



LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY OF WELL NUMBERS 9 AND 17 IN BINAK OILFIELD IN THE SOUTHWEST OF IRAN

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ABSTRACT

The lithostratigraphy and biostratigraphy specifications of Sarvak Formation, Laffan member and Ilam Formation in well numbers 9 and 17 of Binak oilfield along the northwest of Bushehr, both in the southwest of Iran are considered for the study. The thickness of Bangestan Group in well no. 9 is 544m; lithologically they are mostly limestone and shale. This group is divided into three lithological parts. In a part of Sarvak Formation drilling has been completed, while its upper bound is covered with Grupi Formation. According to the microscopic studies of thin sections 3 zones are identified: Assemblage Zone 1, *Favosella washitensis* - Oligosteginid *Calcisphaerula innominata*- *Stomiosphaera sphaerica*- *Pithonella ovalis* Ass. Zone; Zone 2, Ostracoda Acme Zone; Zone 3, *Rotalia skourensis* Acme Zone. Consequently, Cenomanian-Santonian age is determined for well no. 9. The thickness of Bangestan Group in well no. 17 is 358m; lithologically they are limestone and shale. In a part of Sarvak Formation drilling has been completed, while its upper bound is covered with Grupi Formation. According to the microscopic studies of thin sections 4 zones are identified: Assemblage Zone 1, *Praealveolina cretacea*- *Ovalveolina ovum* & Rudist debris Ass. Zone; Assemblage Zone 2, Oligosteginid *Calcisphaerula innominata*- *Stomiosphaera sphaerica*- *Pithonella ovalis* Ass. Zone; Zone 3, Ostracoda Acme Zone; Zone 4, *Rotalia skourensis* Acme Zone. On the basin of assemblage recorded, Cenomanian-Santonian age is determined for well no. 17.

Keywords: Lithostratigraphy, Biostratigraphy, Sarvak Formation, Ilam Formation, Cenomanian, Binak Oilfield.

INTRODUCTION

Zagros mountain range trending NW-SE is located in the south and the southwest of Iran; in its northeast is Zagros thrust belt that is within Kermanshah and the northwest of Bandar Abbas. Geological studies of Zagros started around 19th century and its significance increased when oil exploration in Masjed Soleyman started. A number of Iran-England national oil companies geologists studied these areas. The stratigraphies studies started since 1954 by National Iranian Oil Company, and its results were published by James and Wynd (1965). Zagros mountain range was divided into three areas: Lorestan, Fars and Khuzestan. Fars area is bounded by Persian Gulf in the south, Zagros Fault in the north, Kazeron Fault in the west and Zendan Fault in the east. According to the studies carried by Wynd, zones of Triassic to Pleistocene deposits were introduced in Fars, Lorestan and Khuzestan. It shows that outcrop of Cretaceous system is exposed along Lorestan, Fars and the north of Khuzestan, and the deposits are marine in origin. Cretaceous in Zagros is very important in comparison to other systems; among 27 identified formations in Mesozoic in Zagros, 17 formations consist of Cretaceous.

Zagros has economic interests because of its oilfields, so geological studies has been developed significantly since previous century, and they were published as internal reports in National Iranian Oil Company. James and Wynd (1965) in their report "Stratigraphic nomenclature of Iranian oil company consortium agreement area" studied stratigraphy of Mesozoic and Cenozoic formations in three areas Lorestan,

Fars and Khuzestan. Wynd (1965) in his report "Biofacies of the Iranian consortium agreement area" introduced 66 zones in the biozonation of Zagros basin from Triassic to Pliocene sediments. Wells (1966-1968) did further evaluation on lithostratigraphy facies of Bangestan Group in the Khuzestan region. Hart (1970) studied upper Cretaceous palaeontology and historical geology of Khuzestan region. Khalili (1967) reported the biostratigraphy of Bangestan Group in the southwest of Iran. Amiri Bakhtiar (1991) presented maps of facies and lithofacies for Sarvak and Ilam Formations in different areas of Zagros. Tabatabai (2004) studied facies and stratigraphy of sedimentary environments of Bangestan Group in Kangan and Bozpar anticlines in the southwest of Iran.

In this paper, two wells of Binak oilfield are studied located in the northwest of Bushehr in Iran; and the ages are determined as Cenomanian, Turonian, Coniacian and Santonian.

METHODOLOGY

All thin sections (thickness of fossil elements between lams and lamella 40micron) were prepared by the laboratory of National Iranian Oil Company according to the following standard method: 1- sample selection among cores and cuttings; 2- putting samples on lams and gluing with Canada-Balsam; 3- rubbing thin sections; 4- putting lamella on sections.

A binocular microscope is applied for the study these thin sections and bioclasts are identified which is very important to determine the age of strata. Then, Log Plot 7 software is used to plot lithostratigraphy and biostratigraphy columns.

GEOLOGICAL SETTING

Binak oilfield is located on an asymmetric anticline trending NW-SE in the northwest of Bushehr and 20km to the north of the Ganaveh port along Persian Gulf seaside (fig. 1). This oilfield follows the general trend of Zagros. Its geological coordinates are: 29° 96' N, 50° 51' E.

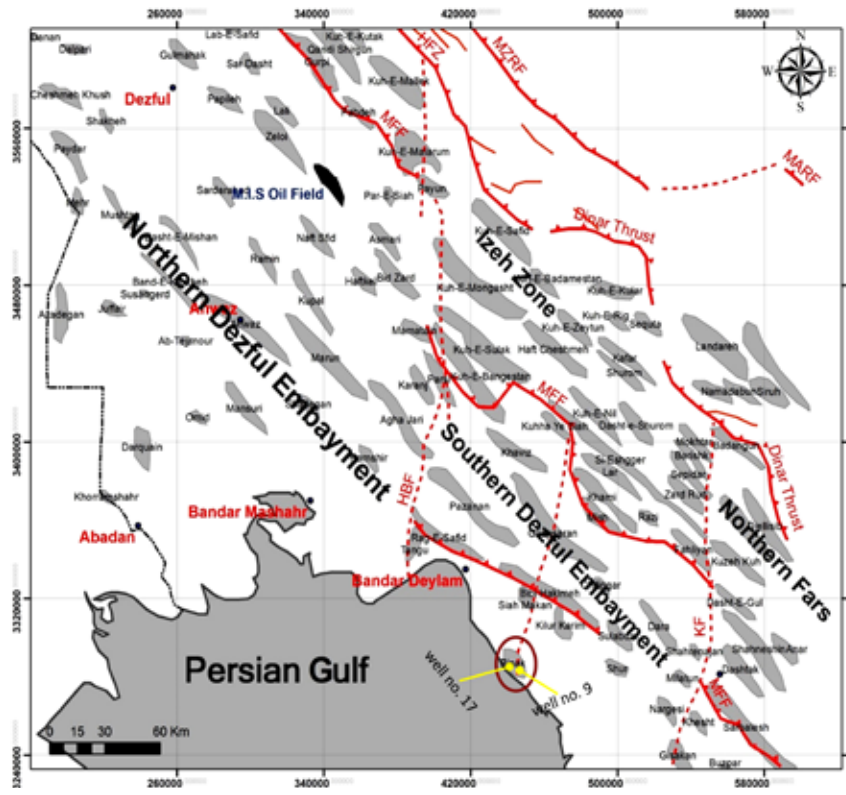


Fig. 1. The location of Binak oilfield (well no. 9 in the eastern ridge anticline and well no. 17 in the western ridge anticline), southwest of Iran [Sherkati & Letouzey 2004]

contains dominantly limestone, and minor amount of dolomite and shale. Fossils recorded in the interval are:

Stomiosphaera sphaerica, *Pseudolituonella reicheli*, *Pithonella trejoi*, *Pithonella ovalis*, *Favusella washitensis*, *Hedbergella planispira*, *Calcisphaerula innominata*, *Heterohelix* sp., *Globigerinelloides* sp.

The observed non-foraminifera in this part are: Shell fragment, Sacocoma debris, Ostracod, Algae debris, Echinoid debris, Rudist debris, Oligostegina.

According to the above fossil assemblage and the lithological specifications, the age of Sarvak Formation is determined as Cenomanian-Turonian.

Part 2: 82m from Laffan member (from 3280m-3362m) contains dominantly shale and minor amount of calcareous shale. Its observed fossils are: *Pithonella ovalis*, *Heterohelix* sp.

The observed non-foraminifera in this part are: Ostracod, Algae debris, Echinoid debris.

According to the above fossil recorded and the lithological specifications, the age of part 2 is determined as Coniacian.

Part 3: 180m from Ilam Formation (from 3280m-3100m) contains limestone and minor amount of dolomite and shale. Its observed fossils are: *Rotalia skourensis*, *Stomiosphaera sphaerica*, *Calcisphaerula innominata*, *Heterohelix* sp.

The observed non-foraminifera in this part are: Algae debris, Echinoid debris, Shell fragment.

According to the above fossils and the lithological specifications, the age of Ilam Formation is determined as Santonian.

LITHOSTRATIGRAPHY OF SUBSURFACE SECTION FOR WELL NO. 9

This subsurface section is in the eastern ridge anticline of Binak. Bangestan Group in well no. 9 of this oilfield has 544m thickness and it mostly contains limestone, shale and minor amount of dolomite and dolomitic limestone. Drilling has been completed in a part of Sarvak and its upper bound is covered by Gurpi Formation. These bounds are lithologically distinctive and fossils are recorded.

So, upper bound of this well is a depth of 3100m and it terminates at a depth of 3644m (Table 1). The lithology of Bangestan Group for this section is as following (Table 2).

Part 1: 282m lower part of Group (from 3362m-3644m)

BIOSTRATIGRAPHY OF BANGESTAN GROUP IN WELL NO. 9

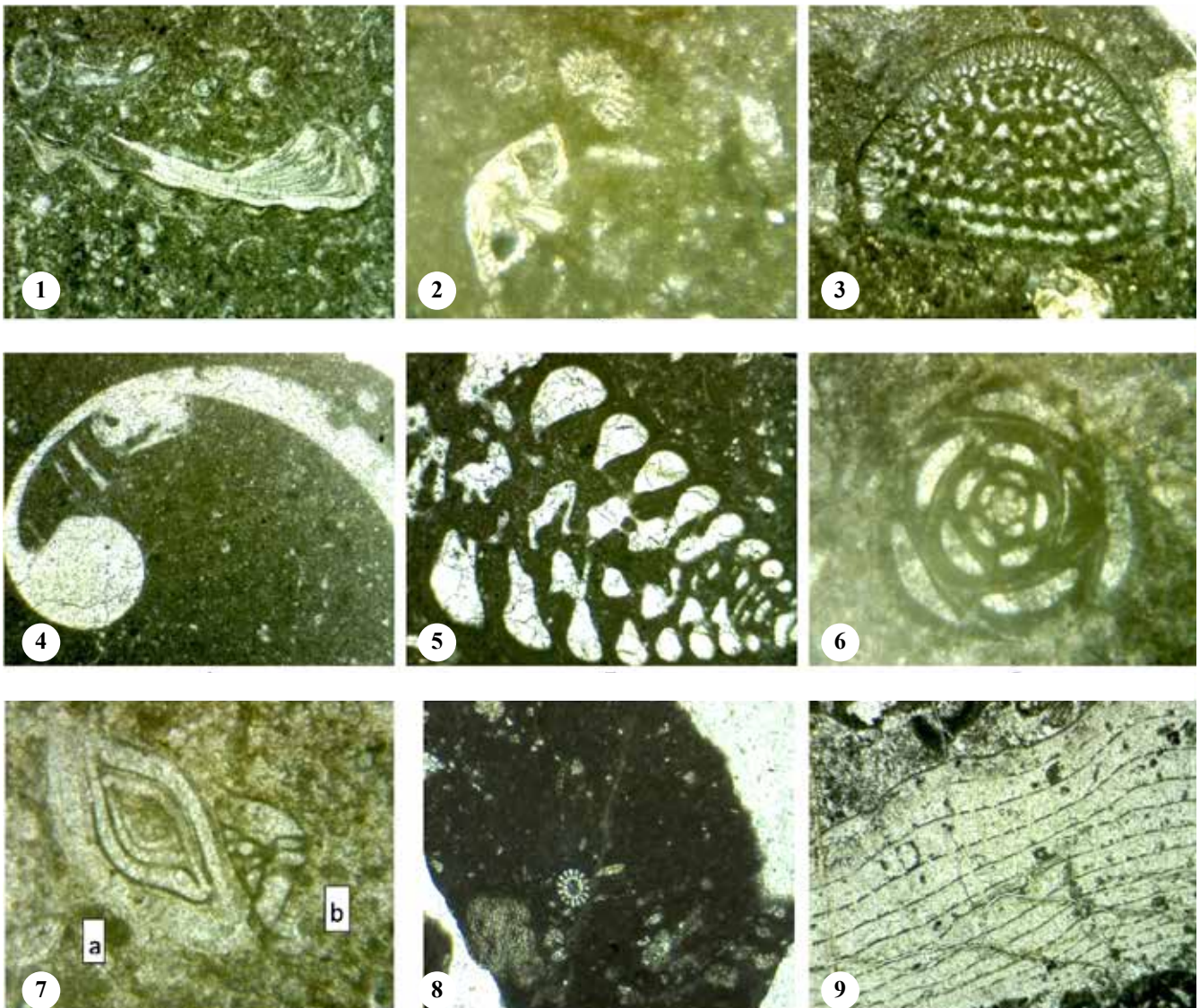
Consequently, our precise studies of paleontology in well no. 9 identify 2 groups of foraminifera and non-foraminifera, that they contain 2 genera, 8 species of foraminifera, and some non-foraminifera:

Foraminifera: *Favusella washitensis*, *Pithonella ovalis*, *Pithonella trejoi*, *Pseudolituonella reicheli*, *Hedbergella planispira*, *Stomiosphaera sphaerica*, *Calcisphaerula innominata*, *Rotalia skourensis*, *Globigerinelloides* sp., *Heterohelix* sp.

Non-foraminifera: Shell fragment, Sacocoma debris, Ostracod, Bryozoa, Algae debris, Echinoid debris, Rudist debris, Oligosteginid.

Table 1. The specifications of well no. 9 in Binak oilfield.

Parts of lithology	Bangestan Group thickness (m)	Base of Bangestan Group (m)	Top of Bangestan Group (m)	Well no.	Oilfield
3	544	3644	3100	9	Binak



EXPLANATION OF PLATE I

1. Shell fragment, Depth: 3620m, x 40, BK#9, Sarvak Formation, Cenomanian. 2. *Rotalia skourensis*, Depth: 3050m, x 100, BK#17, Ilam Formation, Santonian. 3. *Dictyoconus* sp., Depth: 3345m, x 40, BK#17, Sarvak Formation, Cenomanian. 4. Gastropoda, Depth: 3300m, x 40, BK#17, Sarvak Formation, Cenomanian. 5. *Chrysalidina gradata*, Depth: 3320m, x 40, BK#17, Sarvak Formation, Cenomanian. 6. *Quinqueloculina* sp., Depth: 3300m, x 100, BK#17, Sarvak Formation, Cenomanian. 7. a: *Spiroloculina cretacea*, b: *Nezzazata conica*, Depth: 3300m, x 100, BK#17, Sarvak Formation, Cenomanian. 8. Echinoid debris, Depth: 3110m, x 40, BK#9, Ilam Formation, Santonian. 9. Rudist debris, Depth: 3310m, x 40, BK #17, Sarvak Formation, Cenomanian.

The biozonations of deposits are done based on Wynd (1965); however, international stratigraphic guide (1994) is respected. The zones are as following and they are shown in fig. 2:

Assemblage Zone 1: *Favusella washitensis* & Oligosteginid *Calcisphaerula innominata*- *Stomiosphaera sphaerica*-*Pithonella ovalis* Ass. Zone

This zone has 282m thickness and deposits are between 3362m to 3644m, and it contains part 1 of well no. 9 with the following fossils:

Foraminifera: *Stomiosphaera sphaerica*, *Pseudolituonella reicheli*, *Pithonella trejoi*, *Pithonella ovalis*, *Favusella*

washitensis, *Hedbergella planispira*, *Calcisphaerula innominata*, *Heterohelix* sp., *Globigerinelloides* sp.

Non-foraminifera: Shell fragment, *Sacocoma* debris, Ostracod, Algae debris, Echinoid debris, Rudist debris, Oligostegina.

According to the observed fossils, the age of this zone is determined as Cenomanian-Turonian; so, it is comparable with Assemblage Zones numbers 23 and 26 by Wynd (1965).

Zone 2: Ostracoda Acme Zone

This zone has 82m thickness and deposits are between 3280m to 3362m, and it contains part 2 of well no. 9 with the following fossils:

Foraminifera: *Pithonella ovalis*, *Heterohelix* sp.

Non-foraminifera: Ostracod, Algae debris, Echinoid debris.

According to the observed fossils, the age of this zone is determined as Coniacian. The Laffan shale member in this well is determined as the unique zone and it is equivalent with 30a zone that contains Karofita family.

Zone 3: *Rotalia skourensis* Acme Zone

This zone has 180m thickness and deposits are between 3280m to 3100m, and it contains part 3 of studied strata. The following fossils are observed:

Foraminifera: *Rotalia skourensis*, *Stomiosphaera sphaerica*, *Calcisphaerula innominata*, *Heterohelix* sp.

Non-foraminifera: Algae debris, Echinoid debris, Shell fragment.

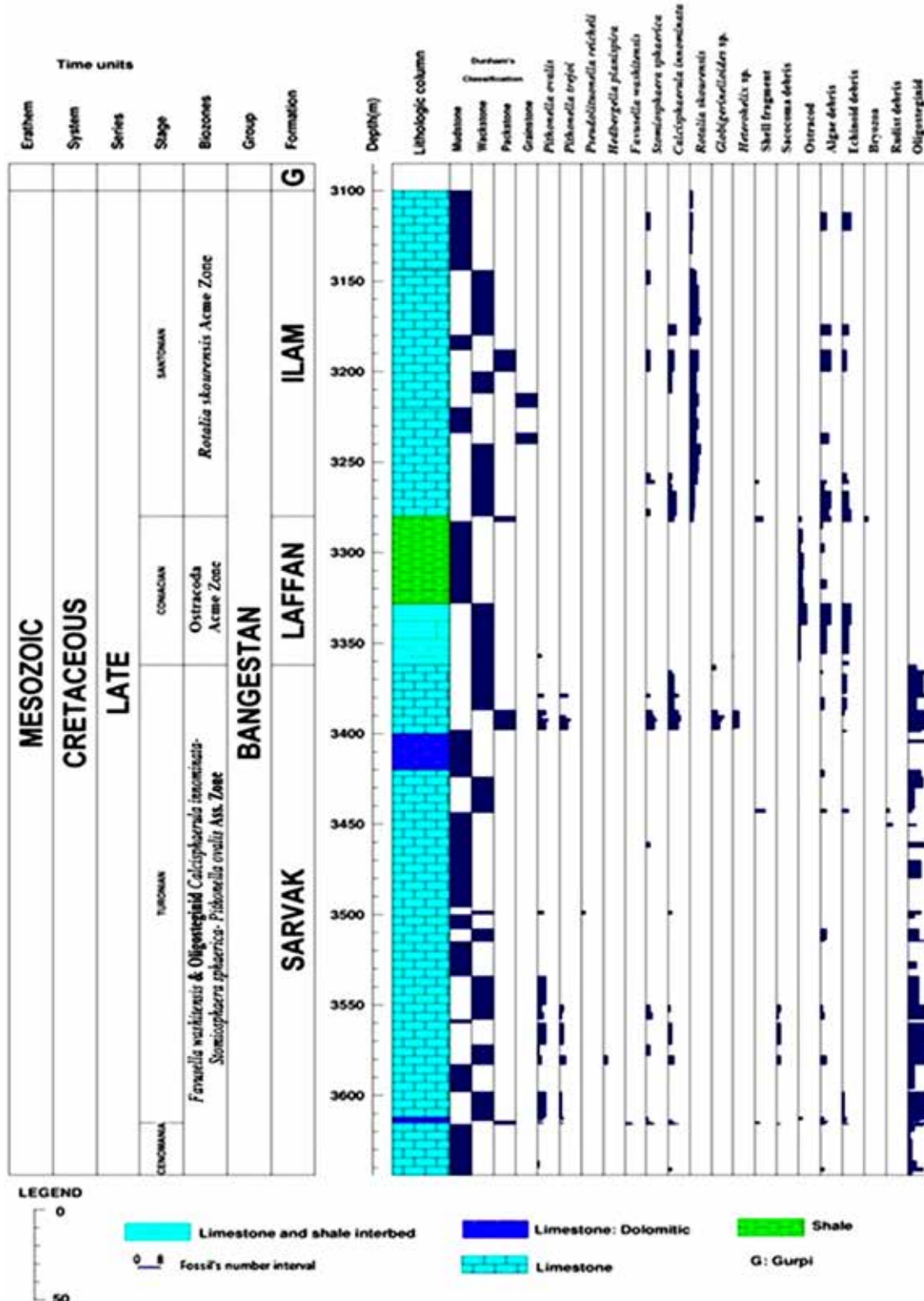
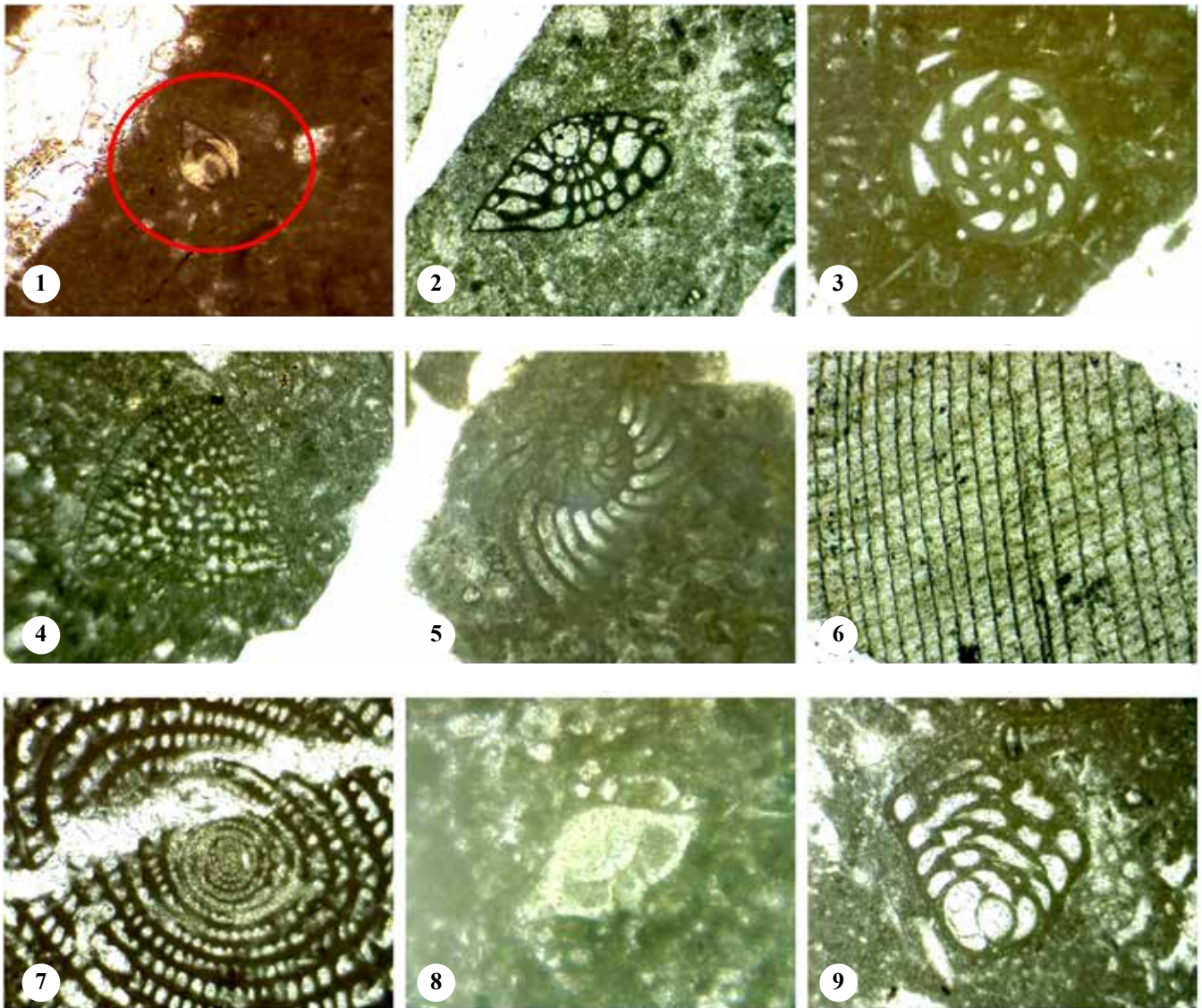


Fig. 2. The vertical expansion of microfossils of Bangestan Group in well no. 9 of Binak oilfield.



EXPLANATION OF PLATE II

1. *Murgeina apula*, Depth: 3300m, x 40, BK #17, Sarvak Formation, Cenomanian. 2. *Trochospira avnimelechi*, Depth: 3325m, x 40, BK #17, Sarvak formation, Cenomanian. 3. *Daxia cenomana*, Depth: 3303m, x 40, BK #17, Sarvak Formation, Cenomanian. 4. *Dictyoconus pachymarginalis*, Depth: 3340m, x 40, BK #17, Sarvak Formation, Cenomanian. 5. *Peneroplis parvus*, Depth: 3305m, x 40, BK #17, Sarvak Formation, Cenomanian. 6; Rudist debris, Depth: 3310m, x 40, BK #17, Sarvak Formation, Cenomanian. 7. *Praealveolina cretacea*, Depth: 3345m, x 40, BK #17, Sarvak Formation, Cenomanian. 8. *Rotalia skourensis*, Depth: 3150m, x 100, BK #9, Ilam Formation, Santonian. 9. *Chrysalidina gradata*, Depth: 3325m, x 40, BK #17, Sarvak Formation, Cenomanian.

According to the observed fossils, the age of this zone is determined as Santonian, and it is comparable with zone number 30 by Wynd (1965).

LITHOSTRATIGRAPHY OF SUBSURFACE SECTION FOR WELL NO. 17

This subsurface section is in the western ridge anticline of Binak. Sarvak and Ilam Formations in well no. 17 of this oilfield have 358m thickness and it mostly contains limestone, shale and minor amount of dolomite. Drilling has been completed in a part

of Sarvak and its upper bound is covered by Gurpi Formation. These bounds are lithologically distinctive and fossils are recorded.

So, upper bound of this well is at a depth of 2993m and it terminates at a depth of 3351m (Table 3). The lithology of Bangestan Group for this section is as following (Table 4).

Part 1: 111m lower part of group (from 3240m-3351m) contains dominantly limestone and minor amount of dolomite. Its observed fossils are:

Stomiosphaera sphaerica, *Pseudolituonella reicheli*, *Nezzazatinella Picardi*, *Dictyoconus pachymarginalis*,

Table 2. The lithology, thickness and age in well no. 9 of Binak oilfield.

PART	DEPTH (M)	THICKNESS (M)	THE DOMINANT LITHOLOGY	FORMATION	AGE
PART 3	3100-3280	180	Limestone Shale	Ilam	Santonian
PART 2	3280-3362	82	shale	Laffan member	Coniacian
PART 1	3362-3644	282	Limestone Dolomite	Sarvak	Turonian Cenomanian

Table 3. The specifications of well no. 17 in Binak oilfield.

Parts of lithology	Bangestan Group thickness (m)	Base of Bangestan Group (m)	Top of Bangestan Group (m)	Well no.	Oilfield
3	358	3351	2993	17	Binak

Spiroloculina cretacea, *Pithonella trejoi*, *Pithonella ovalis*, *Nezzazata conica*, *Nezzazata simplex*, *Nezzazata* sp., *Ovalveolina ovum*, *Murgeina apula*, *Calcisphaerula innominata*, *Biplanata peneropliformis*, *Peneroplis parvus*, *Praealveolina cretacea*, *Trochospira avnimelechi*, *Cisalveolina fallax*, *Daxia cenomana*, *Chrysalidina gradata*, *Dictyoconus* sp., *Heterohelix* sp., *Hedbergella* sp., *Globigerinelloides* sp., *Textularia* sp., *Quinqueloculina* sp., Miliolid.

The observed non-foraminifera in this part are: Gastropoda, Shell fragment, Bryozoa, Sacocoma debris, Algae debris, Echinoid debris, Rudist debris, Oligostegina.

According to the above fossil assemblage and the lithological specifications, the age of Sarvak Formation is determined as Cenomanian-Turonian.

Part 2: 127m from Laffan member (from 3113m-3240m) contains dominantly shale and minor amount of calcareous shale.

The observed non-foraminifera in this part are: Ostracod, Algae debris.

According to the above fossil recorded and the lithological specifications, the age of part 2 is determined as Coniacian.

Part 3: 120m from Ilam Formation (from 2993m-3113m) contains limestone and minor amount of dolomite. Its observed fossils are: *Rotalia skourensis*, *Stomiosphaera sphaerica*.

The observed non-foraminifera in this part are: Bryozoa, Algae debris, Echinoid debris.

According to the above fossil assemblage and the lithological specifications, the age of Ilam Formation is determined as Santonian.

BIOSTRATIGRAPHY OF BANGESTAN GROUP IN WELL NO. 17

So, our precise studies of paleontology in well no. 17 identify 2 groups i.e. foraminifera and non-foraminifera, and they contain 8 genera, 20 species of foraminifera, and some non-foraminifera:

Foraminifera: *Daxia cenomana*, *Peneroplis parvus*, *Praealveolina cretacea*, *Murgeina apula*, *Biplanata peneropliformis*, *Chrysalidina gradata*, *Ovalveolina ovum*, *Nezzazata simplex*, *Nezzazata conica*, *Pithonella ovalis*, *Pithonella trejoi*, *Spiroloculina cretacea*, *Dictyoconus*

Table 4. The lithology, thickness and age in well no. 17 of Binak oilfield

PART	DEPTH (M)	THICKNESS (M)	THE DOMINANT LITHOLOGY	FORMATION	AGE
PART 3	2993-3113	120	Limestone Shale	Ilam	Santonian
PART 2	3113-3240	127	shale	Laffan member	Coniacian
PART 1	3240-3351	111	Limestone Dolomite	Sarvak	Turonian Cenomanian

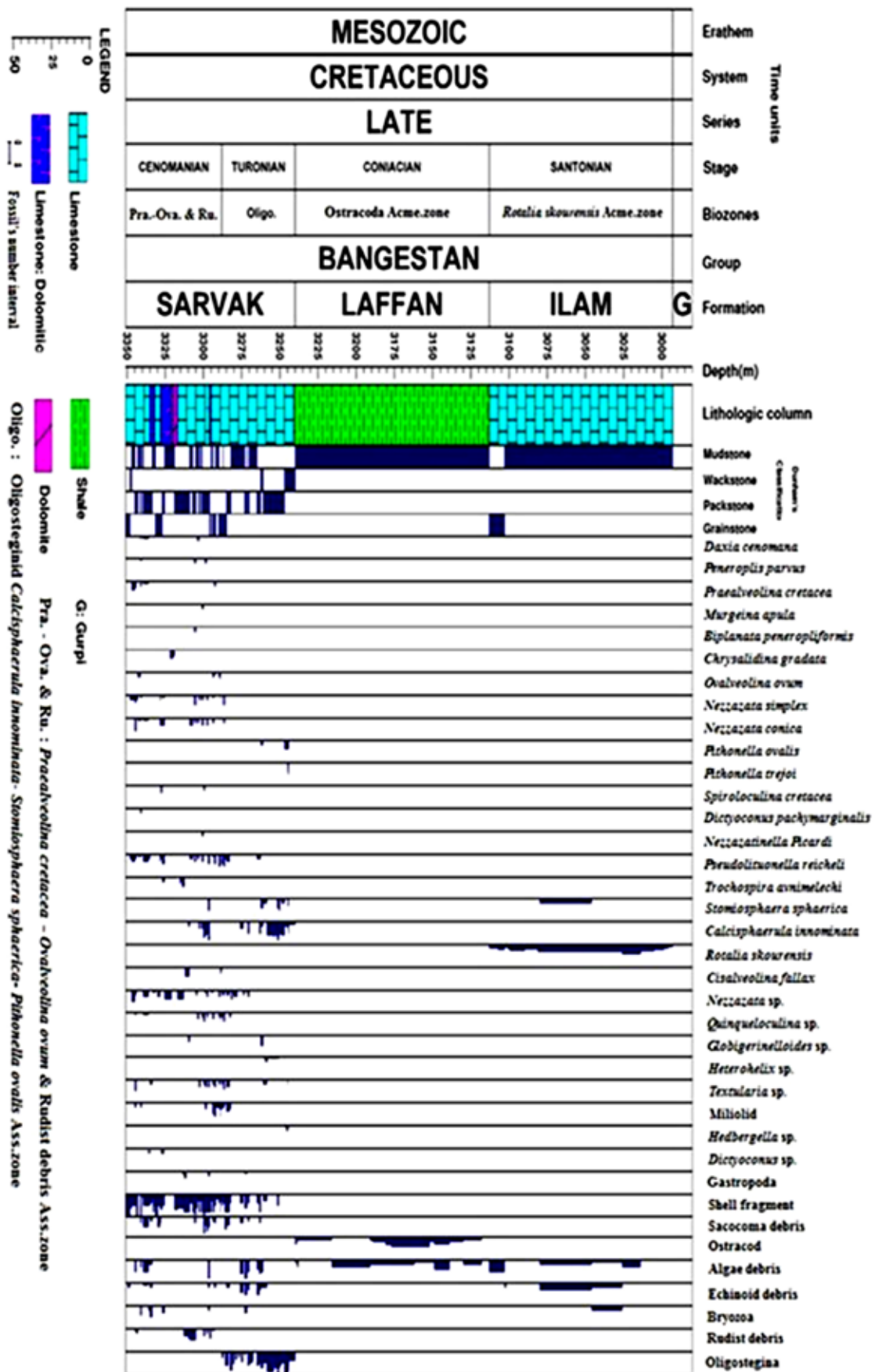


Fig. 3. The vertical expansion of microfossils of Bangestan Group in well no. 17 of Binak oilfield.

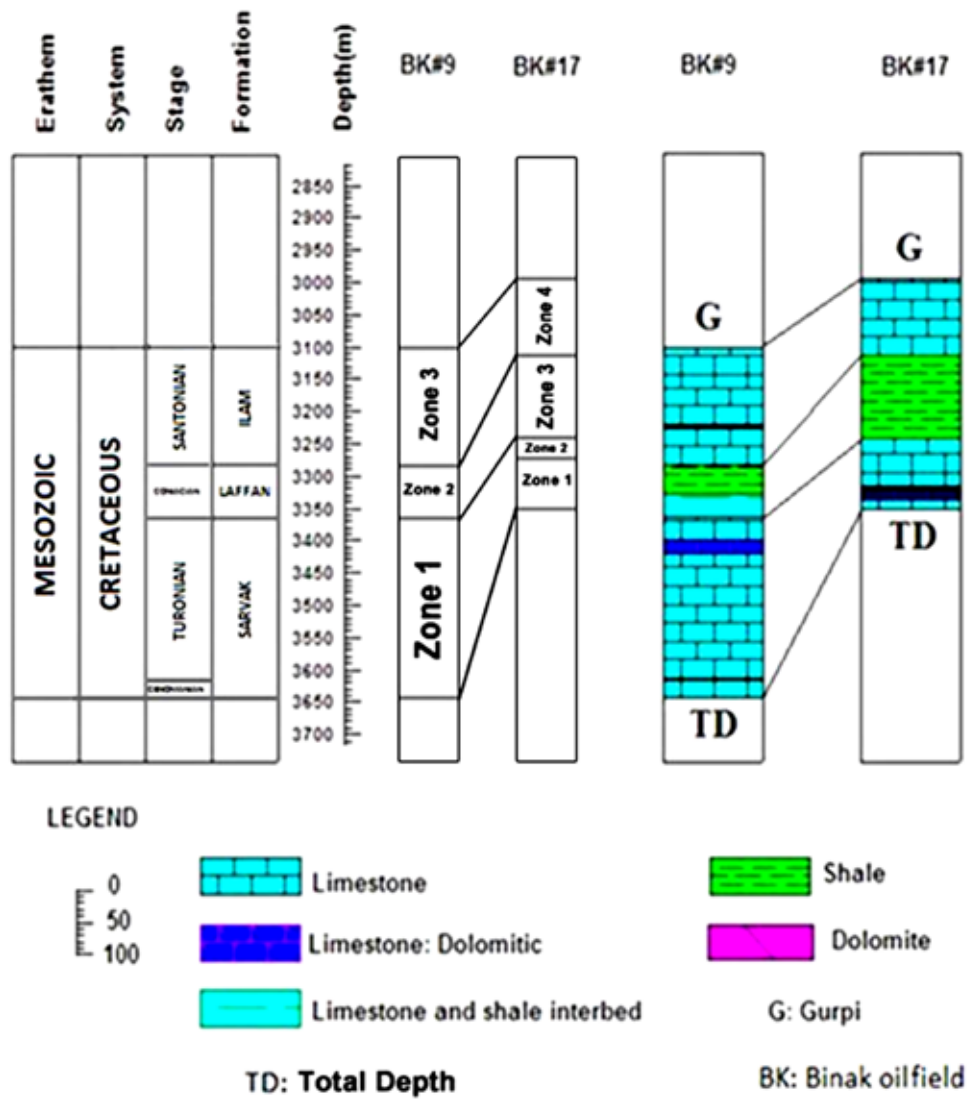


Fig. 4. The correlation of Sarvak Formation, Laffan member and Ilam Formation lithology and biozonation in well numbers 9 and 17 of Binak oilfield (in the northwest of Bushehr).

pachymarginalis, *Trochospira avnimelechi*, *Nezzazatinella Picardi*, *Stomiosphaera sphaerica*, *Calcisphaerula innominata*, *Cisalveolina fallax*, *Pseudolituonella reicheli*, *Rotalia skourensis*, *Hedbergella* sp., *Quinqueloculina* sp., *Globigerinelloides* sp., *Heterohelix* sp., *Dictyoconus* sp., *Textularia* sp., *Nezzazata* sp., Miliolid.

Non-foraminifera: Gastropoda, Shell fragment, Sacocoma debris, Ostracod, Bryozoa, Algae debris, Echinoid debris, Rudist debris, Oligostegina.

The biozonations of deposits are done based on Wynd (1965); however, International Stratigraphic Guide (1994) is taken into consideration. Zones are as follows and they are shown in fig. 3:

Assemblage Zone 1: *Praealveolina cretacea* -*Ovalveolina ovum* & Rudist debris Ass. Zone

This zone has 81m thickness and deposits are between 3270m to 3351m, and it contains part 1 of well no. 17 with the following fossils:

Foraminifera: *Pseudolituonella reicheli*, *Nezzazata conica*, *Nezzazata simplex*, *Calcisphaerula innominata*, *Stomiosphaera sphaerica*, *Nezzazatinella Picardi*, *Dictyoconus pachymarginalis*, *Spiroloculina cretacea*, *Ovalveolina ovum*, *Murgeina apula*, *Chrysalidina gradata*, *Biplanata peneropliformis*, *Peneroplis parvus*, *Praealveolina cretacea*, *Trochospira avnimelechi*, *Cisalveolina fallax*, *Daxia cenomana*, *Textularia* sp., *Dictyoconus* sp., *Globigerinelloides* sp., *Quinqueloculina* sp., *Nezzazata* sp., Miliolid.

Non-foraminifera: Gastropoda, Shell fragment, Bryozoa, Sacocoma, Algae, Echinoid and Rudist debris.

According to the observed fossils, the age of this zone is determined as Cenomanian; so, it is comparable with Assemblage Zones numbers 24 and 25 by Wynd (1965).

Assemblage Zone 2: Oligosteginid *Calcisphaerula innominata*- *Stomiosphaera sphaerica*- *Pithonella ovalis* Ass. Zone

This zone has 30m thickness and deposits are between 3240m to 3270m, and it contains part 1 of well no. 17 with the

following fossils:

Foraminifera: *Stomiosphaera sphaerica*, *Pseudolituonella reicheli*, *Pithonella trejoi*, *Pithonella ovalis*, *Calcisphaerula innominata*, *Heterohelix* sp., *Hedbergella* sp., *Globigerinelloides* sp., *Textularia* sp.

Non-foraminifera: Shell fragment, Sacocoma debris, Algae debris, Echinoid debris, Oligostegina.

According to the observed fossils, the age of this zone is determined as Turonian. It is comparable with Assemblage Zones number 26 by Wynd (1965).

Zone 3: Ostracoda Acme Zone

This zone has 127m thickness and deposits are between 3113m to 3240m, and it contains part 2 of studied strata. The following fossils are observed:

Non-foraminifera: Ostracod, Algae debris.

According to the observed fossils, the age of this zone is determined as Coniacian. The Laffan shale member in this well is determined as the unique zone and it is equivalent with 30a zone that contains Karofita family.

Zone 4: *Rotalia skourensis* Acme Zone

This zone has 120m thickness and deposits are between 2993m to 3113m. The following fossils are observed:

Foraminifera: *Rotalia skourensis*, *Stomiosphaera sphaerica*.

Non-foraminifera: Algae debris, Echinoid debris, Bryozoa.

According to the observed fossils, the age of this zone is determined as Santonian. It is comparable with Assemblage Zones number 30 by Wynd (1965).

CORRELATION OF THE SUBSURFACE STRATIGRAPHIC SECTIONS

An appropriate scale is considered to correlate the subsurface stratigraphic sections for Sarvak Formation, Laffan member and Ilam Formation, and it is plotted for the studied wells (fig. 4). The lithology of each well is presented precisely in conclusions.

CONCLUSIONS

The thickness of Bangestan Group in well no. 9 of Binak oilfield is 544m. Lithologically it contains limestone, shale and minor amount of dolomite and dolomitic limestone. In a part of Sarvak Formation drilling was completed and its upper bound is covered by Gurpi Formation. Our precise studies of fossils and microscopic thin sections identified 2 groups i.e. foraminifera and non-foraminifera, consisting 2 genera and 8 species of foraminifera, and some non-foraminifera. The age of Sarvak and Ilam Formations is Cenomanian-Santonian; and three zones determined in well no. 9 of Binak oilfield are as following:

Assemblage Zone 1: *Favusella washitensis* & Oligosteginid *Calcisphaerula innominata*- *Stomiosphaera sphaerica*- *Pithonella ovalis* Ass. Zone

Zone 2: Ostracoda Acme Zone

Zone 3: *Rotalia skourensis* Acme Zone

The thickness of Bangestan Group in well no. 17 of Binak oilfield is 358m. Lithologically it contains limestone, shale and minor amount of dolomite. In a part of Sarvak Formation drilling was completed and its upper bound is covered by Gurpi Formation. Our precise studies of fossils and microscopic thin sections identified 2 groups i.e. foraminifera and non-foraminifera, consisting 8 genera, 20 species of foraminifera, and some non-foraminifera. The age of Sarvak and Ilam Formations is Cenomanian-Santonian. The four zones determined in well no. 17 of Binak oilfield are as following:

Assemblage Zone 1: *Praealveolina cretacea*- *Ovalveolina ovum* & Rudist debris Ass. Zone

Assemblage Zone 2: Oligosteginid *Calcisphaerula innominata*- *Stomiosphaera sphaerica*- *Pithonella ovalis* Ass. Zone

Zone 3: Ostracoda Acme Zone

Zone 4: *Rotalia skourensis* Acme Zone

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