waters.

3.2.3. Packstone lithofacies:

Packstones are the second most important lithofacies in Um Mahara Formation (Fig 2). They are represented by foraminiferal packstone, skeletal bioclastic packstone, peliodal packstone and algal foraminiferal packstone lithofacies. Most of them occur at the topmost part of the emergence cycles overlying the wackestone lithofacies. In some cycles, they occur in the middle part of the cycles that are capped with either dolostone or dedolostone lithofacies.

3.2.3a.Foraminferal packstone lithofacies:(F.P)

Foraminiferal packstone lithofacies is present in the lower and upper parts of the Um Mahara Formation in the form of four beds, each of which has an average thickness of about 1.5m. It usually caps the emergence cycles and overlies the wackestones lithofacies (Fig.2). The rock is yellowish-grey in color with brown and black patches of manganese. The rock is composed mainly of skeletal particles (40%) which are represented by benthonic and planktonic foraminifera. Benthonic foraminifera are abundant, represented by operculines and miliolids(Pl.2B). Operculines are oval, rounded to subrounded. Most of their chambers if not all are micritized, some are filled with sparry calcite crystals. They are randomly distributed allover the rock. Medium sand-sized miliolids (*biloculina, triloculina and quinqueloculina*) are randomly distributed allover the rock. The miliolid particles are heavily micritized, especially on their outer borders. Fine–grained well-sorted bioclats do occur; they are reworked from echinoid, ostracods and molluscs. The binding material that occurs in between the different types of foraminifera is composed of micrite. Some of which are recrystallized into calcite due to aggrading neomorphism.

Interpretation: Such lithofacies contains well-rounded benthonic foraminifera (operculines, miliolids) which indicate shallow subtidal environment with high energy conditions on platform shoals (El-Tabakh and Aroon, 1998). These particles are well sorted, abraided bioclasts suggesting that they accumulated as shoals on the platform (Wilson, 1975).

3.2.3b.Skeletal bioclastic packstone lithofacies:(Sk.b.p.)

Skeletal bioclastic packstone has a wide distribution in the Um Mahara Formation, as it occurs in its lower, middle and upper parts. Each bed ranges in thickness between 1.m. and 1.5m. It usually caps the topmost part of the emergence cycles overlying the wackestone lithofacies. It is also recorded in the middle part of cycles that is capped by dolostone and dedolostone lithofacies (Fig.2). The rock is greyish-yellow, marly, porous, , fossiliferous with some shell debris.

The rock is made up of skeletal particles (35%), bioclasts (25%) and lime-mud matrix (Pl.2.C). The skeletal particles are ganule-sized, elongate, curved and angular. They are composed mainly of pelecypoda (mollusca) and coelentrata. Most of skeletal particles, if not all, have been recrystallized into pseudospars. They generally show orientation parallel to bedding planes. The bioclasts derived from molluscs, algae, coelentrata and foraminifera, range in size from fine to medium sand-sized. They are highly micritic, rarley recrystallized and badly preserved, with obliterated original fibrous structure. Some debris occasionally has thin micritic envelopes. The interaparticles porosity is usually filled with sparite. They are randomly distributed allover the rock. Micrite is the binding material and contains sporadic fine quartz grains and some organic matter.

Interpretation: The skeletal bioclastic packstones are common in high energy condition. Broken, abraded and bioclasts forming the packstone without orientation indicates high energy condition. Abraded bioclasts and broken algal fragments suggest accumulation as shoals on the platform

(Wilson, 1975).

3.2.3c.Peloidal packstone lithofacies:(Pl.P)

Peloidal packstone occurs in the upper parts of the Um Mahara Formation, represented by two beds, one of which caps a cycle while the second occurs in the middle of the cycle underlying the dolostone lithofacies (Fig.2). The rock is yellow, massive with some black patches and each bed has an average thickness of about 1.5m.

The lithofacies consists of peloids and intraclasts, and local concentrations of fossils of restricted marine assemblage (Pl.2.D). The term peloids (Bathurst, 1975) is used in this study to describe micritic allochems that lack internal structure and look-like pellets in size and shapes. The peloids constitute about 35% of the rock and range in size from fine to coarse sand-sized. They are rounded, oval in shape and show sharp contact with the lime mud matrix. Some of them are recrystallized into microspar due to aggrading neomorphism. The lithoclsts differ from the peloids by their finer size, and irregular boundaries. Some sparse bioclasts are recorded, derived from benthonic foraminifera, ostracods and corals. The cement is dull lime-mud which has been recrystallized into equant calcite crystals .Few isopachous calcite cement does occur around few particles.

Interpretation: The origins of the peloids are uncertain; they may be formed by the micrtization of, or boring of, endolithic algae (Bathurst, 1975). Peloids are produced as fecal pellets or through the micritization of other carbonate grains by boring algae, bacteria, or fungi (Whalen, 1988). The peloidal wackestones and packstones were deposited above storm wave base, and are typified by open marine facies (El-Tabakh and Aroom, 1998). .The abundance of peloids indicates quiet water dominated, during which the effect of borer algae and fungi were active transforming most of the skeletal particles into peloids. They may represent poorly preserved or micritic intraclasts and/or micritized fossils. The abundance of peloids, intraclasts and muddy matrix and lack of subaerial exposure feature suggests a low energy, restricted subtidal to lower intertidal environment of deposition (Strasser, 1988).

3.2.3d.Algal foraminiferal packstone lithofacies:(Al.F.P)

Algal foraminiferal packstone is found in the lower part of the Um Mahara Formation reaching a thickness of about 1.5m. It usually caps the topmost part of the emergence cycles overlying the wackestone and lime mudstone lithofacies. The rock is whitish-grey, rich with fossils such as algae and foraminifera, and is massive and very hard.

The rock is composed mainly of larger foraminifera (35 %), algae (20%) and lime mud matrix (Pl.2.E). Larger foraminifera represented by operculines, miliolids, and biseral forms. The operculines are the abundant type and have a coarse sand-sized and their chambers are filled with calcite. They are well rounded, spherical, with micritic envelopes which show sharp contact with the micritic ground mass. Also, benthonic foraminifera (biserial forams) and echinoides spines and plates are recorded with less abundance in this rock. Algae that have medium sand-sized are represented by *Cymopolia sp., Neomeris sp. and Acicularia sp. of Dasycladaceae phyllum.* Also, there are several segments of algae that are micritized. The interaparticles porosity is filled with sparite. Some microcrystalline grains are recrystallized into pseudosparite and microsparite due to aggrading neomorphism. Scattered large foraminifera, brachiopod, echinoderm, coral and bryzoan fragments do occur and they often show signs of micritization and boring. The lime-mud cement was subjected to diagenetic alteration resulting in the destruction of the original fabric into clear patches of granular pseudospar.

Interpretation: The interpretation of this lithofacies is based on the abundance of algae and different types of foraminifera that indicate shallow subtidal zone. Their concentration as packstones suggests high-energy condition. The presence of micrite matrix and the varied types of algae and foraminifera suggest rather shallow, clear water of open circulation and normal salinity (Bowman, 1978). The micrite envelopes and bored margins of particles and bioclasts indicate slow sedimentation rates.

3.3. Dolostone lithofacies:

Dolostone is important lithofacies in the middle and upper parts of the Um Mahara Formation. It always caps the emergence cycles overlying the packstone, wackestone and lime mudstone lithofacies (Fig.2). They are represented by dolomicrite lithofacies.

3.3. Dolomicrite lithofacies :(D)

Dolomicrite lithofacies usually occurs at the topmost part of the emergence cycles capping the wackestone and packstone lithofacies .It occurs in the middle, upper and topmost part of Um Mahara Formation. Each bed varies in thickness from 0.5m to 1.m.The rock is pale grey, brownish-yellow in colour, cavernous, highly porous, with small black manganese patches, massive, very hard and shows sharp contact with the bracketing lithofacies. The rock consists entirely of dolomite rhombs (80%) and evaporites (15%). Most of the rhombs, if not all, are fine grained (15μm-30μm) and they show xenotopic to hypidiotopic fabric, equigranular texture and are unzoned (Pl.2.F). Evaporites are mainly anhydrite with some gypsum. They consist of elongate laths, replacing the dolomite rhombs. This is evidenced by the presence of relics of dolomite rhombs within evaporite.

Interpretation: The fine-grained crystals of dolomite were probably attributed to replacement of the original calcium carbonate mud (Al-Aasm and Packard, 2000). The unzonned dolomite rhombs suggest that these rhombs were not subjected to further diagenesis and mixed with solution that was responsible for the segregation of the zonation of iron oxides in the dolomite rhombs. These types of dolomites usually occur in the intertidal-supratidal zone. The occurrence of this lithofacies at the topmost part of the depositional cycles (Fig.2) strongly suggests that the fine grained dolomite were formed at the end of deposition during sea level fall during which the concentration of Mg ions were sufficient for dolomitization. The presence of anhydrite crystals in-between the dolomite rhombs indicates evaporation of marine water during the shallowing upward of cycles. The presence of small white patches of calcite crystals in the dolomite may suggest intermittent subaeial exposure that enabled the dedolomitization (Khalifa and Abu El Hasan, 1993).

3.3. Dedolostone lithofacies :(DD)

Dedolostone is a petrographic name indicating a dolostone rock that was replaced by blocky calcite crystals (Khalifa, 1981). In the present work, dedolostones form the topmost part of some emergence cycles that overlies the packstone rocks (Fig.2). It occurs in the middle and upper parts of the Um Mahara Formation measuring an average thickness of about 1.m.The rocks are brownish-grey, with white patches, porous, massive and hard. The rock is made up entirely of dolomite and blocky calcite with some relics of dolomite rhombs. The dolomite rhombs which always show xenotopic texture are very fine-grained with irregular outlines and inequigranular fabric. Most of the rhombs are replaced by blocky calcite. The presence of some relics of rhombs (black brown) within calcite (clear) is a good argument for the replacement of dolomite by calcite. The complete replacement of dolomite by calcite is usually found along dissection cracks. The blocky calcite (30%) replaces the margin of dolomite rhombs and invades toward the core of the rhombs. Calcite crystals are subsequently dissolved, creating intercrystalline secondary porosity between the dolomite rhombs.

Interpretation: The dedolomitization process is the main common diagenetic features in the dolostone rocks. The replacement occurs usually near the earth surface within mixing meteoric water. This process was formed by reaction of fresh meteoric water with dolostone under low temperature and pressure (Chafetz, 1972 and Khalifa, 1981). The effect of fresh water on the dolostone can remove Mg ions that hamper the coarsening of calcite crystals (Folk and Land, 1975). The presence of dedolostone is important in the recognition of paleo-unconformity as well as the paleo-erosion surfaces in carbonate sequence (Khalifa, 1981). Consequently, the presence of such lithofacies with the carbonate sequence in the studied rock unit may suggest repeated subaerial exposure of these cycles during sea level fluctuations.

4. CYCLICITY

Measurements of the stratigraphic sequence of the Abu Ghusun and Um Mahara formations in Ras Banas Peninsula show that, the vertical sequences can be subdivided into meter-scale depositional cycles (Fig.3). The Abu Ghusun Formation consists of two repeated submergence cycles (deepening upward) cycles. These cycles are composed of pure siliciclastics. Each cycle begins at the base with polymictic conglomerate and is capped by litharenite at the top (Fig.3 E).Such vertical sequence of beds in the cycles is referred to different terms, e. g; transgressive cycles (Mathwes,1974), deepening upward cycles (Grotzinger,1986) and submergence cycles (Khalifa,1996)

The above mentioned submergence or fining-upward cycles are usually recorded in the areas that are subjected to sudden subsidence. Fore example, fining upward cycles are described in basin-wide associated with tectonic events (Miall, 1981). In addition, submergence cycles are found in the basal part of the Naqb es Sillim Formation (Turonian-Santonian) at the southern tip of the Bahariya Oasis at the hinge zone between the stable and the unstable shelves (Khalifa, et al., 2002).Hence, the submergence or fining upward cycles were controlled by external factors or allocyclic mechanism. In the Abu Ghusun Formation, the basal part of cycles (polymictic conglomerate) was formed during the initiation of rifting and the formation of high relief of basement rocks.These rocks are considered the main source of conglomerates at the basal part of the cycle. This was followed by ceased faulting and low relief of the basement rocks that gave rise to the deposition of the finer detrital clasts(litharenite) forming the top of cycle. Repetition of these mechanisms can lead to superposition of the submergence and/or fining upward cycles.

The depositional cycles in Um Mahara Formation are of pure carbonates. Each cycle starts with lime-mudstone and ends by a packstone or dolostone lithofacies. Such cycle has different terms, e. g. regressive cycles (Mathwes, 1974), shallowing upward cycles (Grotzinger, 1986) and emergence cycles (Khalifa, 1996). These cycles are described here under three types according to their relation with sea level changes. These genetic terms are: 1) Emergence gradual cycles and 2) Emergence non-gradual cycles (Khalifa, 1996).

1) Emergence gradual cycles: -

Emergence gradual cycles comprise a group of rock strata which differ in their lithological constituents and are arranged in the order that the uppermost bed of the cycle represents shallower environments (Khalifa, 1996). The term gradual cycle is used to describe the balance between the rate of subsidence and rate of sedimentation in relation to sea level changes. It elucidates the gradual vertical transition from one subenvironment to another with shallowing upward, without abrupt change from deep to shallow (Khalifa, 1996). These cycles are well observed in the topmost and the lower parts of the Um Mahara Formation (Fig. 3A, 3B). These cycles consist of lime-mudstone (deeper subtidal) overlain by foraminifral wackestone (shallow subtidal) and skeletal bioclastic packstone (intertidal to shallow subtidal). In the middle and in the topmost part of that formation some cycles are capped by supratidal dolostone facies (Fig.3A).In the lower part, this cycle shows a thin cap, where the thickness of its component beds thin upwards measuring about 6.0m., 2.m and 1.m respectively.

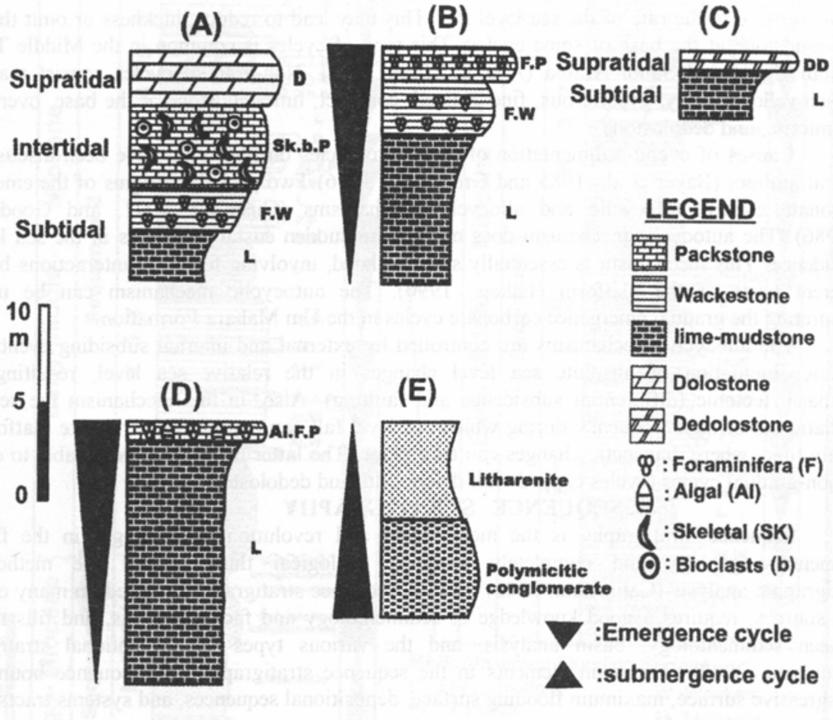

Fig.(3): Emergence carbonate cycles in the Um Mahara Formation (A,B,C,D). Notice, the gradual cycles (A and B) and non-gradual cycles (Cand D). Submergence clastic cycles (E) occur in the Abu Ghusun Formation .

balance between the rate of subsidence and rate of sedimentation in relation to sea level changes. It elucidates the gradual vertical transition from one subenvironment to another with shallowing upward, without abrupt change from deep to shallow (Khalifa, 1996). These cycles are well observed in the topmost and the lower parts of the Um Mahara Formation (Fig. 3A, 3B). These cycles consist of lime-mudstone (deeper subtidal) overlain by foraminifral wackestone (shallow subtidal) and skeletal bioclastic packstone (intertidal to shallow subtidal). In the middle and in the topmost part of that formation some cycles are capped by supratidal dolostone facies (Fig.3A).In the lower part, this cycle shows a thin cap, where the thickness of its component beds thin upwards measuring about 6.0m., 2.m and 1.m respectively.

2) Emergence non-gradual cycles:

The non-gradual cycles describe a cyclic arrangement representing no regular relationship between the subsidence and sedimentation rates i.e, the cycle can begin with deep subtidal facies (lime-mudstone) and ends with supratidal facies without an intervening intertidal zone (Khalifa, 1996). Such cycles usually include two lithofacies types (Figs.3 C and 3 D). These cycles are recorded in the lowermost part (Fig. 3 D) and in the middle and upper parts of Um Mahara Formation with minimum thickness (Fig. 3 C) and were termed condensed cycles by Grotzinger (1986) who stated that condensed cycles occur in cases where the sedimentation rate is low relative to the rate of the sea-level fall. This may lead to reduce thickness or omit the basal lime-mudstone at the base of some cycles. This type of cycles is common in the Middle Triassic of both Egypt and Saudi Arabia (Abu El Ghar, 1997). Non-gradual cycles consist mainly of greyish-yellow, sandy, gypsiferous, fine grained, compact, lime-mudstone at the base, overlain by dolomicrite, and dedolostone.

Causes of cyclic sedimentation of carbonate cycles on platforms have been discussed by several authors (Bayer et al., 1985 and Grotzinger, 1986).Two probable origins of the emergence carbonate cycles: autocyclic and allocyclic mechanisms (Ginsburg, 1971, and Goodwin et al.1986). The autocyclic mechanism does not require sudden eustatic changes in the sea level or subsidence. This mechanism is essentially self regulated, involving feedback interactions between different parts of the platform (Lakew, 1990). The autocyclic mechanism can be used in interpreting the gradual emergence carbonate cycles in the Um Mahara Formation.

The allocyclic mechanisms are controlled by external and internal subsiding events, e. g. eustatic fluctuation of absolute sea level changes in the relative sea level, resulting from intrabasin tectonic (differential subsidence and faulting). Also, in this mechanism the sea level oscillation is of high frequency during which sea level fall can expose the carbonate platform for certain time, where diagenetic changes can take place. The latter mechanism is suitable to explain the non-gradual cycles (cycles capped with dolomicrite and dedolostone).

5. SEQUENCE STRATIGRAPHY

Sequence stratigraphy is the most recent and revolutionary paradigm in the field of sedimentary geology and completely revamps geological thinking and the methods of stratigraphic analysis (Catuneanu, 2002). In fact, sequence stratigraphy is based on many existing data sources, requires a good knowledge of sedimentology and facies analysis, and fills the gap between sedimentology, basin analysis, and the various types of conventional stratigraphy (Catuneanu, 2002). The main elements in the sequence stratigraphy are: sequence boundaries, transgressive surface, maximum flooding surface, depositional sequences, and systems tracts.

5.1. Sequence boundaries:

The sequence boundaries (SB) separating between the three sequences were recognized in the studied sections by their depositional geometries and by facies changes across them. The first sequence boundary (SB-1) is a nonconformity surface that separates between the Precambrian basement rocks below and the sequence-1 above. This unconformity surface consists of polymictic pebbly–sized conglomerates derived from the underlying basement rocks. The second sequence boundary (SB-2) occurs above the Abu Ghusun Formation and below the depositional sequence-2. This surface is an unconformity contact as evidenced by the presence of thin conglomerate bed, derived from the reddish conglomerate bed of the underlying Abu Ghusun Formation (Fig.4). The third sequence boundary (SB-3) occurs at the top of the depositional sequence-2. It is characterized by a flat bed of dolostones which shows uneven and sharp contact with the basal part of depositional sequence-3. Some of the dolostones contains calcite pockets and veinlets along desiccation cracks that mark the phenomena of dedolomitization process at the subaerial exposed zone. The fourth sequence boundary (SB-4) occurs at the top of depositional sequence-3 and consists of dolostones. It exhibits sharp contact with the evaporites of the overlying Abu Dabbab Formation.

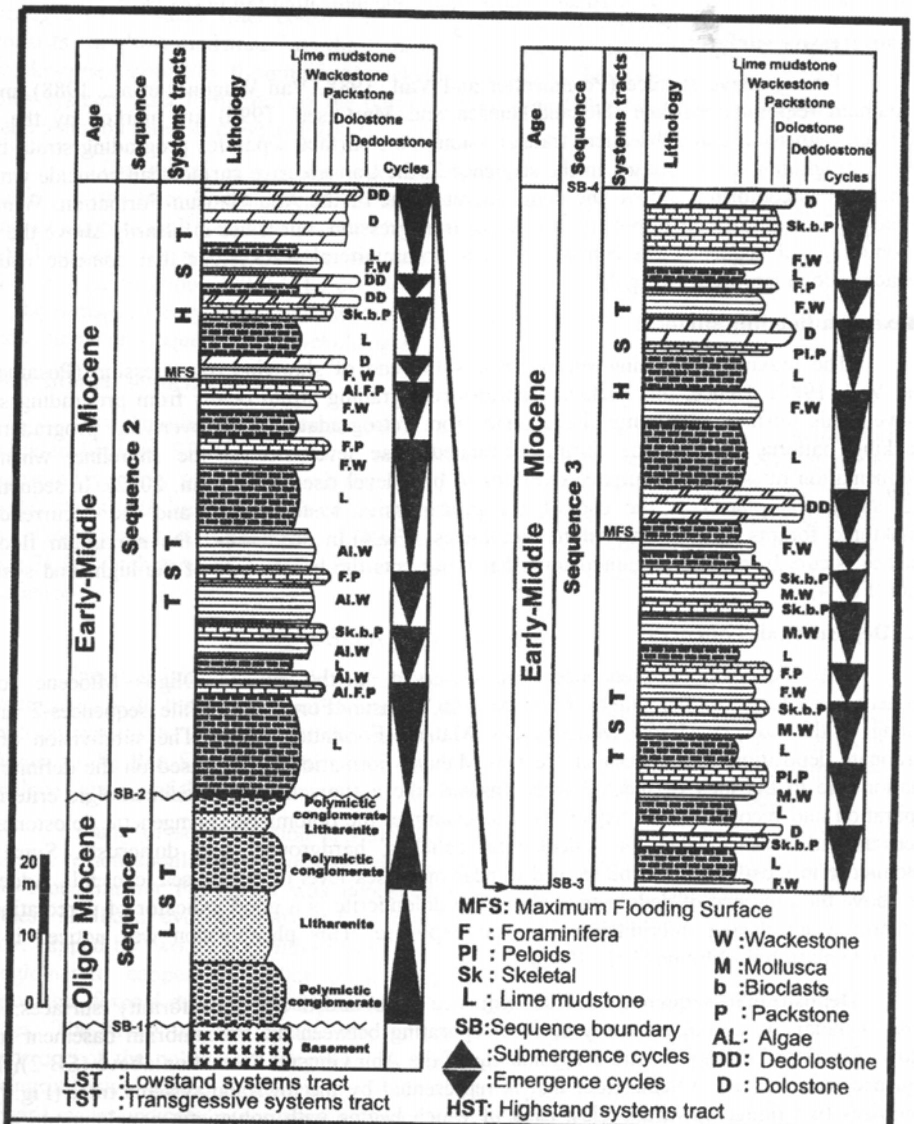

Fig.(4) Sequence stratigraphy and cyclicity of the Abu Ghusun and Um Mahara formations at Ras Banas Peninsula.

In the present study, the identification of the sequence boundaries occurring at the top of sequences-2 and 3 is based on sharp change in carbonate lithofacies from wakestones-packstones to dolostones (dolomicrites and dedolostones) as supported by the opinion of Gartner (1998). This means that the occurrence of thick dolostone of syngenetic origin on the top of sequence-2 can aid in recognition of the sequence boundary. This stems from the fact that the syngenetic dolostones can be formed in intertidal to supratidal zone indicating fall in sea level.

Transgressive surface:

Transgressive surface (Posamentier and Vail, 1988, Van Wagoner et al., 1988) and the maximum regressive surface (Helland-Hansen and Martinsen, 1996) are marked by the point between regression and subsequent transgression. This surface separates prograding strata below from retrograding strata above. In the sequence-2, the transgressive surface can coincide with the surface of unconformity above the conglomerate zone of the Abu Ghusun Formation. While, in sequence-3, it is difficult to put the surface of transgression, but it lies arbitrarily above the thick dolomicrites of sequence-2.It consists of algal foraminiferal wackestone that coincide with the sequence boundary (SB-3)(Fig.4)

Maximum flooding surface:

The maximum flooding surface marks the end of shoreline transgression (Posamentier and Vail, 1988). Hence, this surface separates retrograding strata below from prograding strata above. This surface represents the change from retrogradational to overlying progradational stacking patterns takes place during continued base level rise at the shoreline, when the sedimentation rates start to outpace the rates of base level rise (Catuneaun, 2002). In sequence-2 this surface is placed at the end of the transgressive systems tract and the occurrence of planktonic forams in the wackestone lithofacies (Fig.4).In sequence-3 the maximum flooding surface occurs below the lime-mudstone that represents the basal cycle of the highstand systems tract (Fig. 4).

5.2. Depositional sequences:

Three depositional sequences are observed in the studied Oligo- Miocene rocks. Sequence-1 belongs to the Oligo- Miocene Abu Ghusun Formation, while sequences-2 and 3 belong to the Lower- Middle Miocene Um Mahara Formation (Fig.4).The subdivision of the carbonate depositional sequences of the Um Mahara Formation is not based on the definite age relation due to the lack of index fossils. Instead, the authors used the sedimentolgic criteria in separation and recognition of sequences. For example, the dolomicrite (syngenetic dolostones) is used instead of the paleosols, paleokarsts, caliches, hardground, and duricrusts. Since the dolomicrite in most cases can be formed in near mean sea level or during sea level fall. Added to the above the presence of dedolostone above the dolomicrite is a good indicator of percolation of meteoric water during intermittent subaerial exposure. This phenomenon was noticed in the carbonate platforms (Molina et al., 1999).

Depositional sequence-1: This sequence is bounded by unconformity surfaces. The lower boundary is a nonconformity surface separating between the Precambrian basement rocks below (SB-1) and the polymictic conglomerate of the Abu Ghusun Formation above (SB-2). This sequence includes one systems tract that is represented by the lowstand systems tract (Fig.4). It comprises two fining upward cycles, each of which begins with polymictic conglomerate at the base, capped by litharenite at the top (Fig. 3). Such fining upward cycles represent sediments accumulated during fall in sea level, and the activation of continental sedimentation.

Depositional sequence-2: This sequence constitutes the lower part of the Um Mahara Formation bracketed between SB-2 below and SB-3 above. It includes two systems tracts, transgressive systems tract (TST) at the base and highstand systems tract (HST) at the top (Fig. 4).The transgressive systems tract is bounded by the maximum regressive surface (Helland-Hansen and Martinsen, 1996) or transgressive surface (Posamentier and Vail, 1988) at the base and maximum flooding surface at the top. In this sequence-2, the transgressive systems tract begins with the unconformity surface (SB-2) or raviment surface and the maximum flooding surface that consists of deepest facies (foraminiferal wackestone with planktonics). The transgressive systems tract consists of five shallowing upward carbonate cycles, each of which consists of lime-mudstone at the base, followed by foraminiferal wackestone or algal wackestone, capped by foraminiferal packstone or skeletal bioclastic packstone at the top (Fig.3). This systems tract forms during the portion of base level rise when the rates of rise outpace the sedimentation rates (Catnueaun, 2002).

The highstand systems tract in sequence-2 is restricted by the maximum flooding surface at the base (foraminiferal wackestone), and the thick dolomicrite bed that represents the end of depositional sequence (Fig.4). It corresponds to the late stage of base level rise during which the rates of rise drop below the sedimentation rates, producing a normal regression of the shoreline (Catuneanu, 2002). The cycles in the highstand systems tract differ from that occurring in the transgessive systems tract, where they are capped with dolomicrite and dedolostone which indicating high frequency sea level changes.

Depositional sequence-3:

This depositional sequence builds up the upper part of the Úm Mahara Formation, brackted between SB-3 and SB-4. It includes transgrssive systems tract (TST) at the base and highstand systems tract (HST) at the top (Fig. 4). In this sequence-3, the shallowing upward cycles starts with lime-mudstone or foraminifaeral wackestone, or molluscan wackestone, capped by skeletal bioclastic packstone, dolostone, peloidal packstone and foraminiferal packstone (Fig.2).The highstand systems tract also shows the same cyclic sequence pattern exhibited by sequence-2.

6. DEPOSITIONAL HISTORY

The Ras Banas peninsula represents a part of the Red Sea rift history. It was formed synchronous with the initiation of the main rifting of the Red Sea. This stems form the following observations. 1)-the extension of the peninsula is alignment with the main fracture system that oblique to the Red Sea rift. 2)-Its extension is in alignment with the new basalt intrusion on the southeast margin of the peninsula. 3) The absence of rocks older than the Miocene .

Timing of sedimentation can also relate to time of uplift, where clastic shed from the uplifted region should appear in the record history shortly after uplift begins (Ghebreab, 1998). The Abu Ghusun Formation was deposited in the form of two superimposed fining upward cycles. The basal cycle consists of thin conglomeratic bed nonconformably overlies the basement rock, capped by two beds of litharenite. The second cycle also consists of 5.0m thick. polymictic conglomerate capped by 5.0m thick litharenite. These cycles probably represent fluvial deposition, formed during the early rifting of the Red Sea, which probably forms a thick fan-like facies. The fining upward cycles may reflect highly episodic tectonic control that led to the deposition of the polymictic conglomerate fan at the base. This was followed by flash flooding during intensive rainfall depositing the litharenite at the top of the cycle. The repetitions of fining upward cycles indicate intermittent pulsating phases of tectonic uplift followed by flash flooding events. This interpretation is in harmony with the works of Rust and Koster (1984) and Sopena and Sanchez-Moya (1997) who suggested that the coarse upward succession was deposited immediately after fault movements, while fining upward sequence was produced as the source area becomes degraded during post tectonic evolution.

After the stability of tectonic and rifting, the seawater increased to cover the shelf zone. This gave rise to the deposition of superimposed carbonate cycles of the Um Mahara Formation.. From the vertical lithofacies and cyclic arrangement in this formation led to the subdivision of the carbonate succession into two sequences, the lower sequence (sequence-2) is generally enriched in algal foraminiferal packstone, algal wackestone, operculina foraminifera packstone and algal wackestone with a dolostone bed near the top. The second (upper) sequence (sequence-3) is