The Middle Oligocene Rock Strata (Tarjil Formation) in Ashdagh Mountain, Sangaw District, Sulaimani Governorate, Kurdistan Region , NE Iraq.

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Abstract:

The occurrence of Middle Oligocene rocks in Ashdagh Mountain is previously studied like Baba and Bajwan Formations; both of them belong to Middle Oligocene age; the former Formation represents reef- forereef deposits, while the latter one represents reef-backreef deposits. But Tarjil Formation was not studied in the mountain which is complementary of both Baba and Bajwan Formations and represents forereef- open sea-offshore deposits of the same age. The aim of this study is proving the occurrence of Middle Oligocene sedimentary rock of Tarjil Formation.

Keywords:

Geological setting

The studied area is Ashdagh Mountain which locates in the southeast of Kirkuk city and southwest of Sulaimani city. The Mountain located within the unstable shelf, foothill zone, Erbil - Chamchamal subzone. Geographically, it is located at the intersection of latitude (35^{o} 08^{-} $43^{=}$) and longitude (45^{o} 17^{-} $40^{=}$) as shown in figure (1).

Structurally, Ashdagh Mountain consists of asymmetrical anticline, the northeastern limb has a gentle slope and the southwestern one has a steep slope which probably reversely faulted. It forms enechelon arrangement with both other anticlines Mamlaha and Qara Wais as illustrated in figure (2).

Geomorphologically, a number of karstic features like sinkhole, gallery, collapse and natural bridge with rock falls can be seen due to sulphuric water reaction with rock beds which is coming out beneath Darzila village as illustrated in figure (4). From petroleum point of view, near Darzila village there is an oil seepage which springs from the bottom of Darzila water tributary.

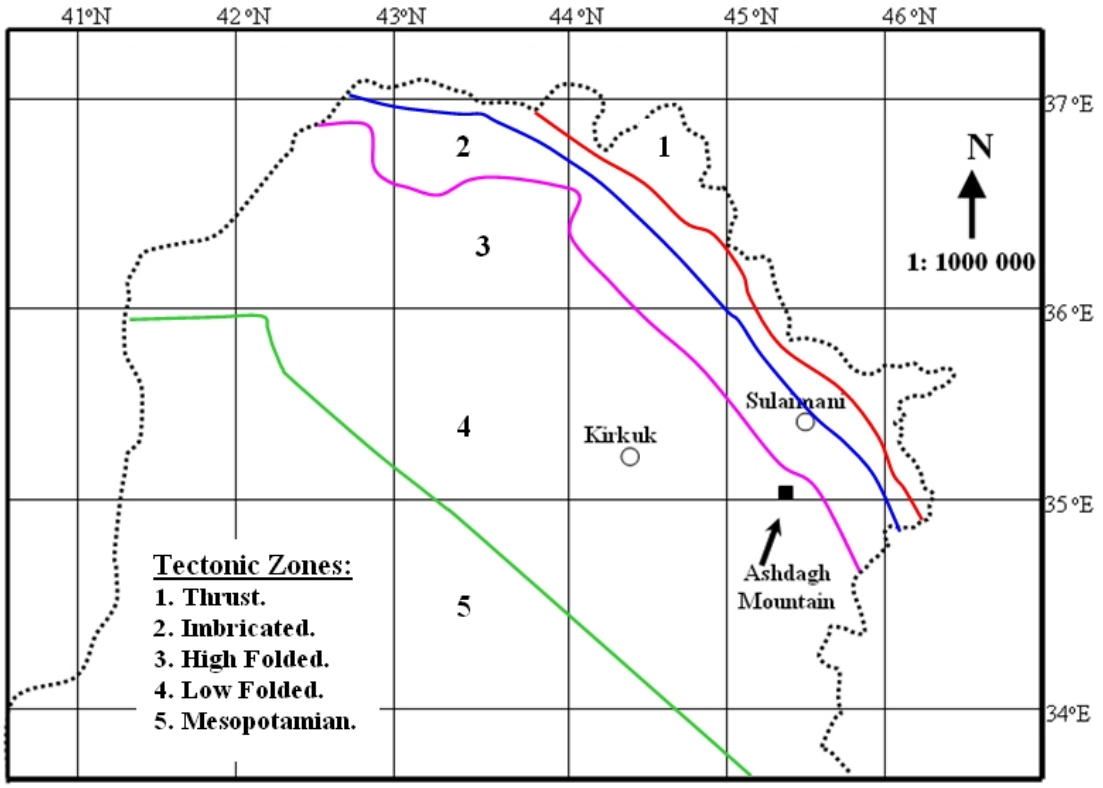

Figure (1): Tectonic map and geographic location of Ashdagh Mountain.

Figure (2): Ashdagh structure appearance (Google Map, tilted photography, 2013). The yellow square spot represents location of the studied area and the red spot denotes Darzila village.

Introduction

The stratigraphy of Ashdagh Mountain is mostly consists of Oligocene rocks which previously studied and proved by Kharajiany (2008). He described that the formations of the mountain are Pila Spi Formation (Middle Eocene), Shurau and Sheikh Alas Formations (Lower Oligocene), Baba, Bajwan and possible Tarjil Formations (Middle Oligocene), Anah Formation (Upper Oligocene), Euphrates and Dhiban Formations (Lower Miocene), Jeribe and Fatha Formations (Middle Miocene) respectively. Additionally, the Formations Euphrates, Dhiban and Jeribe also proved by Kharajiany (2013) in Ashdagh Mountain.

In the study of (Kharajiany, 2008) it is cited that the lithology between Baba Formation and the unconformity of Lower- Middle Oligocene might be representing Tarjil Formation but not confirmed. He also defined the lower part of Baba Formation as 5m of marly limestone and a thick bed of marly-glauconitic conglomerate, which located beneath the marly limestones unit. But he reexamined beds of the valley and demonstrated that the (marly limestone) and (marly- glauconitic breccia) beds are two different Lithologic units, from which the marl- marly limestone represents Tarjil Formation as shown in figure (3 and 4).

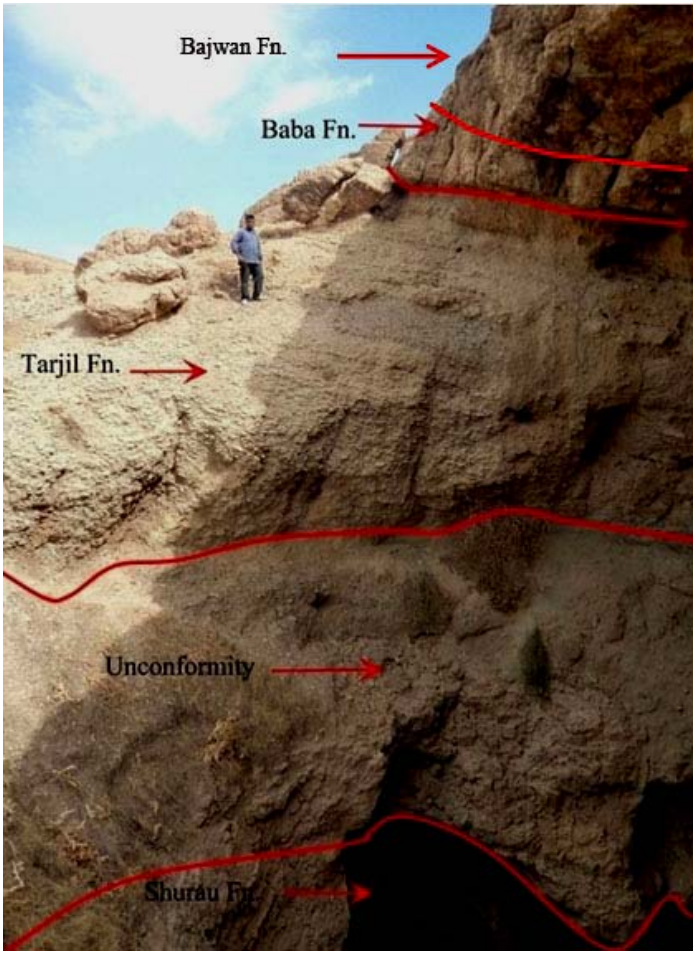

Figure (3): shows Tarjil Formation that sandwiched between unconformity and Baba Formation.

Methods of study

The samples are taken only from Darzila section, which is marked by a yellow square spot in figures (2). The selected section located at 150m of northern side Darzila village as illustrated in figures (4) which is the place from where the marly limestone of Tarjil Formation well exposed. In other places around the mountain's limbs, the lithology is not obvious.

More than 15 samples have taken, 10 thin sections made for the 6 meters of the marly limestone and those thin sections were examined and studied under microscope to demonstrate the microfacies and fossil contents.

Discussion

The Oligocene formations were first studied by Bellen et al (1959) and divided to 9 formations according to their age and Lithologic description (figure 5). These units are deposited within Oligocene basin; the basin represents a reef system. That's backreef- reef- forereef- open sea basins (figure 8). Mainly, the lithologies of backreef and forereef facies are limestone, while the open sea facies is marly limestone.

Figure (4): location of Darzila section, which shows the lithostratigraphy of Tarjil Formation.

Al Naqib (1963) reported the basinal Palani and Tarjil, fore-reef Baba Limestone, and back-reef and reef Bajawan Limestone in Dujaila- south of Iraq. Behnam (1979) recorded 126m of marly moderately hard to splintery silty limestone as Tarjil Formation in Bawagarw anticline, east of Iraq, near Iranian border. Fouad and Nasir (2009) recorded 42m of Tarjil Formation from Jazira area, west of Iraq.

Moreover, the issue about Kirkuk Group Formations (Oligocene rock units) was suspicious and debated whether it is exist in Sulaimani territories or not, after the study of Kharajiany (2008), he proved the appearance of the Oligocene rock units in Ashdagh mountain of Sangaw district which locates between Darbandikhan and Chamchamal towns (Sulaimani and Kirkuk cities). And there are other localities in the high folded zone which doubt to be these rock units are available.

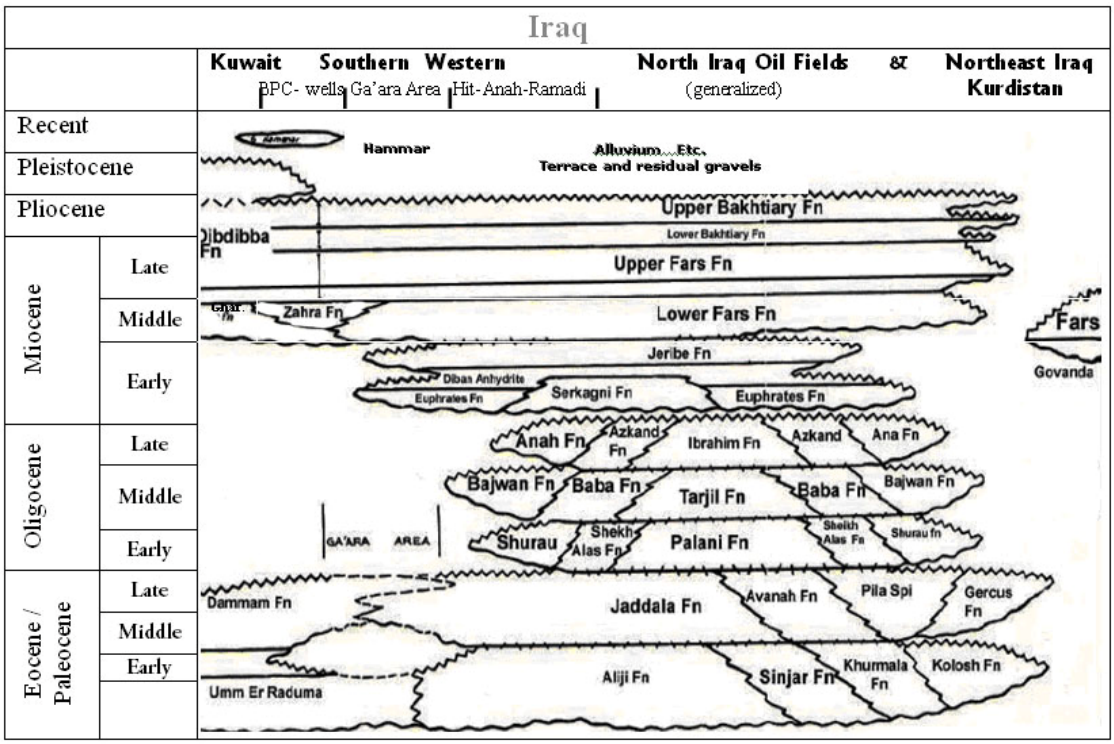

Figure5: Age Relationships of Named Rock Units in Iraq- Tertiary (after Bellen et al, 1959).

Tarjil Formation

Tarjil Formation first described by Bellen 1956 (in Bellen, 1959) from oil well Kirkuk Number 85 (K-85). It consists of 100m of slightly dolomitized globigerinal marly limestone. The Formation recorded from some drilled wells like KorMor, Tarjil dome and Bai Hassan.

Oligocene marls recorded from oil well Dujaila-1 (SE Baghdad) were assigned to Tarjil Formation. In Injana, Naft Khana and Chia Surkh, Oligocene marls and marly limestones, may form part of Tarjil Formation (Jassim and Goff 2006). They also stated that Tarjil Formation unconformably overlies Palani Formation and the upper contact with Baba Formation is gradtitional.

At outcrop in Qara Chauq, the formation comprises 20m of hard yellowish grey limestone overlain by thick bedded limestone with fossils including: *Nummulites sp., Lepidocyclina sp., Rhapydionina sp., Rotalia viennoti*, and *Lenticulina sp*. with Gastropods, Echinoids, Algae, Bryozoa and Pelecypodes, deposited in a relatively shallow water environment. The age of Tarjil formation assigned according to their typical microfossil assemblages, they are: *Globigerina ampliapertura*, BOLLI, *Globigerina ciperoensis* BOLLI, *Globigerina selli (BORSETTI)*, *Globigerina. tripa-ritta* KOCH, *Globigerina parebulloides* BLOW, *Globorotalia opima* BOLLI, *GL. Nana* BOLLI, *Globoanomalina micra* (COLE), *Chilogumblina sp*., *Lenticulina spp*.,

Rotallids, Algae, Bryozoa, *Lepidocyclina (Eulepidina) dilatata* MICHELOTTI, *Nummulites intermedius* D'ARCHIAC. Brun, 1971 also recorded *Globigerina parebulloides, Globigerina gr. triloculinoidae, Globigerinata gr. Unicave, Globorotalia esnaensis* (LE ROY).

Figure (6): interfingering of Tarjil and Baba Formations with conglomerate bed, Darzila village.

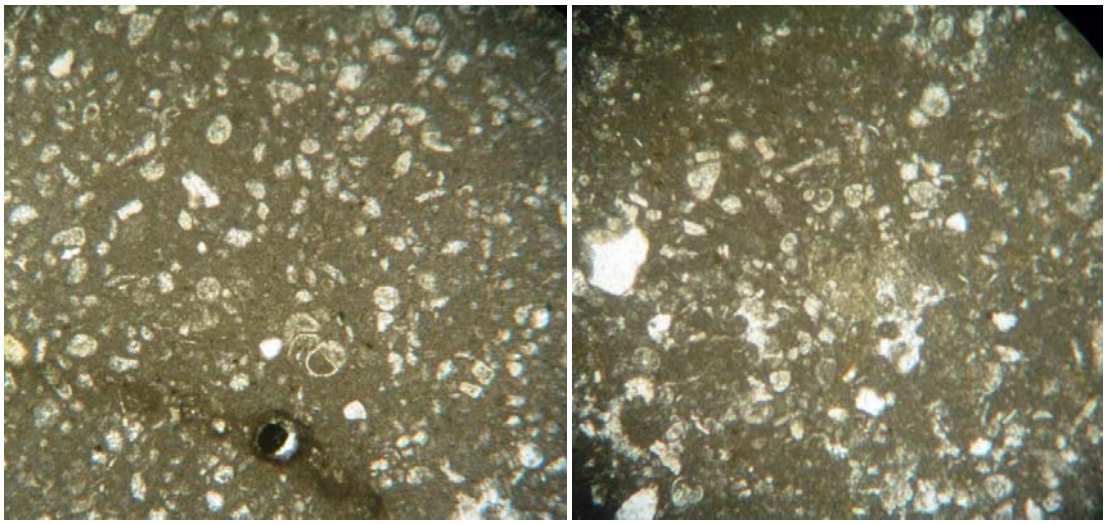

Figure (7): globigerinal faunal assemblage in the marly limestone of Tarjil Formation, Ashdagh Mountain.

In the studied area, Tarjil Formation consists of 5-6 meters of hard splintery yellowish green to grey globigerinal marly limestone (figure 3, 6& 10). The beds partly become marl and friable, the marly limestone beds are dolomitized and partially pellitoidal.

The marly limestone is characterized by globigerinal fauna contents which constituent most part of the rock frame (figure 7). Sometime, the marly limestone of Tarjil Formation interfingers with the polygenetic marly-glauconitic conglomerate bed as illustrated in figure (6). This bed is considered to be representing an unconformity between Lower and Middle Oligocene sediment cycles, below the conglomerate bed, the lithology is dolomitized- milliolidal limestone which belongs to Shurau formation and it dated to lower Oligocene age (figures 3, 4 and 10).

The fossil contents of these rock beds which detected through the thin section study of the mountain showed in figures (8 and 9) are:

Globigerina parebulloides, Globorotalia opima, Globigerinta gr.unicave, Subbotina angiporoides, Chiloguembelina cubensis, Nodosaria sp, Uvigerina hantkeni, Turborotalia cocoaensis, Peneroplis thomasi, Spirolina austriaca, Sphaerogypsina sp and *Austrotrillina howchini with sponge sp* fragment

The fossil contents of the studied units are compared to the Oligocene of Iraq and other countries as studied by Brun (1971), Al-Hashimi and Amer (1985), Stott and Kennett (1990), Leckie et al (1993) Krasheninnikov and Pflaumann (1993), and Li et al (1997).

From the figures (8 &9) which are taken from the thin sections of Darzila section, the fossils of figure 8 (1-11) are planktonic foraminiferas; most of them found on the lower part of the marly limestone, figure 8 (12-15) are benthic and planktonic foraminiferas found in the medium- upper part of the bed.

Figure 9 (15-19) mostly large benthonic and planktonic forams (mixing fauna) seen in the upper part of the beds (most of the samples taken from Darzila section, because it's the only section from which Tarjil Formation detected).

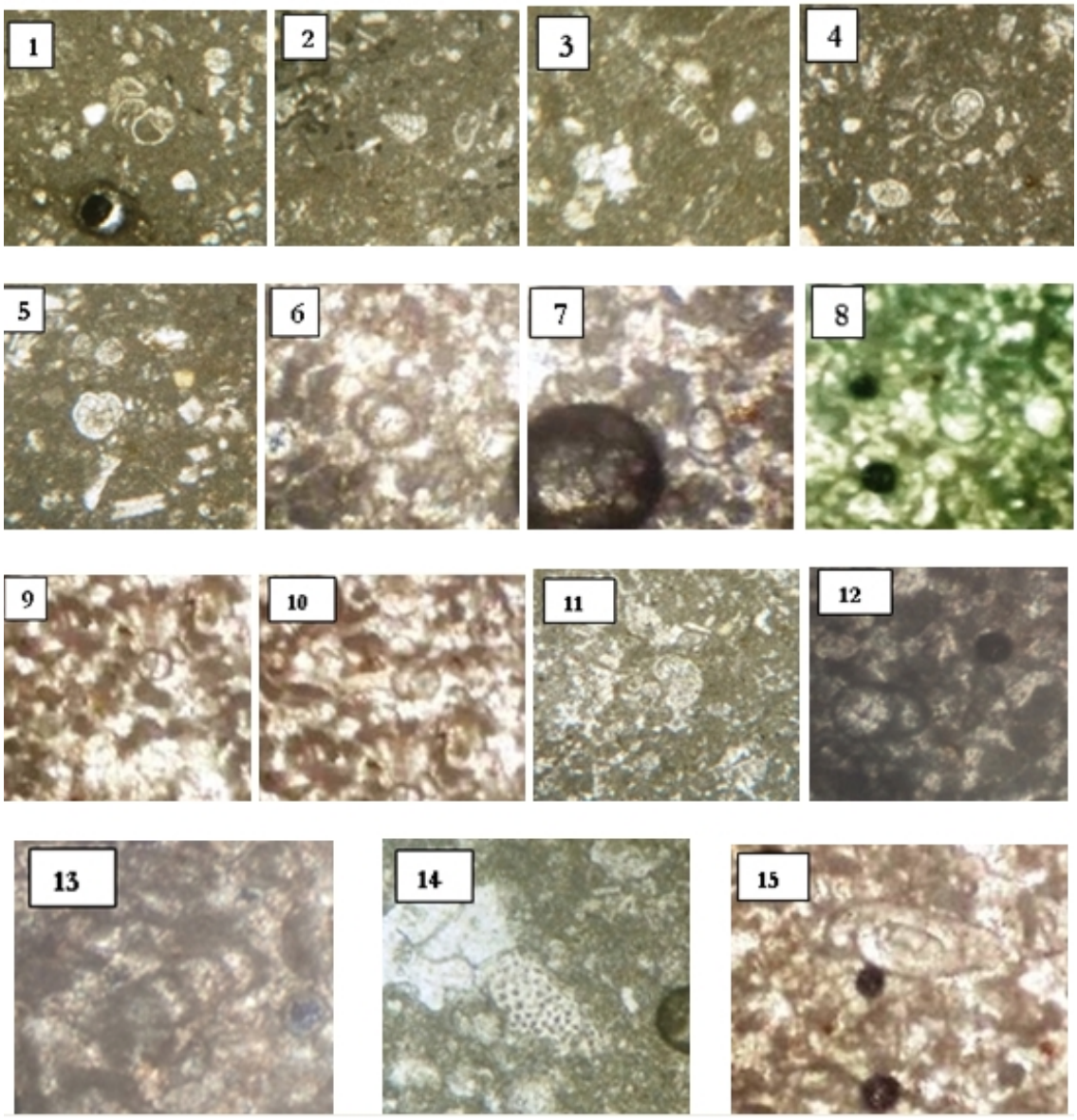

Figure (8): 1-*Globigerina praebulloides* (SlideNo.2T). 2-*Chiloguembelina cubensis (*Slide No.2T). 3- *Nodosaria sp (*Slide No.2T). 4- *Globorotalia opima*, Tarjil (Slide No.2T). 5- *Globorotalia opima (*Slide No.2T). 6- *Turborotalia cerroazulensis* (Slide No.3T). 7- *Pseudohastigerina micra* (Slide No.3T). 8- *Globigerina angiporoides (*Slide No.4T). 9- *Globigerinta gr.unicave* (Slide No.4T). 10- *Globigerina angiporoides* (Slide No.4T). 11- *Globigerina ampliapertura (*Slide No. 4T). 12- *Subbotina angiporoides (*Slide No.T5). 13- *Uvigerina hantkeni (*Slide No.T5). 14- sponge fragment (Slide No.6T). 15- Unknown benthic foraminifera (Slide No.6T).

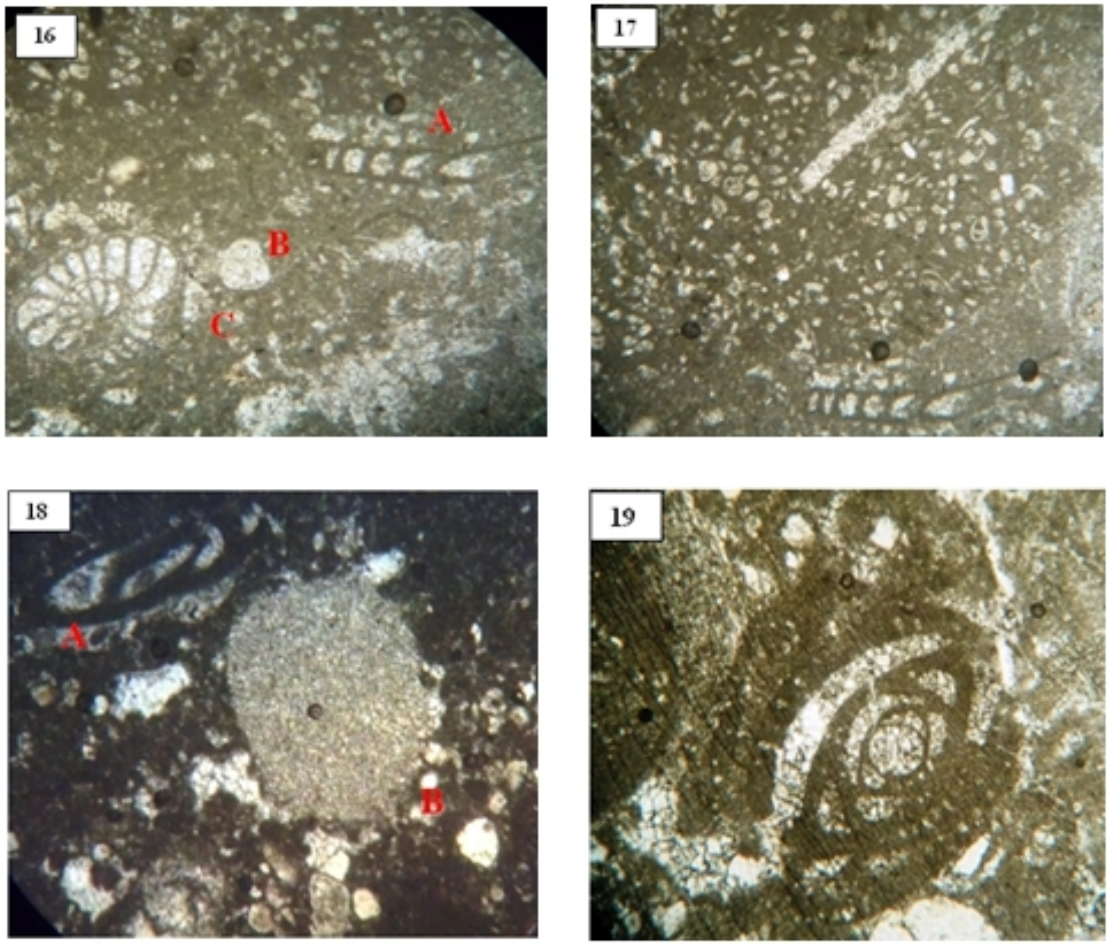

Figure (9): 16- Mixing fauna of *(a) Peneroplis thomasi (b) Spirolina austriaca* and *globigerina venezuelana (*Slide No.6T). 17- *Peneroplis thomasi* with mixing fauna of *globigerina spp(*Slide No.6T). 18- *Sphaerogypsina sp (*Slide No.7T). 19- *Austrotrillina howchini (*Slide No.T7).

There are unrecognizable fossils, they either unknown fossils or the hard parts of the fossil bodies destroyed because of dolomitization and pellet forming of the sediments grains.

In Darzila section, the upper contact of Tarjil Formation is gradational (conformable) with Baba Formation; this gradational is facies change from marly globigerinae limestone to lepidocyclinae limestone. In rare cases Tarjil formation interfingers with Bajwan Formation and contains common fauna (figure 9). The Lower contact of Tarjil Formation is unconformable, which represented by a t hick bed of conglomerate.

Tarjil Formation is only exposed in Darzila Village (Darzila Gorge). While from both sides of the mountain (Timar-Zinana, Shalaii, Miraly and Hazar Kani sections), the marly limestone does not appear, due to little excavation.

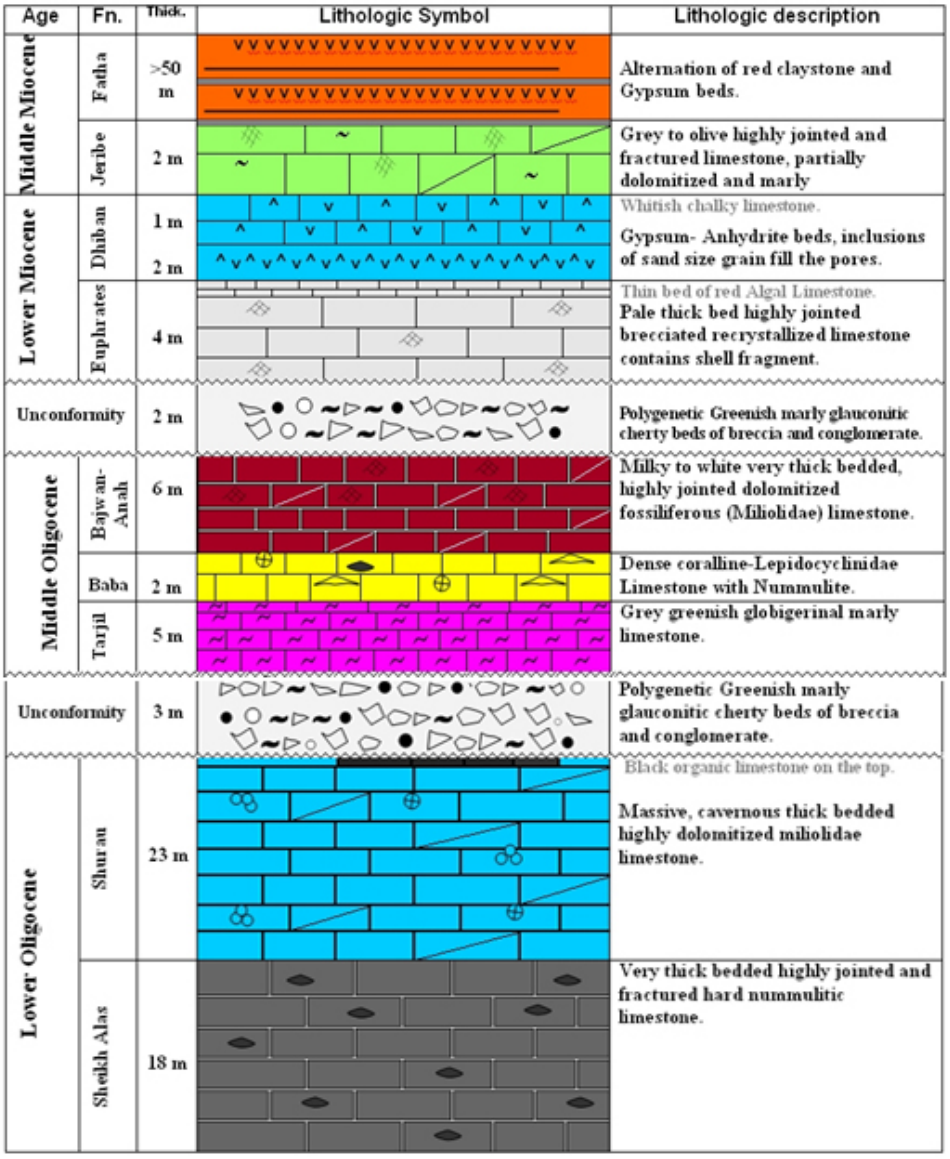

Figure (10): it shows stratigraphic column of Ashdagh Mountain; Tarjil Formation also included, (after Kharajiany, 2008).

Paleoenvironment

During the Oligocene, in Iraq, there were three cycles of sedimentation and all of them were reefal system (figure 11), each of them consists of Lagoon-backreef-reef-forereef-open sea alternation.

The first reef cycle (Early Oligocene) include Shurau Formation (lagoon- back reef-reef Miliolidae and coralline limestone), Sheikh Alas Formation (reef-forereef-Nummulitic limestone) and Palani Formation (from forereef- open sea- offshore marly globigerinal limestone), they have contributed to built the a base for the second cycle of Middle Oligocene ; both cycles are separated by a thick bed of glauconitic conglomerate.

The second reef cycle (Middle to Late Oligocene) is consist of Bajwan Formation (lagoon to back reef– reef with Miliolidae and coralline limestone), Baba Formation (reef- forereef- with Lepidocyclinidae limestone) and Tarjil Formation (forereef- open sea and offshore marly globigerinal limestone). The latter cycle sealed the early Oligocene sediments and contributed in base provision of the third reef cycle.

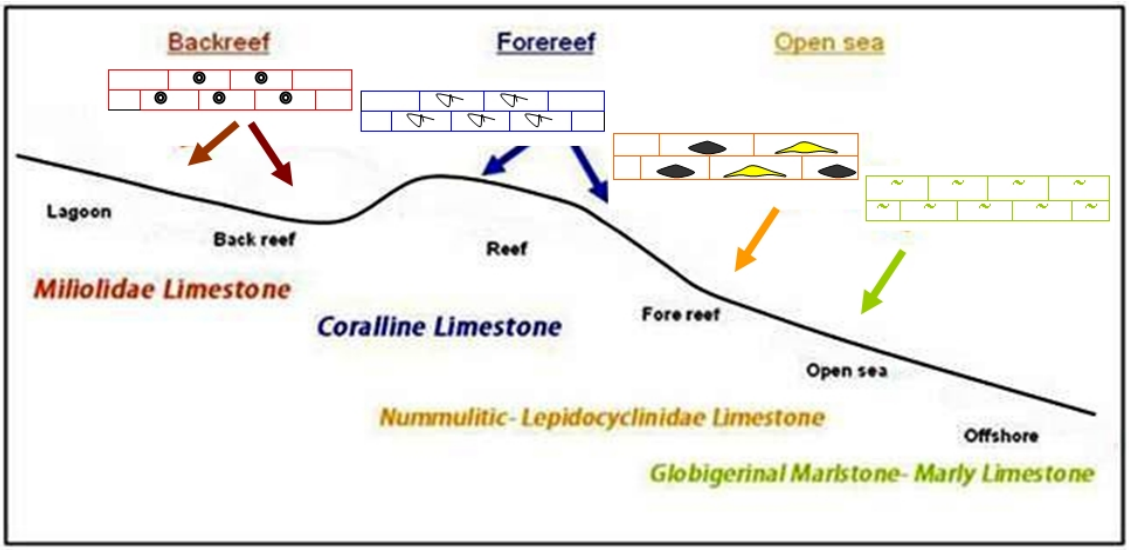

Figure (11): generalized cross section of the Paleoenvironment of Oligocene basin of Iraq; Lagoon-backreef- reef- forereef- open Sea- Offshore (not to scale).

The third is reef cycle (Late Oligocene) is starting with Anah Formation (lagoon-back reef-reef with Miliolidae and coralline limestone), Azqand Formation (reef- forereef Miogypsinoides limestone) and Ibrahim Formation (forereef- open sea- offshore marly globigerinal limestone).

In Ashdagh Mountain, the Middle Oligocene sediments are rested directly on the Lower Oligocene one. It means the lithofacies were orderly sequenced from deeper to shallower one (spatial distribution) later on, the limestone of Bajwan sediments has prograded on marly limestone of Baba Sediments. Same situation, during Early Oligocene, Shurau sediments rested on Sheikh Alas, and Shurau rested on Palani one while during the Middle Oligocene, Bajwan rested on Baba, and Baba rested on Tarjil one. But Al- Hashimi and Amer (1985) explained different story in other localities, he stated that various facies belts are displaced shoreward relative to the corresponding belts of the Lower Oligocene, for instance, Bajawan limestone rests partly on pre-Oligocene sediments, which formed the foreshore during the deposition of Early Oligocene cycle. Thus in Kirkuk the Bajawan limestonen rests on Avanah Formation of Middle- Upper Eocene. Similarly, Baba Formation rested partly on Lower Oligocene back reef - reef deposits of the Shurau Formation. The transitional zone between Baba and Tarjil Formations is found further towards the shore than the transitional zone between the Lower Oligocene fore-reef (Sheikh Alas Formation) and offshore sediments (Palani formation).

In areas where Tarjil Formation unconformably covers Palani formation, glauconite concentration marks the transgressional level. But in the studied area, the out crops of Palani Formation is not obvious, it is missed or eroded and then deposited with the conglomerate bed which is a thick bed of marly glauconitic conglomerated and represents the unconformity between Lower and Middle Oligocene sediments. It considered that with time span the volume of the Oligocene reefal basin reduced or become smaller due to sediment fill and the result was changes in microfacies.

The microfacies of Tarjil Formation in the studied area are the following.

1. (1m) of dolomitized globigerinal wackstone (with barely diversity of globigerinal faunas).
2. (3-4m) of dolomitized globigerinal wackstone (with highly diversity of globigerinal faunas).
3. (1m) of Dolomitized Pellitoidal Milliolidal wackstone mixed with globigerinal wackstone (mixing fauna).

It can be concluded that, the lower part of Tarjil Formation had deposited in the deep water basin which represented by globigerinal marly limestone, while the upper part, the facies consists of a mixing fauna of planktonic, benthic and large benthonic foraminiferas, bryozoa and other faunas which represent more shallowing environment (figure 9: 16-19).

Al-Hashimi and Amer (1985) described two types of facies in Tarjil Formation; a typical basinal facies which are characterized by abundant planktonic and small benthonic Foraminifera localized mainly at its lower part or at the deepest part of the basin, and a shelf margin facies characterized by mixed fauna of planktonic, benthonic and larger Foraminifera with algae and bryozoa, localized frequently at the upper part of the formation. It more likely that most part of the Tarjil Formation had deposited on shelf margin rather than on typical deep basin.

Through the current study and other studies from which Tarjil Formation have recorded (either at surface or subsurface locations), as paleobasin correlation of Tarjil Formation, it regarded to be distributed in Iraq and Kurdistan as following contour map regardless the correlation to the neighbouring countries (that's why some of contour lines are left as disconnected contours). From figure (12); it determined that Ashdagh Mountain is close to the depocenter of the whole Tarjil basin.

The abrupt contour condensing towards north and northwest of Kurdistan interpreted as a major fault or thrust which might cut the northern side of the basin, either before sedimentation or during sedimentation (predeposition or syndeposition fault), made the basin asymmetrical shape, that is narrow from northern side and wide from southern part. Also the basin had not expanded to western part because of the termination of the basin boundary in that side. Nonetheless, the eastern side of the basin not determined because it expands to neighbouring country Iran and it requires information acquirement and accurate correlation to that of Kurdistan.

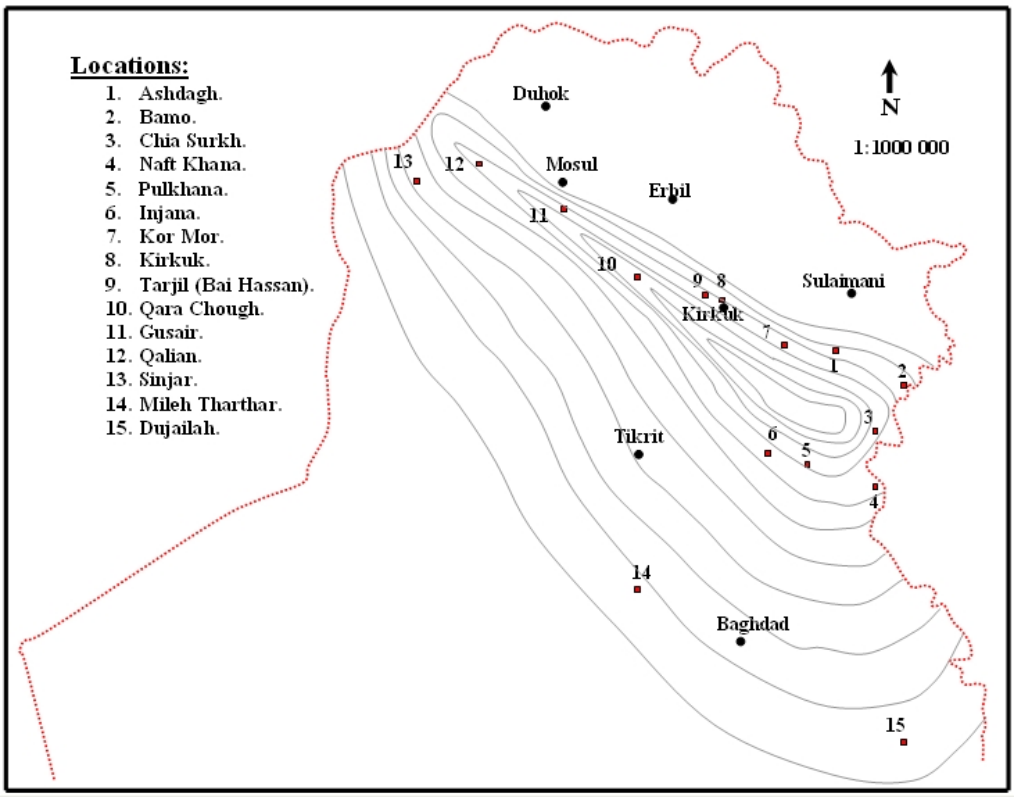

Figure (12): palaeogeographical distribution of Tarjil Formation Which depends on the correlation of the surface and subsurface sections from which Tarjil Formation described and denoted by numbers; the studied area also included.

Conclusions

The following points are concluded from this research:

1. The stratigraphy of Tarjil Formation for the first time is proved and described in Ashdagh Mountain. The age of the rock unit belongs to Middle Oligocene age
2. The Formation is comprises 6-7 meters of grey green splintery globigerinal marly limestone which partially dolomitized and pellitoidal.
3. The fossil contents are mainly planktonic foraminifera like *Globorotalia opima, Globigerina parebulloides, Globigerina ampliapertura, Globigerina angiporoides, Globigerinta gr.unicave, Subbotina angiporoides, Turborotalia cocoaensis,* and lesser amount benthonic foraminifera such as *Chiloguembelina cubensis. Nodosaria sp, Uvigerina hantkeni* and *Nodosaria sp,* while at the upper part of the rock units, large benthonic foraminifers could be seen such as *Sphaerogypsina sp, Austrotrillina howchini, Spirolina austriaca, Peneroplis thomasi* and *sponge fragments*. On the upper part of the rock u nits, mixing fauna of planktonic, benthonic and large benthonic foraminiferas are obvious.
4. The lower contact of Tarjil Formation is represented by a thick bed of conglomerate which is unconformity which located between lower and middle Oligocene ages, beneath the conglomerate the formation of lower Oligocene represented by Shurau Formation (miloidal coralline limestone). The upper contact of Tarjil Formation is gradational with Baba Formation (lepidocyclinae- nummulitic limestone), sometimes Tarjil Formation interfingers with Bajwan Formation (miloidal coralline limestone).

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