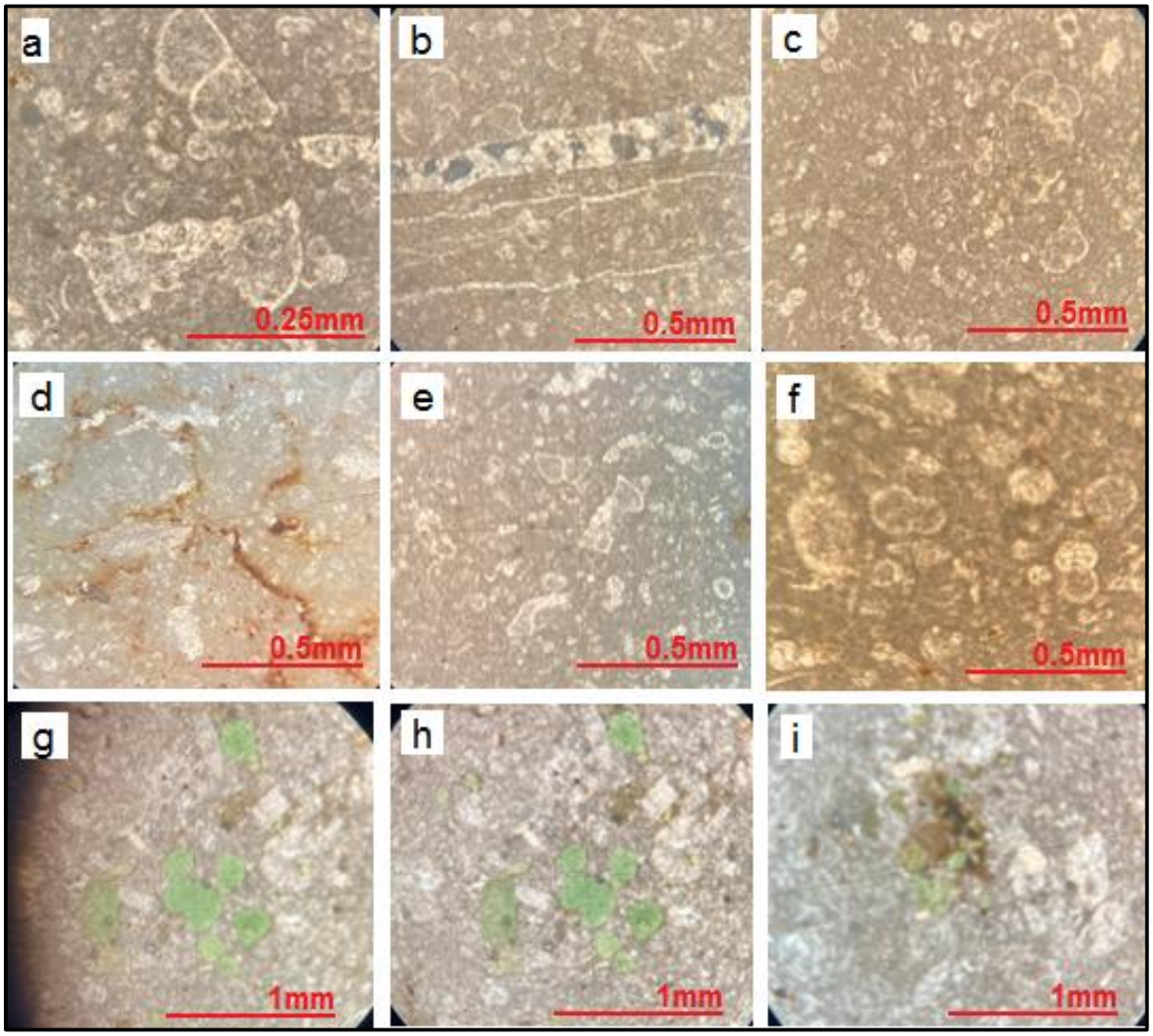

Figure 9. Microfacies Analysis of the Kometan Formation, (a, b, c, d, e & f) Bioclastic packstone submicrofacies (K1) in the Hizop section, SN. 4, 5, 6 & 7. (g, h & i) Bioclastic Glauconitic Lime Packstone to Grainstone submicrofacies (K2), in the Hizop Section, S.N. 1 & 2.

6.2. Microfacies Analysis of the Shiranish Formation

6.2.1. Globigerinelloides Wackstone-Packstone submicrofacies (S1)

This submicrofacies is commonly found in the upper part of the Shiranish Formation at the Hizop section. It consists of approximately 25% *Globigerinelloides*, 15% various foraminifera, and about 2% glauconite, all set within a micritic matrix (Figure 10a, b, c, & d). With a thickness of around 15 meters, it directly overlies the *Globigerinelloides* packstone located in the middle portion of the Shiranish Formation. Notable diagenetic features include micritization, oxidation, pyritization, fossil infilling with granular cement, and compaction. The abundance of *Globigerinelloides* suggests deposition in deep shelf to basinal limestone environments, in line with Flügel (2010). According to Wilson (2010), this submicrofacies corresponds to Standard

Microfacies (SMF 3) and Basin Facies Zone (FZ 1-B), while Flugel (2004) also associates it with open deep shelf environments (FZ 3).

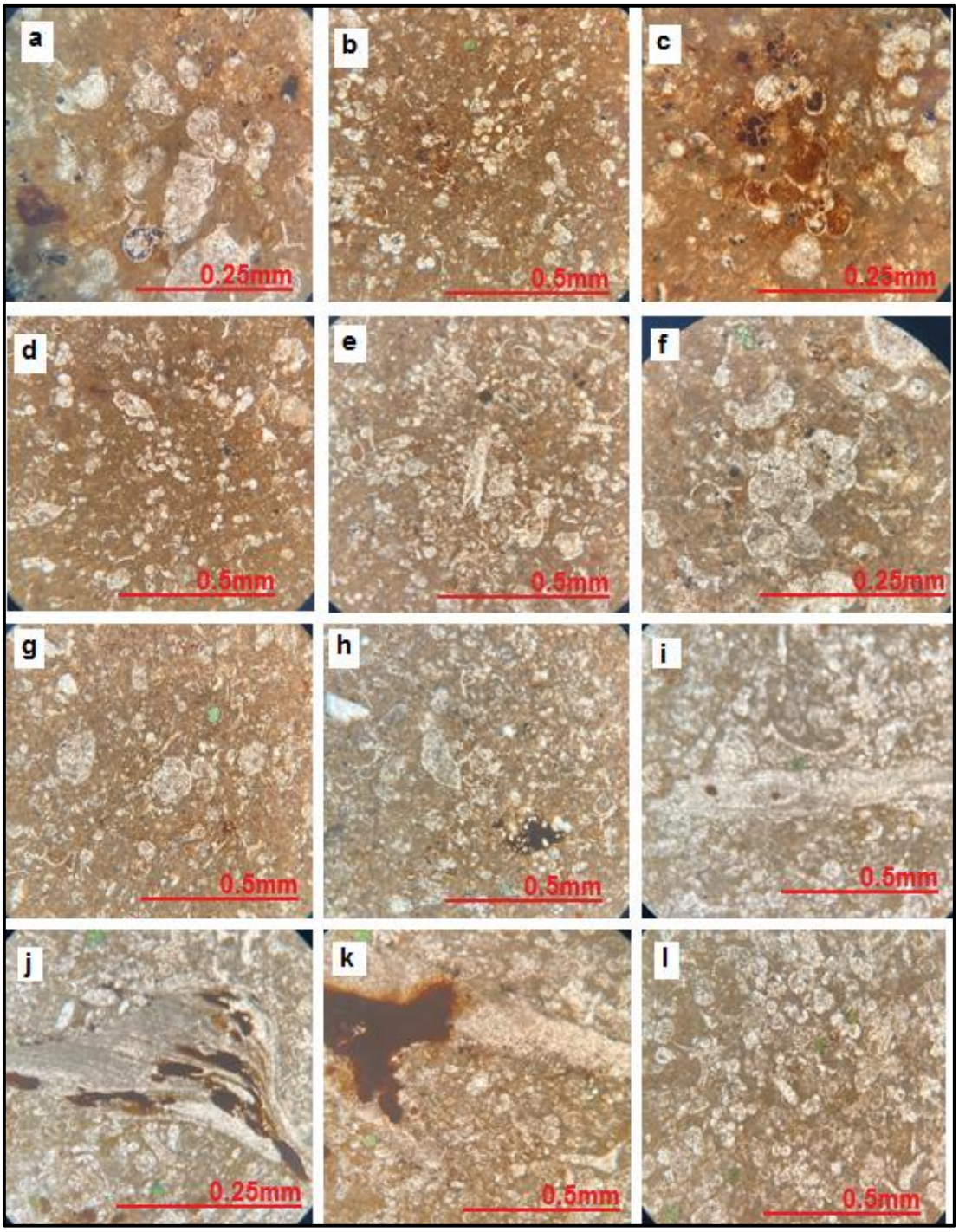

Figure 10. Microfacies Analysis of the Shiranish Formation. (a, b, c & d) *Globigerinelloides* Wackstone-Packstone submicrofacies (S1) in the Hizop section, S.N. 10, 11, 12) (e, f, g & h): *Globigerinelloides* Packstone submicrofacies (S2) in the Hizop section, S.N. 13, 14, 15) (I, j, k & l): Foraminiferal Packstone-Grainstone submicrofacies (S3) in the Hizop section, S.N. 16, 17, &18.

6.2.2. Globigerinelloides Packstone submicrofacies (S2)

This submicrofacies occurs in the middle part of the Shiranish Formation at the Hizop section. It is composed of roughly 25% *Globigerinelloides*, 15% assorted foraminifera, 5% glauconite, and bioclasts derived from pelecypod shells, all hosted within a micritic matrix (Figure 10e, f, g, & h). With an estimated thickness of 10 meters, it lies above the Foraminiferal Packstone-Grainstone of the lower Shiranish Formation and beneath the *Globigerinelloides* Wackestone-Packstone of the upper Shiranish Formation. Diagenetic features noted in this submicrofacies include micritization, oxidation, pyritization, granular cement (particularly filling fossil molds), and compaction. The occurrence of *Globigerinelloides* indicates deposition in deep shelf to basinal limestone environments, in accordance with (Flugel, 2010). As per Wilson (1975), this submicrofacies aligns with Standard Microfacies (SMF 3) and Basin Facies Zone (FZ 1-B), characteristic of an open deep shelf setting.

6.2.3. Foraminiferal Packstone-Grainstone submicrofacies (S3)

This submicrofacies is observed in the lower portion of the Shiranish Formation, near its boundary with the Kometan Formation at the Hizop section. It is mainly composed of a variety of planktic foraminifera, rounded medium sand-sized glauconite grains, and organic matter (Figure 10i, j, k & l), all embedded in a micritic matrix. Positioned above the bioclastic glauconitic packstone-grainstone of the Kometan Formation and beneath the *Globigerinelloides* packstone of the middle Shiranish Formation, this unit has an estimated thickness of 8 meters. Prominent diagenetic alterations include compaction and the presence of fractures filled with densely packed blocky cement. The occurrence of keeled species such as *Dicarinella imbricata*, *D. concavata*, *D. hagni*, *Marginotruncana renzi*, *M. sigali*, *M. marginata*, and *M. coronata* within the micritic matrix (refer to Figure 8) indicates a depositional environment within a relatively pelagic platform setting, as described by Flugel (2010). This submicrofacies corresponds to Standard Microfacies SMF (3) according to Wilson (1975) and to Facies Zone FZ (1) as defined by Flugel (2004).

7. Conclusion

The carbonate sequence at the Hizop section was investigated using microfacies and biostratigraphic analyses. Lithostratigraphically, the succession is composed of hard, stylolitic limestone beds containing abundant chert nodules and iron oxides, characteristic of the Kometan Formation. These rest atop light brown marly limestone and shale belonging to the Shiranish Formation. Petrographic studies reveal two dominant microfacies within the Kometan Formation: bioclastic packstone and glauconitic bioclastic lime packstone to grainstone. In contrast, the Shiranish Formation contains three distinct microfacies: *Globigerinelloides* packstone, *Globigerinelloides* wackestone, and foraminiferal packstone-grainstone. Biostratigraphic analysis has identified four key biozones: the *Globotruncanita elevata* Partial Range Zone, *Globotruncana ventricosa* Interval Zone, *Dicarinella hagni* Partial Range Zone, and *Muricohedbergella holmdelensis* Interval Zone. These zones suggest an Early to Middle Campanian age for the Kometan Formation and a Middle Turonian to Early Santonian age for

the Shiranish Formation. This age discrepancy indicates the presence of a Middle to Late Santonian hiatus, marking an unconformity between the two formations at the Hizop section in the Dokan area.

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About the author

Mr. Zahid M. Gardy is an MWD/LWD Engineer at OILSERV-Oiltech, Iraq. He received his B.Sc. in Applied Geosciences from the University of Duhok and his M.Sc. in Tectonostratigraphy from the University of Sulaimani. From 2018 to 2022, he served as a teaching assistant at the University of Duhok and Duhok Polytechnic University. His research interests focus on stratigraphy, microfacies, and depositional basin analysis of the Upper Cretaceous formations in the Kurdistan Region of Iraq, and he has co-authored publications on lithofacies and microfacies studies of Late Maastrichtian limestones.
e-mail: zahidgardy@gmail.com

Dr. Mushir Mustafa Baziany is an Assistant Professor of Geology at the University of Sulaimani, Iraq. He earned his B.Sc., M.Sc., and Ph.D. in Geology from the same University between 2006 and 2014, specializing in tectonostratigraphy. Since beginning his academic career as a lecturer assistant in 2006, he has authored over 25 scientific papers in both local and international journals. His research focuses on stratigraphy, tectonostratigraphy, and sedimentology of the Zagros Foreland Basin in Iraq.
e-mail: mushir.qadir@univsul.edu.iq

Dr. Sirwan H. Ahmed is an Assistant Professor in the Department of Earth Science and Petroleum at the University of Sulaimani. He earned his PhD in Geosciences from Sorbonne UPMC University and has published 14 peer-reviewed research papers. His primary area of expertise is tectonostratigraphy, through which he has made significant contributions to advancing the understanding of geological structures and sedimentary processes.
e-mail: sirwan.ahmed@univsul.edu.iq