*Bulletin of the Geological Society of Malaysia, Volume 65, June 2018, pp. 37 – 43*

# Sedimentology of the Shiranish Formation in the Mergasur area, Iraqi Kurdistan

Rzger A. Abdula[1,*], Sardar Balaky[1], Rebwar Khailany[2], Alan Miran[1], Mahmud Muhammad[3] & Choman Muhamad[1]

[1] Petroleum Geosciences Department, Science Faculty, Soran University, Iraq
[2] Dirloctorate of Geological Survey, Erbil, Kurdistan Region, Iraq
[3] Geology Department, Science College, Salahadin University, Iraq
*Corresponding author email address: rzger.abdula@soran.edu.iq

**Abstract:** The Upper Cretaceous Shiranish Formation of Shkawtua Village, Mergasur area, Iraqi Kurdistan region consists of alternating mixed siliciclastic and carbonate strata interpreted as an outer shelf open marine (basinal) depositional environment. Fourteen thin sections were studied under polarized microscope to determine the petrographic component, fauna content, and microfacies analysis. The study tries to compare this formation with its equivalences throughout the region. Rock units are divided into: marly limestone, marlstone, and dolostone. The major petrographic constituents are: micrite, pseudospar, replacement dolomite, and fossils. Fossils are the main particles within mudstone, wackestone, and packstone microfacies types. The occurrence of some planktonic foraminifera such as *globigerina cretacea, archaeoglobigerina cretacea*, and rotalipora cushmani *(rotalia sp.)* suggests an Upper Cretaceous age.

**Keywords:** Cretaceous, Shiranish Formation, carbonate sedimentology, Mergasur, Iraqi Kurdistan

## INTRODUCTION

The Shiranish Formation was first defined near the village of Shiranish Islam, northeast of Zakho from the High Folded Zone of Iraqi Kurdistan by Henson (1940, in Bellen *et al.,* 1959). This formation represents the lower part of an Upper Cretaceous (Campanian and Maastrichtian) regional transgressive-regressive depositional sequence that flooded nearly all of Iraq (Dunnington, 1958). The basin of the Shiranish Formation combined tectonically with that of overlying Tanjero Formation in a single basin, which is called initial Zagros Foreland Basin (Karim & Surdashy, 2005; Karim *et al.,* 2008). Despite its great scientific relevance for reconstructing upper Cretaceous events in Iraqi Kurdistan, this unit has only been locally studied (Ahmed *et al.,* 2016). The Jibab Marl Formation of well Anah-1 may be included into the Shiranish Formation (Chatton & Hart, 1961), but cannot be a lateral time transgressive equivalent of the Campanian rudist biohermal units including the massive Hartha and Aqra-Bekhme formations (Kent, 2010). Buday (1980) combined Bekhme and Aqra formations under the name of the Aqra-Bekhme Limestone Formation and stated that it wedges out relatively rapidly and it forms tongues of relatively small thicknesses within the Shiranish Formation.

In the Dukan area, Shiranish Formation rests disconformably on the Turonian Kometan Formation (Abdel-Kireem, 1983; 1986) while the same contact appears to be gradational in the Chaq Chaq stream near Sulaimani City (Al-Badrani *et al.,* 2012). In the Hijran area near Shaqlawa, the formation rests unconformably on the Upper Qamchuqa Formation (Yahya & Al-Shammary, 1993). The variability in thickness of the Shiranish Formation can be linked to the degree of subsidence during deposition and the degree of post-Cretaceous denudation and the replacement of the Shiranish by other synchronous sedimentary units, mainly by the Tanjero and Aqra-Bekhme formations (Buday, 1980). The thickness of the Shiranish Formation in the east of the region reaches 1300m between Hemrin and Mandali (Homci, 1975). The thickness decreases towards the west of Iraq, reaching 50m on the western rim of the Ga'aara depression (Jassim & Goff, 2006).

At the type locality in the Shiranish area, several shallow-water intervals within the middle part of the Shiranish Formation occur (Al-Qayim *et al.,* 1986; Al-Qayim, 1992), but in the Sinjar area, the middle part of Shiranish Formation comprises alternating marls and sandy limestones with sole marks and graded bedding, is interpreted to represent a turbiditic unit (Al-Rawi, 1973).

In the Shiranish area where the type locality of formation is located, sediments of latest Maastrichtian age are absent and accordingly the Shiranish Formation may be dated as Late Campanian-Maastrichtian (Kassab, 1973). The age of upper part of Shiranish Formation may be extended to the Late Maastrichtian in the Sinjar area (Al-Mutwali & Al-Juboury, 2005). The age of the Shiranish Formation may be further extended to the Paleocene based on the foraminifera in Hijran area (Hammoudi, 2011).

## AIM OF THE STUDY

The aim of this study is to describe lithology, vertical and horizontal facies changes, fauna content and petrophysic properties of Shiranish Formation in the Shkawtua Village near Mergasur Town. The study also tries to justify why this research was needed e.g. to shed more light on the depositional environments and development of the Shiranish both laterally and with time and to compare this formation with its equivalences throughout the region. Finally, the study displays an isopach map of the formation and determines the depositional environment according to fauna content and microfacies analysis.

## STUDY AREA

The studied outcrop is located 50m to the west of the main Soran–Mergasur road which is 700m to the south of the intersection between the Soran–Mergasur road and Gora road in Shkawtua village, near Mergasur town, Erbil Governorate in Iraqi Kurdistan. The latitude of the location is approximately 36° 45' 48.7" N and the longitude is about 44° 25' 52.4" E (Figure 1).

## METHODS AND MATERIALS

Field work was performed during the winter of 2016 in order to choose the appropriate outcrop for this study of the Shiranish Formation. The underlying and overlying formations were mapped. Identifying the underlying and overlying formations is important in order to provide confidence that the entire Shiranish could be described. The section was measured and the beds described in hand specimen using a 10X power hand lens. Fourteen samples were collected for petrographic thin section analysis based on vertical facies changes. The petrographic study of the carbonates was carried out using thin sections prepared at the Soran Research Center, Soran University. Thin sections were stained with Alizarin Red 'S' Solution following the procedure of Friedman (1959) in order to detect and differentiate calcite and dolomite. Dunham's (1962) classification scheme was used to classify facies.

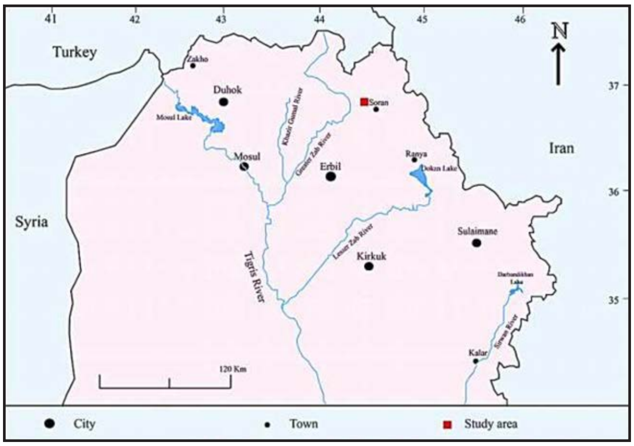


**Figure 1:** Map of Iraqi Kurdistan showing the study area.

## GEOLOGICAL SETTING

The Shiranish Formation in the Shkawtua Village near Mergasur Town is located in the High Folded Zone (Figure 2). The predominant rock units in the studied area are carbonate-sedimentary rocks of Cretaceous age which are commonly exposed within some of the eroded cores and limbs of anticlines in the area. In the Mergasur area (Figure 3), the Shiranish Formation is overlain by the Tanjero Formation and is underlain by the Bekhme Formation.

Different subsurface thicknesses (Figure 4) of Shiranish were reported from recently drilled wells in the Kurdistan Region (Erbil Geological Survey, 2010, pers. comm.). In the study area, the thickness of the formation is around 225m.

## LITHOLOGY

The Shiranish Formation at Shkawtua, near Mergasur Town can be divided into three parts: the upper part

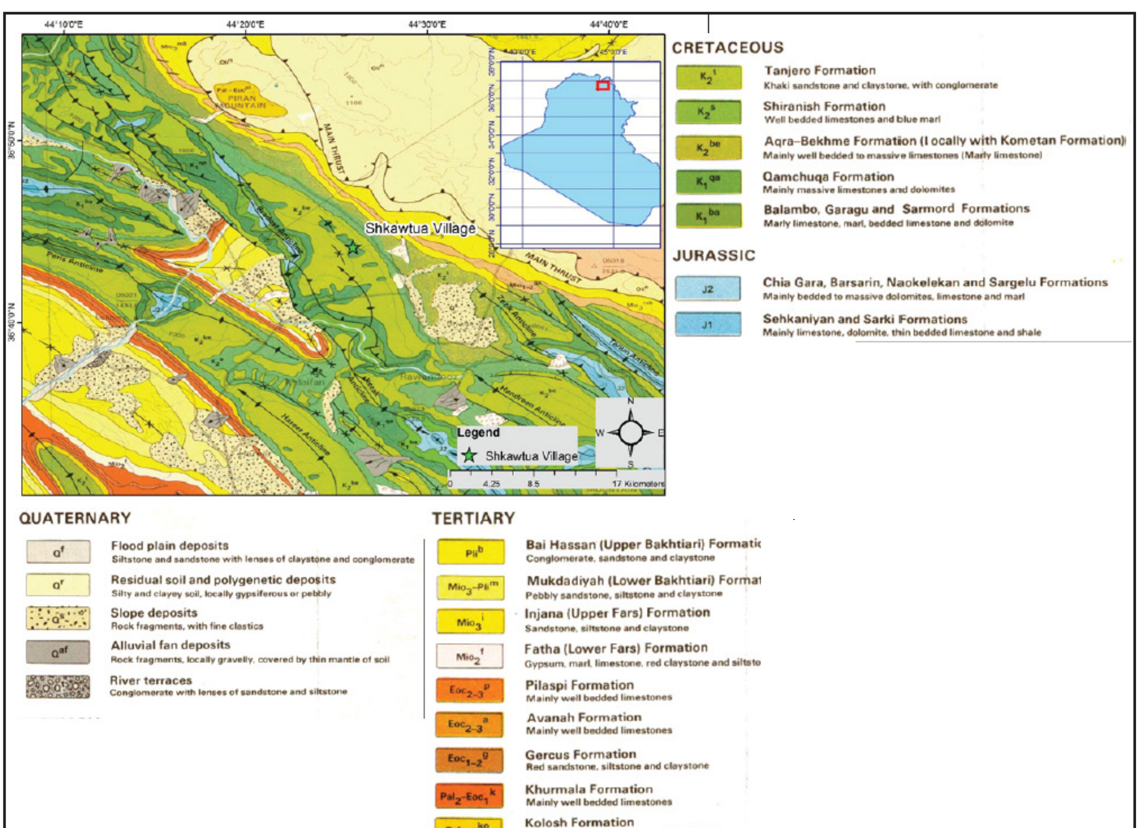


**Figure 2:** Geological map showing the distribution of geological formation throughout the area and the study area of Shiranish Formation in Shkawtua Village near Mergasur Town (upper) and the tectonic zones of Iraqi Kurdistan (lower) (after Sissakian, 1997).

**Figure 3:** Shiranish Formation in Shkawtua Village near Mergasur Town, Iraqi Kurdistan.

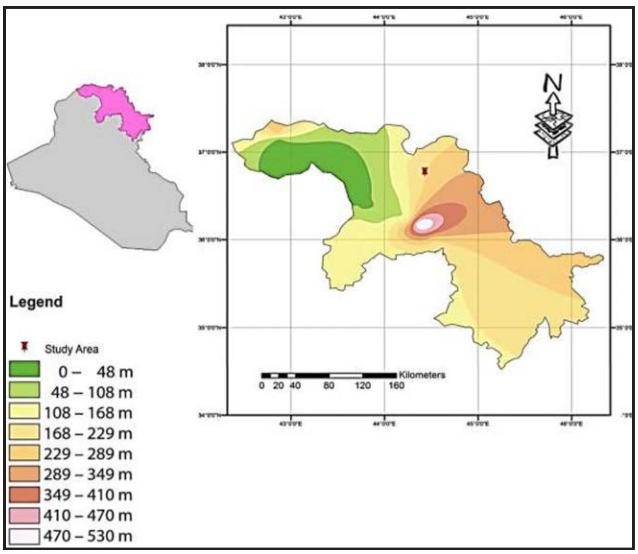


**Figure 4:** Isopach map for Shiranish Formation (the data from Bellen *et al*., 1959; Jassim & Goff, 2006; Erbil Geological Survey, 2010, pers. comm.).

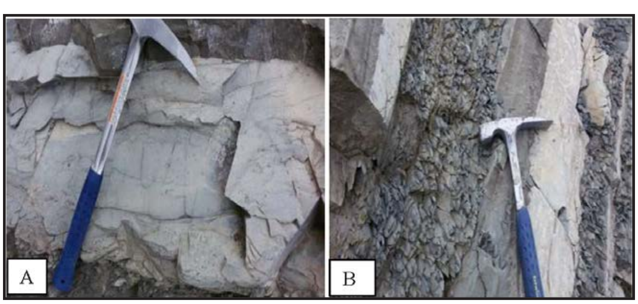


**Figure 5:** The upper part of Shiranish Formation in the studied area (A) marly limestone and (B) beds of marl and limestone.

consists of the alternating marly limestone (Figure 5A), marls and limestone beds (Figure 5B). The stratigraphic parts are:

*Upper Section*: Secondary calcite occurs in the hard marly limestone beds of the upper section (Figure 6). The marly limestone is grey to dark grey color. The thickness ranges of marly limestone and marls are between about 10-35cm and nearly 15-20cm, respectively.

**Figure 6:** The secondary calcite occurs on the marly limestone within Shiranish Formation.

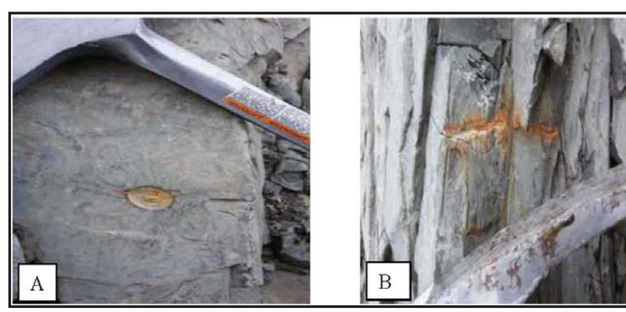


**Figure 7:** Ammonite fossil on the surface of limestone.

*Middle Section*: The middle part also consists of marl and marly limestone, but these beds are soft and contain ammonite fossils (Figures 7a, 7b, 8a, and 8b). The imprint of the fault plane slickenside occurs in the harder limestone beds (Figure 9). The marly limestone is grey and dark grey color. The thicknesses of the marly limestone and marls here are about 30cm and 20cm, respectfully. The occurrence of load casts with flutes on the upper surface of shale is observed within this part (Figure 10).

*Lower Section*: The lower part consists mainly of hard, thick, grey limestone and marly limestone. The thickness of marly limestone beds in this section is about 5-35cm.

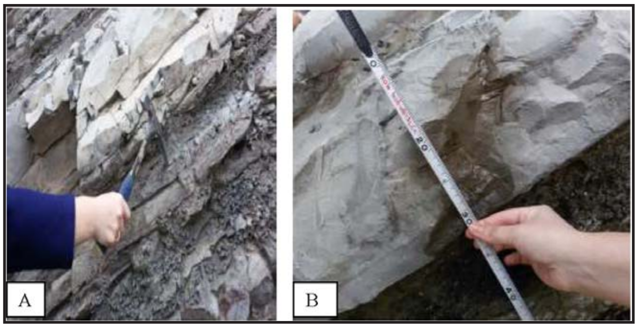


**Figure 8:** Marl and marly limestone beds.

**Figure 9:** Groove casts of fault plane slickenside.

**Figure 10:** Load casts with flute marks on the upper surface of shale.

**Figure 11:** Thin bedded limestone and marly limestone.

**Figure 12:** Fissile shale bed of the lower part of Shiranish Formation.

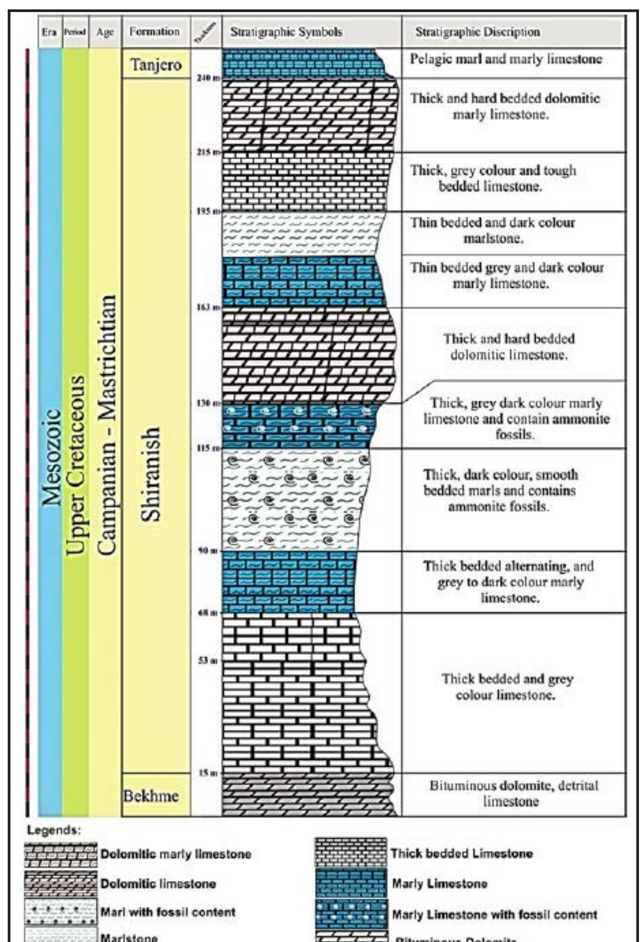


**Figure 13:** The geologic column of Shiranish Formation for the studied outcrop.

The lower part also contains 5-30cm thick beds of marly limestone and fissile shale (Figures 11 and 12, respectively). The lithology of the formation is shown in the geologic column (Figure 13).

## PETROGRAPHY

The major petrographic constituents are micrite, pseudospar, replacement dolomite, and fossils. Fossils include a variety of planktonic and pelagic foraminiferas such as *Globigerina cretacea* (Figure 14a)**,** *Globorotalia menardii* (Figure 14b), *Archaeoglobigerina cretacea* (Figure 14c), *Parasubbotina variospira* (Figure 14d), *Rotalipora greenhornensis* (Figure 14e), *Contusotruncana* (Figure 14f)**,** *Pseudotextularia elegans* (Figure 15a), *Parvularugo globigerina eugubina* (Figure 15b), *Rugoglobigerina macrocephala* (Figure 15c), *Heterohelix globulosa* (Figure 15d), *Rugoglobigerina pennyi* (Figure 15e)**,** *rotalipora cushmani* (*rotalia sp.*) (Figure 15f), ammodiscus *cretaceous*

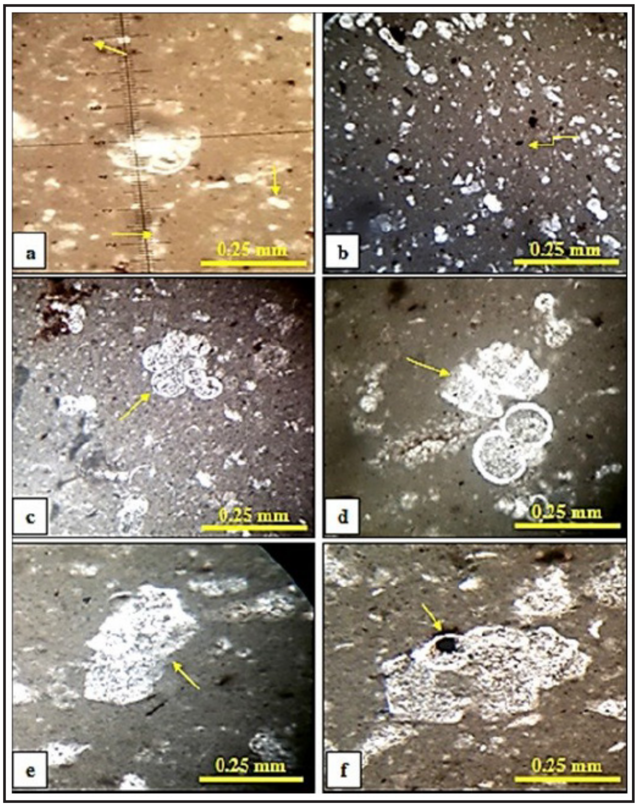


**Figure 14:** Limestone petrography: a) *Globigerina cretacea*, planktonic foraminifera (Maastrichtian-Campanian), contains many chambers filled by clear single calcite crystal, mud and calcite matrix, mudstone, b) *Globorotalia menardii* planktonic foraminifera, grey to light grey, wackestone contains pyrite and yellow to brown micrite, c) *Archaeoglobigerina cretacea*, wackestone contains pyrite and brown micrite, d) *Parasubbotina variospira* pelagic planktonic foraminifera filled by calcite, pyrite, wackestone, e) *Rotalipora greenhornensis* filled by calcite, micrite, pyrite, wackestone, f) *Contusotruncana*, yellow and brown micrite, pyrite, wackestone, Shiranish Formation, Shkawtua Village near Mergasur.

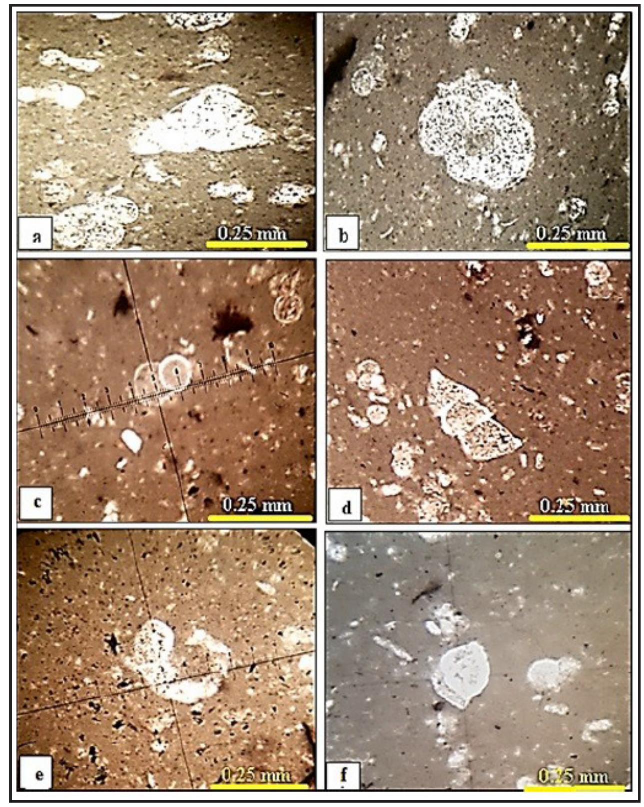


**Figure 15:** Limestone petrography: a) allochem, longitudinal section of a high-spired gastropod, *Pseudotextularia elegans* foraminifera and chambers filled with calcite, wackestone, pyrite, brown micrite and contain some organic matter, b) *Parvularugoglobigerina eugubina* filled by calcite, contain organic matter with micrite and pyrite, wackestone, c) *Rugoglobigerina macrocephala*, contains some organic matter with pyrite, wackestone, d) *Heterohelix globulosa*, contain organic matter with pyrite, wackestone e) *Rugoglobigerina pennyi* foraminifera filled with calcite, contain some pyrite, mudstone, f) Rotalipora cushmani (*rotalia sp.*) planktonic foraminifera, wackestone, Shiranish Formation, Shkawtua Village near Mergasur.

*sp.* (Figure 16a), Woodringina *hornerstownensis sp.* (Figure 16b), *Globigerina bulloides* (Figure 16c), *Heterohelix pulchra* (Figure 16d), *Abathomphalus mayaroensis* (Figure 16e), Pseudoguembelina *excolata* (Figure 16f) and small gastropods (Figure 15a).

The occurrence of some planktonic foraminifera suggests the Upper Cretaceous age such as *globigerina cretacea, archaeoglobigerina cretacea*, and rotalipora cushmani *(rotalia sp.)*.

## MICROFACIES

Benthonic/planktonic forams wackestone is the major microfacies type within the samples studied from the Shiranish Formation dominating the lower and middle parts. The Shiranish wackestone is typically grey to light grey, sometimes yellow to brown, consisting a variety of planktonic foraminifers within the neomorphosed micritic matrix. Generally the microfacies indicate deep basinal reducing environment and it can be correlated with the SMF3 (Mixed Bioclastic Mudstone Microfacies) of facies zone 1 (Flugel, 1982).

## DIAGENESIS

Authigenic minerals include pyrite, replacement dolomite, and the foram-filling calcite crystals. Pyrite (Figures 14 and 15) was precipitated within the marly limestone and limestone beds of Shiranish Formation deposited under a reducing alkaline conditions (Hanjo *et al.*, 1965). Pyrite formation during early diagenesis is a major process for controlling the oxygen level of the atmosphere and the sulfate concentration in seawater (Berner, 1984). Over geologic time the amount of pyrite that may form in sediment is limited by the rates of supply of decomposable organic matter, dissolved sulfate, and reactive detrital iron minerals (Berner, 1984). Reducing conditions necessary for pyritization are available during early burial stages when an anaerobic bacterium becomes active (Larsen & Chilingar, 1979).

## DEPOSITIONAL ENVIRONMENT

The deposition change from wackestone facies in the lower part to mudstone facies in the upper part reflects the

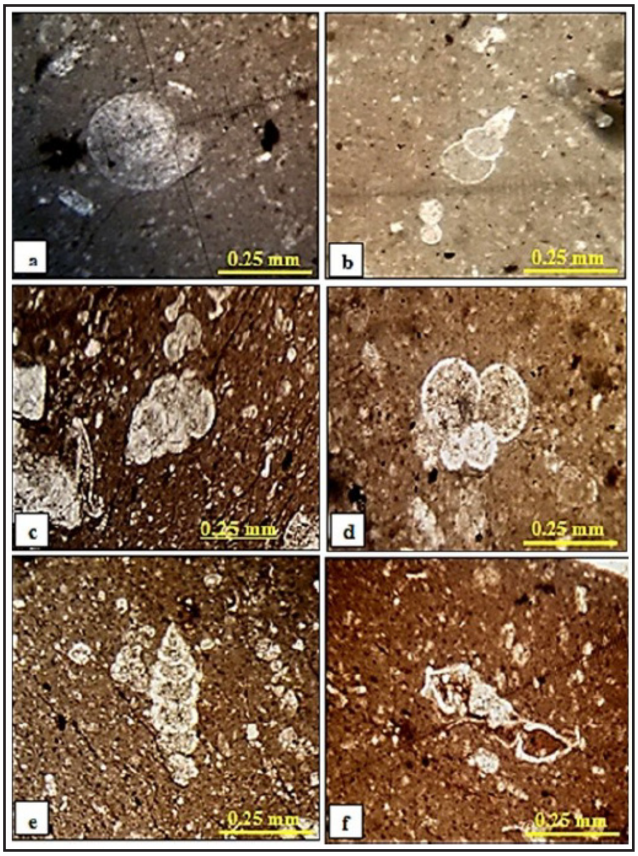


**Figure 16:** Marly limestone petrography: a) *Ammodiscus cretaceous sp.* foraminifera, wackestone, contain pyrite, and organic matter, b) *Woodringina hornerstownensis sp.* foraminifera, mudstone c) *Globigerina bulloides* foraminifera filled with calcite, contain pyrite and organic matter, wackestone, d) *Heterohelix pulchra,* e) *Abathomphalus mayaroensis*, wackestone f) Pseudoguembelina *excolata* filled by calcite, wackestone, Shiranish Formation, Shkawtua Village near Mergasur.

change in environment from a higher energy to lower energy depositional environment, indicating that the depositional basin experienced a deepening upward cycle. This deepening upward by the cycle from a higher energy to lower energy depositional environment is evidenced by the facies changes observed in the Shiranish Formation.

This current microscopic study revealed different facies types of which similarity in litho and bio content was obvious among the facies of studied formation. This would indicate homogeneity of both facies and environment in this studied section. While, concerning the terminology of Dunham's (1962), it was found that wackestone is the most abundant facies followed by packstone and mudstone. All these microfacies were dominated by planktonic foraminiferas with micrite matrix. Emery & Myers (1996) suggested that planktonic foraminiferas are generally common towards the deep open sea environments excluding abyssal where the sea bed is below the carbonate compensation depth. The dominance of micrite within these facies indicates that the sea bottom was stagnant and calm enough for lime mud to accumulate (Dunham, 1962). The presence of organic material within the micrite is evidence of sedimentation occurring in conjunction with low oxygenation levels, in euxinic conditions (Friedman & Sanders, 1978). Petrographic, facies, and textural analyses supports that the Shiranish Formation was deposited in low energy, distal pelagic, open marine environment.

The occurrence of some planktonic foraminifera such as *globorotalia menardii* that were attributed to equatorial and tropical environments, but their preferences was pronounced for a warm sea surface temperatures and normal marine salinities.

## CONCLUSIONS

The following can be concluded from this study:

- The Shiranish Formation consists of limestone, marly limestone and marl.
- The major petrographic constituents are micrite, pseudospar, replacement dolomite and fossils. Fossils are the main skeletal grains and include a variety of planktonic and pelagic foraminiferas within the mudstone, wackestone, and packsotne microfacies types.
- The occurrence of some planktonic foraminifera confirms the Upper Cretaceous age such as *globigerina cretacea, archaeoglobigerina cretacea*, and rotalipora cushmani *(rotalia sp.).*
- Petrographic, facies, and textural analyses, supports that the Shiranish Formation was deposited in a deep basinal, pelagic (open marine), frequently reducing–euxinic environment.
- The presence of some planktonic foraminifera such as *globorotalia menardii* that were attributed to equatorial and tropical environments supports warm sea surface temperatures and normal marine salinities.

## ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the Department of Petroleum Geosciences and Soran Research Center for supplying facilities and for allowing us to use their workshop.

## REFERENCES

Abdel-Kireem, M.R., 1983. A study of the palaeoecology and bathymetry of the foraminiferal assemblages of the Shiranish Formation (Upper Cretaceous), northeastern Iraq. Palaeogeography, Palaeoclimatology, Palaeoecology, 43 (1-2), 169−180.

Abdel-Kireem, M.R., 1986. Contribution to the stratigraphy of the Upper Cretaceous and the Lower Tertiary of the Sulaimani Dokan region, northeastern Iraq. Neues Jahrbuch Und Zentralblat, Für Geologie Und Paleontologien Abhandlungen, 172 (1), 121−139.

Ahmed, S.H., Barrier, E. & Muller, C., 2016. Basin evolution model during Cretaceous in the northeastern of Arabian Plate in Kurdistan region. Arabian Journal of Geosciences, 9, 645. https://doi.org/10.1007/s12517-016-2677-2.

Al-Badrani, O.A., Karim, K.H. & Ismail, K.M., 2012. Nannofossils biozones of the contact between Kometan and Shiranish formations, Chaq Chaq Valley, Sulaimani, NE Iraq. Iraqi Bulletin of Geology and Mining, 8 (1), 19−29.

Al-Mutwali, M.M. & Al-Juboury, F.N., 2005. Litho and biostratigraphy of the Shiranish Formation (Late Campanian-Late Maastrichtian) in Sinjar Area, Northwestern Iraq. Rafidain Journal Science, 16 (1), 152−176.

Al-Qayim, B., 1992. Bioturbated rhythmite of the Shiranish Formation, type-locality, NW Iraq. Iraqi Geological Journal, 25 (1), 185−194.

Al-Qayim, B., Habib, H.R. & Al-Dyni, N., 1986. Petrology and geochemistry of Shiranish Formation (type section) towards sedimentary facies interpretation. Journal of Geological Society of Iraq, 19 (3), 23−136.

Al-Rawi, D., 1973. Contribution to the geology and structure of Jebel Sinjar. Z. Geol. Wiss., Berlin 1, 1441−1447.

Bellen, R.C. van, Dunnington, H.V., Wetzel, R. & Morton, M. (Eds.), 1959. Lexique stratigraphic international. Paris, v. III, Asie, Fascicule 10a Iraq. 333 p.

Berner, R.A., 1984, Sedimentary pyrite formation-an update. Geochemica et Cosmochemica Acta, 48, 605−615.

Buday, T., 1980. The regional geology of Iraq, v. 1, Stratigraphy and Paleogeography. Dar Al-Kutub Publishing House, University of Mosul, Mosul, Iraq. 445 p.

Chatton, M. & Hart, E., 1961. Review of the Cenomanian to Maastrichtian stratigraphy in Iraq. OEC, unpublished report, Baghdad.

Dunham, R.H., 1962. Classification of carbonate rocks according to depositional texture. In: Ham, W.E. (Ed.), Classification of carbonate rocks. AAPG Memoir, 1, 108−121.

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.

Emery, D. & Myers, K., 1996. Sequence stratigraphy, BP Exploration. Stockely Park, Uxbridge, London. 297 p.

Erbil Geological Survey, 2010. pers. comm.

Flugel, E., 1982. Microfacies analysis of limestones. Springer–Verlag, Berlin. 633 p.

Friedman, G.M., 1959. Identification of carbonate minerals by staining methods. Jour. Sed. Pet., 29 (2), 87−97.

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

Hammoudi, R.A., 2011. High resolution biostratigraphy of the K/T boundary in the Higran Section, Shaqlawa Area, Northern Iraq. Iraqi National Journal of Earth Sciences, 11(1), 23−48.

Hanjo, S., Fischer, A.G. & Garrison, R., 1965. Geopetal pyrite in fine grained limestones. Jour. Sed. Pet., 35(2), 480−488.

Homci, H.AL., 1975. Isopach maps of Tithonian to base of Tertiary. Manuscript report, GEOSURV, Baghdad.

Jassim, S.Z. & Goff, J.C. (Eds.), 2006. Geology of Iraq, first edition. Brno, Czech Republic, Prague and Moravian Museum. 340 p.

Karim, K.H. & Surdashy, A.M., 2005. Tectonic and depositional history of Upper Cretaceous Tanjero Formation in Sulaimaniya Area, NE-Iraq. Journal of Zankoy Sulaimani, 8(1), Part A 47−61.

Karim, K.H., Ismail, K.M. & Ameen, B.M., 2008. Lithostratigraphic study of the contact between Kometan and Shiranish formations (Cretaceous) from Sulaimaniyah Governorate, Kurdistan Region. Iraqi Bulletin of Geology and Mining, 4(2), 16−27.

Kassab, I.I.M., 1973. Planktonic foraminifera of the Shiranish Formation type locality (Northern Iraq). Journal of Geological Society Iraq, 6, 100−109.

Kent, W.N., 2010. Structures of northern Iraq and Syria, and their implications for interpretations of the regions' stratigraphy. Search and Discovery Article # 40623, adapted from oral, April 11−14.

Larsen, G. & Chilingar, G.V., 1979. Diagenesis in sediments and sedimentary rocks. Elsevier, Amsterdam. 579 p.

Sissakian, V.K. (Comiler), 1997. Geological map of Arbeel and Mahabad quadrangles sheets NJ-38-14 and NJ-38-15. Iraqi Geological Survey and Mining, national Library Legal Deposit No. 237, Baghdad, Iraq.

Yahya, V.A. & Al-Shammary, T.A., 1993. Sedimentary features and processes in the Shiranish and Tanjero formations, Shaqlawa Area, Arbil, North Iraq. Iraqi Geological Journal, 26(3), 135−154.

*Manuscript received 20 October 2016*
*Revised manuscript received 31 August 2017*
*Manuscript accepted 6 September 2017*