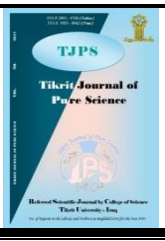
Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

TJPS

IASJ
المجلات الاكاديمية العراقية

Tikrit Journal of Pure Science
ISSN: 1813 – 1662 (Print) --- E-ISSN: 2415 – 1726 (Online)

Journal Homepage: http://tjps.tu.edu.iq/index.php



Microfacies analysis and depositional environment of Shiranish Formation in Selected Sections, Kurdistan Region, NE Iraq

Shapol Shwan Abdulhameed and Waleed S. Shingaly

Earth Sciences and Petroleum Dept., Salahaddin University-Erbil, Iraq

Keywords: Microfacies, Depositional Environment, Shiranish Formation, Smaquli, Rawanduz.

ARTICLEINFO.

Article history:

-Received:	**17 June 2023**
-Received in revised form:	**23 Aug. 2023**
-Accepted:	**24 Aug. 2023**
-Final Proofreading:	**24 Feb. 2024**
-Available online:	**25 Feb. 2024**

Corresponding Author*:
shapol.abdulhameed@su.edu.krd

ABSTRACT

Shiranish Formation in both Smaquli and Rawanduz sections is composed of an alternation of marly limestones, limestone and marl beds with fissile shale beds. Depend on color, lithology and other sedimentological criteria during field observations of the studied sections, the Shiranish Formation is divided lithologically into lower, middle and upper units. Planktonic Foraminiferal Lime Mudstone Microfacies (Shf1), Lime Wackestone (Shf2) and Planktonic Foraminiferal Lime Packstone Microfacies (Shf3) have been defined as three distinct microfacies with four submicrofacies ((Keeled Planktonic Foraminiferal Lime Wackestone submicrofacies (Shf2b), Globular Chamber Planktonic Foraminiferal Lime Wackestone submicrofacies (Shf2a), Bioclastic Lime Wackestone submicrofacies (Shf2c), Planktonic Foraminiferal Lime Wackestone submicrofacies (Shf2d)). The major microfacies in both sections was lime wackestone which is dominated in middle and upper units in both sections. Sedimentological and paleontological evidences suggest that the Formation was deposited in the outer shelf setting and progressed to the upper bathyal setting, in addition to that the microfacies changed from packstone to mudstone meaning deeping upward sequence.

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

TJPS

تحليل السحنات الدقيقة والبيئة الترسيبية لتكوين الشيرانش في مقاطع مختارة اقليم كوردستان، شمال شرق العراق.

شه بول شوان عبد الحميد، وليد سليمان شنكالي

قسم علوم الارض والنفط-كلية العلوم-جامعة صلاح الدين-أربيل

الملخص

يتكون تكوين الشـــيرانش في كل من مقطعي ســـماقولي وروانـدوز من الحجر الجيري المارلي و الحجر الجيري و المارل مع طبقات من الســـجيل. اعتمادًا على اللون الصـــخارية والمعايير الرســـوبية الأخرى أثناء العمل الحقلي و الميداني للطبقات المدروســـة ، تنقســـم التتابع الصـــخري لتكوين شيرانش إلى ثلاث وحدات (السفلية والمتوسطة والعلوية). تضمنت الدراسة الحالية ايضا تحديد السحنات الدقيقة لصخور تكوين شيرانش أنها تتكون من سحنات الحجر الجيري الطيني والحجر الجيري الواكي و الحجر الجيري المرصوص ، و تم تقسيم السحنات الرئيسة إلى سحنات ثانوية وبحسب تواجدها وانتشارها ضمن التكوين ومن ثم تحديد البيئة الترسيبية و وضع الموديل الرسوبي للتكوين، كانت السحنة الدقيقة الرئيسية في كلا المقطعين الحجر الجيري الواكي الذي يسيطر على الوحدتين الوسطى والعلوية. تشير الدلائل الرسوبية و الحياتية إلى أن التكوين قد ترسب في إعداد الرصيف الخارجي وتقدم إلى الباثيل العلوي، بالإضـافة إلى أن حجم الكائنات الدقيقة و الفتاتات و السحنات تغيرت من الحجر الجيري المرصوص إلى الحجر الجيري الطيني مما يعني تغير البيئة الى الاعمق.

1. Introduction

Henson 1940 identified the Shiranish Formation for the first time near the village of Shiranish Islam, northeast of Zakho in Northern Iraq [1]. This formation is the lower part of a regional transgressive-regressive depositional series in the Upper Cretaceous (Campanian and Maastrichtian) that flooded nearly all of Iraq [2].

Due to the lack of late Maastrichtian sediments in the Shiranish area, the formation's type locality provides the possibility of dating the Shiranish Formation to the Late Campanian-Maastrichtian [3]. In the Sinjar area, the upper Shiranish Formation can be dated to the Late Maastrichtian [4]. Based on foraminifera discovered in the Hujran region, the Shiranish Formation's age can be stretched to the Paleocene [5; 6].

Overall, Shiranish Formation is a significant geological formation in northern Iraq that has been the subject of a number of investigations and researches that aimed in revealing its depositional setting, paleoenvironment, and diagenetic conditions.

1.1. Aim of the Study

The main aims for studying these two new sections are to discuss the geology, lithology, sedimentology of the upper Cretaceous Shiranish Formation, and to determine the sedimentary properties and depositional environment of a marl, marly-limestone and limestone units that occur within this Formation.

1.2. Location of Studied Sections

The studied sections are located around the Jali Dam (1st section) in the Smaquli area, and Banazok area around Rawanduz town (2nd section) both sections are in Erbil Governorate, Iraqi Kurdistan Region (Fig.1).

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

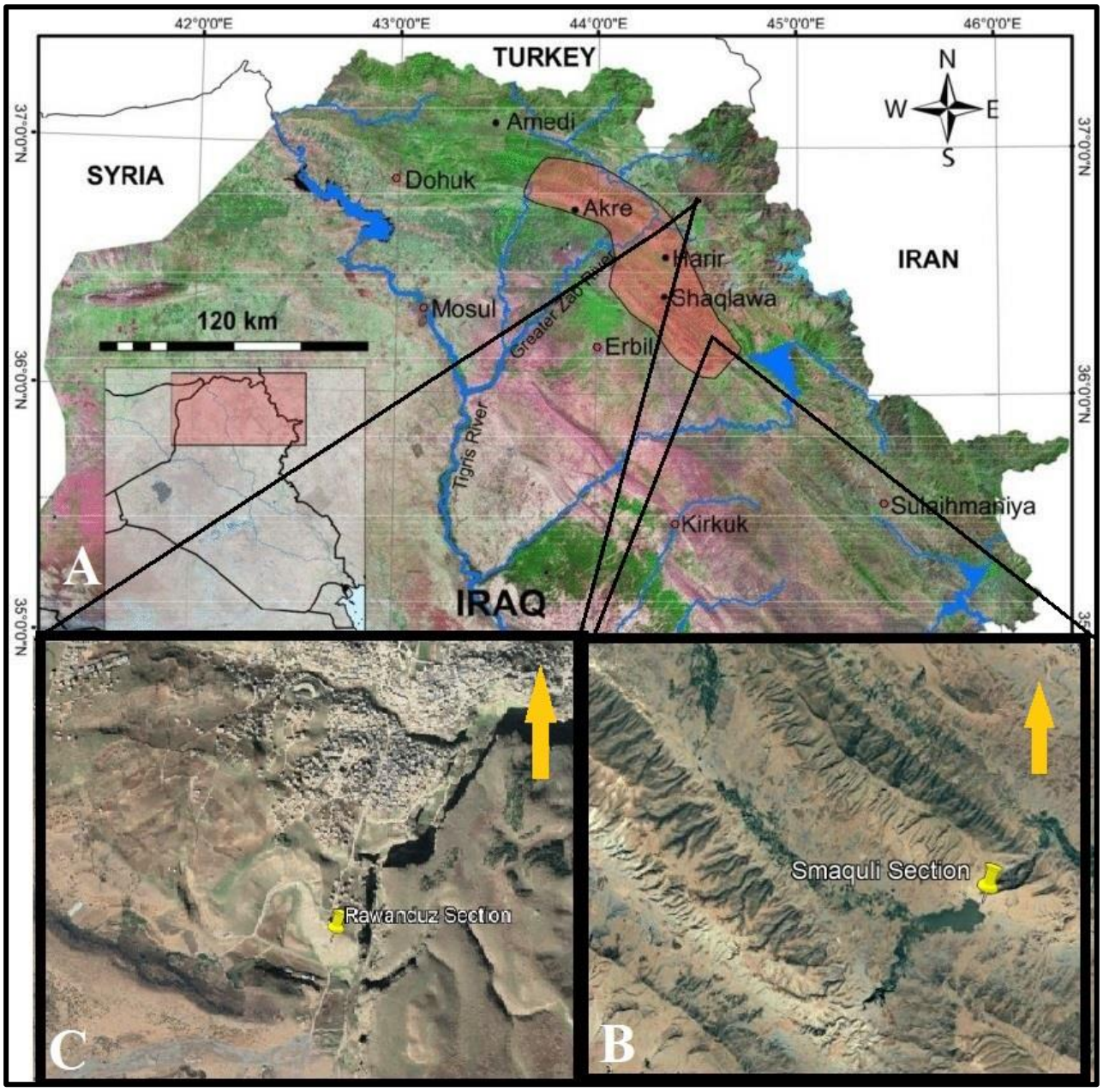


Fig.1 A: Location map of Northern Iraq showing studied sections modified from [7], B: Smaquli Section, C: Rawanduz Section

1.3. Geological Setting

The studied sections of Shiranish Formation are located in the High Folded Zone (HFZ). The HFZ is a component of the Western Zagros Fold-Thrust Belt [8] (Fig.2). Thus, in addition to the form of exposed rocks and climatic environments, tectonic and structural influences have formed the major geomorphologic units and geodynamic processes. The High Folded Zone has a width of 25 to 50 kilometers. The area is composed of sedimentary rocks dating from the Triassic to the Pliocene, as well as different forms of Quaternary sediments [9; 10]. Structurally, the first studied section is located at High Folded Zone near the boundary between High Folded and Low Folded zones, but the second studied section is located at the boundary between High Folded and Imbricate zones [11; 12; 13]. The first Zagros Foreland Basin was created initially when the basin of the Shiranish Formation, which was located below, merged with the basin of the Tanjero Formation, which was located above [14]. The majority of the region is made up of anticlines and synclines that have a high amplitude and trend in the same direction (northwest to southeast). Many of the anticlines are asymmetrical, with the limbs that are located to the southwest being steeper than the ones that are located to the northeast. The cores of certain anticlines are

composed mostly of carbonates and include outcrops of Cretaceous rocks, while the synclines in the surrounding area are filled with Tertiary rocks that are composed of clastic sediments and carbonates.

2.Method and Materials

For this investigation of the Shiranish Formation, fieldwork was conducted at the end of summer 2021 in order to select the suitable outcrops. Lower and upper contacts were detected. More than seventy limestone, marly limestone, and marl hand specimens were obtained. Based on vertical facies variations, 52 samples (24 in Smaquli and 28 in Rawanduz) were collected for thin section petrographic examination. Carbonates were petrographically analyzed using thin sections preparation at Salahaddin University's College of Science and the Faculty of Science at Urmia University in Iran. To identify and distinguish calcite and dolomite, thin sections were coated with Alizarin Red 'S' Solution using Friedman's (1959) technique. Facies were classified using Dunham [15] categorization method.

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

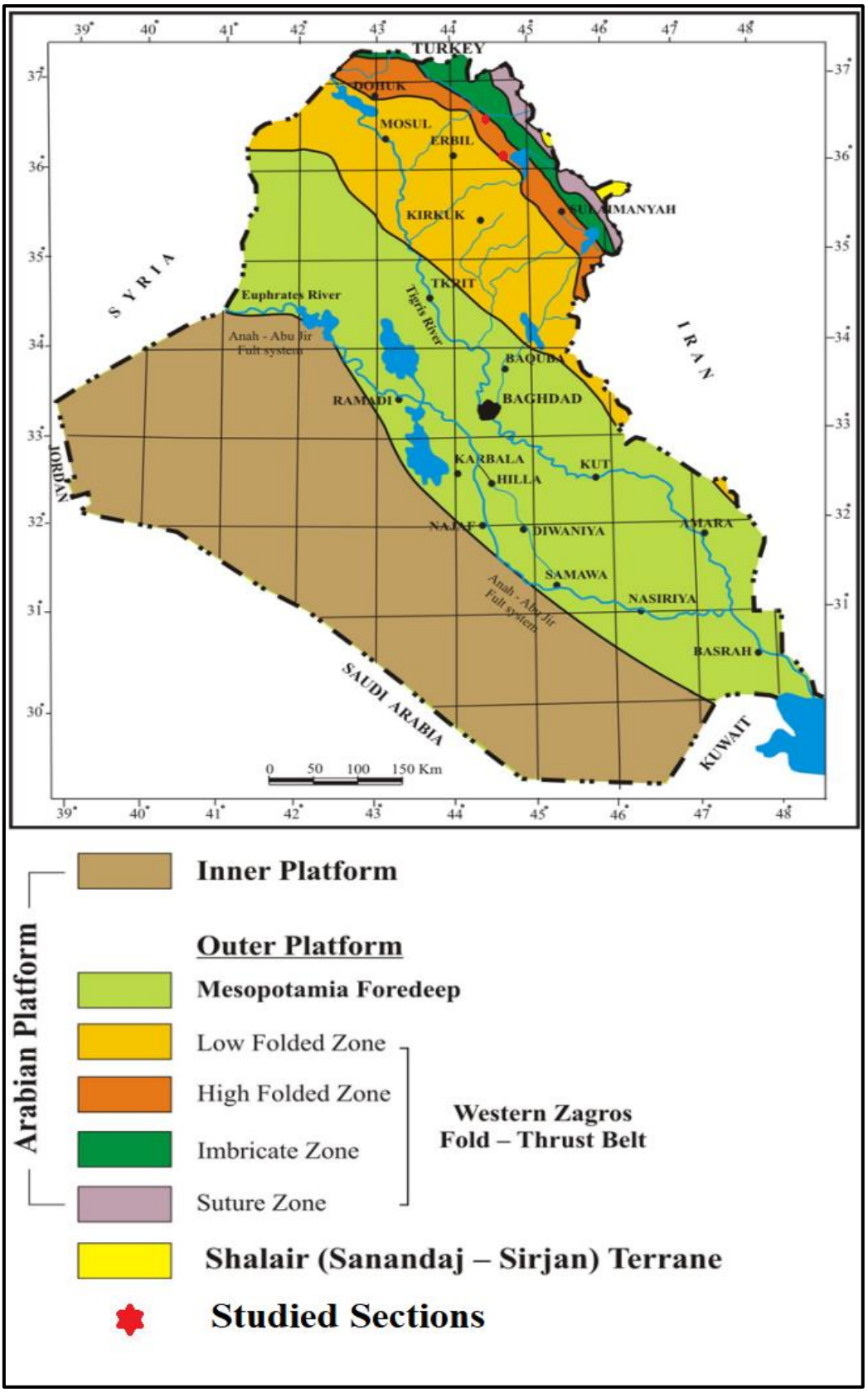


Fig.2 Tectonic map of Iraq showing studied sections [8]

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494
TJPS

3.Result and Discussion

3.1. Lithology

Depend on color, lithology and other sedimentological criteria during field observations of the studied sections we can divided Shiranish Formation's lithology to three units in each section as follows:

- **Smaquli Section:** The thickness of Shiranish Formation in this section is about 136 m and consist of Limestone, Marly limestone and Marl (Fig.3A,4A,4B and 6) as follow:
- **Lower unit:** Alternation between limestone and marly limestone light yellow in color, soft and medium to thick beds, the thickness of limestone beds are from 25 cm to 40 cm while the thickness of marly limestone beds are thinner from 5 cm to 20 cm the overall thickness of this unit is about 36m.
- **Middle unit:** This unit consist of limestone, marly limestone light yellow in color, hard and medium to thick beds with soft beds of bluish grey marl and beds of fissile shale dark grey in color, the thickness of limestone and marly limestone beds ranging from 15 cm to 50 cm while the thickness of marl beds in this unit 50 cm and thickness of shale is about 2 m, the overall thickness of this unit is about 60m.
- **Upper unit:** This unit consist of yellow to light brown hard marly limestone with soft bluish grey marl and thick beds of limestone the overall thickness of this unit is about 40m.
- **Lower boundary:** The lower contact of Shiranish Formation is conformable contact with Bekhma Formation.
- **Upper boundary:** The upper contact of Shiranish Formation is gradational contact with Tanjero Formation.
- **Rawanduz Section:** The thickness of Shiranish Formation in this section is about 157m and consist of Limestone, Marly limestone and Marl (Fig.3B,5A,5B and 7) as follow:
- **Lower unit:** Alternation between limestone and marly limestone light yellow in color, soft and medium to thick beds, the thickness of limestone beds are from 25 cm to 40 cm while the thickness of marly limestone beds are thinner from 5 cm to 20 cm the overall thickness of this unit is about 37m.
- **Middle unit:** This unit consist of limestone, marly limestone light yellow in color, hard and medium to thick beds with soft beds of bluish grey marl and beds of fissile shale dark grey in color, the thickness of limestone and marly limestone beds ranging from 15 cm to 50 cm while the thickness of marl beds in this unit 50 cm the overall thickness of this unit is about 70m.
- **Upper unit:** This unit consist of yellow to light brown hard marly limestone with soft bluish grey marl and thick beds of limestone, the overall thickness of this unit is about 50m.
- **Lower boundary:** The lower contact of Shiranish Formation is conformable contact with Bekhma Formation.
- **Upper boundary:** The upper contact of Shiranish Formation is gradational contact with Tanjero Formation.

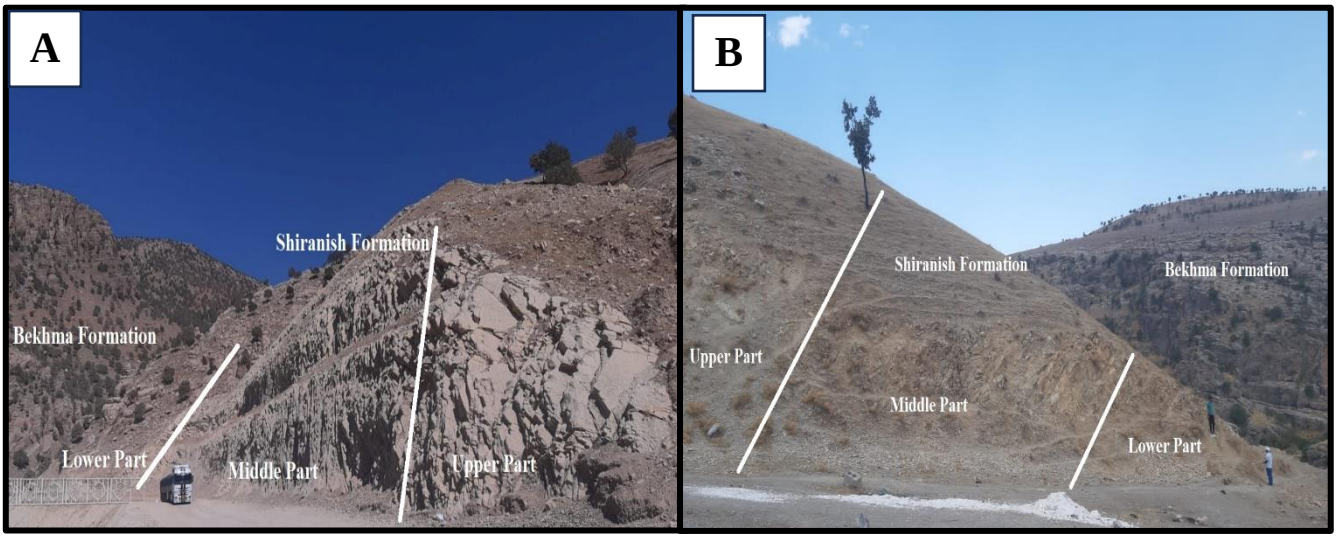


Fig.3 Field photograph showing A: outcrop of Shiranish Formation in Smaquli Section and B: Outcrop of Shiranish Formation in Smaquli and Rawanduz Sections

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494
TJPS

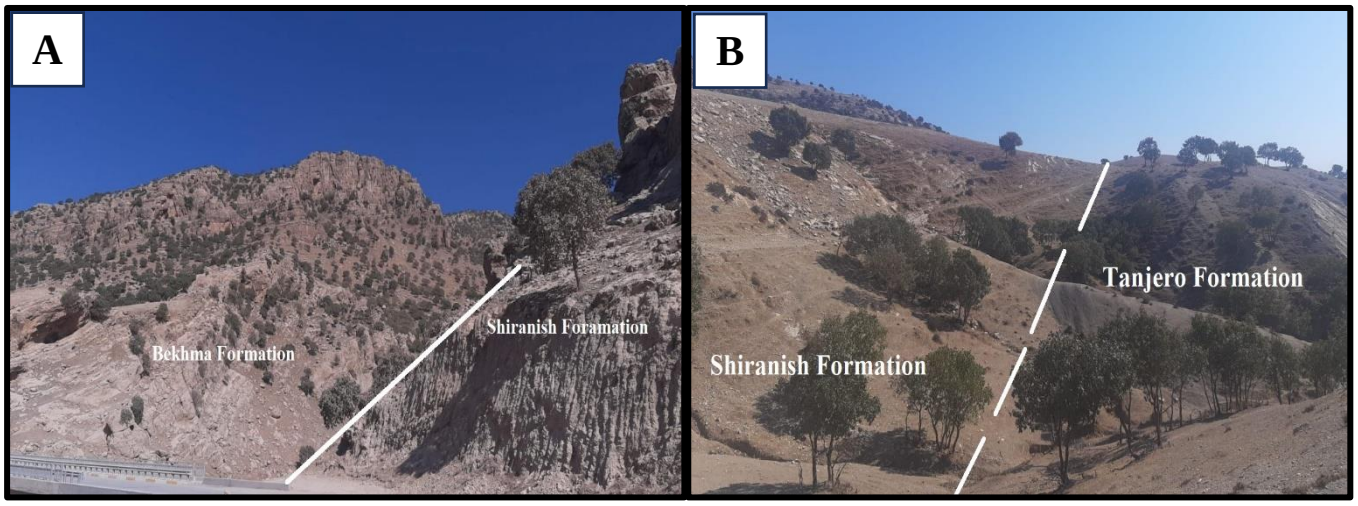


Fig.4 Field photograph showing A: Lower contact of Shiranish Formation in Smaquli Section and B: Upper contact of Shiranish Formation in Smaquli Section

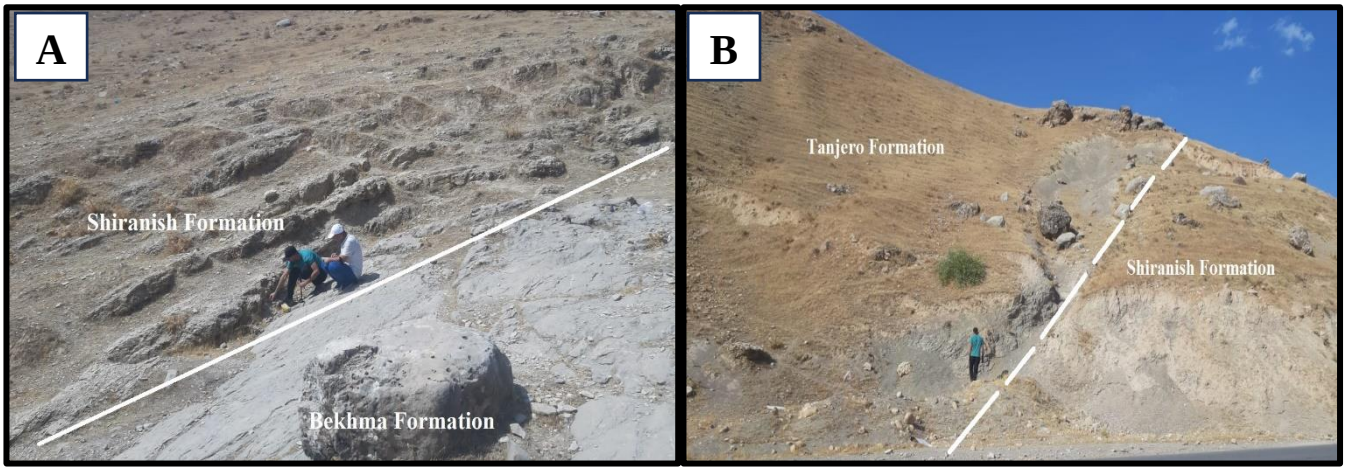


Fig.5 Field photograph showing A: Lower contact of Shiranish Formation in Smaquli Section and B: Upper contact of Shiranish Formation in Rawanduz Section

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

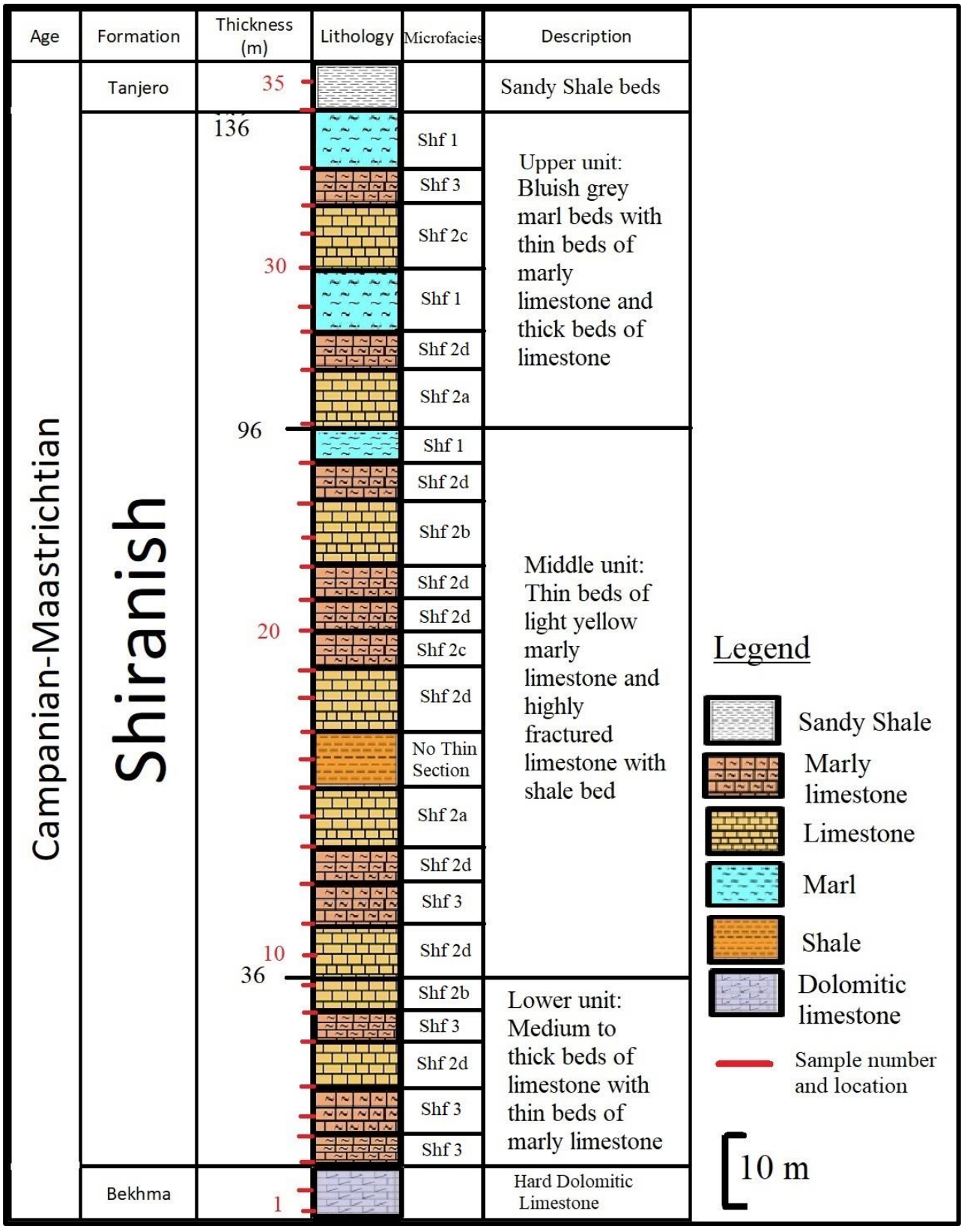


Fig.6 Stratigraphic column of Shiranish Formation of Smaquli Section.

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

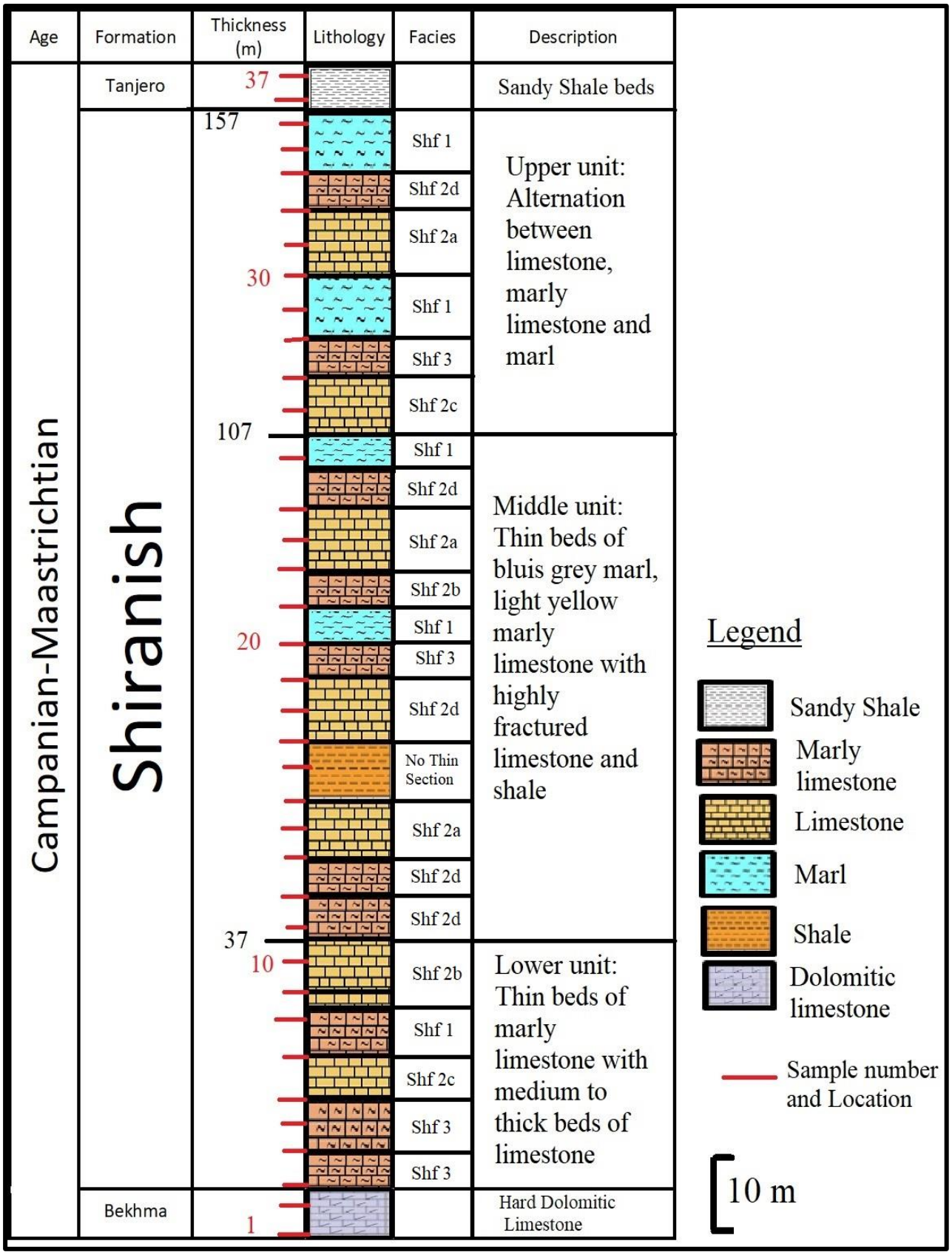


Fig.7 Stratigraphic column of Shiranish Formation of Rawanduz Section.

3.2. Microfacies Analysis

The Shiranish Formation is divided into three primary microfacies, which are designated as Shf1–Shf3, together with various submicrofacies represent the paleoecology and bathymetry of the Formation.

Planktonic Foraminiferal Lime Mudstone Microfacies Shf1: This facies allochems represent fewer than 10% of the total facies content and are dominated by globular planktonic foraminifera such as *Heterohelix*, *Globigerinelloides*, *Rugoglobigerina*, and *Hedbergella*, as well as benthonic foraminifera and echinoderm spines (Fig. 8A). Based on an increase in the ratio of *Heterohelix* to *Globigerinelloides* species, the matrix is composed of micrite with foraminiferal chambers filled with microspare cement or iron oxide as an oxidation product of the facies' mid-outer shelf depositional environment [16; 17]. This submicrofacies matches the (SMF3) of [18; 19] and (FZ2) of [20].

Lime Wackestone Microfacies Shf2: The major microfacies type in Shiranish Formation samples from the lower and middle units. The Shiranish Wackestone is made up of a diversity of planktonic foraminifers within a neomorphosed micritic matrix and is usually yellow to light brown, occasionally light grey. It is classified into three sub-microfacies:

Keeled Planktonic Foraminiferal Lime Wackestone submicrofacies Shf2a: *Globotruncana*, *Globotruncanella*, and *Globotruncanita*, keeled types of planktonic foraminifera, make up the majority of the allochems. They make over 75% of the entire population of planktonic foraminifers. These genera are healthy and of average size. Benthonic foraminifera and rare globular planktonic foraminifera were also detected. With water depths ranging from 150 to 300 m, this facies is likely to have evolved in an outer-shelf to upper-bathyal environment. The range of planktonic foraminifera and the keeled/globular ratio, which rose or decreased according to the facies' transgressive or regressive development, serve as the bounds for these ranges [16; 21] (Fig. 8 B). This submicrofacies matches the (SMF3) of [18; 19] and (FZ2) of [20].

Globular Chamber Planktonic Foraminiferal Lime Wackestone submicrofacies Shf2b: Allochems account for about 20% to 50% of the total microfacies content (Fig. 5b), and include planktonic foraminifer a (*Globotruncaniella sp., Heterohelix sp., and Globigerinelloides*). Micrite constitutes the majority of the matrix in the wackestone. Any forams' chambers are fully filled with microsparite. The paleontological mark for this microfacies pointed to the facies's outer shelf conditions [17] (Fig. 8 C). This submicrofacies matches the (SMF3) of [18; 19] and (FZ2) of [20].

Bioclastic Lime Wackestone submicrofacies Shf2c: Allochems comprise approximately 20% to 30% of the overall microfacies content, and composed of planktonic foraminifera, few benthic foraminifera, ostracods, echinoderm and bivalve. The SMF3 (Mixed Bioclastic Mudstone Microfacies) of facies zone 1 may be associated with the microfacies, which in general imply a deep basinal reducing environment [18; 19] (Fig. 8 D). This submicrofacies matches the (SMF3) of [18; 19] and (FZ2) of [20].

Planktonic Foraminiferal Lime Wackestone submicrofacies Shf2d: This microfacies type predominate in the middle and upper units of the Formation, and composed of a variety of planktonic with few benthic foraminifera, a few ostracods and bivalves which embedded in a micritic matrix. planktonic foraminifera represented by the genera (*Hedbergella, Heterohelix Globotuncana, and Globigerinelloides*). The Shiranish wackestone is light grey in color, although it may also range in color from yellow to brown. This submicrofacies matches the (SMF3) of [18; 19] and (FZ2) of [20] and deposited in an open deep shelf setting (Fig. 8 E).

Planktonik Foraminiferal Lime Packstone Microfacies Shf3: The bottom unit of the Shiranish Formation is where this microfacies is most prevalent. Allochems account for 80% of the overall composition of the brown to light brown marly limestone that makes up this facies. They are mostly planktonic foraminifera, including *Globigerinelloides*, *Globigerinella*, *Globigerinita*, *Globotruncana*, Rosita, *Gansserina*, *Heterohelix*, and *Hedbergella*. There are also bits of shell and a few benthonic foraminifera (Fig.8F). This submicrofacies matches the (SMF3) of [18; 19] and (FZ3) of [20].

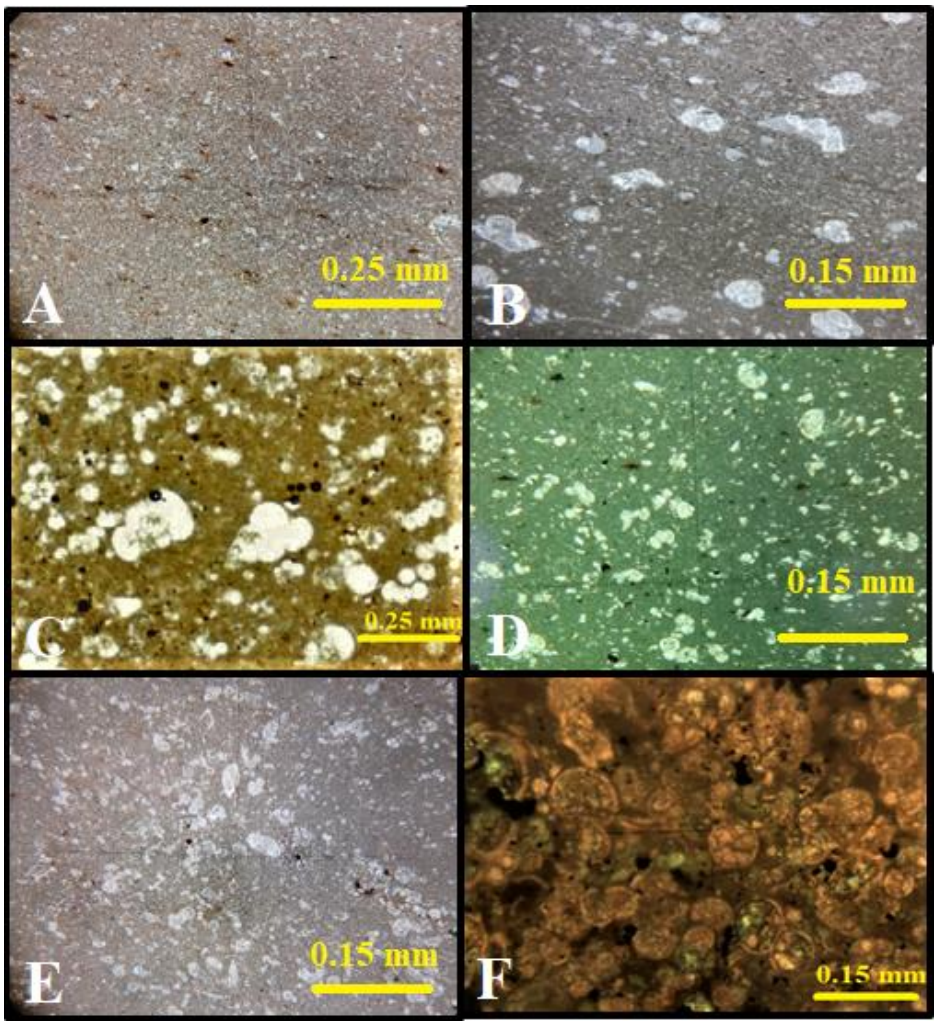


Fig. 8 A. Planktonic foraminiferal lime mudstone microfacies, **B.** Keeled planktonic foraminiferal lime wackestone microfacies, **C.** Globular chamber planktonic foraminiferal lime wackestone submicrofacies, **D.** Bioclastic lime wackestone submicrofacies,
E. Planktonic foraminiferal Lime wackestone submicrofacies, **F.** Planktonic foraminiferal lime Packstone microfacies

Tikrit Journal of Pure Science (2024) 29 (1):149-162
Doi: https://doi.org/10.25130/tjps.v29i1.1494

3.3. Depositional Environment

An accurate detection depositional environment for any sedimentary rocks and Formations should be done by two main evidences which are:

1- **Sedimentological Evidence:** The presence of semi-regular to regular beds of limestone, marly limestone and marl is evidence that the Shiranish Formation's depositional environment was deep and quiet, the presence of micrite matrix in all thin sections also is other evidence for quite environment under the base wave and far from the beach [22].
2- **Paleontological Evidence:** The widespread and large number of planktonic compared with few numbers of benthic foraminifera is evidence of deep marine environment, other evidence is benthic foraminifera with thin wall and small in size.

As a result, after microfacies analysis with linking to sedimentological and biological evidences, all of the findings point to the Shiranish Formation having been formed in deep marine settings ranging from the outer shelf to the upper bathyal in both sections. (Fig.9). This conclusion is confirmed by an earlier study that the upper unit is comprised of blue pelagic marls sometimes dolomitic with occasional thin marly limestone beds rich in microfauna and the lower unit is comprised of thin bedded marly limestone [23] (Fig.9).

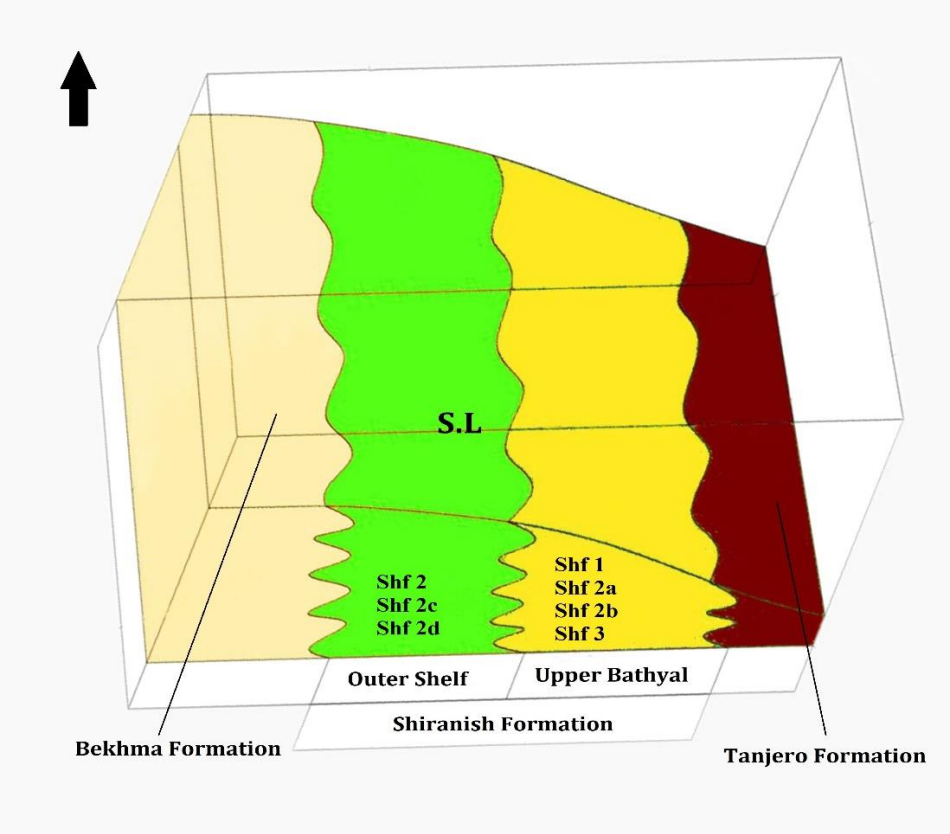


Fig.9 Three-dimensional diagram of depositional setting of Shiranish Formation in both sections.

4.Conclusion

1. The succession of the Shiranish Formation in both sections consists of marly limestone, limestone, marl and shale.
2. The formation was divided into three lithostratigraphic units in both studied sections (lower, middle and upper) units.
3. Three distinct microfacies were defined as Planktonic Foraminiferal Lime Mudstone Microfacies (Shf1), Lime Wackestone (Shf2) and Planktonic Foraminiferal Lime Packstone Microfacies (Shf3) with four submicrofacies ((Globular Chamber Planktonic Foraminiferal Lime Wackestone Microfacies (Shf2a), Keeled Planktonic Foraminiferal Lime Wackestone Microfacies (Shf2b), Bioclastic Lime Wackestone (Shf2c), Planktonic Foraminiferal Lime Wackestone (Shf2d)).
4. The major microfacies in both sections is lime wackestone which is dominated in middle and upper unit in both sections.
5. Sedimentological and biological data concluded that the formation was deposited in outer shelf to upper bathyal settings, with deeping upward sequence.

References

[1] Van Bellen RC, Dunnington HV, Wetzel R, Morton DM (1959) Iraqi lexique stratigraphique internationale, III, Asie, 10a, 333p.

[2] Dunnington, H.V., (1958) Generation, migration, accumulation and dissipation of oil in Northern Iraq. In: Weeks, L.G. (Ed.), Habitat of oil. AAPG. Bull. symposium, 1194−1251.

[3] Kassab IIM (1973) Planktonic foraminifera of the Shiranish Formation, type Locality (Northern Iraq). J Geol Soc Iraq 6:100–109 Kassab IIM (1979) The genus Globotruncana Cushman from the upper cretaceous of Northern Iraq. J Geol Soc Iraq 12:27–127.

[4] AL-Mutwali MM, Al-Juboury FN (2005) Litho and biostrtigraphy of Shiranish Formation (Late Campanian-Late Maastrichtian) in Sinjar area Northwestern Iraq. Rafidain J Sci 16D1:152–176, Geology Special Issue.

[5]Hammoudi RA (2000) Planktonic foraminiferal biostratigraphy of the Shiranish Formation (Upper Cretaceous) in Jambour well No. 13, Northern Iraq. Raf J Sci 11(4):50–58.

[6] Abdula, R.A., Balaky, S., Khailany, R., Miran, A., Muhammad, M. and Muhamad, C., (2018) Sedimentology of the Shiranish Formation in the Mergasur area, Iraqi Kurdistan, Bulletin of Geological Society of Malaysia, v. 65, pp. 37-43

[7] Zebari, M. (2013). Geometry and evolution of fold structures within the high folded zone: Zagros fold-thrust belt, Kurdistan Region-Iraq.

Fouad, S.F., (2015) Tectonic map of Iraq, scale 1: 1000 000.Iraqi Bulletin of Geology and Mining, 11(1), pp.1-7.

[8] Fouad, S.F., (2015) Tectonic map of Iraq, scale 1: 1000 000.Iraqi Bulletin of Geology and Mining, 11(1), pp.1-7.

[9] Sissakian, V.K., Kadhim, T.H. and ABDUL JAB'BAR, M.F., (2014) Geomorphology of the high folded zone. Iraqi Bulletin of Geology and Mining, 6, pp.7-51.

[10] Sissakian, V.K. and Fouad, S.F., (2015) Geological map of Iraq, scale 1: 1000 000, 2012. Iraqi Bulletin of Geology and Mining, 11(1), pp.9-16.

[11] Buday T (1980) The regional geology of Iraq, stratigraphy and paleogeography. Dar Al Kutub Published house, Mosul, 445p.

[12] Jassim SZ and Buday T (2006) Middle Paleocene—Eocene Megasequence AP10. Chapter 13, In: Jassim SZ, Goff JC (eds) Geology of Iraq. Prague and Moravian Museum, Brno, Dolen, pp 205-227.

[13] Jassim SZ and Goff JC (2006) Geology of Iraq. Prague and Moravian Museum, Brno, Dolen, 341p.

[14] Karim, K.H., Ismail, K.M. and Ameen, B.M., (2008) Lithostratigraphic study of the contact between Kometan and Shiranish formations (Cretaceous) from Sulaymaniyah Governorate, Kurdistan region, NE Iraq. Iraqi Bulletin of Geology and Mining, 4(2), pp.16-27.

[15] Dunham RJ (1962) Classification of carbonates rocks according to the depositional texture. In: Ham, W.E. (Eds.) Classification of carbonate rock. American Association of Petroleum Geologists, Memoir, no. 1, pp. 108–121.

[16] Leckie RM (1987) Paleoecology of mid–Cretaceous planktonic foraminifera: a comparison of open ocean and epicontinental sea assemblages. Micropaleontology 33(2):164–176.

[17] Gibson TG (1989) Planktonic benthonic foraminiferal ratios: Modern patterns and tertiary applicability. Marine Micropaleontol 15:29–52.

[18] Flugel, E. (2004) Microfacies of Carbonate Rocks, Analysis, Interpretation and Application. Springer, Berlin, 976p.

[19] Flugel, E. (2010) Microfacies of Carbonate Rocks, Analysis, Interpretation and Application. Springer-Verlag, Berlin, 976p.

[20] Wilson, J. L., (1975) Carbonate facies in geologic history Springer-Verlag. New York, 471.

[21] Koutsoukos EAM, Hart MB (1990) Cretaceous foraminiferal morphogroup distribution pattern, paleocommunities and trophic structures: a case study from the Sergipe Basin, Brazil. Earth Science 81:221–246.

[22] Friedman, G.M. & Sanders, J.E., 1978. Principles of Sedimentology. John Wiley and Sons, New York. 792 p.

[23] Abdula, R.A and Khailani, R., 2016, Shiranish Formation in Garota (Shaqlawa, northern Iraq) as raw material for Portland cement manufacturing, Iraqi Bulletin of Geology and Mining, v. 12, no. 1, pp. 65-72.