مجلة العلوم البحثة والتطبيقية
Journal of Pure & Applied Sciences
www.Suj.sebhau.edu.ly ISSN 2521-9200
Received 08/11/2017 Revised 08/08/2018 Published online 15/08/2018

Facies Analysis of Lower Awynat Wanin Formations in Murzuq Basin, SW of Libya

*Khalid H. Mohamed, Alsharef A. Albaghdady, Mustafa Abdullah , Said Abduallah
Department of Earth Sciences, faculty of Science, Sebha University
*Corresponding Author : Kha.Ali@sebhau.edu.ly

Abstract The Awynat Wanin Group crops out on the southern flank of the Al Gargaf Uplift in the Murzuq Basin. The group has already been described and subdivided into lower and upper parts in previous studies by several authors. However, as already known, the differentiation between both parts remains unclear, especially between the similar formations of the Lower Part of the Awynat Wanin Group in study area. The Lower Part of Awynat Wanin Group includes the Bir Al Qaser, the Idri and the Qutta Formations. Intensive field works were carried out and six detailed stratigraphic logs have been measured and described in the study area. Macro to Mesofacies analysis concepts were applied in order to identify, characterise and describe the different facies of each formation separately, and finally to compare and differentiate between these similar formations of Awynat Wanin Group by using facies analysis methods. Based on lithological facies analysis and field relationships, the three investigated formations can be differentiated as following. The Bir Al Qaser Formation consists mainly of sandstone facies deposited unconformably up on the Lower Paleozoic lithostratigraphic units of the Al Hasawna, Mamuniyat and Tanozoft formations. These unconformities are found in study area and attributed to the tectonic events prior to the Middle Devonian Age. The Bir Al Qaser Formation overlies conformably by Idri Formation in study area. The Idri Formation is characterized by yellow brittle sandstone facies and contains abundant large scale cross bedding structures, whereas the Qutta Formation is composed mainly of white colored quarttizic sandstone facies as well as silty claystones facies, with high portions of trace fossils in the lower part of it.
Keywords: Murzuq Basin, Awynat Wanin Group, Facies Analysis, trace fossils, Iron concretion.

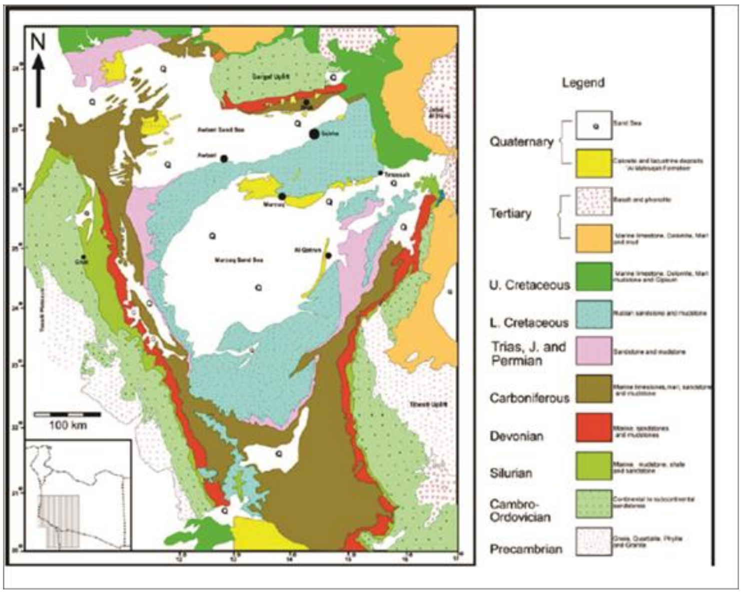
تحليل السحنات لتكوينات عوينات ونين السفلية في حوض مرزق جنوب غرب ليبيا

*خالد حسين محمد و الشارف عبدالسلام البغدادي و مصطفى عبدالله و سعيد عبدالله
قسم علوم الارض – كلية العلوم – جامعة سبها، ليبيا
*للمراسلة: Kha.Ali@sebhau.edu.ly

ملخص تكشف مجموعة عوينات ونين في الجزء الجنوبي لمرتفع القرقاف بحوض مرزق، وقد وصفت هذه المجموعة وقسمت الى جزء سفلي وجزء علوي عن طريق عدة أبحاث. والاختلاف بين الجزئين مازال غير واضح، خاصة بين التكوينات السفلية لهذه المجموعة في منطقة الدراسة، ويتألف الجزء السفلي من تكوينات بئر القصر، و إدري، و قطة، وقد أجريت دراسة حقليه مكثفة، وتم اخذ ست قطاعات تفصيلية ووصفت سحنها الرسوبية لتعريف وتمييز السحنات المختلفة لكل تكوين ومن ثم التفريق بين هذه التكوينات المتشابهة باستعمال طرق تحليل السحنات. وتم الاعتماد على التحليل السحني والعلاقات الحقلية للتمييز بين التكوينات الثلاثة المدروسة، فتكوين بئر القصر يتألف اساسا من سحنات رملية متموضعة بأسطح عدم التوافق فوق الوحدات الصخرية لحقبة الحياة القديمة المتمثلة في تكوينات الحساونة، والمومنيات، وتانزوفت. فأسطح عدم التوافق هذه وجدت في منطقة الدراسة وهي تعزى إلى الأحداث التكتونية السابقة لفترة الديفوني الأوسط. والسطح العلوي لتكوين بئر القصر يتمثل بسطح عدم توافق مع تكوين إدري في منطقة الدراسة. أما تكوين إدري فيتميز بسحنات من حجر رملي صلب متعدد الألوان يحتوي على التطبّق المتقاطع الكبير الحجم ، بينما تكوين قطة يتألف أساسيا من سحنات الحجر الرملي الكوارتيزي وسحنات الغرين، والحجر الطيني المحتوي على آثار المستحاثات.
الكلمات المفتاحية: حوض مرزوق ، مجموعة عوينة وينين ، تحليل السحنات ، آثار المستحاثات.

1– INTRODUCTION

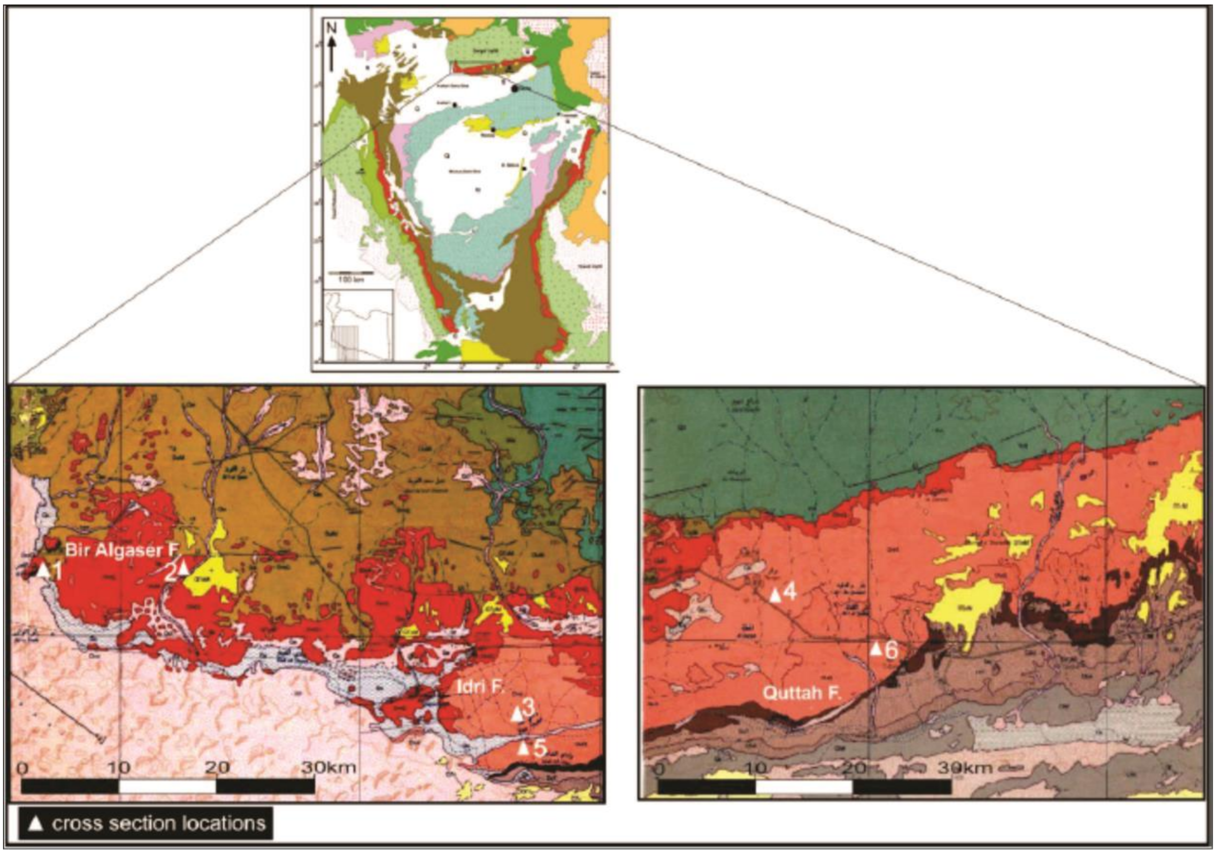
The Murzuq Basin is located SW Libya, approximately between 23° - 27° N and 11° - 16° E (Fig. 1). It is one of the several endorheic intracratonic basins of the North African Platform, and covers an area over 350,000 km² [1]. The current borders of the Murzuq Basin are the Gargaf Uplift to the north, the Tassili Plateau to the west, and the Haruj volcanic complex and the Tibesti Uplift to the east. Toward the south, the basin extends into the Djado Basin in Niger. According to [1], the Murzuq Basin is described as an erosional remnant of a much larger Palaeozoic and Mesozoic sedimentary basin, which originally extended over much of North Africa. The present day borders of the Murzuq Basin were delineated mainly by erosion resulting from multiphasic tectonic uplifts. The flanks of the basin are comprised of the Tassili Plateau (Tihemboka High) in the west, the Tibesti High in the east, and the Gargaf Uplift in the north. These uplifts were generated by numerous tectonic movements, which were varying from Mid Palaeozoic through to Tertiary times [2]. The sedimentary rocks in the central part of the basin have a thickness of about 3500 m, mainly comprised of Palaeozoic, Mesozoic sandstones and shales [3; 4; 5; 1; 6; 7; 8;]. The oldest Palaeozoic rocks outcrop on the external margins of the basin. Triassic, Jurassic and Cretaceous sediments form an escarpment in the middle part of the basin. Cenozoic sediments consist of about 100 m thick of Palaeocene marine limestone, dolomite and marl, which are preserved at the northernand northeastern margin of the Murzuq Basin (Fig, 1).



(Fig.1). Geological map of the Murzuq Basin shows the main stratigraphic units within the basin, modified after El Chair, (1984).

The Wadi ash Shati is a depression stretching in an N-S direction, 10 to 20 km wide and about 180 km long at the northern border of the Murzuq Basin. Cambrian, Ordovician, Devonian and Carboniferous sedimentary rocks outcrop, gently dipping to the south. Devonian formations in the study area belong to the unit originally named Awynat Wanin Formation by [9]. The type section of the Awynat Wanin formation is located in northwestern rim of Al Gargaf Uplift. It consists mostly of sandstone, siltstone and claystone with significant layers of ferruginous oolitic sandstone. Their total thickness ranges ~200 m on the western part of the study area, while it decreases to less than 80 m at the eastern part of the study area [10]. According to [11] the depositional environment of Awynat Wanin group was deposited in deltaic environment ranging from delta front to fluvial distributary channels, or reworked by tides and storm waves. The age of Awynat Wanin group was assigned to Eifelian to Famennian time by [12]. [13] mapped Awynat Wanin Formation on the southern margin of Al Gargaf Uplift for the first time. [14] divided the entire succession of Awynat Wanin into eight sequences. The lower part consists of four cycles, which was named the Awynat Wanin Formation, whereas the Upper part includes four cycles too and was named the Chatti Formation. [15] carried out a comprehensive geological survey in the Wadi ash Shati area, focusing mainly on iron ore deposits within the Awynat Wanin Group. According to [10], the Awynat Wanin Group was recently divided into six formations, the Bir Al Qaser, the Idri, the Quttah, the Dabdab, the Tarut and the Ashkidah, by several workers for purpose of a regional geological mapping project of Libya (e. g. between the Bir al Qaser on the Idri Sheet and the Wadi Kunayr, on the Al Fuqaha Sheet). Nevertheless, the differentiation of both parts is still unclear, especially between the similar formations of Lower Part of Awynat Wanin Group in the study area. The Lower Part of the Awynat Wanin Group includes the Bir Al Qaser, the Idri and the Qutta formations. These formations crop out along the southern margin of the Wadi ash Shati depression, located less than 100 kilometers from the city of Sabha. The geographical proximity and the well-exposed outcrops of these deposits were a real motive for us to carry out such a study in the study area. Due to the similarity between these formations, it was necessary studying these deposits carefully and trying to differentiate between them. The aim of this study was to integrate the vertical rock sequences with lateral facies patterns in order to distinguish and reconstruct their depositional environment as well the main dynamic processes during the deposition of these similar formations. Macro to Mesofacies analysis concepts and field relationships between the investigated formations were applied in order to describe, characterise and identify the different facies of each formation separately. The result of these analysis were also used to and as to compare and differentiate between the similar formations of the Awynat Wanin Group. As a result of this study, which is based on facies analysis and field relationships, these three investigated formations can be lithologically distinguished and differentiated.

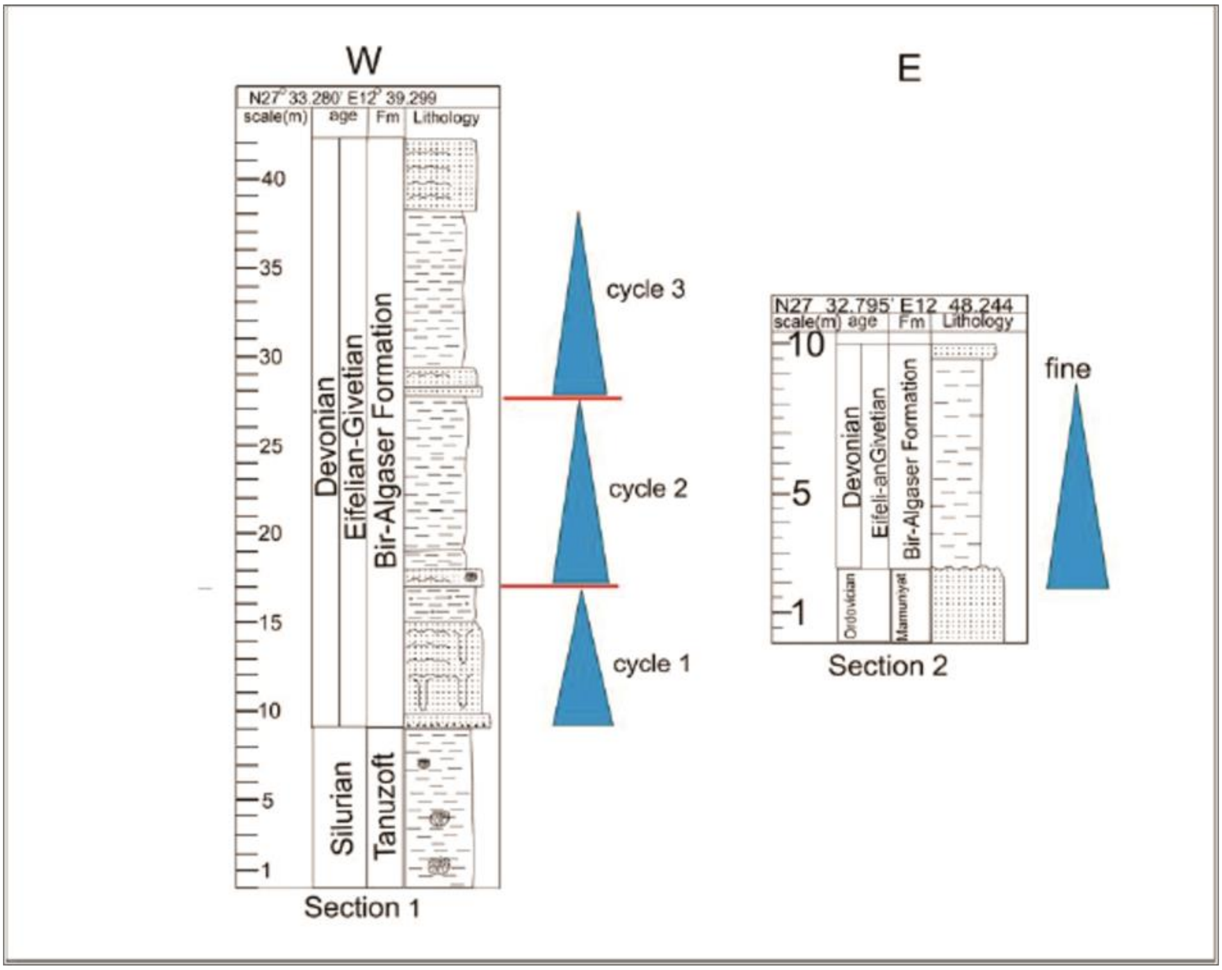
2 - METHODS Intensive field work was carried out and detailed six stratigraphic logs have been measured and described in the study area(Fig 2). Macro to Mesofacies analysis concepts were applied in order to identify, characterise and describe the different facies of each formation separately, and finally to compare and differentiate between these similar formations of Awynat Wanin Group by using facies analysis methods.



(Fig 2) stratigraphic logs locations in the study area from 1 to 6.

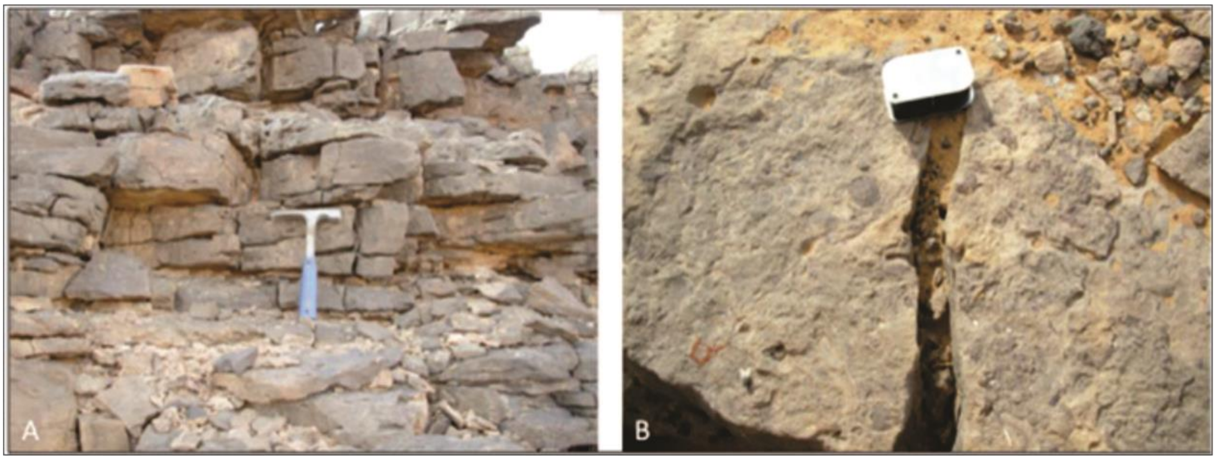
3-RESULTS AND DISCUSION: Representative outcrops of the Lower part of the Awynat Wanin formations are shown in Figs (3, 7 and 11). The sandstone, siltstone, and silty claystone sequence overly unconformably the Lower Paleozoic lithostratigraphic units (sandstones and shale) such as Al Hasawna, Mamuniyat and Tanozoft Formations. These unconformity surfaces were traced and found in study area. They are attributed to the tectonic events prior to the Middle Devonian age. The lower part of Awynat Wanin Formation consists of three distinct formations, which can be differentiated by viewing lithological characterisations of every formation separately.

3.1- Bir Al Qaser Formation: This Formation corresponds to cycle I of the Awynat Wanin Formation according to [16]or to the "Aouinet ouenine Formation I" of [17].It consists mainly of various types of sandstone with silty-argillaceous sediments. Sandstone deposits prevail in eastern part of study area, whereas the silty-argillaceous deposits dominate in the western part of study area. The Bir Al Qaser Formation is deposited unconformably above the Lower Paleozoic lithostratigraphic units such as Al Hasawna, Mamuniyat and Tanozoft Formations. These unconformities were found in study area and attributed to the tectonic events prior to the Middle Devonian Age. The Bir Al Qaser Formation overlies conformably by Idri Formation in the study area. The Bir Al Qaser Formation can be divided into two facies (Fig. 3). The fossil content is restricted to fragmentarily preserved Brachiopod fossils with poorly preserved trace fossil such as vertical and horizontal borrows (Figs 6a & 6b). These trace fossils occur frequently within the thin intercalations of sandstone and siltstones. According to [18] the Bir Al Qaser Formation contains Brachiopods with fragmented to crashed fossils such as pelecypods, tentaculites, plant and abundant trace fossils (Fig. 4b). The sedimentary structures are represented by a large scale cross bedding and symmetrical ripple marks restricted to the upper part of the facies (Fig. 5b). Lenticular bedding (wedge bedding) within large channel fill structures occur occasionally containing boulders which are abundant in the lower part of this facies (Fig. 5a). Sandstone and mudstone intercalations are found in the lower part of the facies.

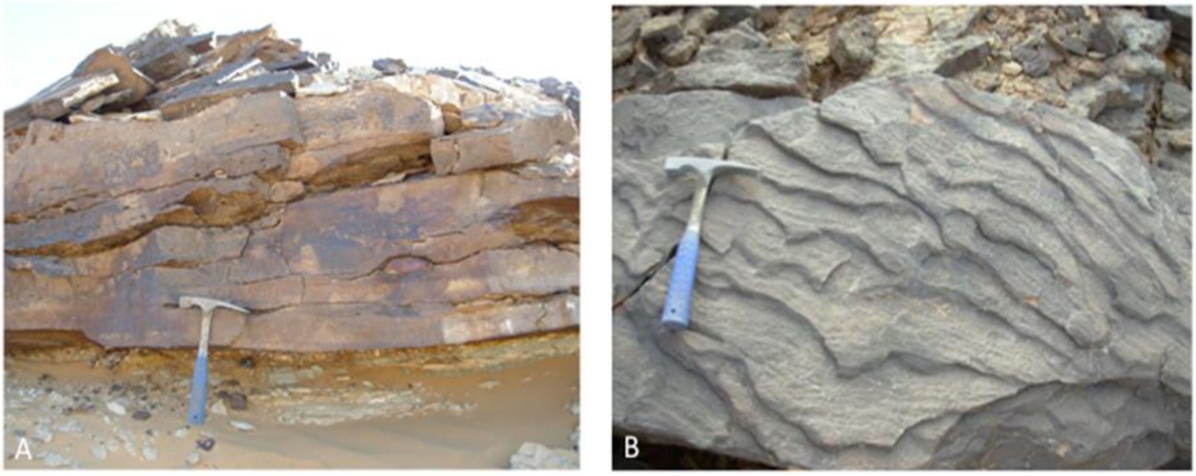


(Fig. 3). Measured sections of Bir Al Qaser Formation show the different two main lithological facies

These intercalations are characterised by differential erosion process, which affected the mudstone layers whereas the sandstone layers are more resistance to erosion processes (Fig. 5a). Locally massive and thinly bedded structures to poorly developed laminations were observed.



(Fig. 4) Filed photos show the Sandstone banks of the Bir Al Qaser Formation with thickening upward trend (A). Fragmentarily preserved Brachiopod fossils of Bir Al Qaser Formation (B)



(Fig. 5) Field photos show the sharp contact between mudstone (below) and sandstone facies (above). Note the large Channel fill structures with characteristic lenticular or flaser structures within the channel fill geometry. Note the isolated sandstone Boulder between the large sandstone lenses (A). Symetrical ripple marks in the sandstone facies of Bir Al Qaser Formation (B).

(Fig. 6) Field photo display abundant biotorbation holes and traces fossils within the sandstone facies of Bir Al Qaser Formation (A and B).

Interpretation

This facies is interpreted as a symmetrical cycle of sedimentation. It is dominated in the east and decreased gradually to the west of the study area. We interpreted the deposits of facies as a regressive and low stand deposits. The both differences of the occurrence as well as of the thickness within this facies indicate clear changes in the depositional environment of the facies in space and time during the sedimentation of this facies. The cross bedding structures and basal layer in lower part of the facies demonstrate high to moderate currents caused by relative agitated water conditions. Additionally, the crushed shells within this facies (Fig. 4b) indicate a relative high-energy environment. Therefore we interpreted the occurrence of lenticular bedding within the facies as an indicator of relative high currents or wave depositing sand, alternating with slow-moving water conditions producing mud deposits. In general, all sandstone beds of this facies were interpreted as successive finning/coarsening-upward small cycles, each of which shows as clear fluctuations of a shallowing upwards trend, especially in the eastern part of the study area during the deposition.

1.2- Silty Argillaceous Facies

This facies is represented by several grey silty claystone to green coloured beds. Their thickness ranges from one meter to 8 meters (Fig. 3). Variable types of claystone and siltstone occur with minor to fine sand intercalations. This facies starts with a claystone bed, showing various colours, predominantly greenish to grey. It consists of claystone sediments with fine intercalations of siltstone and fine sand. Macrofossils are totally absent in this facies. The sedimentary structures are represented exclusively by fine bed lamination, restricted to beds with high silt content.

Interpretation

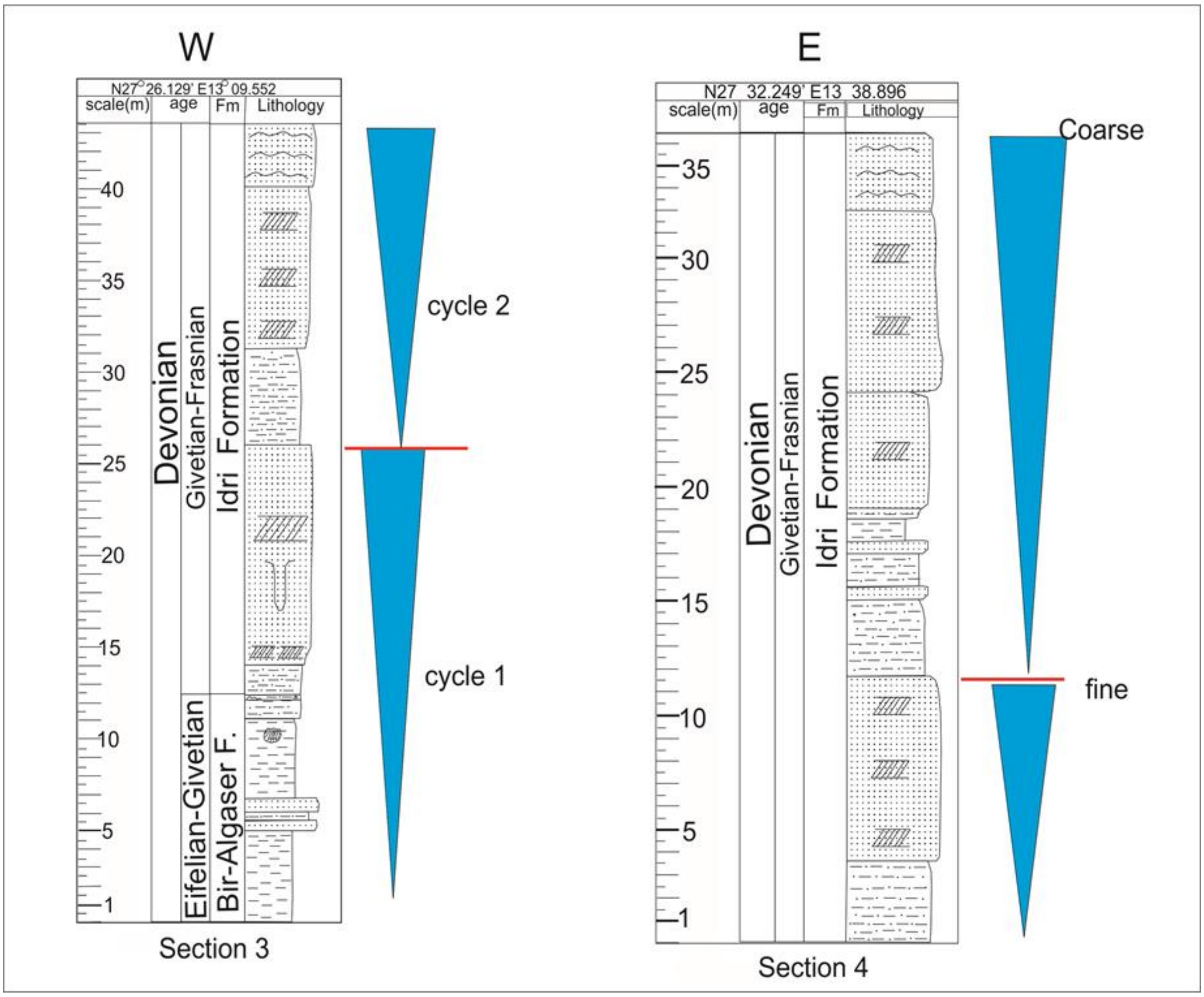
This facies is interpreted as a symmetrical repeated cycle of sedimentation, which prevails in the western part of study area, in contrast to decreasing gradually in the eastern part. The silt and clay deposits with intensive fine lamination structures of this facies demonstrate non-dynamic sedimentation conditions. The deposits of this facies are interpreted as transgressive or high stand deposits. In general, silty claystone beds of this facies were interpreted as a successive fining-upward minor cycles, each of which shows as a clear indication of a deepening upwards trend, especially in the western part the study area.

3.2- Idri Formation

The Idri Formation corresponds to II, IIIa and IIIb of the Awynat Wanin Formation according to [16] or to the Awynat Wanin Formation II of [17]. The formation was named after the village of Idri in Wadi ash Shati area. It consists mainly of quartzitic and quartzse sandstone beds with two silty-argillaceous sediments (Fig. 7). In study area, the Idri Formation is deposited conformably on the Bir Al Qaser Formation, overlying conformably by Qutta Formation. From bottom to top, the Formation is described as shown in Figure (7) as the following:

3.2.1- Sandstone Facies

The sandstone facies consists of mainly by two types of sandstone beds (quartzitic and quartzes), ranging from 50 cm to 12 m in thickness (Fig. 7). Based on measured sections (3, and 4 in Figure 7). This facies starts at the lower part of both measured sections, with relative thick whitish-grey coloured quartzitic sandstone bed. It consists of fine to medium sand grains, poorly to moderately sorted. Abundant lenticular bedding structures and massive bedding were observed in this facies. Dense vertical and horizontal borrows of different shapes and sizes are common in the both measured sections (Fig. 7).

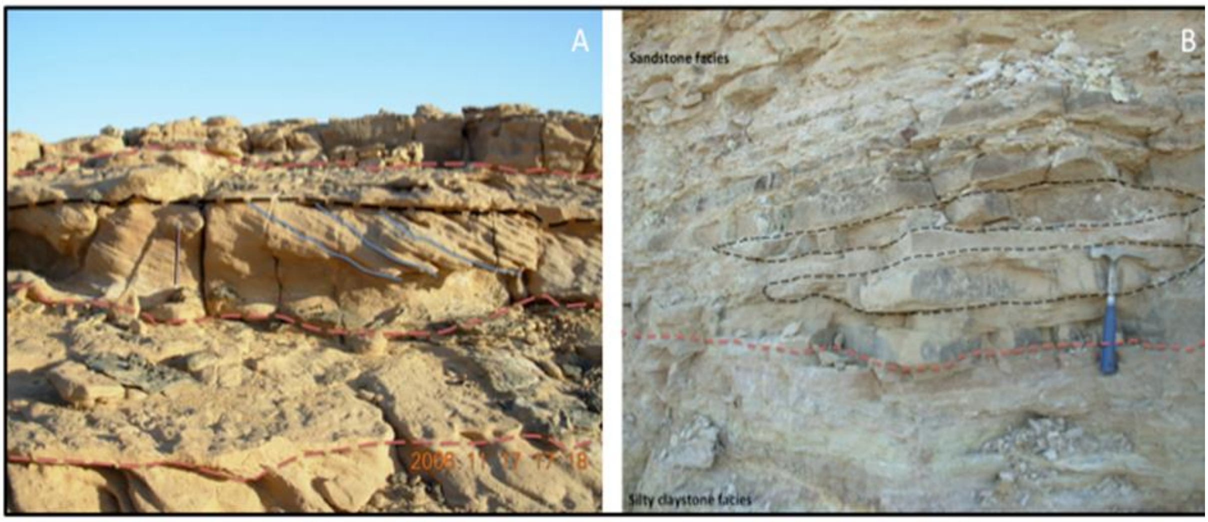


(Fig. 7). Measured sections of Idri Formation show two main different lithological facies with the interpreted cycles

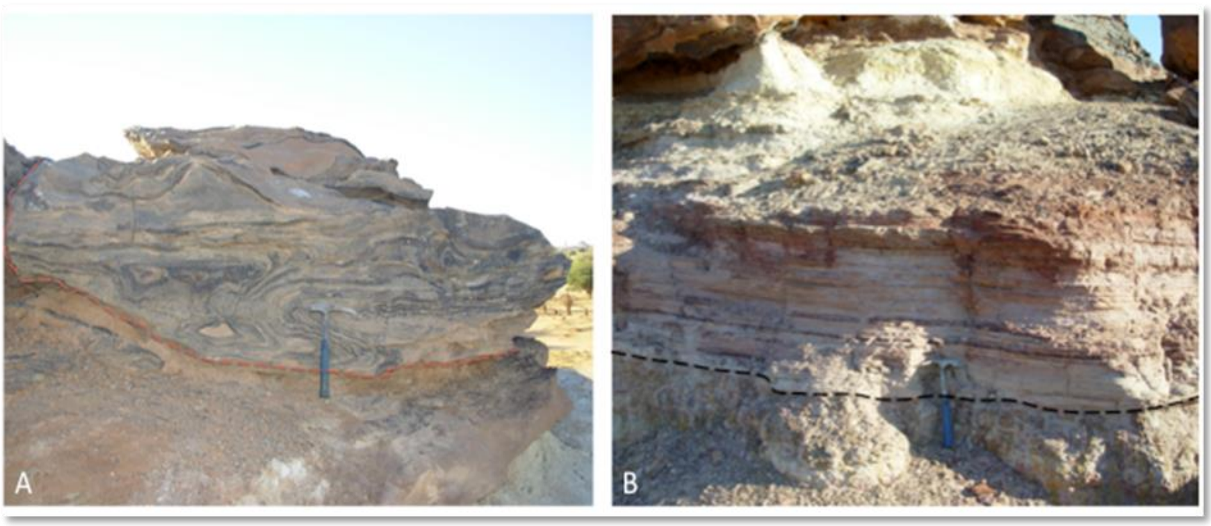
Fossil content is restricted to preserved trace fossil, which are only found as vertical and horizontal borrows. These trace fossil occur frequently within the thin intercalations of sandstone and siltstones. Macrofossils are totally absent in this facies. The sedimentary structures are abundant large scale cross bedding structures more than 1 m high and 2 m long (Fig. 8a). Tabular, planner and trough cross bedding types were observed (Fig. 8a). Frequent reverse and normal graded bedding are also present in the middle and in the upper parts of this facies (Fig. 10a). Frequently large channel-fills structures were found with dense lenticular bedding. Moreover, flaser structures were observed in this facies (Figs. 8 a and 9 a). Lenticular bedding structures display alternating layers of sand and mud deposits (Fig. 8b). The size of lenticular bedding bodies ranges from 50 cm to several meters long (Figs. 8a and b). Spectacular complex slump structures are found in the upper part of the facies (Fig, 8a). Abundant to frequent vertical joints of varying sizes were sporadically observed. In addition, symmetrical ripple marks also were observed in the middle and upper parts. Abundant black iron nodules of different shapes were found in the upper parts (Fig. 10b).

Interpretation

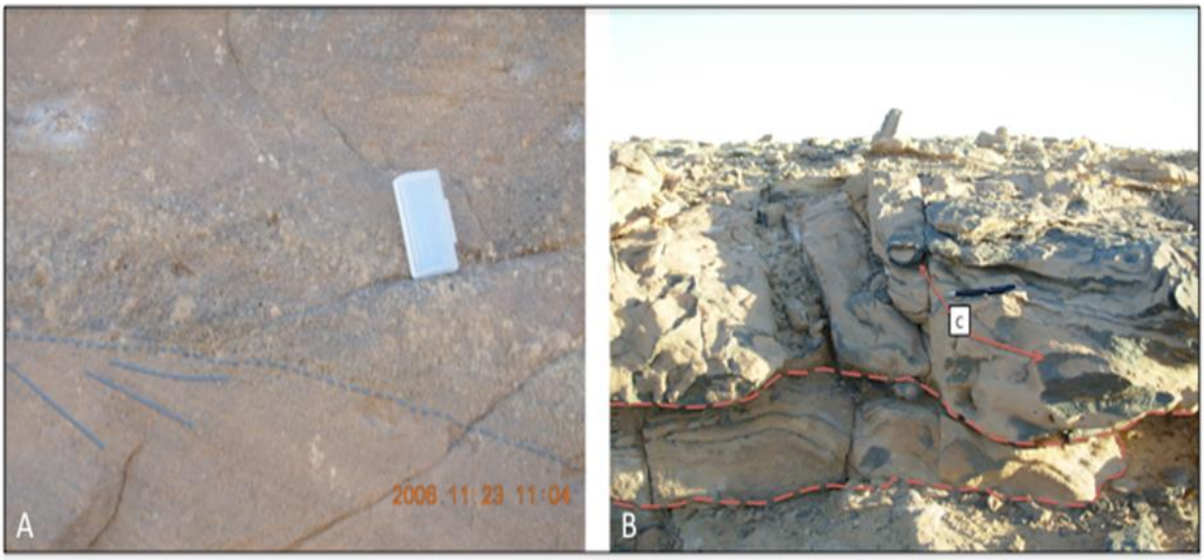
This facies is interpreted as a symmetrical repeated cycle of sedimentation dominated in the study area, during the deposition of the Idri Formation (Fig. 7). Abundant lenticular beddings show sedimentary patterns in this facies, displaying alternating layers of mud and sand, which were formed during periods of seldom water activity, although commonly found in high-energy environments, frequently occurring in the intertidal and supratidal zone. And – contrarily - Lenticular bedding is normally indicative of tidal rhythm, tidal currents and tidal slack, in a particular environment. The abundant large cross bedding structures indicate that the facies was deposited in a high dynamic environment with high currents and intensely agitated water conditions. These large cross bedding structures are interpreted as several sets of small progradation structures, which were deposited in a local delta environment. In general, progradation structures indicate high influx of sediments stemming from the adjacent land areas during the same time. Beyond this they indicate a lack of a space during the sedimentation process of this facies. The complex structures were interpreted as slump structures resulting from dehydration. Local tectonic movements could have been also responsible for such structures.



(Fig. 8). Field photos displays large channel fill geometry structures with dense and complicated slump structures occur in the upper part of the Idri Formation (A). Fine laminated silty claystone facies with different intercalations of fine sand. Note the conglomerate bed at the base (B).



(Fig. 9). Field photos display laterally pitchout sand bodies (lobs) with large cross bedding structures interpreted as geometry of progradated small delta within the upper part of Idri Formation (A) Close view shows the boundary between sandstone facies and the silty claystone facies. Note the abundant flaser and lenticular bedding within the sandstone facies in the Lower part of Idri Formation (B).



(Fig. 10) Field Photos show reverse graded bedding and cross bedding in the upper part of sandstone facies (A). Abundant iron nodules (C) with large lenticular bedding structures are characterised the sandstone facies (B)

Two coarsening upward cycle are inferred from the measured section (Fig. 7). The facies development shows a strong terrestrial influence, which clearly shows an increasing trend towards the eastern part of study area. All sandstone beds of this facies exhibit successive coarsening upward small cycles, each of which shows as a clear shallowing upwards trend during the sedimentation process.

3.2.2- Silty Argillaceous Facies

Similar to the previously described Bir Al Qaser Formation, this facies is represented by several silty claysones grey to green, brown and dark red coloured beds (Fig. 9 b). Their maximum thickness ranges from 3 - 5 meters (Fig. 7). Variable types of claystone and siltstone are present with fine sand intercalations, increasing gradually toward the upper part of facies (Fig. 9b). Both measured sections start with this facies, which characterized by various colours, mostly greenish to grey, consising of claystone, siltstone sediments with dense fine sandstone intercalations. Macrofossils such as Brachipods and pelecypods were also found in this facies.

Rare ripple marks and fine bed lamination restricted only to beds with high silt contents make up the sedimentary structure.

Interpretation

The silt and clay deposits with intensive fine lamination structures of this facies reveal relative tranquill sedimentation conditions without currents. In general, this facies was interpreted successive finning upward small cycles, each of which shows as a clear indication of deepening upwards trend, especially in the western part the study area.

3- Qutta Formation

This Formation corresponds to IV of the Awynat Wanin Formation according to [16] The Qutta Formation was named after the village of Qutta in Wadi Ash Shati area. The Quta Formation consists of argillaceous beds at the bottom, and quartzitic and quartzse sandstone beds at the top (Fig. 11). This Formation deposited conformably up on the Idri Formation and is overlying conformably by the Dabdab Formation in study area. From bottom to top, the Formation can be described as follows immediately below.

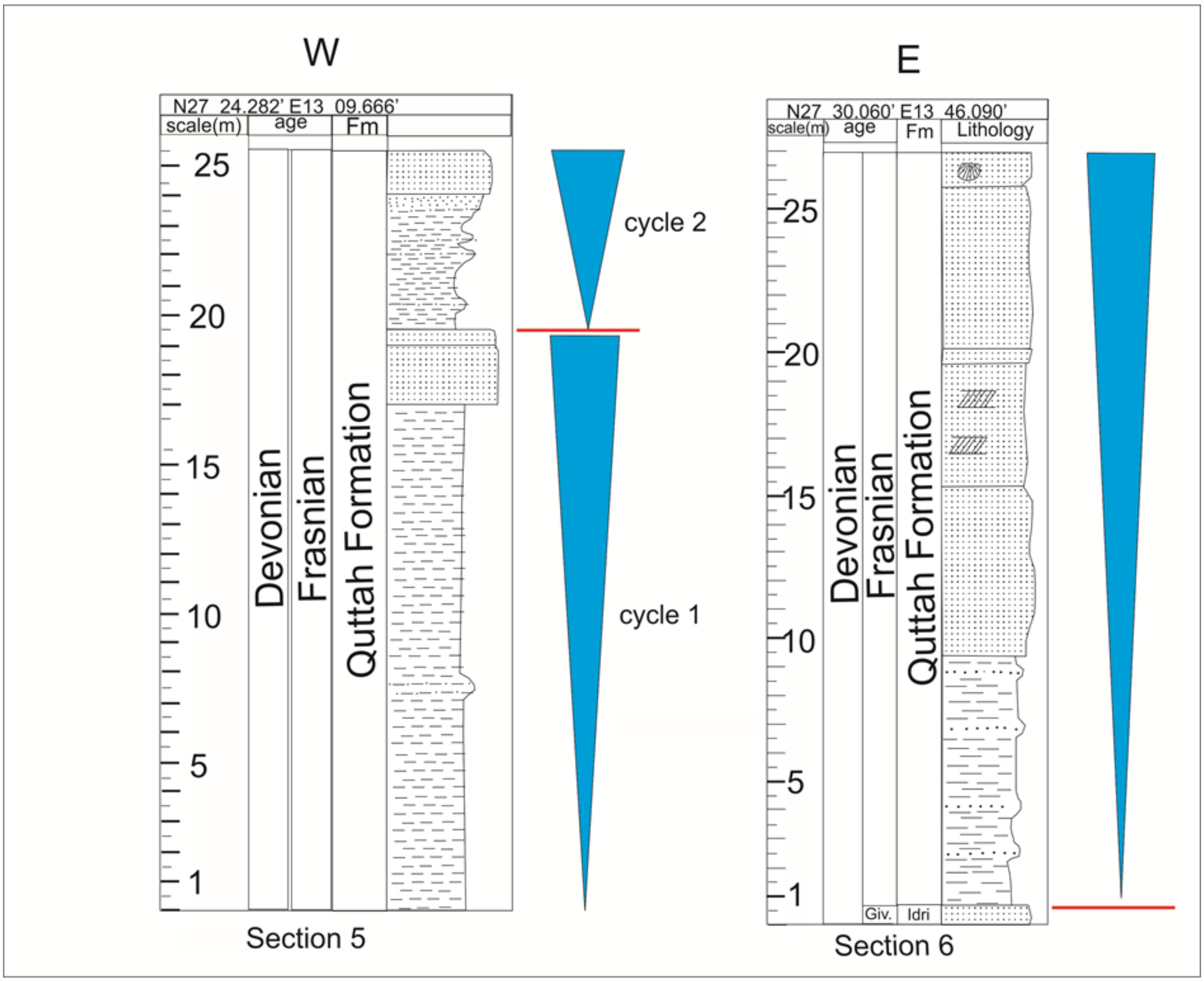


Fig. 11) Two measured sections of Qutta Formation displays the different two main lithological facies with the interpreted and inferred two cycles in the western and one cycle in the eastern part of study area

4.3.1- Sandstone Facies

Sandstone deposits dominate in the formation. They are represented mainly by several types of sandstones (quartzitic, quartzes and less frequently ferruginous). The thickness of the sandstone beds ranges from 50 cm to m 10 m (Fig. 11). Based on measured Sections (5 and 6) in Fig. 11, the Qutta Formation commences with silty argillaceous beds at the both measured sections followed by relative thick dark to brown-grey coloured sandstone layer and quartzitic sandstone beds at the top. It consists of coarse to medium-sand grains, ranging from relatively poor to moderately sorted in the West. The eastern part the formation begins with white silty argillaceous bed, which gradually changes to several intercalations of fine sandstone beds with high ratio of silt. Figure 11 (section 6) shows an increase of sandstone and decrease of silty claystone deposits in the east. Ferruginous sandstone beds are typically brown to dark-purple in colour. This type of sandstone contains abundantly small to medium conglomerates of pebble size lay galls. Thin and thick bedding, with parallel and lenticular bedding, is more common in the middle part of this facies while the upper part is more massive. Bioturbation borrows of different shapes and sizes were found. These are common in the both measured sections (Fig. 13).

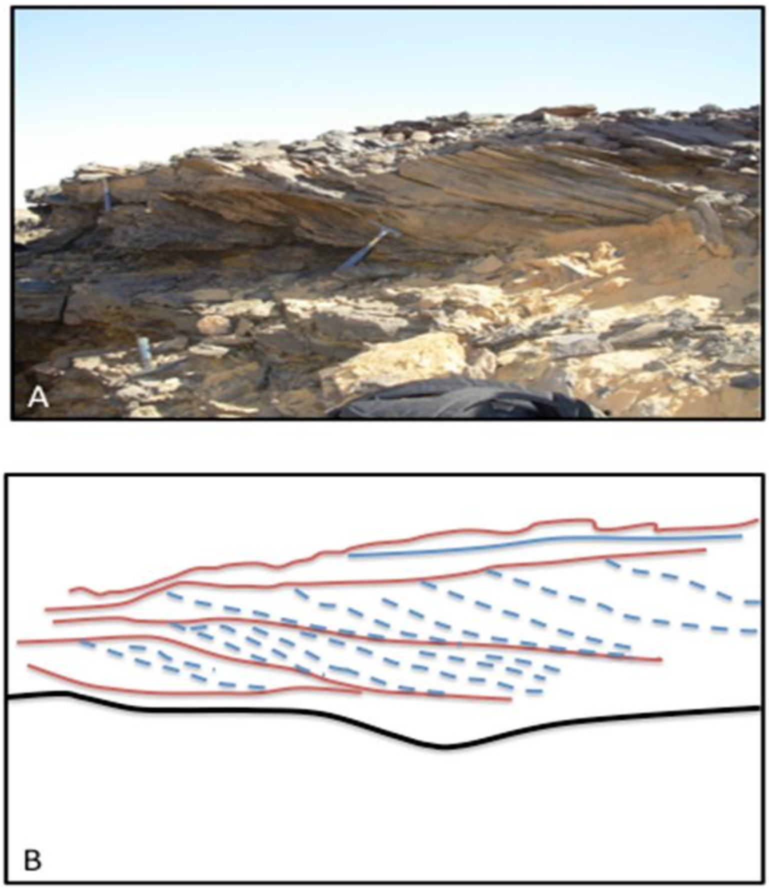


Fig. 12). Field Photo shows a very large cross-bedding structure in the middle part of Qutta Formation (A). The inferred small delta geometry from the upper large cross bedding structures (B).

Brachiopods and pelecypods were found in the upper bed of the measured section (Fig. 11). Abundant trace fossils occur frequently within the quartizitic sandstone and siltstones., the Bifungites Fezzanensis being characteristic. Sedimentary structures are cross bedding, being less frequent than in the Idri Formation. Tabular, planner and trough cross bedding types were observed (Fig. 12 a and b). These cross bedding structures occur in different sets, which can be traced laterally. They build a progradation units as shown in Figs. 12a and b.

Interpretation

Sandstone facies development of Qutta Formation suggests clear changes of the depositional environment in both time and space. Two coarsening up ward cycle are inferred from the measured section 5 (Fig. 11), whereas one cycle can be seen the east as it is shown section 6. (Fig.11). As we have seen in the previous described Idri formation, sandstones facies development shows a strong terrestrial influence, which clearly has increasing trend towards the eastern part of study area. Based on this interpretation, the whole sandstone facies exhibit successive coarsening upward small cycles. All these cycles indicate a clear shallowing upwards trend during the sedimentation of this facies.

(Fig. 13). Field photo shows the characteristic trace fossil is Bifungites fezzanensis of Qutta Formation in Wadi ash Shati.

4.3.2- Silty Argillaceous Facies

This facies is represented by several silty claystones grey to white beds. Their maximum thickness ranges from less than 1 meter to less than 12 meters (Fig. 11). Variable types of claystone and siltstone are presented with high of fine sand intercalations increases gradually toward the upper part of facies (Fig. 11). Both measured sections start with this facies, which characterized by variegated colours mostly white to grey claystones beds. It consists of claystone, siltstone sediments with dense fine intercalations of sandstone beds. Abundant trace fossil of Bifungites fezzanensis were found (Fig. 13) Macrofossils such as Brachiopods and Pelecypods were rarely found in this facies. Sedimentary structures are represented by rare ripple marks. Vertical joints and fine lamination restricted only to beds with high silt and fine sand contents.

Interpretation

The silt and clay deposits point to a relative calm sedimentation conditions, absent from currents with little circulation during the deposition. The silty claystone beds of this facies are interpreted as successive finning upward small cycles. Every cycle shows a clear indication of deepening upwards trends, especially in the western part area during the deposition of this facies.

Conclusion

The Middle and Upper Devonian deposits from the lower part of Awynat Wanin Group in the northern flank of Murzuq Basin of SW Libya include three lithological units namely the Bir Al Qaser, the Idri and the Qutta Formations. The Bir Alqaser formation consists mainly of sandstone facies and silty claystone facies deposited unconformably up on the Lower Palaeozoic lithostratigraphic units, Al Hasawna, Mamuniyat and Tanozoft Formations. These unconformities were found in study area attributed to the tectonic events prior to the middle Devonian Age. The Bir Al Qaser Formation is conformably overlies by Idri Formation. The Idri Formation is characterized by yellow colored brittle sandstone facies and by abundant large scale cross bedding structures, whereas the Qutta Formaion is a compound, mainly of white colored silty claystone deposits and quarttizic sandstone facies. In the western part of the study area, the Qutta Formation is dominated mainly by silt and claystones facies, with high portions of trace fossils. Generally, the Bir Al Q aser, Idri and Qutta Formations crop out. They mainly consist of two lithological facies: sandstone and silty claystone. These formations provide an example of well a exposed a littoral zone to a deltaic complex, containing both transgressive and regressive facies. Both facies are uniformably similar, with a little local lateral and vertical variations - and are traceable for long distances, tens of kilometres. Silty claystone deposits represent transgressive facies, whereas the progradational regressive facies is sandstone. The characteristics and interrelationships of the two different facies are explained by several sedimentation cycles (coarsening upward and finning up small cycles). Regressive facies (Sandstone facies) existed contemporaneously during phases of active sediment, whereas the transgressive facies (Silty claystone deposits) existed contemporaneously during periods of diminished or absent detrital influx. The depositional environments of both facies were subjected to changes in space and time. In summary, the facies analysis of these formations shows a strong terrestrial influence, which clearly increases towards the eastern part of study area. In contrast the western part the basin appeared deeper, dominated by relative deep marine environment. The entire lower part of the Awynat Wanin Group consists of mixed successive, coarsening upward and finning up small cycles, each of which shows repeated or frequent shallowing, displaying deepening upward trends, representing a minor transgressive/ regressive pulls.

REFRECNCE

[1]- Davidson, L. et al. (2000). The structure, stratigraphy and petroleum geology of the Murzuq Basin, southwest Libya. Symposium on Geological Exploration in Murzuq Basin (Eds. MA. Sola and D. Worsley), Elsevier, Amsterdam, p. 295-320.

[2]- Klitzsch, E. (2000). The structural development of the Murzuq and Kufra Basins - significance for oil and mineral exploration. In: Sola, M.A., Worsley, D. (Eds.), Geological Exploration in Murzuq Basin. Elsevier Science, Amsterdam, pp. 143–149, Chapter 7.

[3]- Mamgain, V.D. (1980). The pre-Mesozoic (Precambrian to Palaeozoic) Satigraphy of Libya – A. Reappraisal. Bulletin, No., 14. Industrial Research Centre, Tripoli, 104 p.

[4]- Grubic, A., Dimitrijevic, M., Galecic, M., Jakovlject Z., Komarnicki, S., Protc D., Radulovic, P. and Roncevic, G. (1991). Stratigraphy of western Fezzan (SW Libya). Third Symposium on the Geology of Libya, vol. 4 (Eds. M.J. Salem, O.S. Hammuda and B.A. Eliagoubi), Elsevier, Amsterdam, p. 1529-1564.

[5]- Pierobon, E.S.T. (1991). Contribution to the stratigraphy of the Murzuq Basin, SW Libya. Third Symposium on the Geology of Libya, vol. 5 (Eds. M.J. Salem and M.N. Belaid), Elsevier, Amsterdam, p. 1766-1784.

[6]- Echikh, K. and Sola, M.A. (2000). Geology and Hydrocarbon occurrences in the Murzuq Basin, SW Libya. Symposium on Geological Exploration in Murzuq Basin (Eds. M.A. Sola and D. Worsley), Elsevier, Amsterdam, p. 175-222.

[7]- Sutcliffe, O.E., Adamson, K. and Ben Rahuma, M.M. (2000). The geological evolution of the Palaeozoic rocks of western Libya: a review and field guide. Second Symposium on the Sedimentary Basins of Libya, Geology of Northwestern Libya. Field Guide. Earth Sciences Society of Libya. 93pp

[8]- Carr, I. D. (2002). Second-order sequence stratigraphy of the Palaeozoic of North Africa. J. Petrol. Geol. 25, 259 – 280.

[9]- Lelubre, M. (1948). Le Paleozoique du Fezzan sud-oriental. C. R. Soc. Geol. Fr., 18, 4, 79 - 81

[10]- Seidl, K. and Rohlich, P. (1984). Sheet Sabha (NG 33-2), Geological Map of Libya, scale 1:250,000,Explanatory Booklet, Industrial Research Centre, Tripoli.

[11]- Hallett, D. (2002). Petroleum Geology of Libya. Elsevier Science B.V., Amsterdam, 503 p.

[12]- Gundobin, V.M. (1985). Sheet Qararat al Marar (NH 33- 13), Geological Map of Libya, scale 1:250,000, Explanatory Booklet, Industrial Research Centre,Tripoli

[13]- Goudarzi, G. H. (1970). Geology and Mineral Resources of Libya. A Reconnaissance. U. S. Survey Prof. Paper, 660.

[14]- Moreau-Benoit, A., 1976. Les spores et débris végétaux. Mémoires de la Société géologique et minéralogique de Bretagne, Rennes 19, 27–58.

[15]- French study Group (1976). Studies for the development of the Wadi ash Shati Iron ore Deposit (2nd and 3rd Stages, 1973 – 1976). Unpublished report, Ind. Res. Cent., Tripoli.

[16]- Collomb, G.R. 1962. Etude geologique du Jebel Fezzan et de sa bordure Palaeozoique.

[17]- Massa, D. and Moreau-benoit, A. 1976. Essai de synthese stratigraphique et palynologique du System devonien en Libye occidentale. *Rev. Inst. Fr. Petr.* vol. 31

[18]- Parizek, A., Keen, L. and Rohlich, P. (1984). Sheet Idri (NG 33-1), Geological Map of Libya, scale1:250,000, Explanatory Booklet, Industrial Research Centre, Tripoli.

[19]- Palaeozoic rocks of western Libya: a review and field guide. Second Symposium on the Sedimentary Basins of Libya, Geology of Northwestern Libya. Field Guide. Earth Sciences Society of Libya. 93pp