International Journal of Geography and Geology
2016 Vol. 5, No. 10, pp. 194-208
ISSN(e): 2305-7041
ISSN(p): 2306-9872
DOI: 10.18488/journal.10/2016.5.10/10.10.194.208

MICROBIOSTRATIGRAPHY, MICROFACIES AND DEPOSITIONAL ENVIRONMENT OF THE SARVAK FORMATION IN BI BI HAKIMEH OIL FIELD (WELL NO. 29), SOUTHWEST IRAN

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ABSTRACT
The Sarvak Formation in Bi Bi Hakimeh oil field (well No.29) with the thickness of 324 m consists of limestone in Cenomanian - Turonian period. The upper boundary of the Sarvak Formation is in the form of disconformity with the Gurpi Formation. The lower boundary of Sarvak Formation is not clear because of lack of sequential excavation. According to microbiostratigraphy studies, 4 genera and 2 species of planktonic foraminifera and 22 genera and 28 species of benthic foraminifera are identified and based on them, three biozones were introduced including Nezzazata–Alveolinids assemblage zone, Rudist debris, and Oligosteginid facies. The zones are in consistence with zones introduced by Wynd (1965). *In the study area (southwest of Iran), the Sarvak Formation is subdivided into 8 microfacies that are distinguished by petrographic analysis on the basis of their depositional textures and fauna. In addition, four major depositional environments were identified in the Sarvak Formation. These include shelf lagoon, platform margin, slope and basin environmental settings, which are interpreted as a carbonate shelf without an effective barrier separating the platform from the open ocean.*

Keywords: Microbiostratigraphy, Microfacies, Sarvak formation, Bi Bi Hakimeh oil field, Cenomanian – Turonian.

Received: 10 October 2015/ **Revised:** 2 May 2016/ **Accepted:** 17 August 2016/ **Published:** 20 September 2016

Contribution/ Originality

This study is one of very few studies which have investigated the upper cretaceous sequences of oil fields. The results of this study will help to make biostratigraphy biozones, interpretation of microfacies and depositional environments upper cretaceous, Recognition of lithology specificities and Separation and definition of the upper cretaceous sequences.

1. INTRODUCTION

The Sarvak Formation is the unit for thick carbonate strata as a part of Bangestan Group and was deposited in Zagros zone, in south margin of Neotethys. According to James and Wynd (1965) from Albian to Campanian, a sediment cycle is identified composed of Kazhdomi, Sarvak, Surgah and Ilam formations in Zagros, which are called as Bangestan Group. They have also identified type section in Sarvak strait located on the southern edge of Bangestan Mountain in the northwest of Behbahan and in Khuzestan Province. Until now, biostratigraphy, microfacies and depositional environment of the Sarvak Formation in Jahrum Mountain (Khosro and Fossiluni, 1994) sample shear (northwest of Behbahan), Sefidkooh (Lasemi and Jalilian, 1997) and Landran section in southwest of Semirom (Vaziri and Safari, 2003) have been studied. Moreover, some studies have been adopted

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about several under fabric stratigraphy samples of the mentioned formation (Teimurian, 2004). The Sarvak Formation in the studied section has a thickness of 324 m in well No. 29 with Lambert coordinates of N: 904.743 and E: 2.051.620 located in from Bi Bi Hakimeh oil field. The field with a length of 70 km and width of 5 km is centralized in the south of embayment of Dezful in southwest zone of Iran in the distance of 210 km from southeast of Ahwaz and in the south of oil field of Gachsaran (Fig. 1). It should be mentioned that the mentioned formation is placed on the Kazhdomi Formation and in beneath of the Gurpi Formation.

The main objectives of this paper are to describe and interpret the stratigraphy, biostratigraphy, facies and depositional environments of the Sarvak Formation in the Bi Bi Hakimeh oil field in order to understand the geological evolution of the area during that time interval.

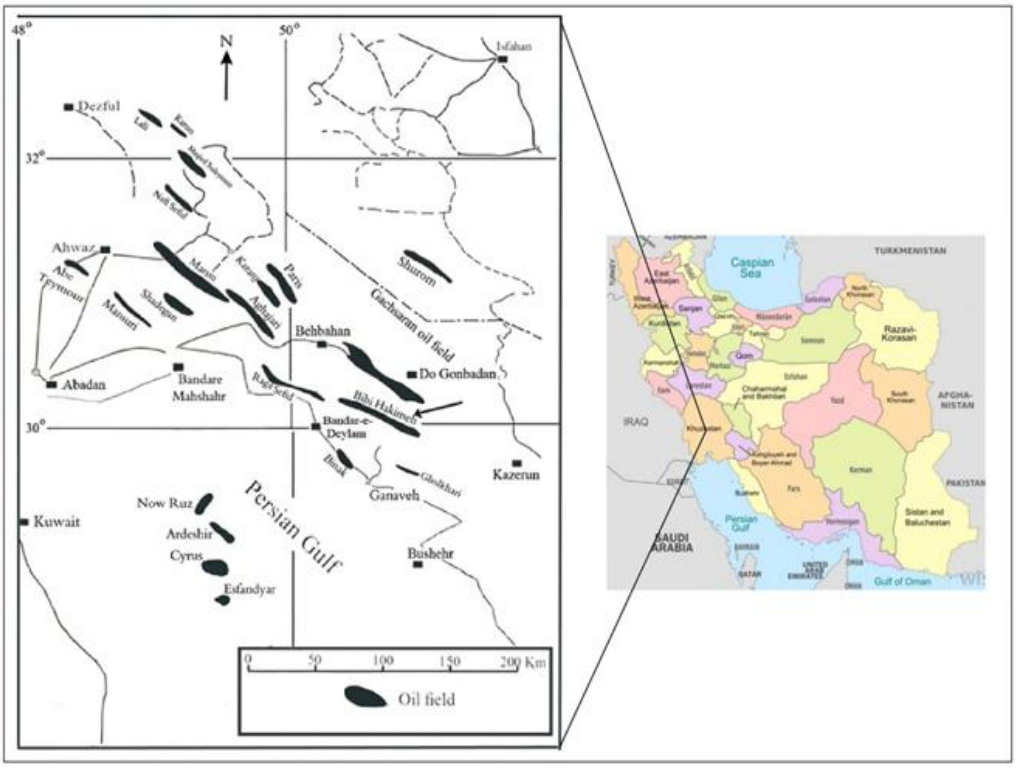

Figure-1. Geographical location of Bi Bi Hakimeh oil field, SW Iran

(Kalantary, 1969)

1.1. Materials and Methods

Thin sections of collected samples from the Sarvak Formation in Bibi Hakimeh oil field (well no. 29) were studied under a polarized microscope in order to study of microfauna and microfacies and, 3 biozones and 8 microfacies were detected. Recognized biozones are in consistency with biozones named by Wynd (1965). For classification of facies the concepts of Flugel (2004); Dunham (1962); Embry and Klovan (1971) and study of microfauna the concepts of Bolli (1959,1966); Bolli (1945); Postuma (1971); Caron (1983; 1989) and have been used.

Through studying final reports and graphic well logs, and thin sections; identification of microfossils and facies, photography, and preparation of microfossils plates and their distribution in stratigraphy column, displaying detected zones and also stratigraphy of depositional sequence became possible.

2. DISCUSSION

2.1. Lithostratigraphy of Sarvak Formation in Studied Well

The Sarvak Formation with 324 m thickness in well no. 29 from the depth of 1952 to 2276 meter is thickness excavated from this formation and its real thickness is different in Various zones. The Sarvak Formation, according to lithology features in studied well can be divided and described into three members as follow (Fig. 2):

- Member 1 (depth 1952-1986m): This member (34m) consists of white to light-gray, thin- and medium-bedded limestones with facies of wackestone and packstone and includes mainly pelagic fossils.
- Member 2 (depth 1386-2255m): This member (269m) consists of cream to white, thick-bedded limestones with facies of wackestone and fine calcite aggregates. In some sections of the limestone, recrystallization is clear. The dominant fossil of this member is rudist sections and in scattered form of fossils of deep sections that illustrates in the fact bar mass forehead.
- Member 3 (depth 2255-2276m): This member (21m) consists of white dolomite, limestone, and light-brown calcareous dolomite and includes facies of wackestone to packstone in terms of Dunham divisions. Dominant fossil in this zone is related to semi-trapped lagoon zone.

Because of lack of taking excavation operations to the final step, Sravk Formation can't indicate total thickness considered by Sarvak Formation in this zone.

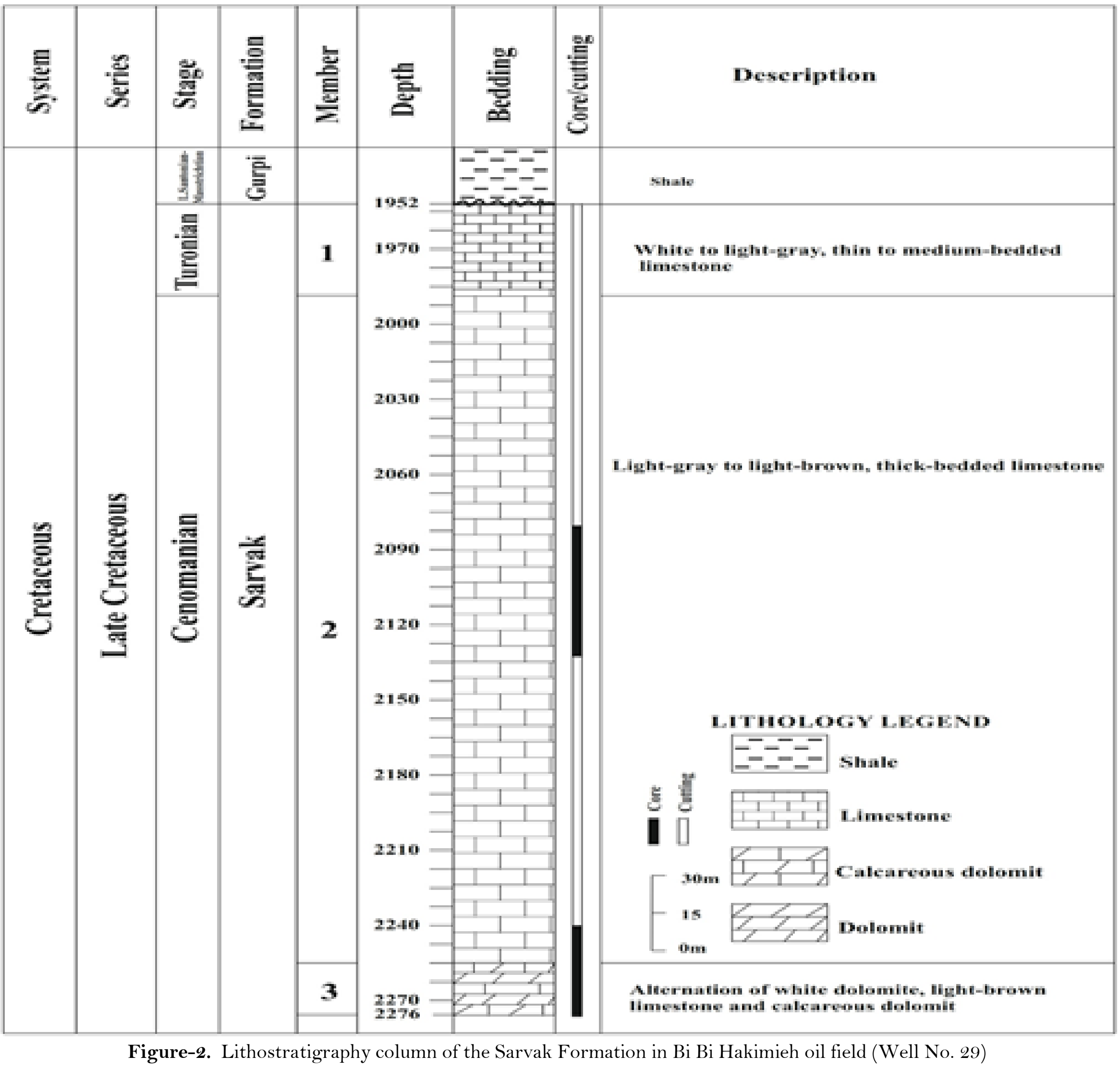

Figure-2. Lithostratigraphy column of the Sarvak Formation in Bi Bi Hakimieh oil field (Well No. 29) (Rikhtegarzadeh, 2016)

2.2. Microbiostratigraphy of the Sarvak Formation in Studied Well

According to studied microfauna, 4 genera and 2 species of planktonic foraminifera and 22 genera and 28 species of benthic foraminifera were detected (plate 1-3) and 3 biozones were recognized as follow (Fig. 3):

- ***Nezzazata* – Alveolinids assemblage zone**

This biozone is located in middle part of the Sarvak Formation and has a thickness of 288 meter (2276m-1988m). The biozone can be specified with the concentration of following fossils:

Cisalveolina fallax (Reichel, 1941) *Praealveolina cretacea* (D Archiac, 1837) *Nezzazata simplex* (Omara, 1956) *Nezzazata conica* (Smout, 1956).

Microfossils of this zone are as follow:

Dicyclina schlumbergeri (Munier-Chalmas, 1887) *Pseudolituonella reicheli* (Marie, 1955) *Chrysalidina gradate* (Orbigny, 1839) *Cuneolina pavonia* (Orbigny, 1839) *Cisalveolina lehneri* (Orbigny, 1839); *Pseudorhipidionina bingstani* (De Castro, 1965) *Spiroloculina cretacea* (Reuss, 1854) *Pseudorhapydionina dubia* (De Castro, 1965) *Biplanata peneropliformis* (Hamaoui and Saint-Marc, 1970) *Murgeina apula* (Luperto, 1968) *Cyclolina cretacea* (Orbigny, 1846) *Nezzazatinella picardi* (Henson, 1948) *Merlingina cretacea* (Hamaoui, 1965) *Coxites zubairensis* (Smout, 1956) *Nummoloculina regularis* (Philippson, 1887) *Nezzazata gyra* (Smout, 1956) *Mangashtia viennoti* (Henson, 1948) *Nummoloculina heimi* (Bonet and Coskin, 1958) *Orbitolina conica* (D Archiac, 1837); *Trochospira avnimelechi* (Hamaoui, 1965) *Rhaphydionina liburacia* (Stache, 1913) *Cycledomia iranica* (Hamaoui, 1964) *Neoiraqia convexa* (Henson, 1948) *Nezzazata concave* (Smout, 1956) *Nezzazata* sp., *Nezzazatinella* sp., *Cisalveolina* sp., *Pseudolituonella* sp.,*Orbitolina* sp., *Dicyclina* sp., *Nummoloculina* sp., *Calcisphaerula innominate* (Bonet, 1956) Miliolids, Textularids.

The zone is equivalent for biozone 25 (*Nezzazata*- Alveolinids assemblage zone) of Wynd (1965) and temporally, it belongs to Cenomanian. This age is also confirmed by Khalili (1974). Bolz (1977) has considered the probability of expansion of this zone to Albin that is not correct at least about the studied well since the biozone begins from middle parts of the Sarvak Formation. Bourgeois (1969) believes that upper boundary of the biozone is limited to highest part of Cenomanian. He believes that upper boundary of the zone is a non-continuous boundary that can be observed in most zones of Zagros in upper parts of Cenomanian. Recent studies indicate that all *Ovalveolina* related to this zone (e.g. Cisalvelina Sp. Ovalveolina sp. and Praealveolina sp.) extinct near the boundary of Cenomanian. The extinction can be because of the existence of OAE: Oceanic Anoxic Event 2 in Cenomanian-Turonian boundary (Husinec *et al.*, 2000).

- **Rudist debris zone**

The biozone has been defined by Wynd (1965) and Bolz (1978) believes that temporarily the biozone is an insignificant stratigraphy unit, since the presence of rudist debris in Aptin to Maastrichtian period and even older times (Motiei, 1994). This biozone has a thickness of 74 meter (2251m-2177m) and based on biological facies 24 (Rudist debris zone) of Wynd (1965) is inside the bozone of *Nezzazata* – Alveolinids assemblage zone. Dominant fossil of this zone is rudist debris, with following fossils:

Dicyclina schlumbergeri (Munier-Chalmas, 1887) *Pseudolituonella reicheli* (Marie, 1955) *Chrysalidina gradate* (Orbigny, 1839) *Cuneolina pavonia* (Orbigny, 1839) *Cisalveolina lehneri* (Orbigny, 1839) *Spiroloculina cretacea* (Reuss, 1854) *Pseudorhapydionina dubia* (De Castro, 1965) *Nezzazatiella picardi* (Henson, 1948) *Merlingina cretacea* (Hamaoui, 1965) *Mangashti viennoti* (Henson, 1948) *Nummoloculina heimi* (Bonet and Coskin, 1958) *Trochospira avnimelechi* (Hamaoui, 1965) *Nezzaata* sp., *Nezzazatinella* sp., *Cisalveolina* sp., *Pseudolituonella* sp.,*Orbitolina* sp., *Dicyclina* sp., *Nummoloculina* sp., Miliolids, Textularids.

In terms of time adjustment, the zone is invaluable, since rudist debris can be observed from Aptian to the end of Late Cretaceous in low-depth facies of Zagros; although the age of this zone is considered according to the stratigraphy of Cenomanian.

- ***Oligostegina* facies**

This biozone is located in upper part of the Sarvak Formation with a thickness of 36 meter (1988m-1952m). In terms of facies, it is pelagic mudstone-wackestone. The biozone can be specified with the concentration of following fossils:

Globigerinelloides bolli (Bolli, 1959) *Calcisphaerula innominata*, *Stomiosphaera sphaerica*.

Microfossils of this zone are as follow:

Hedbergella sp., *Hedbergella planispira* (Tappan, 1940) *Heterohelix* sp., *Whiteinella* sp., *Nezzazatinella* sp., Miliolids, Textularid

In this zone, according to the emergence of dominant species of *Globigerinelloides Bolli*, beginning of Turonian can be demonstrated. The biozone is adjusted with biological facies 26 (*oligostengina* facies) of Wynd (1965) and main range of the zone if from Albin to Turounian. Age of the biozone is considered to Turonian based on identified fossil population.

The upper boundary of the Sarvak Formation in the studied well is a disconformity without outcrops of the Ilam Formation and Gurpi Formation (evidence of Gurpi Formation, the existence of pelagic fossils of *Globotruncana arca*, *Globotruncanita stuarti*) overlies directly the Sarvak Formation. It is because of lack of upper biozone of Sarvak Formation and Ilam Formation. The sedimentary gap between Gurpi and Sarvak Formations is a result of epirogenic movement of Sub-Hersinian from Late Turonian to Middle Santonian which caused precipitation of Gurpi deposits with Late Santonian to Maastrichtian age on middle Turonian deposits. In the studied well, the lower boundary of Sarvak Formation is not clear because of lack of lower sequential excavation.

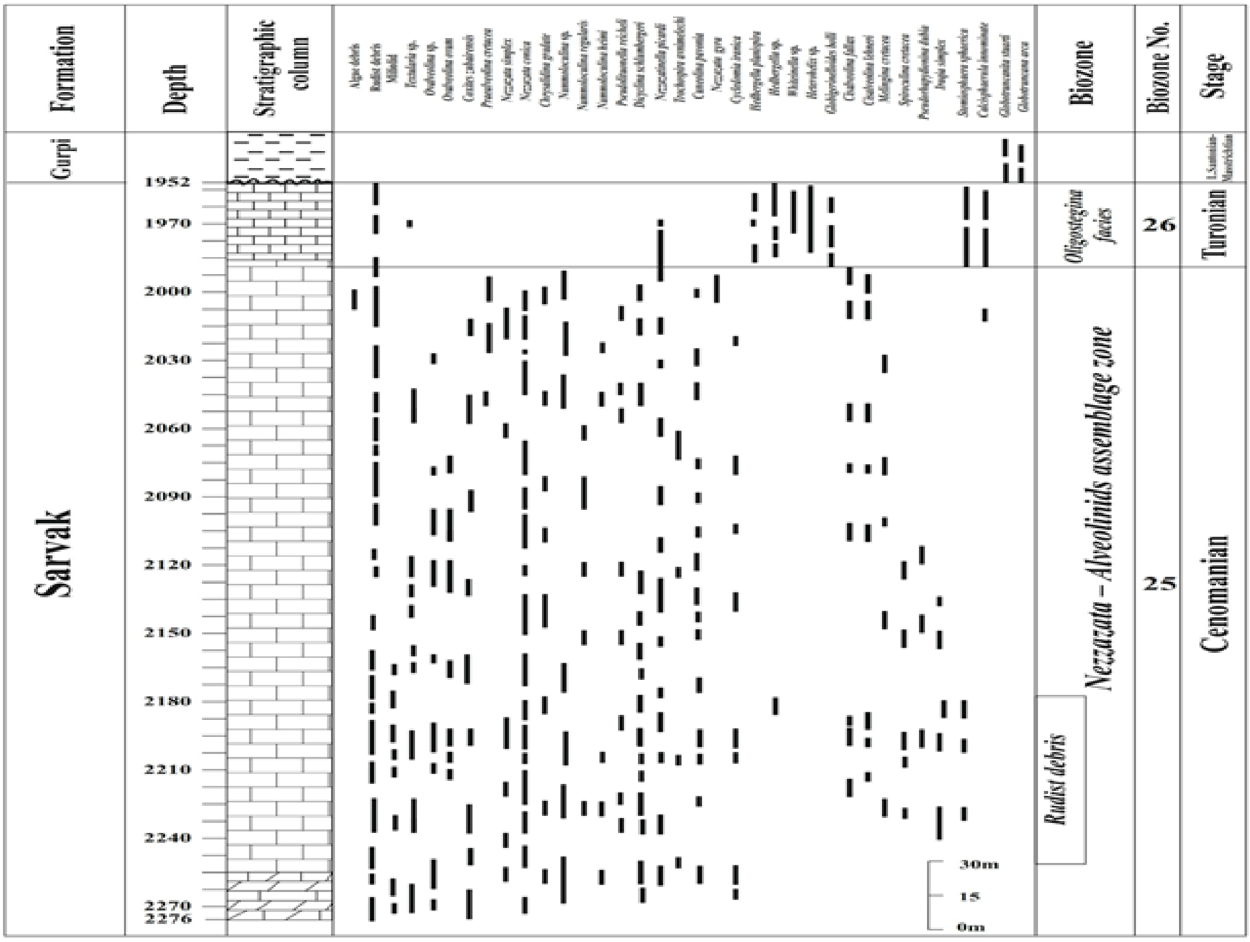

Figure-3. Biostratigraphy chart of the studied section. In the biozones column. 1: *Nezzazata*–Alveolinids assemblage zone, Rudist debris, and *Oligosteginid* facies.

(Rikhtegarzadeh, 2016)

2.3. Microfacies Analysis and Depositional Environments of the Sarvak Formation in Studied Well

The primary depositional features discernible in thin sections of the rock, including textures, microfossils and sedimentary structures, led to the recognition of 8 facies (Fig. 4 and 5).

2.3.1. Open Marine Facies Group

The group includes four microfacies (A1, A2, A3 and A4).

A1: Planktonic Foraminifera Wackestone to Packstone

The main components of this facies are planktonic foraminifera accompanied by oligosteginids. This microfacies is lime mud-dominated and lacks a shallow-water neritic fauna. Ammonites are the dominant macrofauna of this facies.

Interpretation: The low-energy hydrodynamic regime indicates deposition below the normal wave base (Wilson, 1975; Flugel, 1982;2010; Geel, 2000). The abundance of planktonic foraminifera, ammonites and the fine-grained matrix suggest an outer shelf basin environment.

A2: Echinoid Oligostegina Wackestone to Packstone

This facies is found in the thick to massive beds of the lower part of the Sarvak Formation. It is dominated by oligostegina and echinoid debris. Undetermined small foraminifera, sponge spicules and peloids are also present. This microfacies has a fine-grained matrix.

Interpretation: Faunal components and textural features, suggest that this microfacies formed in a low- to medium-energy, open marine environment.

A3: Bioclastic-Foraminiferal (b & p) Wackestone to Mudestone

The main components of this facies are planktonic foraminifera, benthic foraminifera, echinoid and peloid. This microfacies is lime mud-dominated.

Interpretation: This facies type indicates deposition in an open marine, low-energy environment. Open marine, deep subtidal environments are indicated by large amounts of well-preserved planktic foraminifers and the lack of abraded detritus. The low-energy hydrodynamic character indicates deposition below the storm wave base (Wilson, 1975; Flugel, 2010).

A4: Benthic Foraminifera Bioclast Wackestone to Packstone

The main characteristics of this microfacies are fine grains of rudist and echinoid debris, peloids and undifferentiated small benthic foraminifera in mud-supported textures. Minor particles include sponge spicules, oilgosteginids, gastropod debris, green algae, large benthic foraminifera (alveolinids and orbitolinids), Nezzazata and Nezzazatinella. The degree of fragmentation in the large benthic foraminifera is relatively high.

Interpretation: The depositional environment is interpreted as the lower part of a carbonate slope. This interpretation is supported by the faunal components, wackestone–packstone texture, the small size, high degree of fragmentation of bioclasts. This facies reflects an off shore transport rudist into distal middle shelf environment. Rudists obviously derived from the platform margin.

2.3.2. Shoal Facies Group

The group is formed of two microfacies of B1 and B2.

B1: Rudist Floatstone

Large rudist fragments and echinoid debris are the main components. The non-skeletal components consist of peloids. Subordinate components include cortoids; benthic foraminifera include alveolinids, orbitolinids, miliolids, Nezzazata, small Rotalia and gastropods. The degree of fragmentation and micritization in the benthic foraminifers is relatively high. Textures are floatstone with a bioclastic wackestone– packstone matrix..

The texture of this facies is floatstone based on (Embry and Klovan, 1971) classification and is wackestone–packstone based on Dunham (1962) classification scheme.

Interpretation: The faunal components, textural features and the reworked characteristics of the rudist fragments suggest that this microfacies formed in an upper slope environment under low to medium-energy.

B2: Bioclast Peloid Grainstone

The microfacies contains common peloids as well as fragments of bioclast, benthic foraminifera, bivalve, echinoderm, rudist, gastropoda and a green alga. The grains are medium sorted to well sorted, fine to medium sand size and vary from sub-angular to rounded.

Interpretation: The fragmented fauna, well-sorted components, and grainy texture suggests a high-energy shoal environment above the fair-weather wave base, separating the open marine from more restricted marine environment (Flugel, 2010; Khatibi Mehr and Adabi, 2013).

2.3.3. Lagoon Facies Group

The facies group includes two microfacies of C1 and C2.

C1: Bioclast Benthic Foraminiferal Wackestone To Packstone

The main characteristic of this microfacies is the diverse benthic foraminifera in mud-supported textures. Benthic foraminifera include miliolids, alveolinids, orbitolinids and Nezzazata. Rare to common green algae are also present. Other components such as echinoids, rudists, sponge spicules, peloids, gastropods and bivalves are subordinate.

Interpretation: This facies represents deposition in an open lagoon, low-energy environment, as indicated by the fine grain size (textures). The diversity of the fauna shows that this part of laoon environment had good water circulation, normal salinity and oxygen content within the water column and the sediment surface. The existence of green algae indicates good aeration and light penetration (Zhicheng *et al.*, 1997).

C2: Benthic Foraminiferal Bioclast Wackestone

This facies is characterized by the dominant presence of gastropods, shell fragments, green algae and other components such as small benthic foraminifera (miliolids and Nezzazata) and rare peloids are present. The matrix is fine-grained micrite.

Interpretation: This facies was deposited in restricted low-energy lagoonal environments, as indicated by low-diversity skeletal fauna and the stratigraphic position. The limited diversity of bioclasts and dominance of micrites indicate deposition in a low-energy lagoonal environment with poor connection with the open marine environment. The low biotic diversity of the foraminifera indicates a high-stressed habitat in very shallow restricted areas, where great fluctuations in salinity and temperature probably occurred.

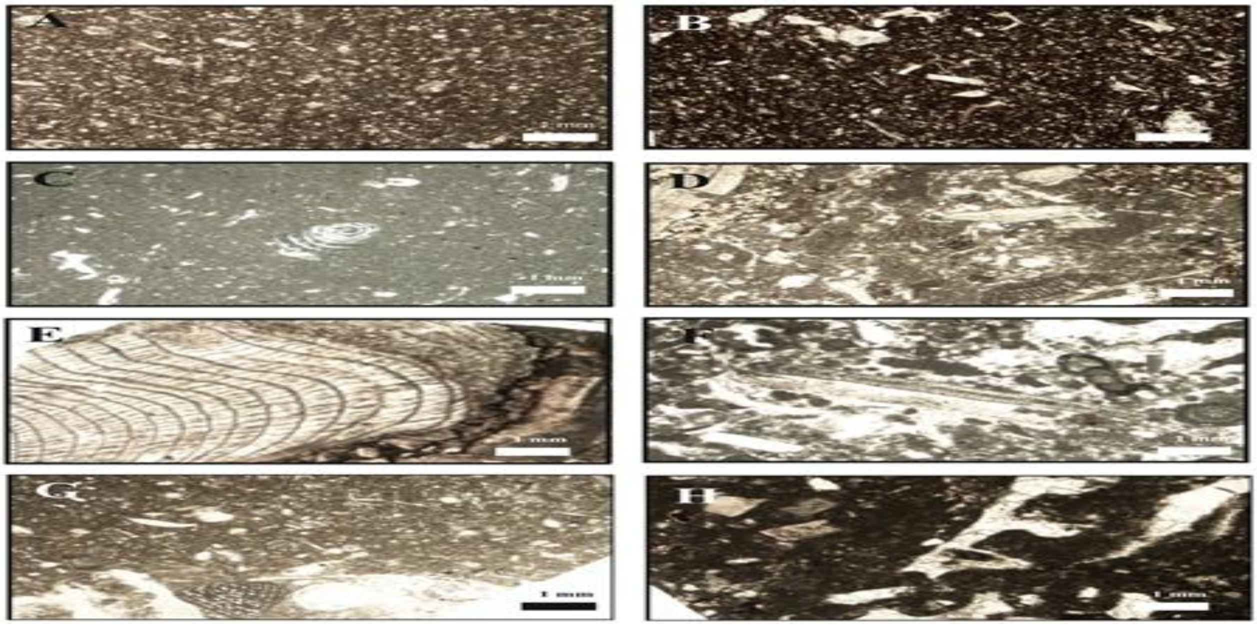

Figure-4. Microfacies of Sarvak Formation A) Planktonic foraminifera wackestone to packstone, B) Echinoid oligostegina wackestone, C) Bioclastic-foraminiferal (b & p) wackestone to mudstone, D) Benthic foraminifera bioclast wackestone to packstone, E) Rudist debris floatstone, F) Bioclast peloid grainstone, G) Bioclast benthic foraminiferal wackestone to packstone and H) Benthic foraminiferal bioclast wackestone

(Rikhtegarzadeh, 2016)

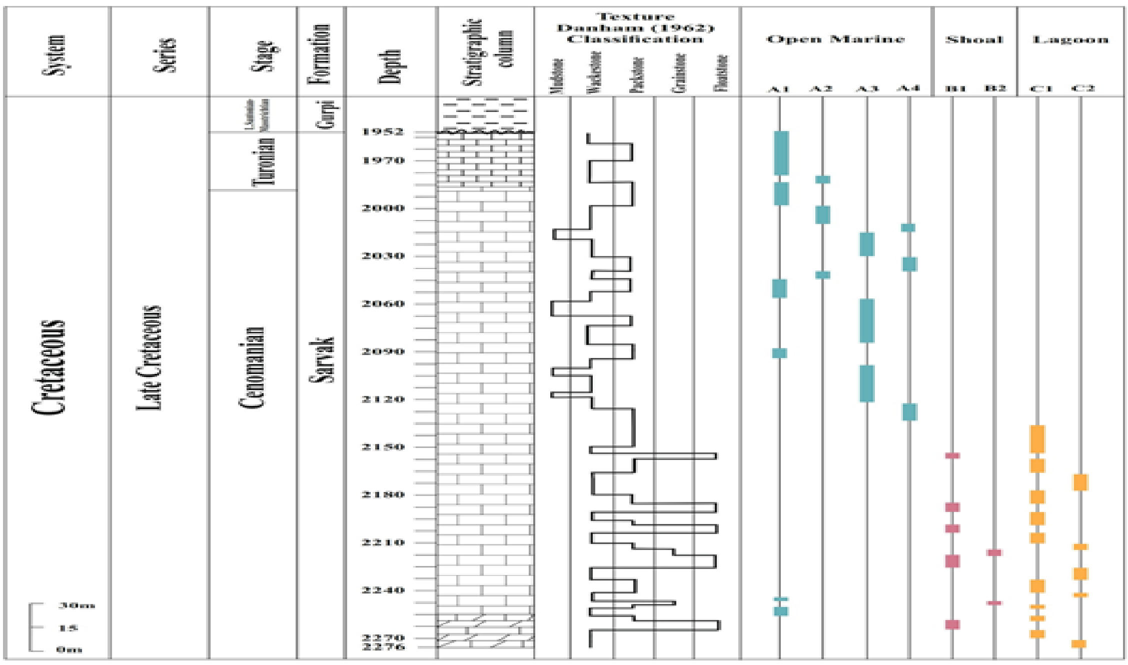

Figure-5. Microfacies column of the Sarvak Formation in Bi Bi Hakimieh oil field (Well No. 29).

(Rikhtegarzadeh, 2016)

2.4. Interpretation of Depositional Environment of the Sarvak Formation

The Sarvak Formation represents sedimentation on a carbonate shelf on the basis of the distribution of the biota, textures and vertical facies relationships. The carbonate shelf environments are separated into: (1) the inner shelf, (2) the middle shelf and (3) the outer shelf (Flugel, 2010) (Fig. 6).

The inner shelf facies types are highly variable but contain abundant imperforated tests of foraminifera (e.g., miliolids, alveolinids and Nezzazata), dasycladacean and gastropods. The inner shelf deposits represent a wider spectrum of marginal marine deposits indicating open lagoon and protected lagoon conditions. Open shallow subtidal environments are characterized by microfacies type (C1) that include high-diversity of benthic foraminifers, dasycladacean and rudist fragments. The fauna and flora support the interpretation of this association as deposited in warm, euphotic, shallow water under low-energy conditions, in an inner shelf setting. Restricted shallow subtidal environments of deposition are characterized by low-diversity benthic foraminiferal assemblages (C2). The foraminiferal associations are commonly dominated by imperforated foraminifera. Restricted conditions are suggested by lack of normal marine biota and the presence of restricted biota (imperforated foraminifera) (Reiss and Hottinger, 1984; Hottinger, 1997).

The platform margin is represented by bioclast peloid grainstone. Bioclast peloid grainstone is interpreted to represent a shoal in a shallow subtidal zone (B2), characterized by the winnowing of coarse-grained and sorted rudist fragments. The predominantly coarse and well-sorted grain size indicates deposition in a well-circulated environment in a shallow subtidal zone (Schulze *et al*., 2005).

The middle shelf can be divided into a proximal and a distal middle shelf. The proximal middle shelf is characterized by coarse grained skeletal floatstones (B1). Skeletal grains are dominantly rudist and echinoid fragments. Deposition took place in shallow water near the fair-weather wave base. The distal middle shelf sediments are dominated by fine-grained skeletal wackestone–packstones (oligosteginids, fine-grained rudists and echinoids fragments) (A3 and A4). The distal middle shelf facies are differentiated from the proximal middle shelf by the smaller size of components, the greater amount of micritic matrix and the presence of oligosteginids. Indicators of the outer shelf deeper water facies are high amounts of intact tests of planktonic foraminifers. Abundant of oligosteginids, siliceous sponge spicules and ammonites (A1 and A2) also indicate deeper water and fully marine conditions. The chert nodules are common in the proximal part of outer shelf. The basin is characterized by abundant oligosteginids, planktonic foraminifers and ammonites (A1 and A2). The direction of transition from the shallow marine environment to a deeper marine environment is concluded to be from northeast to southwest (Fig. 6).

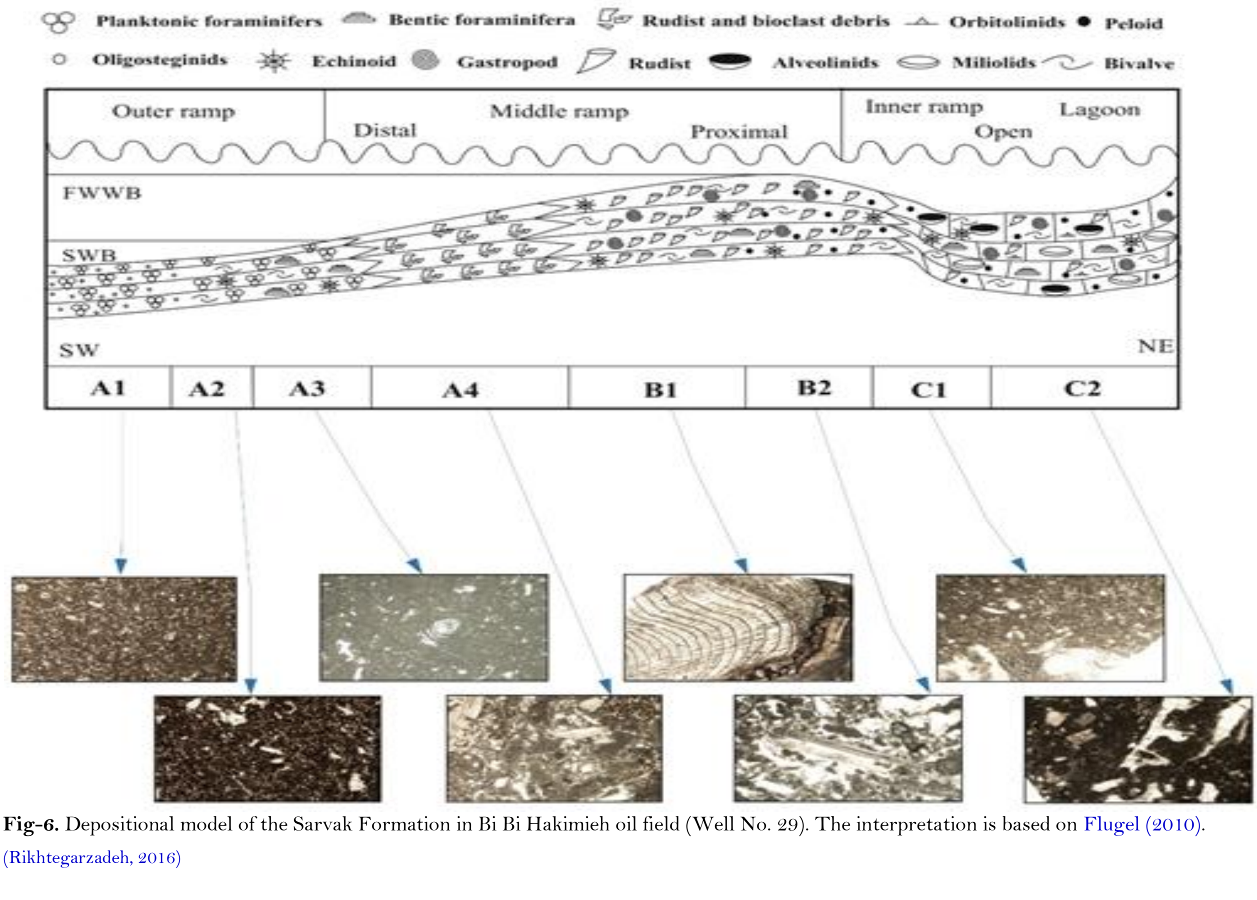

Fig-6. Depositional model of the Sarvak Formation in Bi Bi Hakimieh oil field (Well No. 29). The interpretation is based on Flugel (2010). (Rikhtegarzadeh, 2016)

3. CONCLUSION

3.1. According to biostratigraphy studies, 4 genera and 2 species of planktonic foraminifera and 22 genera and 28 species of benthic foraminifera are identified and based on them, three biozones were introduced including *Nezzazata*–Alveolinids assemblage zone, Rudist debris, and *Oligosteginid* facies. The zones are in consistence with zones introduced by Wynd (1965). According to studied microfauna, the age of Sarvak Formation in studied well is specified from the time of Cenomanian to Turonian.

3.2. According to the study, 3 members of lithostratigraphy were detected in this well for Sarvak Formation as follows:

- Member 1 (depth 1952-1986m): This member (34m) consists of white to light-gray, thin- and medium-bedded limestones with facies of wackestone and packstone and includes mainly pelagic fossils.
- Member 2 (depth 1386-2255m): This member (269m) consists of cream to white, thick-bedded limestones with facies of wackestone and fine calcite aggregates.
- Member 3 (depth 2255-2276m): This member (21m) consists of white dolomite, limestone, and light-brown calcareous dolomite and includes facies of wackestone to packstone in terms of Dunham divisions.

3.3. According to microfacies studies, 8 microfacies were detected in this well for Sarvak Formation.

3.4. The sedimentological analysis shows that the Sarvak Formation was formed by a carbonate shelf bordering an intrashelf basin, with abundant rudists in the mid-shelf environment and pelagic facies (oligostegina and planktonic foraminifera) in the outer shelf and basin environments. The sedimentation of the Sarvak Formation took place on a shallow carbonate shelf setting, in a facies belt consisting of an inner shelf, middle shelf, outer shelf and basin. In the inner shelf, the most abundant microfacies are wackestone– packstone with benthic foraminifera (such as alveolinids, orbitolinids and miliolids) and rudist fragments. The shoal facies are marked by bioclast peloid grainstone. The proximal middle shelf is dominated by floatstones with large rudist fragments, while wackestone–packstone and fine-grained rudists and echinoids are present in the distal middle shelf. The outer shelf is represented by wackestone–packstones with oligostegina and planktonic foraminifera. The basin environment is dominated.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study. The authors are grateful to the Tehran Science and Research Branch Islamic Azad University and National Iranian South Oil fields Company for providing financial support.

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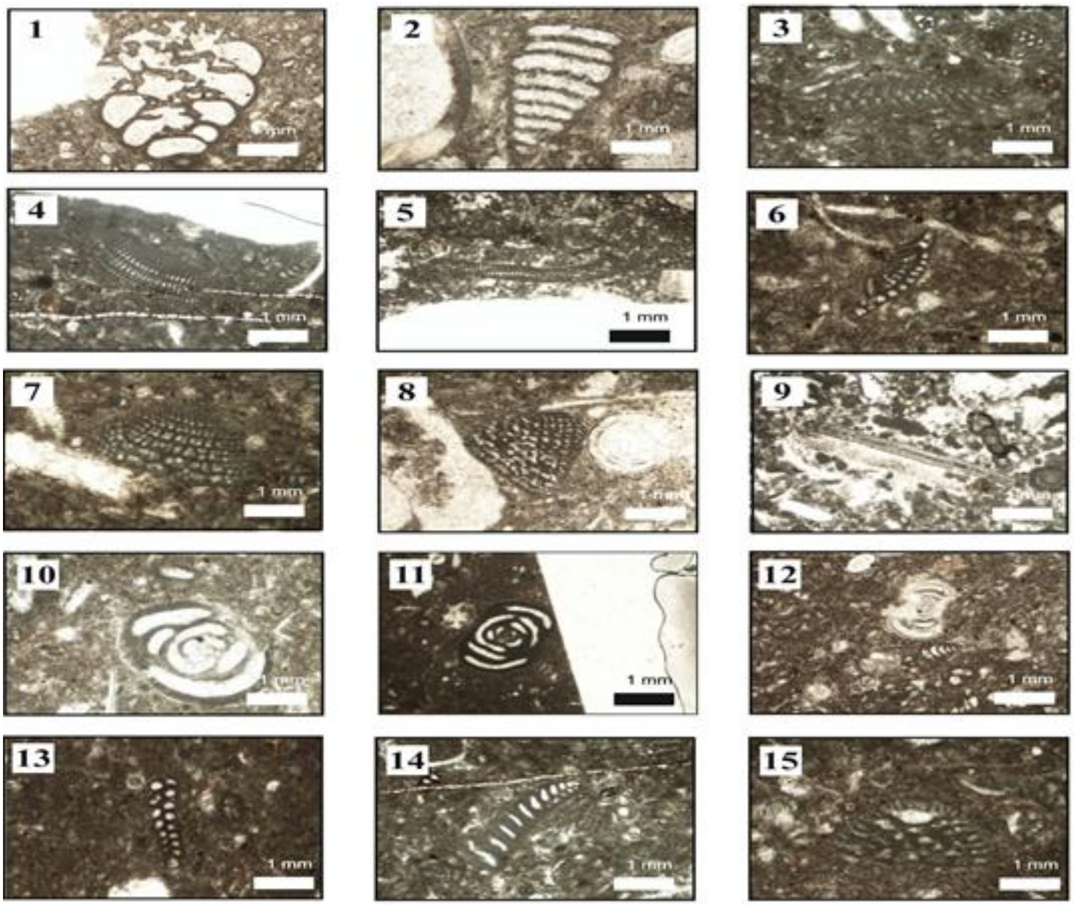

Plate 1

Fig. 1: *Chrysalidina gradate* (Orbigny, 1839) Axial section, depth 2255m

Fig. 2: *Pseudolituonella reicheli* (Marie, 1955) Longitudinal section, depth 2230m

Figs. 3-5: *Dicyclina schlumbergeri* (Munier-Chalmas, 1887) Axial section (fig. 3), Oblique transversal section (figs 4, 5), depths 2230m, 2252m,

Fig. 6: *Coxites zubairensis* (Smout, 1956) Sub-axial section, depth 2270m

Fig. 7: *Orbitolina* sp., Sub-axial section, depth 2277m

Fig. 8:*Neoiraqia convexa* (Henson, 1948) Sub-axial section, depth 2235m

Fig. 9: *Cycledomia iranica* (Hamaoui, 1964) Sub-axial section, depth 2135m

Figs. 10-11: *Nummoloculina heimi* (Bonet and Coskin, 1958) Axial section, depths 2257m, 2225m

Fig. 12: *Nummoloculina regularis* (Philippson, 1887) Axial section, depth 2225m

Fig. 13: *Mangashtia viennoti* (Henson, 1948) Axial section, depth 2248m

Fig. 14: *Merlingina cretacea* (Hamaoui, 1965) Sub-axial section, depth 2225m

Fig. 15: *Orbitolina conica* (D Archiac, 1837) Axial section, depth 2270

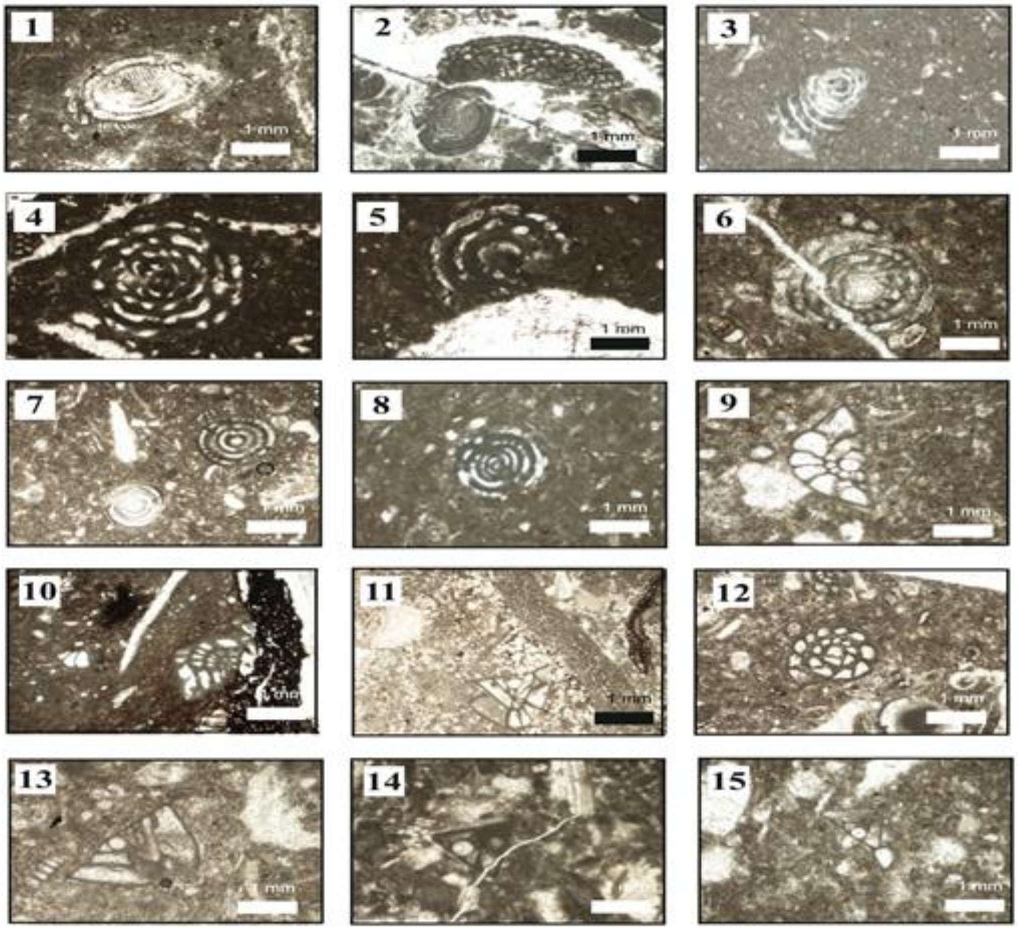

Plate-2.

Figs. 1-3: *Praealveolina cretacea* (D Archiac, 1837) Axial section (fig. 1, 2) Sub-equatorial section (fig. 3), depths 2115m, 2245m

Fig. 4: *Cisalveolina fallax* (Reichel, 1941) Sub-equatorial section, depth 2225m

Figs. 5-6: *Cisalveolina* sp., Sub-equatorial section (fig. 5), Axial section (fig. 6), depths 2260m, 2275m

Figs. 7-8: *Cisalveolina lehneri* (Orbigny, 1839) Axial section, depths 2115m, 2190m

Fig. 9: *Nezzazata simplex* (Omara, 1956) Axial section, depth 2255m

Figs. 10-12: *Nezzazata conica* (Smout, 1956) Axial section, depths 2250m ,2225m

Figs. 13-15: *Nezzazata gyra* (Smout, 1956) Axial section, depth 2000m

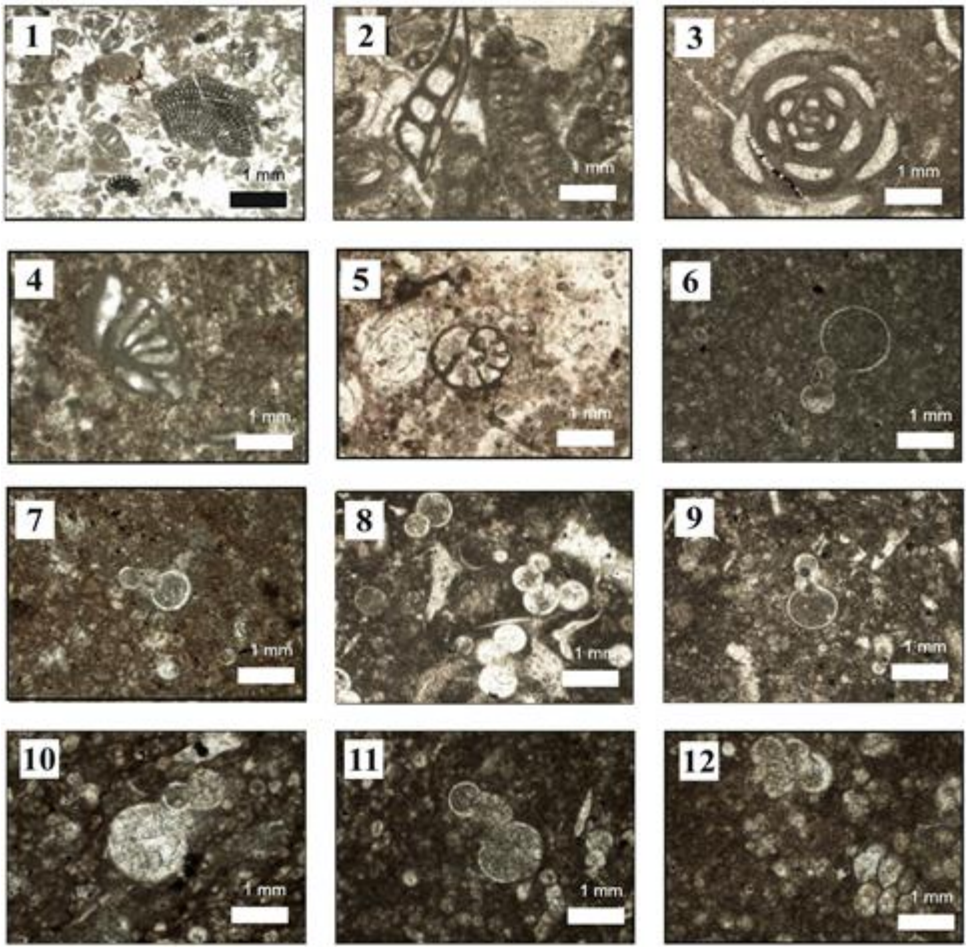

Plate-3.

Fig. 1: *Cuneolina pavonia* (Orbigny, 1839) Sub-axial section, depth 2255m

Fig. 2: *Nezzazata concave* (Smout, 1956) Sub-axial section, depth 2242m

Fig. 3: *Quinqueloculina* sp., Axial section, depth 2250m

Fig. 4: *Trochospira avnimelechi* (Hamaoui, 1965) Sub-axial section, depth 2255m

Fig. 5: *Nezzazatinella picardi* (Henson, 1948) Sub-equatorial section, depth 2230m

Fig . *6: Globigerinelloides bolli* (Bolli, 1959) Axial section, depth 1986m

Fig. 7: *Hedbergella planispira* (Tappan, 1940) Axial section, depth 1988

Fig . *8-10: Hedbergella* sp., Equatorial section (fig. 8), Axial section (figs. 9-10), depths 1960m, 1975m

Fig. 11: *Whiteinella* sp., Axial section, depth 1970m