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Lithostratigraphy ,biostratigraphy of Paleocene-lower Eocene squences in Dezful embeyment, South West Iran

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Abstract

Paleocene and Lower Eocene deposits in SW Iran are known as Pabdeh formation.Pabdeh formation is one of the most important lithostratigraphy unit as source rock has been deposited in Zagros basin over an extremely long period in time. The area under research is the Ghachsaran 55 subsurface Section located from the Ghachsaran oil field in Dezful embeyment in zagros fold zone. The Lower boundry of this formation around Ghachsaran basin is identified by Gurpi formation. Study on lithostratigraphy of Paleocene and lower Eocene deposits have been led to the separation following units: clay limestone section in gray colour,11m in thickness, clay limestone section 18m in thickness containing chert inter layers, silt clay limestone section 3m in thickness , The clay limestone section 3m in thickness containing chert interlayers, clay limestone section 4m in thickness . biostratigraphy investigation of Pabdeh formation have been led to the identification of 39 species and 9 genera of foraminifers.In addition , basis of Paleocene-Early Eocene planktonicforamimnifers bioevent in Wade biozonation such as Morozovella velascoensis, Globanomalina pseudomenardii, Psudohastigerina wilcoxensis, Acarinina soldadoensis , Morozovella subbotinae , Morozovella formosa , 9 biozones and 4 subzones are recogenized and these correlated with oldest biozones of (Wynd 1965) Beside,the bio-boundary of Paleocene and early Eocene is identified based on (Wade et al. 2011).

Keywords: *Pabdeh Formation, Ghachsaran, Paleocene, Eocene.*

1. Introduction

The Paleocene and lower Eocene Deposits in the Southwest of Iran (Zagros Basin) are indicative of the Pabdeh Formation. This formation has a thickness of 798m in the model section and is divided into two unofficial purple shale and chert limestone parts (Berberian and King 1981). This formation has been deposited in the Zagros Basin over an extremely long period in time (Motiei 1994). This formation as a primal rock and reservoir potential and located between the Asmari and Bangestan Reservoirs has assumed great importance (Alavi 2004). Various investigations have been performed on the Pabdeh Formation and facies, age, and comparatively different thicknesses in different regions of the Zagros Basin have been proposed (Motiei 1994) (Fig1). The area under research is the Ghachsaran 55 subsurface Section located from the Ghachsaran Oil Field in Dezful embeyment, where no biostratigraphic or lithostratigraphic research have thus far been performed. The precise aim of the current research is the investigation and identification of the Paleocene and Eocene rock deposit sequences of the Pabdeh Formation in the aforementioned section, the determination of biological incidences, and the identification and differentiation of the biological biozones. The biological boundary of the Late Paleocene with the Early Eocene era were determined according to these biozones and their stratigraphic place varies in comparison to the previous research.

2. Geological Setting

The Zagros sedimentary basin is one of the structural units based in the Southwest of Iran (Agard et al. 2005). The Zagros sequences are divided into Precambrian metamorphic basement and basement surface sedimentation (Berberian 1984) There are three distinct stages in the evolution of the Zagros basin (Alavi 2004). The continental shelf dating from the late Precambrian to the Middle Triassic when Zagros formed part of the Gondwana, The great Syncline stage going from the Middle Triassic to Paleocene, and the post orogenic stage dating from the Paleocene to the present (Motiei 1994). The Zagros orogenic Belt in Iran formed part of the Himalayan Alpine Range stretching for approximately 2000km in a northwesterly direction from the east of the Anatoli Fault to The Oman Lineaments in southern Iran (Berberian 1984). This belt comprises three parallel zones:

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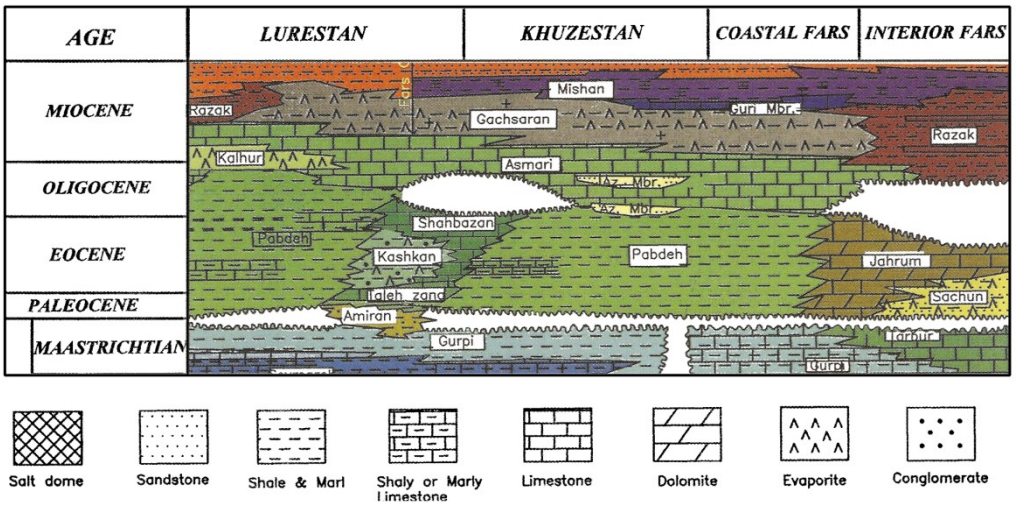

Fig1. distrubiotion of Pabdeh Formation in Zagros basin (Ala 1982)

The Urmia Dokhtar magma composite, The Sannadaj Sirjan zone, and the Zagros fold and thrust belt (Berggren et al. 1995). The area under research, part of the Zagros fold zone, in Dezful embeyment is located in Southwest border of Iran, contour Lorestan and Fars provinces To the northwest to the southeast drawn and the geographicaly view has coverd Fars,Khozestan, Bushehr and part of Kohkiluyeh & Boyer –Ahmad provinces (Bordenave 2002). This section is located in the Province of Kohkiluyeh & Boyer –Ahmad 320km from Ahwaz and 25km from the town of Sardasht at a longitude of 50°25′35′′East and a latitude of 30°25′12′′North (Fig 2). The Paleocene and Lower Eocene deposits in this section have a thickness of 39m and are mainly formed from chert and clay limestone.

3. Material and method

The Ghachsaran subsurface section 55 is located within the Ghachsaran Oil Field. The sedimentation sequence in this region has a thickness of 3029m while the Pabdeh Formation is 205m thick and its upper and lower borders are contiguous with the Asmari and Gurpi Formations respectively. The paleo logs of the abovementioned subsurface section were produce by the employees of the petroleum company in 1974. Thin films were produced and the foraminifera was investigated by areflective microscope. The samples were photographed maintaining a high degree of preservation following the determination of the species and forms. A multitude of sources were used in the determination of species and forms, some of which are as follows:

(Postuma 1971; Berggren et al. 1995; Olsson 1999; Berggren et al. 2000; Premoli-Silva et al. 2003; Berggren and Pearson 2005; Pearson et al. 2006; Payros et al. 2007; Wade et al. 2011) .

4. Lithostratigraphy

The Paleocene and Lower Eocene deposits of the Pabdeh Formation in the Ghachsaran 55 subsurface section with a thickness of 39m is divided lithologically into the following units in ascending order:

The clay limestone section in gray colour,11m in thickness containing Glauconite, Iron, and planktonic Foraminifera; the clay limestone section 18m in thickness containing chert inter layers, benthic, planktonic Foraminifera and Peloid; the silt clay limestone section 3m in thickness containing benthic,planktonic Foraminifera, and peloid; The clay limestone section 3m in thickness containing chert interlayers, benthic,planktonic Foraminifera and peloid; and finally the clay limestone section 4m in thickness containing benthic, planktonic Foraminifera, and peloid (Fig 3)

5. Biostratigraphy

The systematic investigation of planktonic Foraminifera in the Paleocene and Lower Eocene deposits of the Ghachsaran 55 subsurface section resulted in the classification of 39 species and 9 forms of planktonic Foraminifera, 3 forms and species of benthic Foraminifera, and one non-Foraminifera form. The Wade Biozonation was implemented in this study while the Wynd biozonation mentioned as one of the oldest defined biozonation and applied for a long period in all relevant research and in relation to these sequences. 9 biozones and 4 subzones have been identified based on planktonic Foraminifera and according to the Wade biozonation, while two biozones have been determined in accordance with the Wynd Biozonation. The determination of biozones following the identification of species and forms were based on biological occurrences, the most prominent of which are as follows:

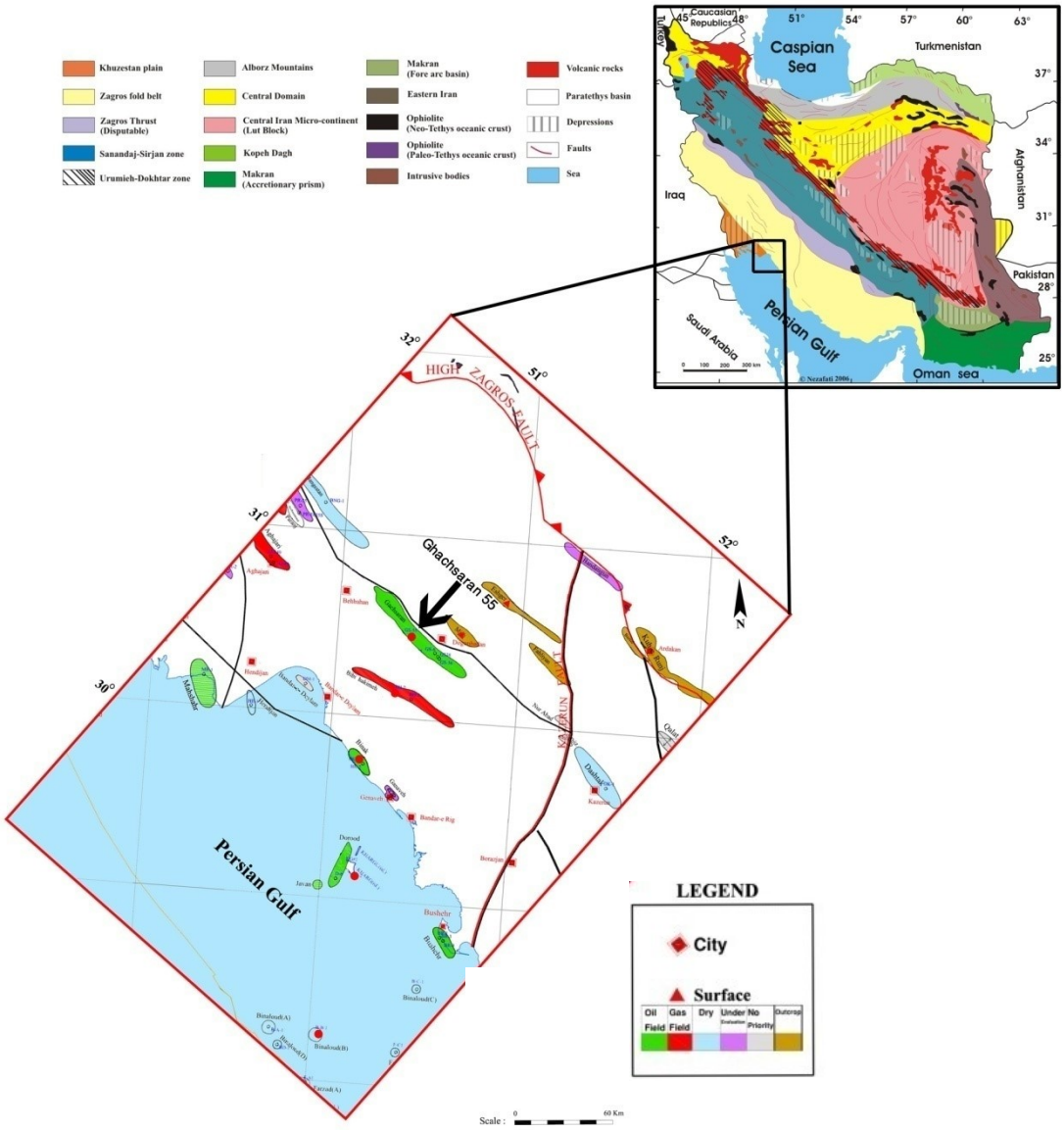

Fig2. General map of Iran and location and Geological map of the study area, ,modified from Geological and Exploration IOOC, Tehran, 1969

Morozovella velascoensis, Globanomalina pseudomenardii, Psudohastigerina wilcoxensis, Acarinina soldadoensis, Morozovella subbotinae, Morozovella formosa

These zones are described as per below:

The (Wade et al. 2011) Biozonation (Fig 4)

5.1. Zone P4. *Globanomalina pseudomenardii* Taxon-range Zone

Category: Taxon-Range-zone

Author: (Berggren et al. 1995)

This biozone has been determined according to the domain of the *Globanomalina pseudomenardii* species. The source of this biozone does not lie within this section although its end is identified by the disappearance of the above species at a depth of 2186m. This biozone is aged to be Middle – late Paleocene(Thanetian). This biozone includes three subzones of which the P4a subzone was not identified in this section.

5.1.1. P4b. *Acarinina Subsphaerica* Subzone

Category: Partial-Range-subzone

Author: (Berggren et al. 2000)

This subzone is of the Partial – range type and covers the distance between the highest occurrence, *Parasubbotina variospira* (HO) and the lowest occurrence of *Acarinina soldadoensis*(LO).

In the Gachesaran section the lower boundary of this subzone does not fall within the said section due to the non-occurrence of the *Parasubbotina variospira* species and the lowest occurrence at a depth of 2189 is

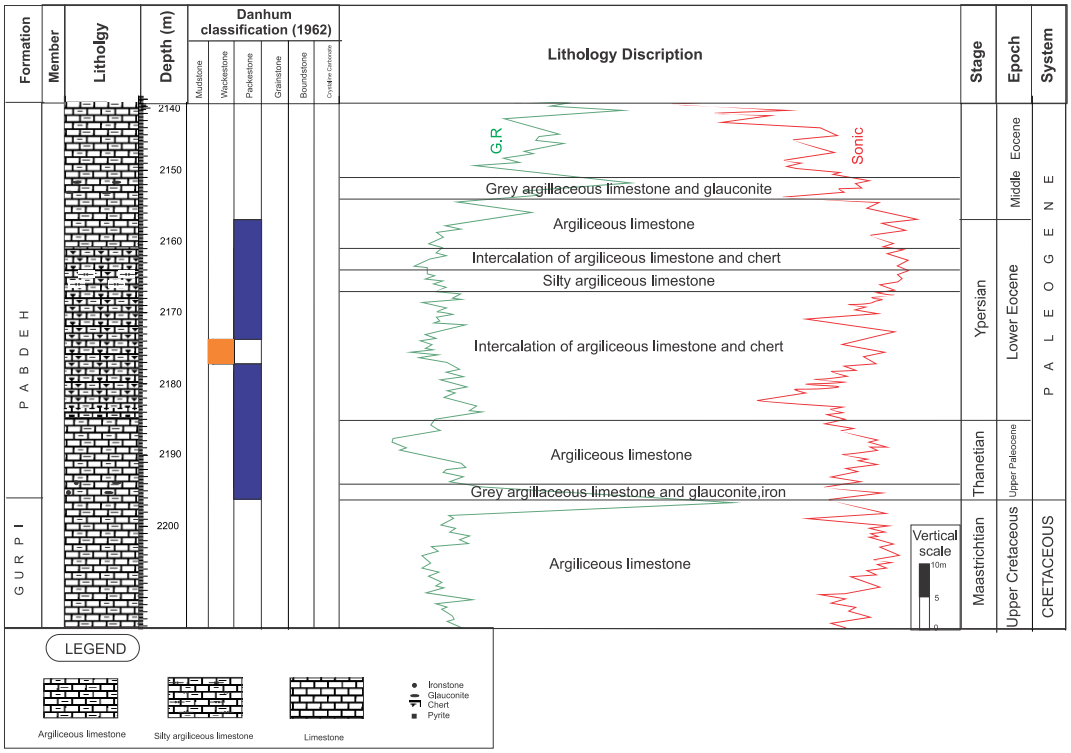

Fig3.Lithostratigraphy column of Paleocen-Lower Eocene sequences in Ghachsaran subsurface (Moghadam and Jalali 1974)

identified as its upper boundary. The fossil complex concomitant with this zone includes:
Acarinina sp. , *Acarinina nitida, Morozovella apanthesma, Acarinina subsphaerica, Subbotina triangularis,Igorina tadjikistanensis, Igorina pusilla, Morozovella velascoensis, Igorina albeari, Morozovella acutispira, Morozovella conicotruncata, Morozovella angulate, Globanomalina pseudomenardii, Subbotina velascoensis, Morozovella acuta*
The age of this subzone is determined as late Paleocene (Thanetian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.1.2. P4c. *Acarinina Soldadoensis Globanomalinapseudomenardii* Subzone

Category: Concurrent-Range-subzone
Author: (Berggren et al. 1995)
This subzone is of the concurrence – range type and covers the distance between thelowest occurrence, of*Acarinina soldadoensis* (LO) and the highest occurrence of*Globanomalina pseudomenardii*(HO).

In the Ghachsaran section the lower boundary of this subzone was identified at a depth of 2189m with the lowest occurrence of Acarinina soldadoensis as the lower boundary while the highest occurrence of the *Globanomalina pseudomenardii* at a depth of 2186was recognized as its upper boundary. The fossil complex concomitant with this zone includes:
Globanomalina pseudomenardii, Acarinina soldadoensis, Morozovella aequa, Acarinina esnaensis, Acarinina coalingensis, Acarinina decepta,Subbotina velascoensis, Morozovella acuta, Acarinina sp., *Acarinina nitida, Morozovella velascoensis, Igorina albeari*

The age of this subzone is determined as Late Paleocene (Late Thanetian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.2. Zone P5. *Morozovella velascoensis* Partial - Range Zone

Category: Partial-Range-zone
Author: (Berggren and Pearson 2005)
This subzone is of the partial – range type and covers the distance between thelowest occurrence, of *Acarinina sibaiyaensis* (LO) and the highest occurrence of*Globanomalina pseudomenardii* (HO).

In the Gachesaran section the lower boundary of this subzone was identified at a depth of 2186m with the highest occurrence of *Globanomalina pseudomenardii* as the lower boundary while the highest occurrence cannot be determined due to the lack of identification of the *Acarinina sibaiyaensis* species.

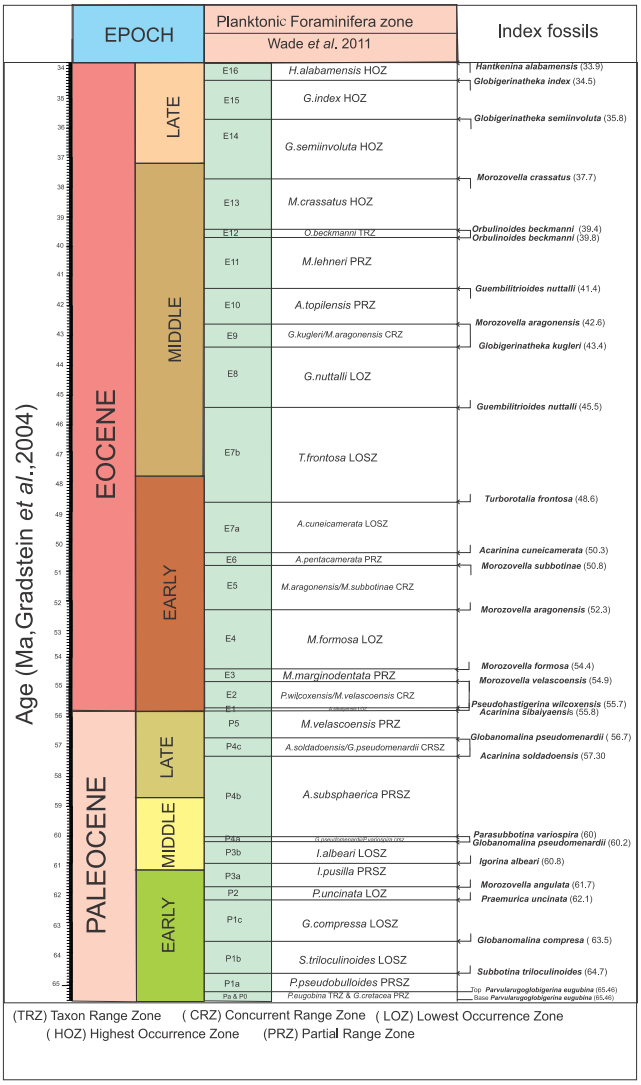

Fig 4.Biozonation and bioevent for Paleocen-Eocene based (Wade et al. 2011)

5.3. Zone E1. *Acarinina sibaiyaensis* Lowest – Occurrence Zone

Category: Lowest – Occurrence-zone

Author: (Berggren and Pearson 2005)

This subzone is of the lowest – occurrence type and covers the distance between thelowest occurrence of*Acarinina sibaiyaensis* (LO) and the highest occurrence of*Pseudohastigerina wilcoxensis*(HO).

In the Ghachsaran Section, the lower boundary of this biozone cannot be determined duo to the lack of identification of the *Acarinina sibaiyaensis* species. The upper boundary is determined at a depth of 2181m with the lowest occurrence of *Pseudohastigerina wilcoxensis.*

The boundary between the E1 & P5 biozones in the Gachsaran Section is indistinguishable. Therefore the age of the span between the lower boundary of the P5 biozone at 2186m and the upper boundary of the E1 biozone at a depth of 2181m is determined to be Late – Paleocene to Early Eocene (Latest Thanetian – Sparnacian).

5.4. Zone E2. *Pseudohastigerina wilcoxensis/ Morozovella velascoensis*Concurrent – Range Zone

Category: Concurrent – Range-zone

Author: (Berggren and Pearson 2005)

This subzone is of the concurrent - rangetype and covers the distance between the lowest occurrence of *Pseudohastigerina wilcoxensis*(LO) and the highest occurrence of *Morozovella velascoensis*(HO).

In the Ghachsaran Section, the lower boundary of this biozone was determined as the lowest occurrence of *Pseudohastigerina wilcoxensis* at a depth of 2181m while the upper boundary was established to be the

highest occurrence of *Morozovella velascoensis* at a depth of 2179m.
The fossil complex concomitant with this zone includes: *Acarinina soldadoensis, Morozovella aequa, Acarinina esnaensis, Acarinina collectea, Acarinina decepta,Subbotina velascoensis, Morozovella acuta, Acarinina intermedia,Acarinina aquensis, Morozovella velascoensis, Igorina convexa, Subbotina inaquispira, Morozovella gracilis, Pseudohastigerina wilcoxensis*

The age of this zone is determined as early Eocene (Sparnacian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.5. Zone E3. *Morozovella velascoensis*Partial – Range Zone

Category: Partial–Range-zone
Author: (Berggren and Pearson 2005)
This subzone is of the partial – range type and covers the distance between the highest occurrence of *Morozovella velascoensis* (HO) and the lowest occurrence of *Morozovella formosa*(LO).

In the Ghachsaran 55 Section, the lower boundary of this biozone was determined as the highest occurrence of *Morozovella velascoensis* at a depth of 2179m while the upper boundary was established to be the highest occurrence of *Morozovella formosa*at a depth of 2175m.
The fossil complex concomitant with this zone include: *Acarinina aquiensis, Igorina convexa,Morozovella gracilis, Morozovella subbotinae ,Acarinina coalingensis ,Morozovella aequa*
The age of this zone is determined as early Eocene (Ypresian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.6. Zone E4. *Morozovella formosa*Lowest occurrence Zone

Category: Lowest – occurrence-zone
Author: (Berggren and Pearson 2005)
This zone is of the lowest - occurrence type and covers the distance between the lowest occurrence of *Morozovella formosa* (LO) and the highest occurrence of *Morozovella aragonensis*(HO).

In the Ghachsaran Section, the lower boundary of this biozone was determined as the lowest occurrence of *Morozovella formosa* at a depth of 2175m while the upper boundary was established to be the highest occurrence of *Morozovella aragonensis*at a depth of 2167m.
The fossil complex concomitant with this zone include: *Acarinina primitiva, Morozovella lensiformis, Acarinina pseudotopilensis, Acarinina decepta, Acarinina esnaensis, Morozovella aequa, Morozovella subbotinae, Subbotina inaquispira, Pseudohastigerina wilcoxensis, Morozovella gracilis*
The age of this zone is determined as early Eocene (Ypresian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.7. Zone E5. *Morozovella aragonensis / Morozovella subbotinae* Concurrent - Range Zone

Category: Concurrent – Range-zone
Author: (Berggren and Pearson 2005)
This zone is of the lowest - occurrence type and covers the distance between the lowest occurrence of *Morozovella aragonensis* (LO) and the highest occurrence of *Morozovella subbotinae*(HO).

In the Ghachsaran Section, the lower boundary of this biozone was determined as the lowest occurrence of *Morozovella aragonensisa* at a depth of 2167m while the upper boundary was established to be the highest occurrence of *Morozovella subbotinae*at a depth of 2164m.
The fossil complex concomitant with this zone includes: *Acarinina primitiva, Pseudohastigerina wilcoxensis, Acarinina pseudotopilensis, Morozovella caucasica, Dentoglobigerina yeguaensis, Acarinina pentacamerata, Morozovella crassata, Morozovella aragonensis, Acarinina aquiensis, Acarinina coalingensis, Globigerinatheka sp , Acarinina bullbrooki, Acarinina graveli, Acarinina decepta, Acarinina esnaensis, Subbotina inaquispira, Igorina convexa*

The age of this zone is determined as early Eocene (Ypresian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.8. Zone E6. *Acarinina pentacamerata* Partial - range Zone

Category: partial – range-zone
Author: (Berggren and Pearson 2005)
This subzone is of the partial - range type and covers the distance between thehighest occurrence of*Morozovella subbotinae* (HO) and lowest occurrence of*Acarinina cuneicamerata*(HO).

In the Ghachsaran Section, the lower boundary of this biozone is determined by the highest occurrence of the Morozovella subbotinae at a depth of 2164m. The upper boundary cannot be established due to the non-recognition of *Acarinina cunicamerata.*

5.9. Zone E7. *Acarinina cuneicamerata* Lowest – occurrence Zone

Category: Lowest – occurrence-zone
Author : (Payros et al. 2007)

This biozone is of the lowest - occurrence type and covers the distance between the lowest occurrence of *Acarinina cuneicamerata* (LO) and the highest occurrence of *Guembelirioides nuttali*(HO). This biozone is aged to be of the Early Eocene and Middle Eocene.

This biozone is divided into the following subzones:

5.9.1. Subzone E7a *Acarinina cuneicamerata* Lowest – occurrenceZone

Category: Partial-Range-zone

Author: (Payros et al. 2007)

This zone is of the lowest - occurrence type and covers the distance between the lowest occurrence of *Acarinina cuneicamerata* (LO) and the lowest occurrence of *Turborotalia frontosa*(LO).

The lower boundary of this biozone cannot be determined in the Ghachsaran Section due to the non-recognition of the *Acarinina cuneicamerata* species while the upper boundary is determined by the lowest occurrence of the *Turborotalia frontosa* at a depth of 2159m. The boundary between the E6 & E7a cannot be established on this basis and therefore the same biozones are determined for the depths of 2164 to 2159m.The fossil complex concomitant with this zone includes:

Acarinina coalingensis, Acarinina collectea, Acarinina intermedia, Acarinina interposita, Acarinina pentacamerata, Dentoglobigerina yeguaensis

The age of this zone is determined as early Eocene (Ypresian) according to the biozone defined by Wade and comparison and conformation with the same subzone and its fossil complex.

5.9.2. Subzone E7b. *Turborotalia frontosa* Lowest – occurrenceZone

Category: Partial-Range-zone

Author: (Payros et al. 2007)

This zone is of the lowest - occurrence type and covers the distance between the lowest occurrence of *Turborotalia frontosa* (LO) and the lowest occurrence of *Guembelitrioides nuttalli*(LO).

In the Ghachsaran Section the lower boundary of this biozone is determined by the lowest occurrence of the *Turborotalia frontosa* species at a depth of 2159m while the upper boundary is established by the lowest occurrence of the *Guembelitrioides nuttalli* of the Middle Eocene age though itdoes not fall within the research area. The fossil complex concomitant with this zone includes:

Acarinina coalingensis, Acarinina collectea, Acarinina intermedia, Acarinina primitiva, Acarinina interposita, Acarinina bullbrooki, Acarinina pentacamerata, Dentoglobigerina yeguaensis, Turborotalia frontosa,Chilloguembelina sp.

Therefore the age of this subzone is determined to be Early - Middle Eocene according to the fossil complex (Fig 5).

Ghachsaran subsurface

6. Discussion

The biozonation of the Paleocene and Eocene Foraminifera has been presented by various people. (James and Wynd 1965) is one of the oldest biozonations performed on the Zagros deposits in accordance with the planktonic and benthic Foraminifera. The biozone previously defined by Wynd has been reviewed by the application of the (Wade et al. 2011) biozonation and conformation with the deposits of the lower section of the Pabdeh Formation in the Ghachsaran subsurface section. It is therefore necessary to consider the (James and Wynd 1965) biozonation and its conformation with the said section.

***Morozevella velascoensis – Globanomalina pseudomenardii* Zone**

Category: assemblages-zone

Author: (James and Wynd 1965)

This biozone defined by Wynd is referred to as zone number 42 and is determined by the occurrence of the *Morozovella velascoensis* and *Globanomalina pseudomenardii* species at a depth of 2196m. The upper boundary of this biozone is established by the last occurrence of *Morozovella velascoensis* at a depth of 2179m. The fossil complex concomitant with this zone includes (Fig 6 and 7):

Acarinina sp., *Acarinina nitida, Morozovela apanthesma, Acarinina subsphaerica, Subbotina triangularis, Igorina tadjikistanensis, Igorina pusilla, Morozovella velascoensis, Igorina albeari, Morozovella acutispira, Morozovella conicotruncata, Morozovella angulata, Globanomalina pseudomenardii, Morozovella acuta, Subbotina velascoensis, Morozovela apanthesma, Subbotina triangularis, Igorina tadjekestanensis, Acarinina soldadoensis, Morozovella aequa, Acarinina esnaensis, Acarinina coalingensis, Acarinina deceptaesnaensis, Acarinina Subbotina velascoensis, Morozovella acuta, , Acarinina soldadoensis, Morozovella gracilis, Acarinina aquiensis, Pseudohastigerina wilcoxensis, Acarininaintermedia, Subbotina inaquispira, Acarinina collectea, Igorina convexa*

The age of this zone is determined as Late Paleocene according to the biozone (No. 42) defined by Wynd, its comparison and conformation, and the concomitant fossil complex.

***Morozevella subbotinae – Morozovella Formosa Morozovella aragonensis* Zone**

Category: assemblages-zone

Author: (James and Wynd 1965)

This zone referred to as zone Number 45 comprises the abovementioned fossil complex and is located at the

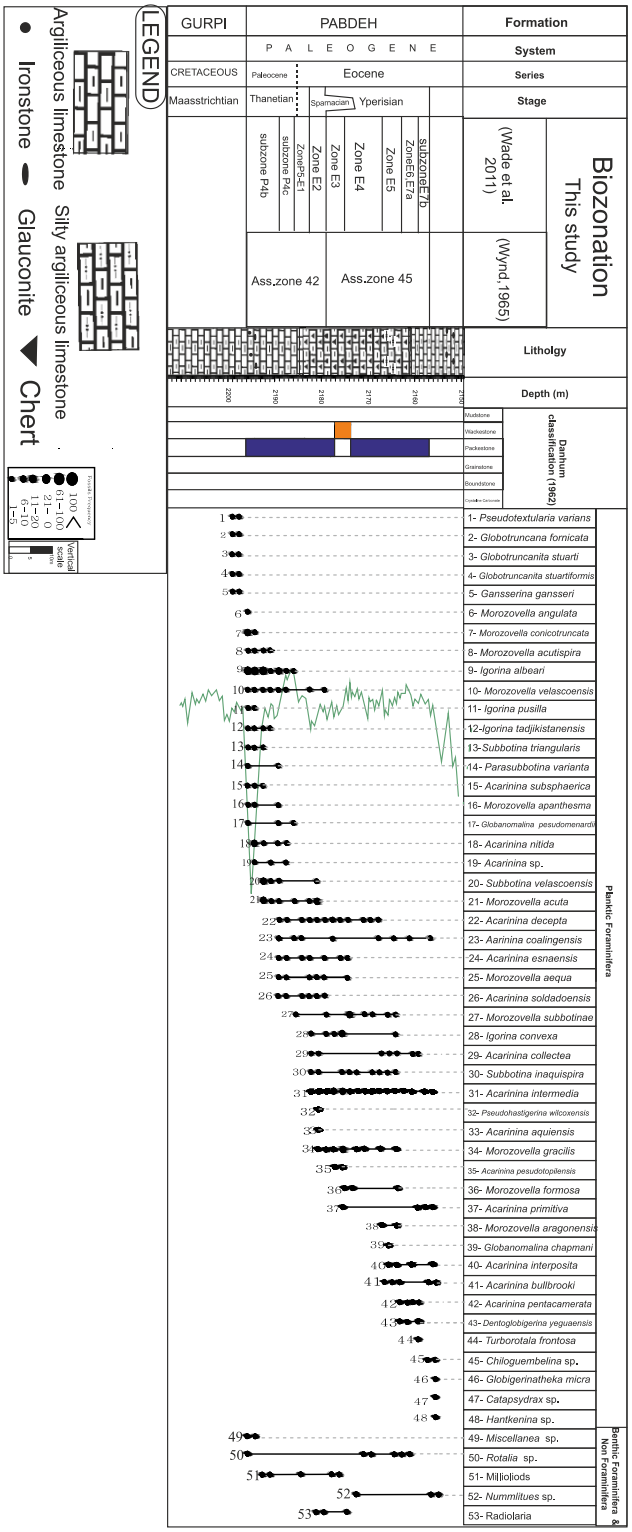

Fig5. Biostratigraphy and Biozonation in Paleocen-Lower Eocene sequences in Ghachsaran subsurface

upper occurrence boundary of *Morozovella velascoensis* and the lower occurrence boundary of *Morozovella spinulosa & Hantkenina sp*. It is determined by the last occurrence of the *Morozovella velascoensis* at a depth of 2179m as the lower boundary of the biozone andthe first occurrence of *Hantkenina sp.* at a depth of 2157m

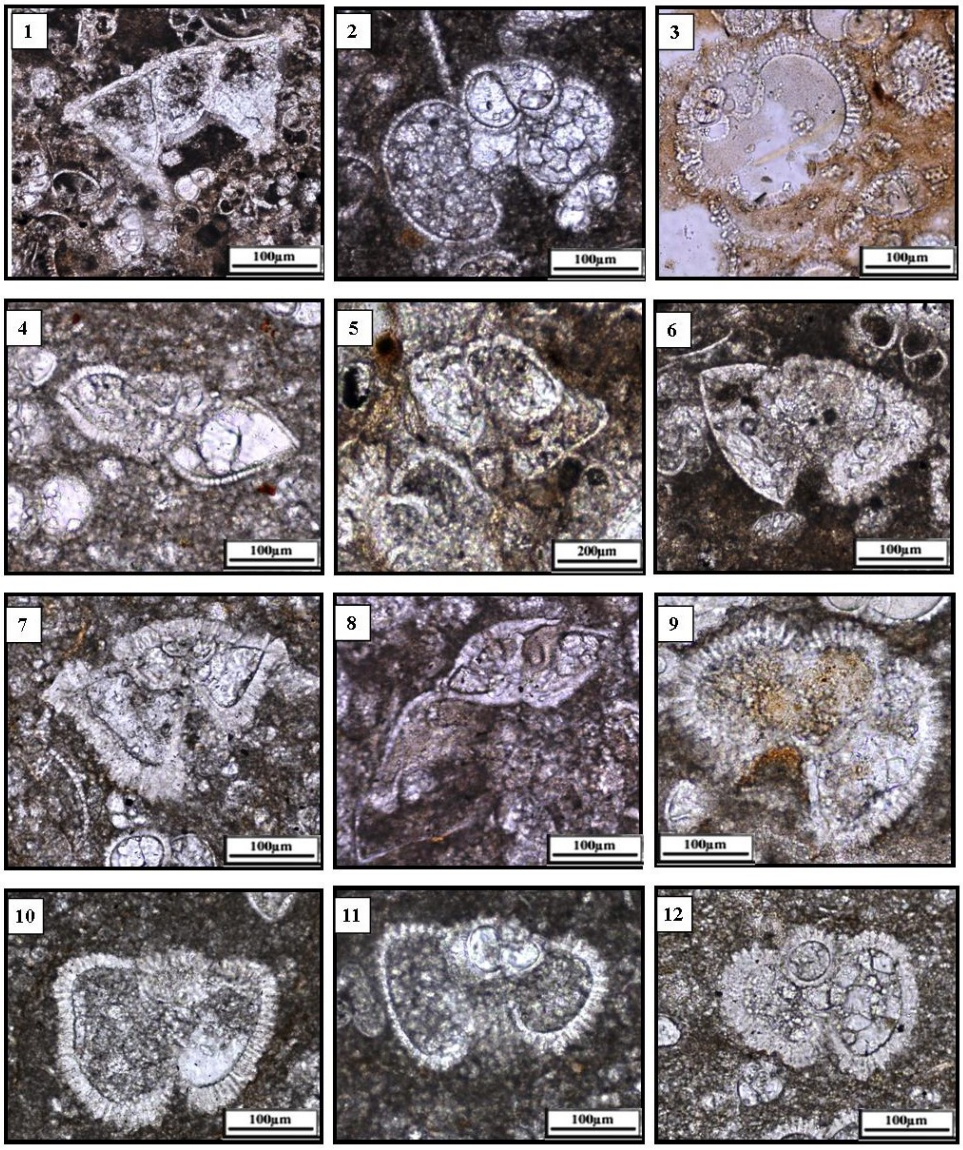

Fig 6. 1.*Morozovella velascoensis* (Cushman 1925) , 2.*Subbotina inaquispira* (Subbotina 1953) 3. *Acarinina nitida* (Martin 1943) , 4.*Globanomalina chapmani* (Parr 1938) , 5. *Igorina pusilla* (Bolli 1957) ,6. *Morozovella aequa* (Cushman and Renz 1942) ,7.*Morozovella subbotinae* (Morozova 1939), 8.*Globanomalina pseudomenardii* (Bolli 1957), 9. *Acarinina primitiva* (Finlay and Marwick 1947) , 10.*Acarinina decepta* (Martin 1943), 11. *Acarinina esnaensis*(LeRoy 1953) , 12.*Acarinina soldadoensis* (Brönnimann 1952)

.as the upper boundary of the zone. The *Morozovella subbotinae* species was established *at 2186m* while the *Morozovella Formosa* was determined to be at a depth of 2176m. The fossil complex concomitant with this zone includes:

Acarinina primitiva, Morozovella lensiformis, Acarinina pseudotopilensis Morozovella aequa, Morozovella subbotinae, Morozovella aragonensis, Morozovella gracilis, Subbotina inaquispira , Acarinina decepta,Morozavella subbotinae, Igorina convexa,Globanomalina chapmani, Acarinina collectea, Acarinina interposita, Dentoglobigerina yeguaensis, Acarinina coalingensis, Pseudohastigerina wilcoxensis, Acarinina bullbrooki, Acarinina pentacamerata, Truncorotalides rohri, Chiloguembelina sp.

The age of this zone is determined as Late Eocene according to the biozone (No. 45) defined by Wynd, its comparison and conformation, and the concomitant fossil complex.

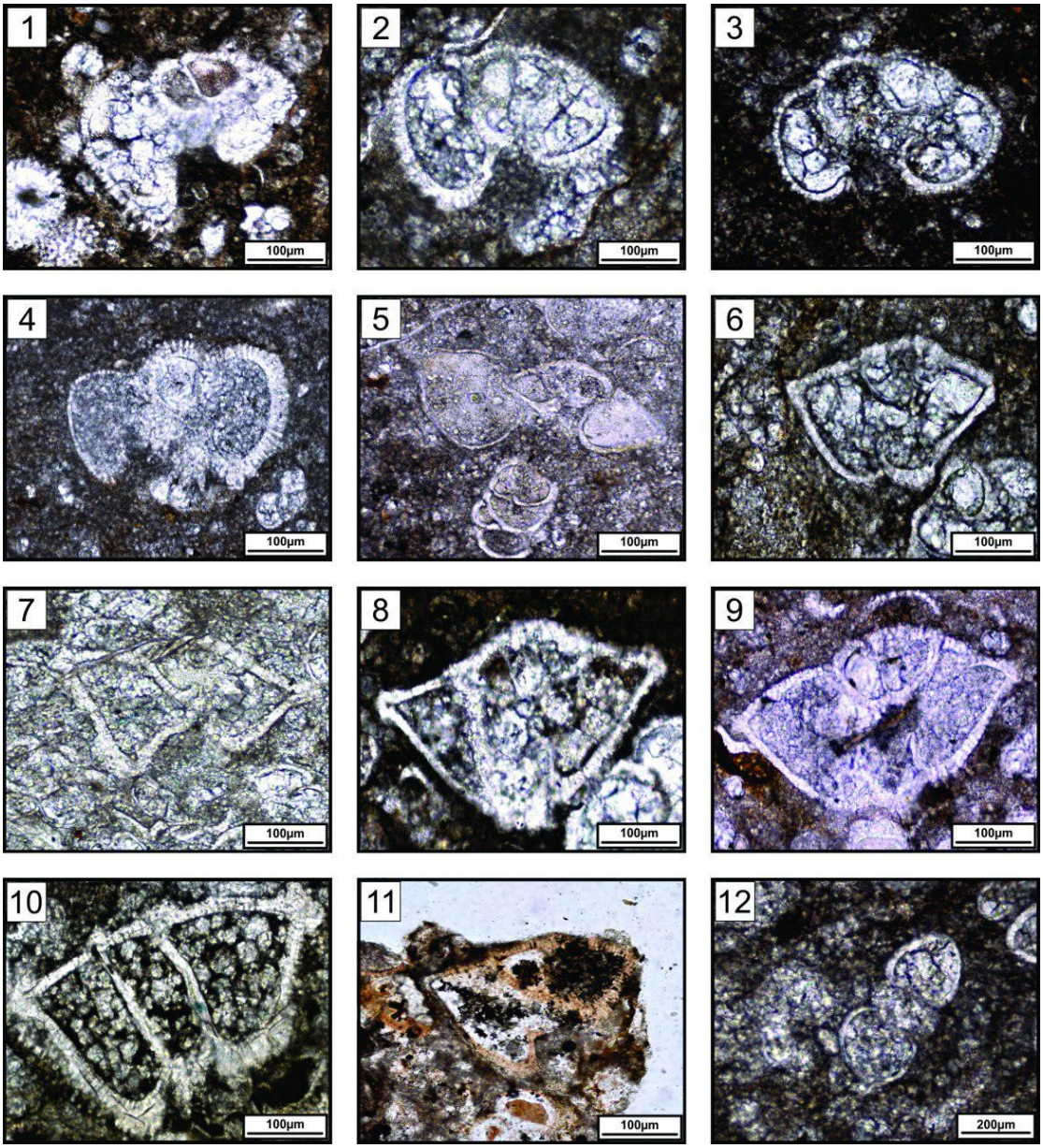

Fig 7: 1.*Acarinina pesudotopilensis* (Subbotina 1953), 2.*Acarinina pentacamerata* (Subbotina 1947),3. *Acarinina intermedia* (Subbotina 1953) ,4. *Acarinina gravelli* (Brönnimann 1952), 5.*Globanomalina planoconica* (Subbotina 1953), 6.*Morozovella lensiformis* (Subbotina1953),7.*Morozovella gracilis* (Bolli 1957), 8.*Morozovella formosa* (Bolli 1957), 9.*Morozovella crassata* (Cushman 1925), 10.*Morozovella caucasica* (Glaessner 1937),11. *Morozovella conicotrucata* (Subbotina 1947),12.*Pseudohastigerina wilcoxensis* (Banner and Blow 1959)

As previously stated the No. 42 biozone conforms to the upper Paleocene deposits according to the Wynd bionization while the No. 45 biozone conforms to the lower Eocene deposits. Investigation and conformation of the Wynd biozonation of these deposits determined the age of this section of the Pabdeh Formation as Late Paleocene – Early Eocene. However, the Late Paleocene – Early Eocene biozone according to the Wynd Biozonation located at the boundary between the Biozones number 42 and number 45 (at a depth of 2179m in the Ghachsaran 55 subsurface section) has been reviewed and according to the Wade bionization placed at the end of the P5 Biozone and the beginning of the E1 biozone.

Precise determination of the boundary has not been possible due to the non-occurrence of the *Acrinina sibaiyaensis* species and the depth of 2186m to 2189m

has been identified as the Late Paleocene – Early Eocene boundary.

7. Conclusion

The thickness of the Upper Paleocene and Lower Eocene sequences of the Pabdeh Formation in the Ghachsaran 55 Subsurface Section is 39m. Its lower boundary is isocline with the Gurpi Formation and includes the transformation of clay limestones into chert clay limestones, glauconite and Iron. Biostratigraphical research identified 39 form and 9 species of planktonic Foraminifera while 9 biozones and 4 subzones were established according to (Wade et al. 2011).

P4- *Globanomalina pseudomenardii* Taxon-range Zone
Subzone P4b. *Acarinina subsphaerica* Subzone
Subzone P4c. *Acarinina soldadoensis / Globanomalina pseudomenardii* Subzone
Zone P5. *Morozovella velascoensis* Partial – range Zone
E1. *Acarinina sibaiyaensis* Lowest – occurrence Zone
Zone E2.*Pseudohastigerina wilcoxensis/Morozovella velascoensis*Concurrent- range Zone
Zone E3. *Morozovella marginodentata* Partial – range Zone
Zone E4. *Morozovella ormosa* Lowest – occurrence Zone
Zone E5.*Morozovella aragonensis /Morozovella subbotinae* Concurrent- range Zone
Zone E6.*Acarinina pentacamerata* Partial – range Zone
Subzone E7a. *Acarinina cuneicamerat a* Lowest-occurrence Zone
Subzone E7b. *Turborotalia frontosa* Lowest-occurrenceZone

The lower section of the Pabdeh Formation was also compared and conformed to the oldest Wynd biozonation. According to the Wynd biozonation Biozone Number 42- *Morozevella velascoensis – Globanomalina pseudomenardii* Zone to the Upper Paleocene deposits while the number 45- *Morozevella subbotinae – Morozovella formosa Morozovella aragonensis* Zone biozone conforms to the Lower Eocene deposits. Comparison of these biozones indicated that the Late Paleocene – Early Eocene biozone must be reviewed and is changed from 2179m (according to the Wynd biozonation) to the 2186m - 2189m range (according to the Wade biozonation) in the Ghachsaran 55 Subsurface Section.

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