

Tertiary Stratigraphic Map, Correlation and Cross Section of the Daryanah Al Abyar Area, Al Jabal Al akhdar, NE Libya

Saad El Sakran¹ & Belkasim khameiss² & FARAJ, Faraj H

¹Department of Geography, University Of Sheffield,UK. Email: elsakransaad@gmail.com

² Department of Geological Sciences, Ball State University, Muncie, IN 47306. Email:
Bkb28_1981@yahoo.com.

³ Earth Sciences Department, Garyounis University, University Road, 13, P.O. Box 9480,
Benghazi, Libya.

Abstract

Stratigraphic correlation between sixteen valleys in the Daryanah Al Abyar area. These valleys are located in the northwestern part of Jabal AL Akhdar, northeast Libya and this study area covers 192.5 km². These valleys expose marine rocks within seven rock units. From the oldest to youngest these are the Apollonia, and Dranah Formations (Eocene), the Al Baydah Formation, the Algal Limestone, and Shhate Marl member (Oligocene), the Al Faydiah Formation (Oligo-Miocene), and the Al Rajmah Group comprising the Benghazi and Wadi Al Qattarah Formations (Miocene).

Most of the formations and their respective members aforementioned are marine sequences. Additionally, Quaternary deposits cover a large part of the study area and they disconformably overlie the Tertiary rocks that occur on the plateau, escarpment, and on the floor of all valleys.

The aim of our stratigraphic study is to determine the boundaries between these rock units. In the northeastern part of the study area the rock units represent the Apollonia Formation,

while in the southern part, this formation is missing but younger formations are present. In addition, this correlation is based on the lateral facies analysis between the marine rock units.

1.Introduction

Al Jabal Al Akhdar lies in the northeast of Libya in a province known as Cyrenaica that is bounded by the Mediterranean Sea from the north, the Cyrenaica platform from the south, the Sirt basin from the west, and the Western-Desert of Egypt from the east (Fig. 1.1).

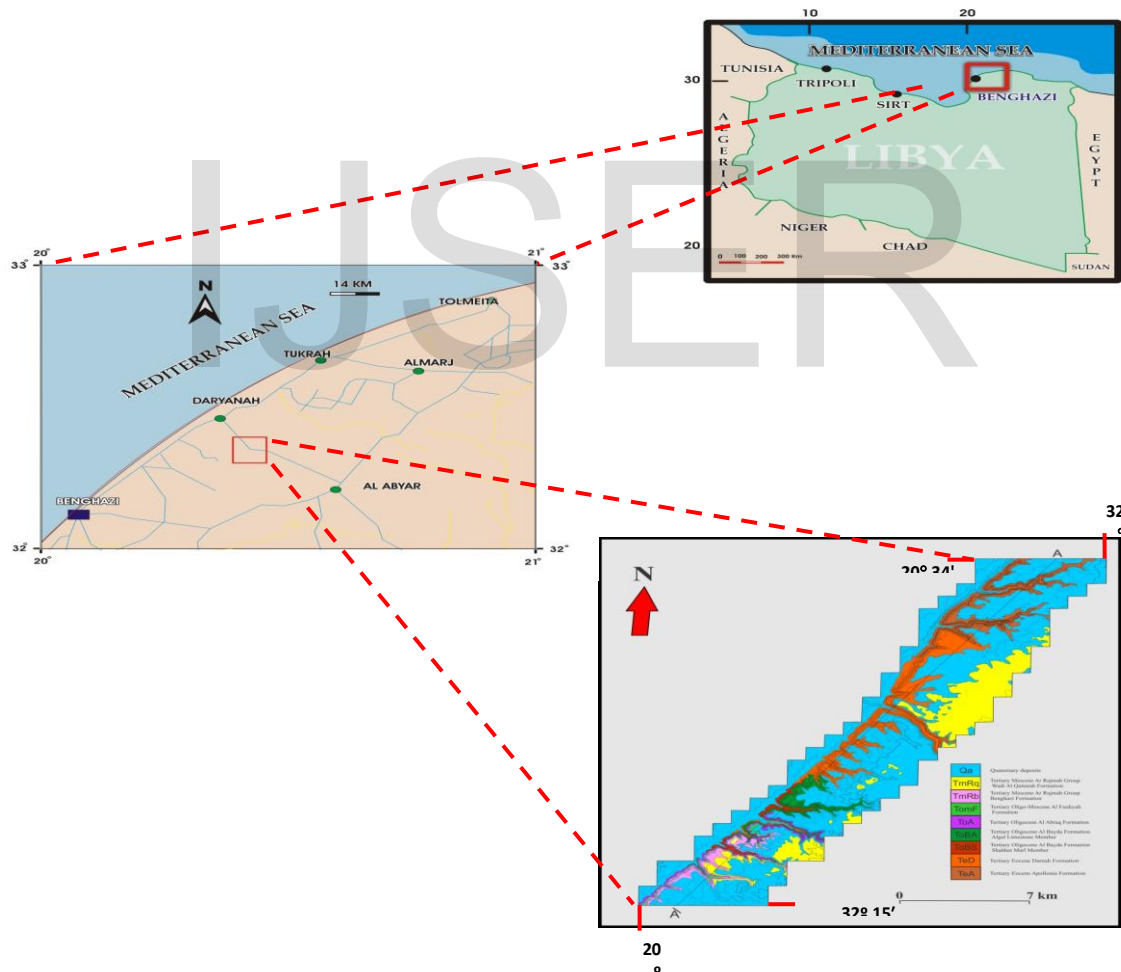


Fig. 1: Location map of the study area.

Note Libyan map source :<http://geology.com/world/libya-satellite>

The study area (Daryanah Al Abyar) is located in the northwestern part of Al Jabal al Akhdar in northeastern Libya. It is about 192.5 Km² and located between latitudes 20°34' 75" ,32° 15' 49.8", N, and longitude 20° 27' 42", 32 28' 98" E (Fig. 1).

The sedimentary sequence of the study area has been investigated and seven rock-units are recognized (Fig. 4), They include the Apollonia, Darnah, Al Bayda, Al Abraaq, Al Faidiyah, Benghazi, and Wadi Al Qattarah Formations, which are ranging in age from the lLower Eocene to the uUpper Miocene. The Quaternary deposits disconformably overlaying the Tertiary rocks and it has covered a large part of the study area.

The distribution of these rock -units along the study area has been outlined and a stratigraphic map has been prepared based on data gathered from my our colleagues conducting fieldworking ion the region (Fig. 2). A cross section and stratigraphic correlation has been prepared for the study area and used to interpret the depositional history of the region (Fig. 3 and Fig.4). In the following section, however,we provide an overview of the stratigraphy and the rock -units have been are outlined.

Stratigraphy of the study area:

1.2.1 Apollonia Formation (Early Eocene):

The name was first introduced by (Gregory, 1911); as the Apollonia Limestone after the ancient Greek settlement apollonian, now called Susah, in the Al Bayda sheet area in northern Cyrenaica.

This formation represents deposition in an open-marine setting and Rohlich (1974) suggested a turbidity environment for some of the exposures based on contorted bedding features, an erosional channel, and repeated cycles of fining upward carbonate sequences. In the study area, the upper boundary of the Apollonia Formation interfingers with the Darnah Formation. The maximum thickness of Apollonia Formation in the study area was measured to be 120 m at Wadi Musa (NE) and decreases toward Wadi El Ehliga to the southwest.

1.2.2 Darnah Formation (Middle-Late Eocene):

The Darnah Limestone was named by Gregory (1911), after the coastal town of Darnah which is located along the main Darnah-Tobruk road (Banerije, 1980). The Darnah Formation is described by Klen (1974), Rohlich (1974) and Zert (1974).

The Darnah Formation was deposited in a shallow neritic and littoral environment, as is based on faunal and lithologic evidence (Klen, 1974). The lower boundary is a gradational contact (interfingering relationship) with Apollonia Formation while the upper boundary is disconformable with the Al Bayda Formation. This formation is characterized by the presence of large *Nummulites gizehensis*, a small *Nummulites* sp., and fragments of mollusks and echinoids. In the study area, the maximum thickness of the Darnah Formation about 140 m at Wadi Zazah (NE) and decreases toward Wadi AZ Zad (SW).

1.2.3 Al Bayda Formation (Early Oligocene):

The name introduced by Rohlich (1980), after the town of Al Bayda, is located in northern Cyrenaica. This formation is marked by upper and lower unconformable boundaries. It includes two members:

1.2.3.1 Shahhat Marl Member (Lower unit):

The name was introduced by Kleinsmeide and Van Den Berg (1968) the Shahhat Marl Member is developed, but only on the northern slope of Al Jabal Al Akhdar.

The fauna present in the Shahhat Marl Member is dominated by large foraminifera (Klen, 1974). The high degree of flat morphology of these organisms is indicating indicates an open shelf and shallower fore slope, corresponding to the standard facies.

In the study area, the maximum thickness of the Shahhat Marl Member is about 40 m at Wadi AZ Zad (SW) and decreases toward Wadi Al Buwayrat (SW). The Sahhat marl Member is absent at Wadi Al Watyat (SW), exposed again at Wadi Al Kuf (SW) and decreases in thickness toward Wadi Al Juibiyah (SW).

1.2.3.2 Algal Limestone Member (Upper unit):

This member is exposed on the north, west and south west of Al Jabal Al Akhdar (Rohlich, 1974). The name was introduced by Kleinsmeide and Van Den Berg (1968). The lower contact of this member is gradational with Shahhat Marl Member, but the upper contact is disconformably with the overlying Benghazi Formation.

The previous authors worked in Al Jabal Al Akhdar region demonstrated that the Algal Limestone Member was deposited in a shallow marine neritic and littoral environment (Rohlich, 1980). The study area,, the maximum thickness of Algal limestone Member is about 80 m at Wadi Az Zad (SW) and decreases toward Wadi Al Kuf (SW), exposed again in the Quarry of Wadi Al Juibiyah (SW).

1.2.4 Al Abraaq Formation (Middle-Late Oligocene):

The name of Al Abraaq Formation was introduced by (Rohlich, 1974) in the village Al Abraaq. This formation corresponds to the Al Abraaq calcarenite member of Alkuf Formation. (Kleinsmeide and van der Berg, 1968), The lithological nature and fossil contents in the Al Abraaq Formation indicate a deep neritic to shallow marine depositional environment (Klen, 1974), In the study area, the lower contact with underlying Algal Limestone Member is disconformable while and the upper contact is disconformable with Al Faidiyah Formation. The maximum thickness of the Al Abraaq Formation about 40 m at Wadi Al Buwayrat (SW), and decreases toward Wadi Abdelhamed (SW).

1.2.4 Al Abraaq Formation (Middle-Late Oligocene):

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In the study area, the lower contact with the underlying Algal Limestone Member is disconformable while and the upper contact is disconformable with Al Faidiyah Formation. The maximum thickness of the Al Abraaq Formation about 40 m at Wadi Al Buwayrat (SW), and decreases toward Wadi Abdelhamed (SW).

1.2.5 Al Faidiyah Formation (Oligo-Miocene):

The name was introduced by Pietersz (1968) as Faidia Formation, which described its type section, along the road near Qaryat Al Faidiyah (about 16 km south of Shahhat City). The base of this formation is marked by glauconitic marl (Pietersz, 1968). The depositional environment of Al Faidiyah Formation is shallow neritic (Klen, 1974). (Rohlich, (1974) suggested a local brackish element environment based on the palaeontological content and the lithology of the formation.

In the study area, Al Faidiyah Formation is bounded by two disconformableities surfacescontacts, the upper boundary with Benghazi Formation, and the lower one with Al Abraq Formation. The maximum thickness of the Al Faidiyah Formation about 40 m at Wadi Al Watyat (SW), and decreases toward Wadi Abdelhamed (SW).

1.2.6 Ar Rajmah Group (Middle to Late Miocene):

Klen (1974) and Rohlich (1974) divided Ar Rajmah Formation into two members, namely the Wadi al Qattarah Member and the Benghazi Member. El-Hawat and Abdulsamad (2004) raised the term Ar Rajmah Group and the divided this group into the mMiddle Miocene rock units of the Benghazi Formation and the Late upper Miocene rock units of the Wadi Al Qattarah Formation.

1.2.6.1 Benghazi Formation (Middle Miocene):

The name, Benghazi Limestone, was introduced by Gregory (1911), Benghazi Limestone for a sequence of massive, fossiliferous limestone units of middle Miocene age.

The depositional environment of the Benghazi Member of Ar Rajmah Formation is shallow marine environment according to (Klen, 1974).

In the study area, it is bounded by two disconformable surfaces, the upper boundary with the Wadi Al Qattarah Formation, and the lower one with the Al Faidiyah Formation. The maximum thickness of the Benghazi Formation is about 35 m at Wadi Al Juibiyah (SW) and decreases toward Wadi ABdelhamed (SW).

1.2.6.2 Wadi al Qattarah Formation (Late Miocene):

The name was introduced by Klen (1974) for the upper member of Ar Rajmah Formation after its type locality at Wadi Al Qattarah. Wadi Al Qattarah Formation was deposited in a shallow marine to lagoonal environment (Klen 1974). This is indicated by the presence of the Miliolids and the large sized ooids. In the study area, its exposed at 300 m above sea level as patches over most of the area and bounded by two disconformities of Quaternary deposits, while in Wadi Al Kuf and Wadi Al Juibiyah its exposed at 230 m above sea level and with a lower boundary disconformity with the Benghazi Formation and the upper boundary disconformity with Quaternary deposits. The maximum thickness of the Wadi Al Qattarah Formation is about 15 m at Wadi Al Juibiyah (SW).

1.2.7 Quaternary deposits:

The modern Quaternary geology of northern Cyrenaica was introduced by Hey (1956), Rohlich (1974), and Klen (1974). The Quaternary deposits covered large parts of the study area and occur on the plateau, escarpment, and at the floor of all wadis. They lie disconformably on the older Tertiary sediments.

1.3 Conclusion of correlation in the study area:

When we see the final picture demonstrated by the NE-SW correlation we can understand what happened between the 13 adjacent sectors respectively (F, E, C, 8, 7, 6, 5, 4, 3, 2, 1, B, and A) during the deposition of its formations. The datum line between all the all sectors is the marker bed which is represented by the top of the Apollonia Formation as a datum 1 between sector E and F, top of Darnah Formation as a datum 2 between sector C and 8, bottom of Wadi Al Qattarah Formation as a datum 3 between sector 8 and sector to sector 1 , and bottom of the Benghazi Fformation as a datum 4 between sector B and A. The Apollonia Formation (Early Eocene) is found in three areas (F, E and C) in the NE direction and pinches out with the Darnah Formation (Middle-late Eocene) between sectors C and 8 toward SW direction. TThe Darnah Formation is much thinner when we go toward the SW direction. In contrast, the other formations; (Al Baydah Formation (Early Oligocene), Al Abraaq Formation (Middle-Late Oligocene), Al Faidiyah Formation (Oligo-Miocene) and the Benghazi Formation of Ar Rajmah Group) crop out appearance in the other sectors (4-A) beside these formations increasing in thickness at in the same direction NE to SE.; that's mean :

During the deposition of the Apollonia and Darnah Fformations the depositional direction was became from NE toward SW direction, while, at the beginning of the Oligocene the depositional direction changed to against direction until the beginning of the Miocene age (similar conclusion after El-Barassy and Emhana, 2005). But however, in sector 3 the Al Baydah Formation is much thicker than adjacent areas which gloss usshows this area was lower than associated areas during the deposition of Al Baydah Formation. TAnd the Darnah Formation disappears in sector 3, while, it's appearing presence in the lower parts of sides the study area which refers indicatesto the presence of this formation in the subsurface of sector 3 . The areas between sector 8 to sector B are capped by the Wadi Al Qattarah Formation of the Ar Rajmah

Group, while, it is absent in the other sectors that refers these sectors (A, C, E, and F) were emergentd during the deposition of this formation Change of depositional direction during the Miocene to the SW-NE direction is also demonstrated by El-Hawat and Abdulsamad (2004). These deposits are represented by the Benghazi and Wadi Al Qattarah Formations of the Ar Rajmah Group (Middle-Late Miocene). We believe that the sector 3 was a low area compared with the adjacent area toward NE direction. The Darnah Formation is associated with the Al Baydah Formation (laterally) at sector 3 and 4, based on our correlation, these sectors (3 and 4) were not affected by any tectonic movements such as faulting, because sectors 5 to 8 were higher than sector 3 and 4 where the deposition of Al Baydah Formation stopped at sector 5.

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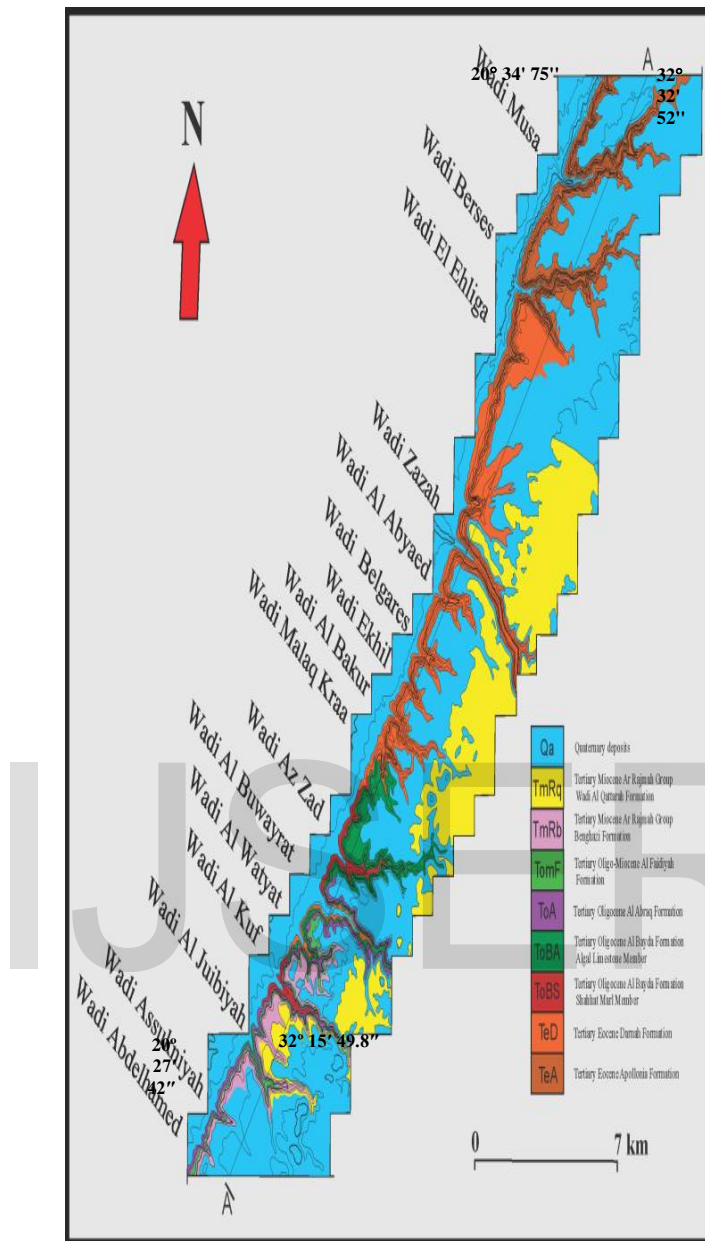


Fig.2.A stratigraphic map of the study area .

1.4 Conclusion of stratigraphic map and cross section:

The main results of the stratigraphic map and the cross section yielded the following conclusion: Seven rock units are found in the study area. From the oldest to youngest these rock units are: Apollonia Formation (Early Eocene), Darnah Formation (Middle-Late Eocene), Al

Bayda Formation (Early Oligocene), Al Abraaq Formation (Middle-Late Oligocene), Al Faidiyah Formation (Oligo-Miocene), Benghazi Formation (Middle Miocene) and Wadi Al Qattarah Formation (Late Miocene)., Aall of these formations are marine carbonate sequences ranging in ages from lower Eocene to upper Miocene. The Quaternary deposits covered a large part s of the study area, and it's are disconformably with the overlying the Tertiary rocks.

There is an interfingering contact between the Apollonia Formation and the Darnah Formation located at Wadi Bares. In the study area, the relationship between all rock units in all wadies is can be interpreted as a lateral changes of facies (i mean just on these map).

The thickestmaximum thickness of all the rock units in the study area is are the Apollonia and Darnah Fformations in the NE direction and decreasing toward the SW direction, while, change in the deposition during the Miocene to it became toward SW-NE direction.

The Pinches out of the Darnah Formation pinches out to theward SE direction at Wadi Az Zad and is the formation is exposed again after the Wadi Az Zad. " Bbased on ourmy interpretation this phenomenon may be the resulted from of the topography of the study area.

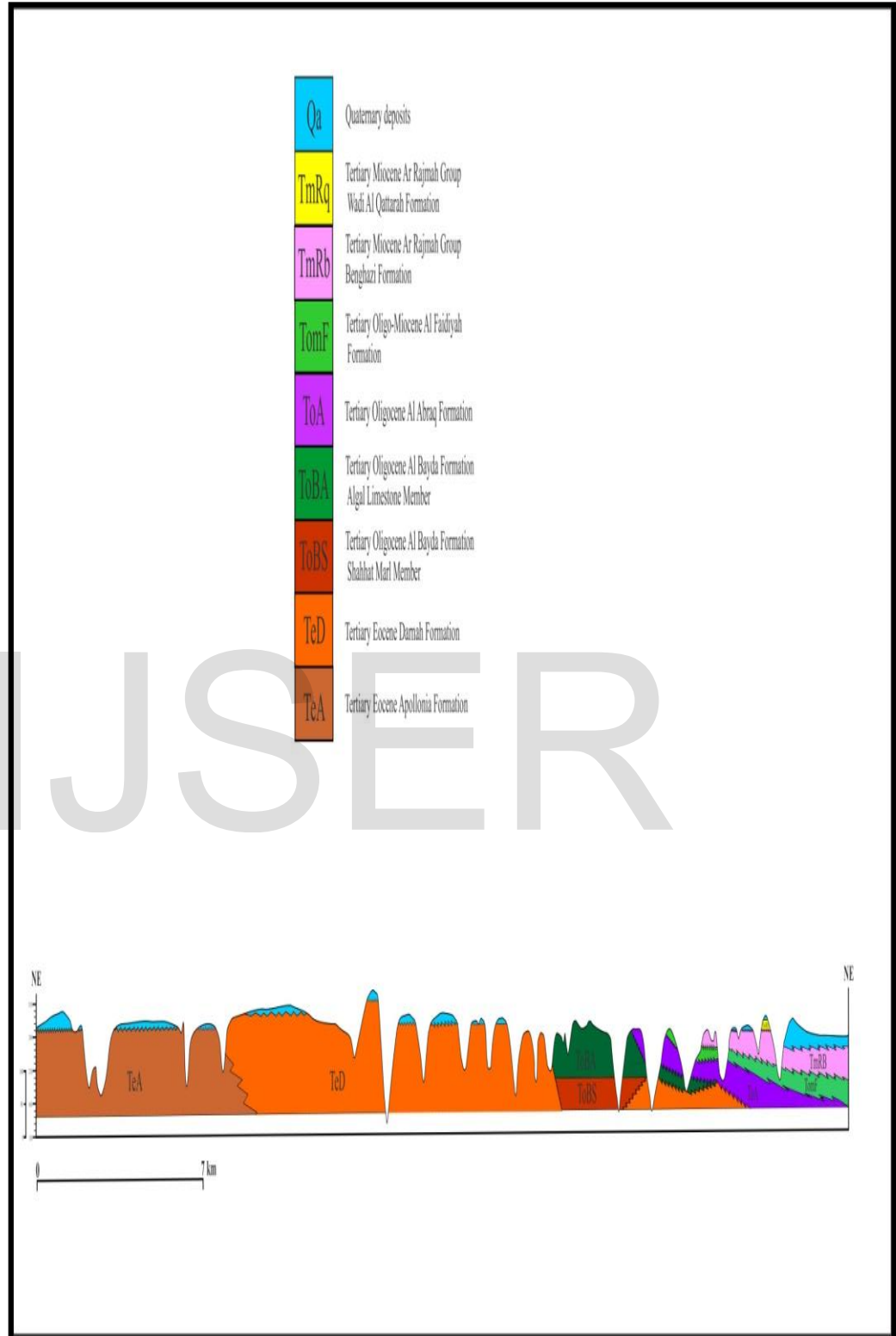


Fig .3. A cross section of the study area.

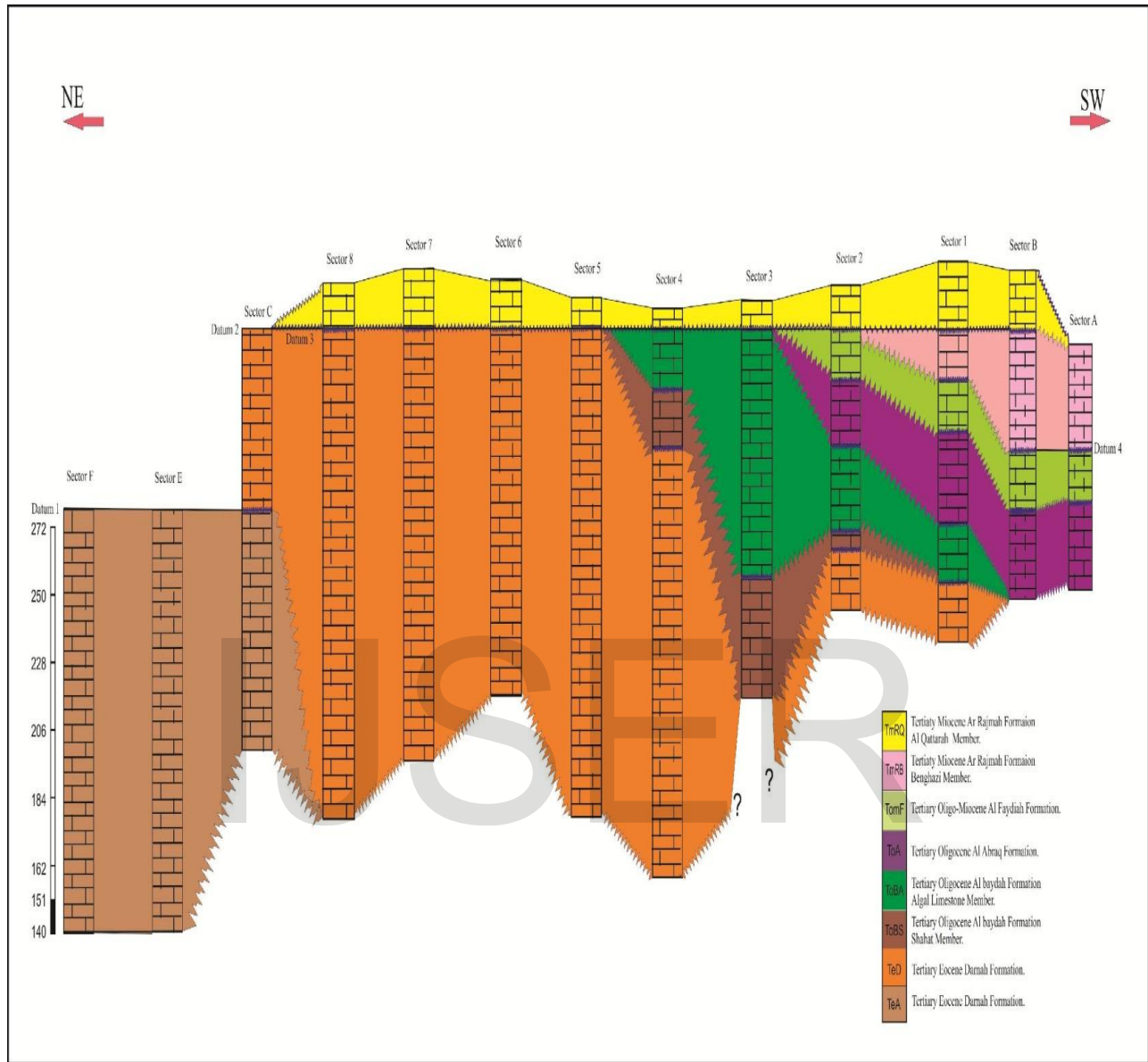


Fig. 4. Correlation of the study area showing the depositional history of the region .

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