

**Chapter VII**  
**Summay and**  
**Conclusions**

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## VII. Summary and Conclusions

The present work deals with the integrated litho-and biostratigraphy, microfacies associations, depositional environments, sequence stratigraphy and the geological history of the Upper Cretaceous-Lower Eocene succession in the Farafra Oasis.

The Farafra Oasis is one of the most characteristic depressions present in the Western Desert of Egypt. It is located about 560 km southwest of Cairo and about 300km west of Assiut. The floor of the oasis is occupied by the Maastrichtian chalk, while the Lower Paleocene-Lower Eocene clastic/carbonate sediments characterize its scarp faces and plateau surfaces. The Upper Cretaceous-Lower Eocene succession of the Farafra Oasis is invoked by a variety of shallow and deep marine sediments with many distinct lateral variations in facies and thickness. Few studies were published on the eastern and western parts of the Farafra Oasis.

Fourteen surface stratigraphic sections have been measured and sampled in east and west Farafra Oasis. These sections are chosen to represent the whole lateral and vertical facies and thickness changes in the Farafra Oasis. Different lithologies of the same age can be recognized in and around the Farafra Oasis. The age assignment, sequence boundaries and the environmental interpretations of the different sediment types give a clear picture about the aerial distribution of various facies and help in solving the stratigraphic problems in the study area.

The succession cropping out in the Farafra Oasis ranges in age from Santonian to Early Eocene. It is classified into seven rock units; these are from older to younger: El-Hefhuf, Khoman,

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Dakhla, Tarawan, Esna and its lateral coeval Ain Dalla, and Farafra formations, respectively.

El-Hefhuf Formation is well developed in Wadi Hennis and east Bir El-Obeiyid. It has an exposed thickness ranges from 11-35m thick. El-Hefhuf Formation represents the oldest exposed rocks in the Farafra Oasis. It is composed of two rock units with a sharp contact inbetween. The lower unit is composed of clastic sequence of shale, cross-bedded sandstone, massive sandstone, and siltstone, partly glauconitic. The upper unit starts with oyster bank which is followed by phosphatic sandy dolostone with common shark teeth and burrows. The latter have different straight, bifurcated and flask shapes. The contact between El-Hefhuf Formation and the overlying Khoman Formation is a sharp unconformable contact between the hard dolostone and the chalk of Early Maastrichtian age.

Five dominant facies associations are recognized in El-Hefhuf Formation. These are:

1. Upper deep subtidal shale/mudstone.
2. Shallow subtidal massive/cross-bedded sandstone (ferruginous quartz arenite).
3. Lower intertidal phosphatic sandy lime-mudstone.
4. Shallow/deep subtidal oyster rudstone with *Pycnodonte vesicularis*.
5. Upper intertidal sandy dolostone.

El-Hefhuf Formation seems to have been deposited in a shallow marine environment with oscillations from upper intertidal to upper deep subtidal. The clastic facies of El-Hefhuf Formation represents the first depositional sequence SQ1. The

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base of this sequence is not exposed while its top is marked at the base of a *Pycnodonte vesicularis* rich bed with many reworked Cenomanian fossils. The upper boundary defines the base of the Campanian and separates between the lower clastic and upper carbonate units by a sharp erosional contact. It consists of progradational parasequence sets of alternating upper deep subtidal shale/mudstone, subtidal lower shoreface massive-bedded sandstone and subtidal upper shoreface cross-bedded sandstone that define its highstand systems tract. The carbonate facies of El-Hefhuf Formation represents the second depositional sequence SQ2. This depositional sequence includes a lower transgressive deposit of shallow/deep subtidal oyster rudstone, lower intertidal sandy phosphatic dolostone and sandy argillaceous limestone.

The Khoman Formation is widely distributed throughout the floor of the northern Farafra Oasis. It reaches its maximum thickness in the northern escarpment of the Farafra Oasis (50m thick) and is made up mainly of snow-white chalk; moderately hard, massive and fine-grained, While at Qur Hadida, the chalk is topped by dolostone intercalated with mudstone and algal stromatolites especially near top. The Khoman Formation comprises the following four facies associations:

1. Deep middle to upper continental slope foraminiferal wackestone
2. Shallow inner shelf mudstone
3. Lower intertidal lime-mudstone
4. Upper intertidal dolostone

The basal part of the Khoman Formation indicates deposition in a deeper middle shelf environment, whereas the overlying

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sediments of the upper part of the *Rugoglobigerina hexacamerata* CF8b Zone has been deposited in a relatively deeper sea oscillating between outer shelf and upper continental slope depth. Shallower conditions of deep middle shelf start with the upper part of the *Gansserina gansseri* CF7 Zone and the base of the overlying *Contusotruncana contuse* CF6 Zone. Very shallow conditions of shallow inner shelf dominated in the top part of the Khoman Formation.

The Khoman chalk is highly fossiliferous with planktics and benthics which belong to three planktic foraminiferal zones, namely: *Rugoglobigerina hexacamerata* Interval Zone CF8b and *Gansserina gansseri* Partial Range Zone CF7 which form the lower-middle part of the Khoman Formation and the *Contusotruncana contusa*/ *Pseudotextularia intermedia*/ *Racemiguembelina fructicosa*/ *Pseudoguembelina hariaensis* Interval Zone (CF6-CF5-CF4-CF3 Undifferentiated Zone), which belongs to the upper part of Khoman Formation

The Khoman Formation represents the third depositional sequence SQ3. The lower boundary of this sequence is an unconformity surface separating between the Campanian part of El-Hefhuf Formation and the Khoman Formation, the upper boundary is a paraconformity surface at the top of the formation due to the missing of the Latest Maastrichtian and the lower part of the Danian. The SQ3 consist of retrogradational parasequence sets of deep middle/outer shelf foraminiferal wackestone with a shallow middle shelf foraminiferal wackestone at the base that belong to the transgressive deposits and progradational parasequence of middle shelf foraminiferal wackestone at the base and lower intertidal lime-mudstone at the top of the highstand

deposits.

The Dakhla Formation is widely distributed in the central and southern parts of the Western Desert. It is represented in the Farafra Oasis by its uppermost part of its upper Kharga Shale Member. The formation ranges in thickness from 1-10m. It is missing in south Qaret Sheikh Abd Alla; this perhaps reflects uplift of this area during deposition of the Dakhla Formation. This Formation consists of two informal units; a lower argillaceous chalk unit with many reworked foraminiferal fossils of Maastrichtian age at the base, which maintain its basal unconformity surface. While, the upper unit is formed of foraminiferal calcareous shale with many gypsum veinlets.

The formation includes the following three facies associations.

1. Deep middle shelf foraminiferal wackestone
2. Deep middle/outer shelf pelagic shale
3. Shallow inner shelf foraminiferal lime-mudstone

The facies associations and faunal content of the Dakhla Formation indicate a transgressive event of the sea level, which increases upward with the increasing of the planktic foraminifers. The formation however, has been deposited in middle/outer shelf, inner shelf environment.

The Dakhla Formation is fossiliferous with abundant planktics and benthics which belong to the *Globanomalina compressa*-*Praemurica uncinata* Interval Subzone P1c, *Praemurica uncinata*-*Morozovella angulata* Interval Zone P2 and *Morozovella angulata*-*Globanomalina pseudomenardii* Interval Zone P3.

The Dakhla Formation represents the fourth recorded depositional sequence SQ4. The lower boundary is a disconformity surface separating the top part of the Khoman Formation from the basal part of the Dakhla Formation. While, the upper boundary is an erosional unconformity surface due to the missing of the *Praemurica uncinata-Morozovella angulata* P2 Zone and *Morozovella angulata-Globanomalina pseudomenardii* P3 Zone (northwest Ain Maqfi), which represents a time gap of from about 61.2Ma to about 57.1Ma. In Bir Murr and Shakhs El-Obeiyid, this hiatus is recorded due to the missing of the P3 Zone, while in Ain Maqfi, this hiatus recorded due to the missing of the P3b Subzone. In the extreme northern part of the Farafra Oasis at south Qaret Sheikh Abd Alla, the whole Dakhla Formation is missing which equivalent to about 9.0 Ma. This contact (SB4) is conformable in the Bir Bidni due to continuous sedimentation.

The Tarawan Formation is well exhibited in the Farafra Oasis. It is characterized by a marked change in thickness from 1m in Bir Murr to 23m in northwest Ain Maqfi. This formation is composed of chalk and argillaceous limestone with calcareous claystone interbeds at the middle part of El Quss Abu Said; it belongs to the *Globanomalina pseudomenardii* Zone (P4). The top part of the Tarawan Formation is composed of calcareous shale at northwest Farafra-Ain Dalla passage. It is intensively burrowed with *Thalassinoides* in its upper part especially toward the paleohigh areas. The Tarawan Formation includes the following facies associations:

1. Outer shelf pelagic foraminiferal packstone
2. Outer shallow middle shelf pelagic shale
3. Lower shallow subtidal bioclastic foraminiferal packstone

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#### 4. Lower intertidal foraminiferal lime-mudstone

The Tarawan Formation is characterized by gradual upward shallowing conditions as evidenced from the rapid vertical variation in the facies associations and decrease upward in planktic/benthic ratio ratios. These shallowing conditions most probably are connected with an episode of tectonic activity in the Egyptian Paleocene called the *Velascoensis* Event by Strougo (1986).

The Tarawan Formation represents the fifth recorded depositional sequence SQ5. Its upper boundary is a sharp erosional surface due to the missing of the Latest Paleocene *Morozovella velascoensis* P5 Zone especially along the eastern part of the Farafra Oasis. The SQ5 is formed of transgressive systems tract and highstand systems tract. The transgressive deposits are followed by the maximum flooding surface, which represents the change from pelagic facies to shallower facies of the overlying highstand systems tract at northwest Bir Bidni, Shakhs El-Obeiyid and northwest Ain Maqfi. The latter is composed of aggradational to progradational parasequence sets of shallow middle shelf foraminiferal wackestone and calcareous shale, lower shallow subtidal bioclastic foraminiferal packstone and lower intertidal foraminiferal lime-mudstone

The Esna Formation is widely distribution in the scarp face of the Farafra Oasis. It is locally absent in south Qaret Sheikh Abd Alla. It exhibits marked lateral facies and thickness changes in the studied area depending on the basin paleotopographic setting. It ranges in thickness from 20-150m and is composed of green shale and mudstone intercalated in its upper part with argillaceous limestone. In the eastern and northern parts of the Farafra Oasis,

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the Esna Formation starts at the base with the Maqfi Member, while in southeast Qur Hadida the basal part of the Esna Formation consists of evaporite, shale and sandstone which are capped by limestone with algal stromatolites. The formation unconformably overlies the Tarawan Formation.

The Esna Formation is fossiliferous with abundant planktics and benthics especially in its lower part which belong to the *Morozovella velascoensis* Zone P5b-c and *Morozovella subbotinae* Zone P6a in the central and western parts of the Farafra Oasis, while the middle and upper parts of the formation ascribe to the *Morozovella aragonesis*/*M. formosa* Zone P7 and lower part of the *Morozovella aragonesis*/*Acarinina aspensis*-*Hantkenina nuttalli* Zone (P8-P9 undifferentiated)

The Esna Formation includes the following six facies associations:

1. Deep middle/outer shelf pelagic shale
2. Shallow inner shelf calcareous shale
3. Lower shallow subtidal miliolids alveolinid bioclastic packstone
4. Lower shallow subtidal foraminiferal packstone
5. Supratidal sabkha
6. Lower shoreface calcareous quartz arenite

The faunal and lithologic characteristics of the basal Maqfi Member suggest deposition in a lower shallow subtidal environment, while in the paleo-low areas, the basal part of the Esna Formation indicates deposition in a deep middle/outer shelf environment. The overlying sediments of the middle and upper

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parts of the Esna Formation are deposited under shallower conditions between shallow subtidal to upper deep subtidal setting (shallow inner shelf).

The Ain Dalla Formation has a limited aerial distribution, only found in Ain Dalla and Shakhs El-Obeiyid areas. It is introduced to replace the Esna Formation in Ain Dalla and to represent the well-bedded chalky limestone with chert bands at the top. The formation is found to overlie unconformably the Tarawan Formation and to underlie the Farafra Formation with a sharp lithologic contact.

The formation contains the following microfacies associations:

1. Deep middle/outer shelf foraminiferal wackestone
2. Lower shallow subtidal alveolinid wackestone
3. Deep subtidal calcareous shale
4. Lower intertidal sandy silicified dolostone
5. Lower intertidal lime-mudstone

The lower part of Ain Dalla Formation has been deposited in a deep middle/outer shelf setting. It is interrupted by shallowing conditions to deposit a lime-mudstone and sandy silicified dolostone of lower intertidal regime, while the upper part of Ain Dalla Formation is interpreted to be deposited in a lower shallow subtidal environment. In the upper part of Ain Dalla Formation, the planktics are nil, while the larger foraminifers are frequent indicating a regressive event.

The depositional sequence SQ6 covers the lower part of the Lower Eocene Esna and Ain Dalla formations. The base of this

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sequence is marked by the sequence boundary SB5 which separated the Thanetian from Early Ypresian, while its top is characterized by the missing of the *Morozovella formosa*/*M. lensiformis*-*M. aragonensis* Subzone P6b; this sequence boundary SB6 is characterized by the presence of a thick evaporite bed in southeast Qur Hadida, submarine break in the southern slope of El Quss Abu Said or by intense dolomitization in Ain Dalla and Shakhs El-Obeiyid. It separates between the Early and Middle Ypresian.

Sequence 6 includes both transgressive and highstand systems tracts. The transgressive deposits consist of outer shelf pelagic shale and deep middle/outer shelf foraminiferal wackestone. While, the highstand deposits are formed of shallow middle shelf calcareous shale and foraminiferal wackestone, shallow inner shelf calcareous shale, lower intertidal lime-mudstone and silicified dolostone. The depositional sequence SQ7 on the other hand, represents the main part of the Esna and Ain Dalla formations as well as the lower part of the overlying Farafra Limestone in the Farafra Oasis

The Farafra Limestone has a great extension, forming the cap rock of El-Quss Abu Said Plateau as well as the northern and eastern plateaus of the Farafra Oasis. It is composed of limestone with argillaceous content at base and dolomitic limestone at the top. In the northern reach of the Farafra basin, the Farafra Limestone is composed of dolomitic limestone such as in Ain Dalla and south Qaret Sheikh Abd Alla.

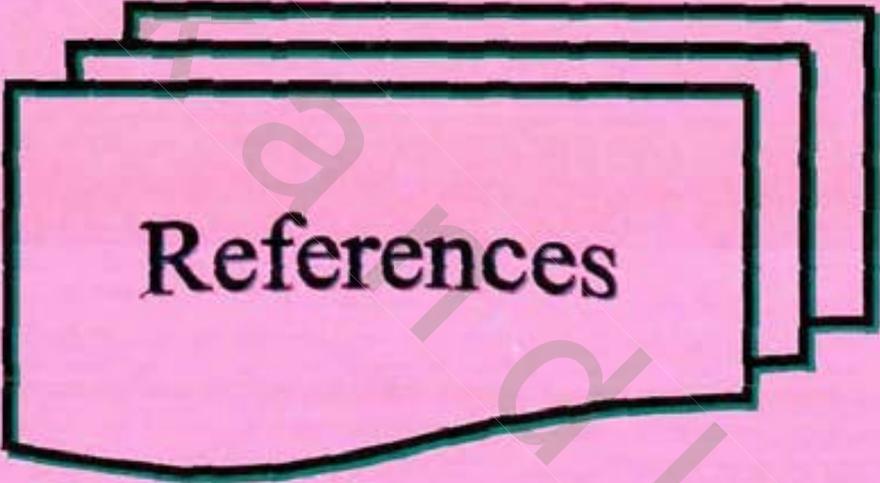
The Farafra Limestone yields the following facies associations:

1. Deep subtidal calcareous shale.

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2. Upper shallow subtidal nummulitic alveolinid packstone.
  3. Lower shallow subtidal nummulitic wacke/packstone.
  4. Lower intertidal lime-mudstone.
  5. Lower intertidal dolomitic lime-mudstone.

In general, the lower part of the Farafra Limestone has been deposited in a shallow subtidal environment which became shallower in the upper part of the formation (lower intertidal flat). The contact between the Esna Formation and the Farafra Limestone is gradational in eastern and western escarpments of the Farafra Oasis.

The upper part of the Farafra Limestone corresponds to the last recorded depositional sequence in the Farafra Oasis, the depositional sequence SQ8, due to the detection of an unconformity surface in the middle part of the Farafra Limestone. This surface is characterized by an intensively bored hard ground with *Thalassinoides*.

The word "References" is centered within a graphic consisting of three overlapping rectangular boxes with a black border. The top box is slightly offset to the right, the middle box is slightly offset to the left, and the bottom box is slightly offset to the right, creating a layered effect. The text is in a bold, black, serif font.

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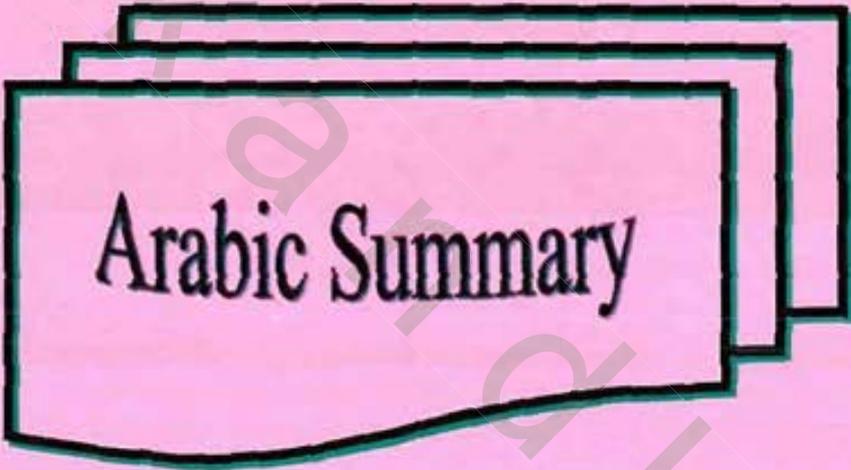
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Arabic Summary



استراتيجية تنابع الطباشيري العلوي - الثالث السفلي  
في واحة الفرافرة - الصحراء الغربية - مصر

رسالة مقدمة

للحصول على

درجة العالمية ( الدكتوراه ) في العلوم

( جيولوجيا )

من الجيولوجي

**شريف فاروق محمد أحمد**

بكالوريوس علوم جيولوجيا (جامعة الأزهر 1996)

ماجستير علوم جيولوجيا (جامعة الأزهر 2003)

إلى

جامعة الأزهر

كلية العلوم

قسم الجيولوجيا

2006

# بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿قُلْ سِيرُوا فِي الْأَرْضِ فَانظُرُوا كَيْفَ بَدَأَ الْخَلْقَ ثُمَّ ارْجِعُوا إِلَى اللَّهِ لَعَلَّكُمْ تَعْلَمُونَ﴾

﴿الَّذِينَ يَتَّبِعُونَ النَّسَاءَ (الْحَمْرَاءَ) (الَّذِينَ) جَاءَهُمْ مِنَ اللَّهِ نُورٌ وَقَدَرُوا عَمَلَهُمْ﴾

بِسْمِ اللَّهِ  
الْحَمْدُ لِلَّهِ  
الْعَظِيمِ

إهداء

إلى روح أبي الكريم

إلى أرواح شهداء المسلمين

إلى كل نفس تريد أن ترقى بالعلم والإيمان

إلى من يبحثون عن حقائق الكون ليهدتوا من خلالها  
إلى عظمة الخالق وحقيقة الوجود

إلى كل هؤلاء...

أقدم هذا العمل المتواضع

الباحث

شريف فاروق محمد احمد

## الملخص العربي

ظلت أطراف واحة الفرافرة من ناحية الشرق والغرب مناطق يكتنفها الغموض وتحوطها التخمينات نظراً لصعوبة الوصول إلى هذه المناطق حيث تكثر الكثبان الرملية بها، وقد درست المناطق الوسطى من واحة الفرافرة القريبة من الطريق الإسفلتي الرئيسي المتجه إلى واحة الداخلة وبقيت المناطق الشرقية والغربية من واحة الفرافرة غامضة، لذا تم التطرق إلى هذه المناطق لمحاولة كشف جزء من هذا الغموض.

ولإنجاز هذه الدراسة تم اختيار أربعة عشر قطاعاً جيولوجياً سبعة منها في الأجزاء الشرقية (وهي قطاعات بنر مر، عين مقفى، جنوب شرق قور حديده، قور حديده، جنوب شرق قارة الشيخ عبد الله، شرق عين مقفى، وادي حنس) وإما السبعة الأخرى فتقع في الأجزاء الغربية من واحة الفرافرة (وهي شمال هضبة القس أبو سعيد، جنوب هضبة القس أبو سعيد، شمال غرب بنر بدني، شرق شخص الأبيض، شخص الأبيض، عين دالة وجبل سفره). ويمتد التابع في واحة الفرافرة من عهد السانتوني إلى عهد الأيوسين المبكر. وقد أمكن تقسيم هذه القطاعات إلى سبعة مكونات وهي

### 1. مكون الهفوف:

يوجد هذا المكون في منخفض الفرافرة بشكل محدود، حيث ينحصر تواجده في الأجزاء المنخفضة طوبوغرافياً على شكل تلال صغيرة الحجم في وادي حنس وشرق شخص الأبيض. ويتألف من طفل أخضر يتميز بوجود حبيبات من الجلوكونيت متبادل مع حجر رملي عديم الحفريات ينتمي للسانتوني، ويعلوه طبقات من حجر الدولوميت الذي يتميز بوجود حبيبات من الفوسفات التابع للكمباني ويتميز مكون الهفوف بوجود خمس سحنات دقيقة وهي

1. Upper deep subtidal shale/mudstone.
2. Shallow subtidal massive/cross-bedded sandstone (ferruginous quartz arenite).
3. Lower intertidal phosphatic sandy lime-mudstone.
4. Shallow/deep subtidal oyster rudstone with *Pycnodonte vesicularis*.

## 5. Upper intertidal sandy dolostone.

ويفصل بين السحنات الفتاتية والسحنات الكربونية فاصل طبقي ويستدل على ذلك بوجود حفريات السينوماني الشهيرة مثل *Ceratostreon flabellatum* (Goldfuss), and *Ilymatogyra (Afrogyra) africana* (Lamarck) المعاد ترسيبها مع مستعمرات من *Pycnodonte vesicularis* (Lamarck) التابعة للعصر للكمباني. وتمثل السحنات الكربونية أول تقدم بحري حقيقي غطى منطقة الدراسة خلال الكمباني متبوع بتهقّر بحري في نهاية الكمباني المتأخر.

## 2. متكون الخومان:

ينتشر هذا المتكون في بمساحات شاسعة في أرضية منخفضة الفرازة ويكون أشكالاً سطحية متنوعة أثر تعرضها لعوامل التجوية المختلفة ومن أشهرها الأبراج الكارستية وموائد الشيطان. ويتألف من طباشير أبيض غني بالفورامينيفرا التابعة للمسترختي. وقد تبين أن الحد الفاصل بين الطباشيري العلوي والباليوجين السفلي يقع عند قاعدة النطاق CF6. كما تضح من خلال الدراسة التفصيلية للمحتوي الحفري أن الراوسب تكون أقل عمقا مع تقدم الزمن. وقد أمكن تتبع ذلك من خلال دراسة وفرة وتنوع الفورامينيفرا الهائمة ذات الحافة الحادة (keeled) المنتشرة في الأجزاء السفلية لهذا المتكون والتي تقل كلما اتجهنا لأعلى، وكذلك أفراد heterohelicids المنتشرة بوفرة في أواخر الطباشيري العلوي. وقد سجل وجود دولوميت متبادل مع طفل في الأجزاء السفلية فقير في المحتوى الأحفوري في منطقة قور جديدة.

وقد أمكن تقسيم متكون الخومان إلى ثلاثة نطاقات حيوية كالآتي من أسفل لأعلى:

- *Rugoglobigerina hexacamerata* (CF8b) Zone
- *Gansserina gansseri* (CF7) Zone
- *Contusotruncana contusa* / *Pseudotextularia intermedia* / *Racemiguembelina fructicosa* / *Pseudoguembelina hariaensis* Interval Zone (CF6-CF5-CF4-CF3 Undifferentiated).

ويتميز متكون الخومان بوجود أربع سحنات دقيقة وهي

1. Deep middle to upper continental slope foraminiferal wackestone
2. Shallow inner shelf mudstone
3. Lower intertidal lime-mudstone
4. Upper intertidal dolostone

ويفصل بين متكون الهفوف والخومان فاصل طباقي عبارة عن طبقة من الدولوميت ينحصر سمكها في منخفض الفراقرة إلى متر واحد فقط مقارنة بسمكها في منخفض البحرية الذي يصل إلى ٢٦ متر.

### ٣. متكون الداخلة:

يظهر هذا المتكون في واحة الفراقرة متمثلاً بعضو الخارجة الذي يختفي تدريجياً كلما اتجهنا ناحية الشمال ويتألف الجزء السفلي منه من حجر طقلي طباشيري بينما الأجزاء العلوية تتألف من طفل أخضر غني بالفورامينيفرا. وترسب متكون الداخلة تحت بيئة شاطئية ضحلة تميل للعمق كلما اتجهنا لاعلى وقد امكن تقسيم هذه المتكون إلى أربعة نطاقات حيوية كالاتي من اسفل لاعلى:

- *Globanomalina compressa*-*Praemurica uncinata* Interval Subzone (P1c)
- *Praemurica uncinata*-*Morozovella angulata* Interval Zone (P2)
- *Morozovella angulata*-*Globanomalina pseudomenardii* Interval Zone (P3).

ويتميز متكون الداخلة بوجود سحنات دقيقة وهي

1. Deep middle shelf foraminiferal wackestone
2. Deep middle/outer shelf pelagic shale
3. Shallow inner shelf foraminiferal lime-mudstone

كما تبين ان الحد الفاصل الداني /والسيلاندي (Danian/Seldanian) يقع عند قاعدة تحت النطاق P3b للفورامينيفرا الهائمة. ويحد هذا المتكون من اعلى فاصل طباقى تم تحديده في الاجزاء الشرقية والغربية من منخفض الفراقرة، وذلك بسبب غياب النطاق

الحيوي P3 مما يدل على أن هذه المناطق تمثل حواف حوض الترسيب.

#### ٤. متكون الطروان:

يتمثل هذا المتكون في الهضبة الشرقية لمنخفض الفراقرة من حجر جيرى وحجر جيرى طباشيرى، يتغير إلى حجر جيرى يتخلله بعض الراقات من الطفل في منطقة القس أبو سعيد، بينما تتغير أجزاءه العلوية في طريق الفراقرة - عين دالة إلى طفل، وكذلك أجزاءه السفلية في منطقة شخص الأبيض مما يدل على النشاط التكتونى للمنطقة فسي تلك الفترة الزمنية والتي تتميز بوجود نطاق *Globanomalina pseudomenardii* Zone.

وقد ترسب متكون الطروان في بيئة عميقة مرورا بالرصيف القاري العميق حتى المنحدر القاري العلوي خاصة في الأجزاء العلوية من متكون الطروان. ويتميز متكون الطروان بوجود سمات دقيقة وهي:

1. Outer shelf pelagic foraminiferal packstone
2. Outer shallow middle pelagic shale
3. Lower shallow subtidal bioclastic foraminiferal packstone
4. Lower intertidal foraminiferal lime-mudstone

ويحد هذا المتكون من أعلى فاصل طباقى في منخفض الفراقرة وذلك لغياب ثغره طباقية صغيرة ( minor hiatus ) متعللاً بغياب تحت نطاق P5a في منطقة القس أبو سعيد وغياب أيضاً تحت النطاق P5a & P5b في معظم أجزاء الفراقرة.

#### ٥. متكون إسنا:

ويتألف من طفلة فاتحة اللون تحتوى على بعض التداخلات من الحجر الجيري خاصة في الأجزاء العليا لهذا المتكون، وتتغير الأجزاء السفلى لمتكون الإسنا في الاطراف الشرقية من منخفض الفراقرة إلى حجر جيرى غنى بالالوفيو لينيات ويسمى عضو المقى الذي ترسب في بيئة بحرية ضحلة. وترسيب الجزء السفلى من متكون الإسنا في بيئة بحرية عميقة إلى متوسطة العمق، أما الجزء العلوي فيرجع ترسيبه في

بينات ضحلة، وقد استدل على ذلك من الانتشار الواسع لمجموعة المحاريات والفورامينيفرا الكبيرة.

ويتميز متكون إسنا بوجود ستة سحنات صخرية كالآتي:

1. Deep middle/outer shelf pelagic shale
2. Shallow inner shelf calcareous shale
3. Lower shallow subtidal miliolids alveolinid bioclastic packstone
4. Lower shallow subtidal foraminiferal packstone
5. Supratidal sabkha
6. Lower shoreface calcareous quartz arenite

ولقد أسفرت الدراسة الحالية عن تحديد الوضع الاستراتيجرافي لعضو المقفي Maqfi Member في منخفض للفرافة حيث ثبت أنه يمثل بداية الإوسين ويتغير إلى طفل في منطقة القس أبو سعيد. ويحد هذا الطفل وعضو للمقفي فاصل طباق من أعلى وذلك لغياب *Morozovella formosa/M. Lensiformis-M. aragonensis* Subzone P6b

كما تبين أن الحد الفاصل بين الإوسين المبكر والمتوسط يقع عند قاعدة النطاق الحيوئي (*Morozovella aragonensis/M. formosa* Zone (= P7)) المتمثل بالسطح السفلي لطبقة المتبخرات التي سجلت لأول مرة في الدراسة الحالية في متكون الإسنا بمنطقة قور حديده التي تضاهي السطح السفلي لتجمعات للنيمبوليت في منطقة جنوب القس أبو سعيد.

## ٦. متكون عين دالة:

يتواجد هذا المتكون في منخفض عين دالة، ويتألف من حجر جيرى طباشيري غنى بالفورامينيفرا الهائمة في الأجزاء السفلي و بالفورامينيفرا الكبيرة في الأجزاء العليا. ولقد أثبتت الدراسة الحالية أن منطقة شخص الأبيض تمثل منطقة تداخلات بين متكون الإسنا و عين دالة، وأن هذه التداخلات والتغيرات في السحنات للصخرية تدل على النشاط التكتوني لهذه المنطقة وتتراوح بيئة ترسيب متكون عين دالة بين بيئة بحرية عميقة و ضحلة.

ويتميز متكون عين دالة بوجود خمس سحنات صخرية كالاتي:

1. Deep middle/outer shelf foraminiferal wackestone
2. Lower shallow subtidal alveolinid wackestone
3. Deep subtidal calcareous shale
4. Lower intertidal sandy silicified dolostone
5. Lower intertidal lime-mudstone

ويحد هذا المتكون من اعلى فاصل طبقي يقع ايضا بين P6a, P7 فوق طبقة من الحجر الدولوميتي الرملي السليكاتي المميزة لمتكون عين دالة.

#### ٧. حجر جيرى الفرافرة:

ويتألف من حجر جيرى وحجر جيرى دولوميتى مع قليل من الطفل التابع ل *Morozovella* الذي يحتوي على النطاق الحيوي *aragonesis/Acarinina aspensis-Hantkenina mattalli Zone (= P8-P9 Undifferentiated)*. سيطرت بيئة الرصيف القاري الضحل على هذا المتكون وذلك للانتشار الواسع لللافيونيات والنيمو لبتات وايضا الحفريات الكبيرة

يتميز متكون للفرافرة بوجود خمس سحنات دقيقة وهى:

1. Deep subtidal calcareous shale.
2. Upper shallow subtidal nummulitic alveolinid packstone.
3. Lower shallow subtidal nummulitic wacke-/ packstone.
4. Lower intertidal lime-mudstone.
5. Lower intertidal dolomitic lime-mudstone.

ويحد هذا المتكون من اعلى فاصل طباقى تم تحديده في منطقة القوس ابو سعيد والهضبة الشرقية من منخفض الفرافرة، وذلك بسبب الانتشار الواسع لـ *Thalassinoides* بين الحجر الجيري والحجر الجيري الدولوميتى.