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Tectonostratigraphy of Eocene-Miocene Constructions in the Interior Areas of Fars and Hinterland of Bandar Abbas (Faulted Folded Zagros)

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ABSTRACT

The Zagros zone is located in the southwest of Iran and is bounded eastwards by the Minab fault. Its geological construction consists of a series of compressed anticlines with an axial surface usually vertical with a northwest southeast trend. This shows that Zagros is the marginal and mobile part of the Arabic platform and in the final sedimentation stages in this large basin, the syncline has been inclined to southwest under influence of gradual changes of fold axis. According to lithostratigraphic and tectonic assessment and the function of orogeny phases, for the first time in the region the relation between tectonostratigraphy introduced for Eocene-Oligocene and Miocene sedimentations with sequential facies series related to the mentioned sedimentations is noticeable and convergence is observed. For instance, the sequential boundaries show convergence with tectonostratigraphy boundaries in the majority of cases; for instance, in the Eocene-Oligocene boundary due to the function of Pyrenean orogeny phase disconformity is clear between the facies of Asmari and Jahrom constructions. Moreover, this shows that at that time the sediments have exited the water. This issue can be attributed to Tethys Alpine orogeny phases. The noticeable point is that the water surface process shows convergence globally with the tectonostratigraphy boundaries in the region. Of course, in cases which convergence does not exist, the local tectonics has played its own role.

Keywords Tectonostratigraphy, Orogeny phase, Eocene, Sequential stratigraphy, Miocene.

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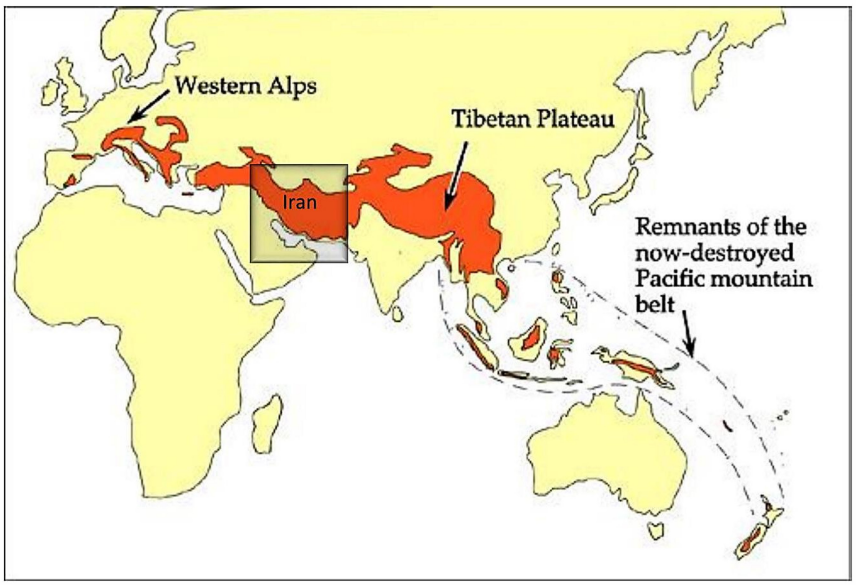

Fig. 1. Alpine-Himalayan orogeny belt and the location of Iran in it.

INTRODUCTION

Iran is geographically located in the southern margin of Eurasia plane and in the longitude between 44°5' and 63°18' and latitude between 25° 3' and 39° 47' this country has warm and dry climate. Iran is a platform land whose oldest rocks which in fact form the crystalized basement rocks of Iran, are about 1000 to 1500 years old. They are very young compared to the basement rocks of other locations in the world, which are about 3800 million years old (Rahimi 2013).

Iran is considered a part of the folded Alpine—Himalayan belt which is located between two supercontinents of Eurasia in the north and Gondwana in the south. These two supercontinents were one before and it was called the Megagea or Pangea (Khosrotehrani 2005) (Fig. 1). The accretion and breakup of supercontinent would form the dominant control on the geographic position and timing of all tectonically intercede activity and would there by profoundly influenced the tectonostratigraphic record of an area (Albaroot et al. 2016). The tectonic changes in a region can play a fundamental and important role in the changes in conditions of deposition of sediments in the sedimentary basin of sea progression and regression, disconformities and changes in the pressure and temperature applied to the rocks in the region. In this way, tectonic events make changes in rocks facies. Therefore, studying the sedimentary basins is necessary in identifying effective tectonic events during their expansion. One way to reach this aim is to study the stratigraphy sections and compare the chages in thickness and type of the construction in the adjacent areas. By studying stratigraphy sections we can find out about the changes in water surface and basin depth and thus the sea progression and regression and occurrence of disconformities and land subsidence of sedimentary basin.

Bandar Abbas hinterland located in southeast part of Zagros sedimentary basin in south of Iran and north of the Arabian plate. The eastern boundary of this hinterland is Minab Fault and its southern border crosses through Persian Gulf. Its northern border is according to the Razak fault. Zagros sedimentary rocks and structures (anticlines and synclines) in Bandar Abbas area show a different orientation than other parts of this basin. Anticlines and synclines of this zone are mostly eastern-western that is different from NW—SE trend of other zones of Zagros basin. The Guri Member has two different trends of thickness including northern-southern and eastern-western in the Zagros basin (Motiei 1993). The first thickness

trend has a range from 100 m in the west and southwest to 1,000 m in the north of Bandar Abbas. The second trend has a range from 1,000 m in the north of this zone to 100 m in the south of Bandar Abbas (Movahed 1995). This Member extends from the south of shiraz (Fars Province) to the Bandar Abbas area (Motiei 1993), some recent studies have reported the development of the Guri Member in the Dezful area in Khuzestan province (Homaiun - Zadeh 2002, Heidari et al. 2014).

The geographical location and access ways to the study area

In this study, five stratigraphy sections were taken and examined. The geographical location of the regions shas been explained below and access ways to them have been depicted (Fig. 2) (adapted from Iran roads of Iran Mapping Organization 2007).

Saadi mountain region

The section is taken from Asmari and Jahrom constructions in the southeast of Shiraz with geographical coordinates of X=52°56′00′′E and Y=29°31′00′′ N, 25 km from Shiraz.

Yasuj region

In this study, the Yasuj stratigraphy from Asmari and Pebdeh and Gachsaran constructions have been studied. Their geographical locations are, Latitude : 30°27′00′′ N, Longitude : 51°48′00′′ E this section is 25 km distant from Shahid and Yasuj cities.

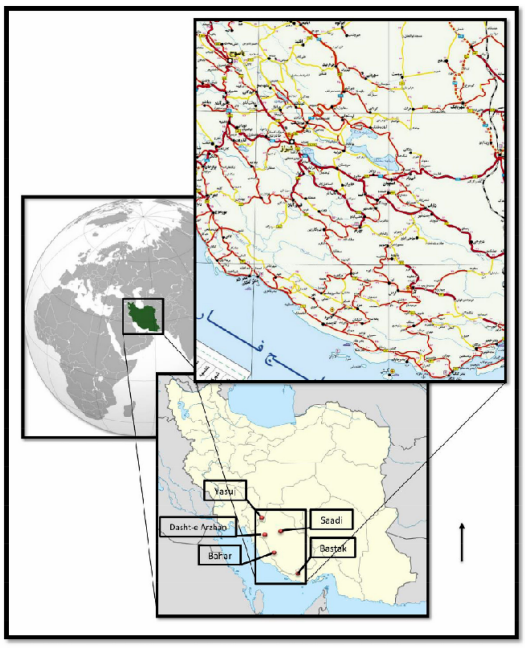

Fig. 2. The geographical location of the study area.

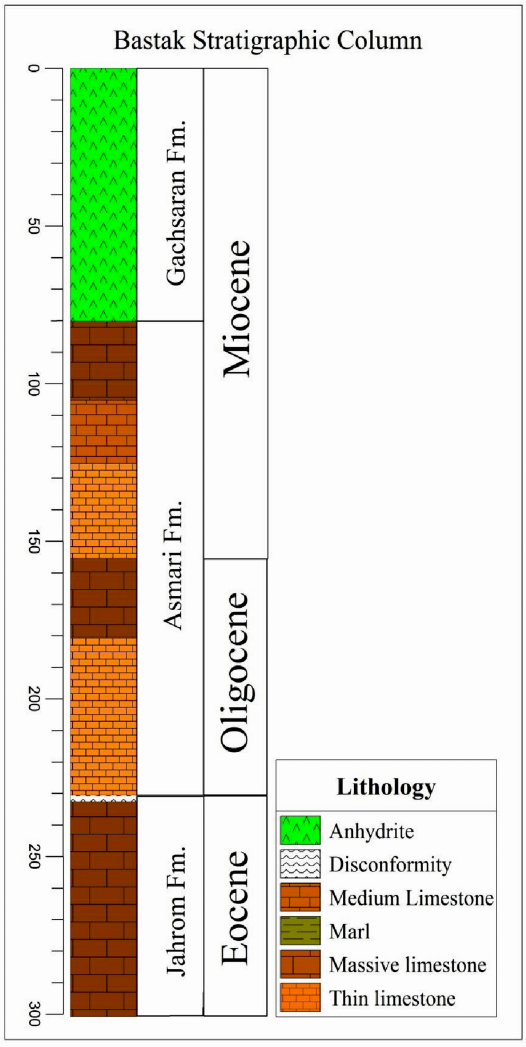

Fig. 3. Bastak stratigraphic column.

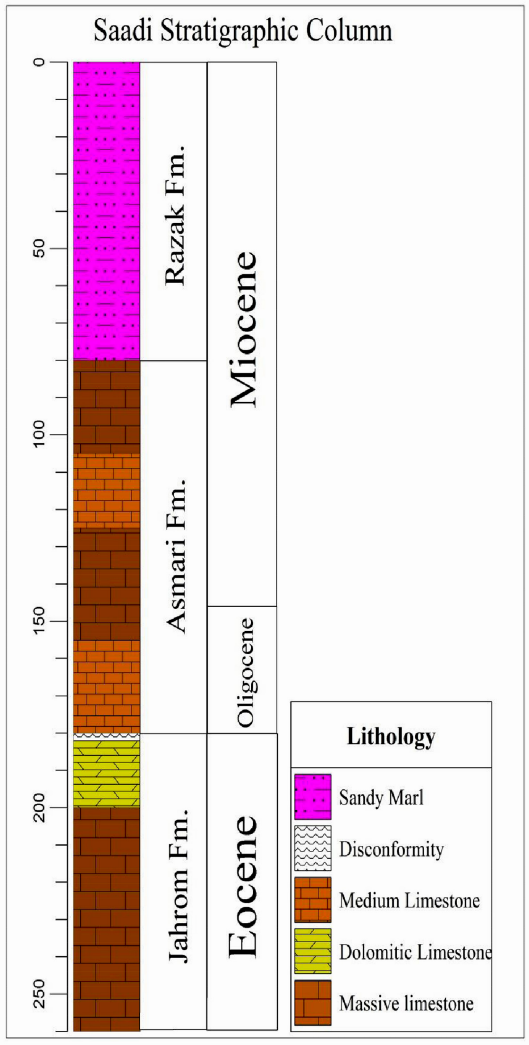

Fig. 4. Saadi stratigraphic column.

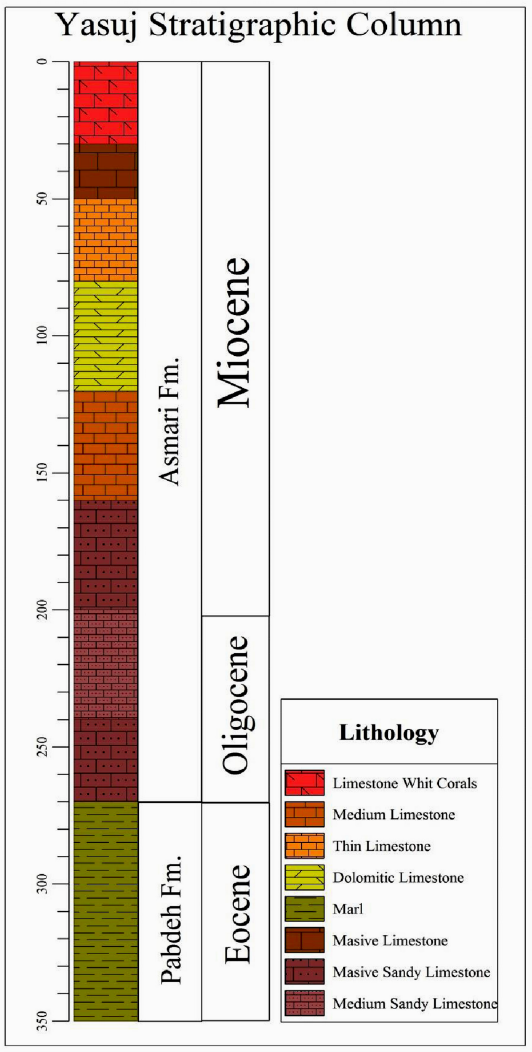

Fig. 5. Yasuj stratigraphic column.

Bahar anticline region

This section has been taken from Pabdeh , Asmari and Gachsaran constructions. Bahar anticline is distant 31 km from southwest of Farashband in Zagros orogeny belt. The geographical location of Bahar anticline is X : 52°17′00′′ E, Y : 28°37′00′′ N.

Bastak region

The stratigraphy location under study is near Bastak city and this section has been taken from Jahrom, Asmari and Gachsaran constructions. The geographical location of Bastak city is X : 54°23′00′′E, Y : 27°12′00′′ N.

Arjan plain region

Arjan plain is located 60 km from west of Shiraz in the Zagros belt. In the Arjan plain section, the sample includes Pabdeh, Asmari and Gachsaran constructions. The geographical location of Arjan plain is X : 51°57′00′′ E, Y : 29°40′00′′ N.

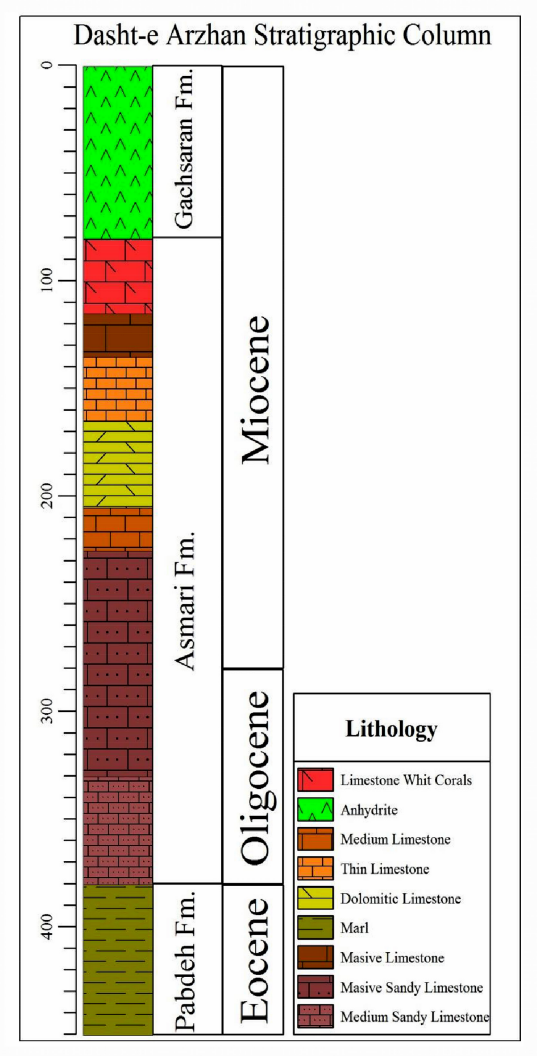

Fig. 6. Arjan plain stratigraphic column.

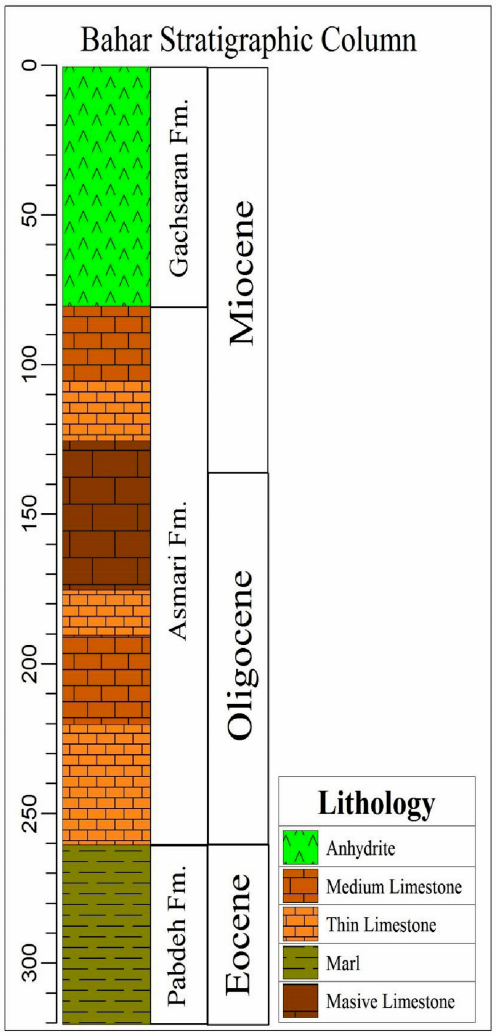

Fig. 7. Bahar anticline stratigraphic column.

MATERIALS AND METHODS

Tectonostratigraphy is a relatively new and actively developing field in the geology of sedimentary basins. This branch of geology studies the relationships between large lithostratigraphic units, for example, facially heterogeneous sequences, with particular attention to the influence of tectonic processes upon the origin of stratigraphic successions. At the same time , tectonostratigraphy is an integral part of classical geology and its fundamental started evolving very long ago in different countries and by various researchers. For instance, great importance of angular unconformities was recognized as early as in the 18 th century (Hutton 1795, Nikishin and Kopaevich 2008) to reach the determined aims in this research, after collecting the fundamental data, the study of all the previous research related to the subject started. In the next step, all the aerial and satellite photographs and geological maps were prepared. In order for general familiarization, we visited the regions containing outcrop around the region. Then, considering the subject, a more precise visit from the region was done. From the whole area, the most proper sections

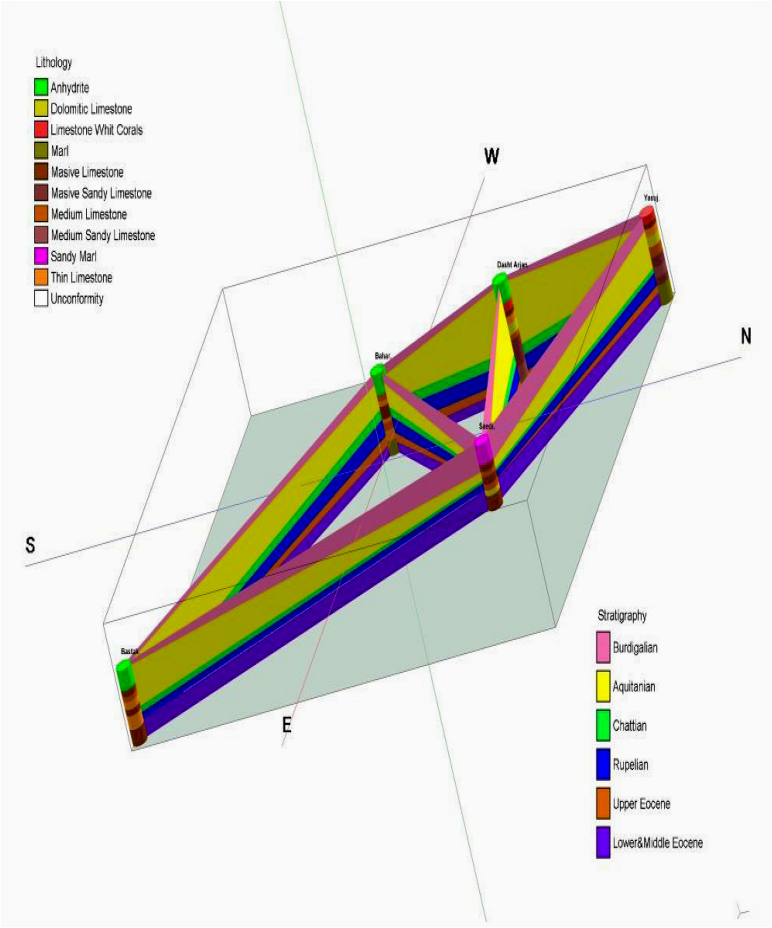

Fig. 8. 3D Fence Diagram of Eocene-Miocene.

were selected for systematic sampling. In addition, some regions were chosen for scattered sampling to complete the data. In the next step, field withdrawal was made out of the selected sections. Then, from the stratigraphy columns of the regions, the 3D Fence diagram, the Isopach map and the Paleogeography map of them was restored in the Eocene-Oligocene and Miocene period. The sedimentary environment of deposits was determined and the related patterns were provided. Finally, the sections under study were compared to each other.

RESULTS AND DISCUSSION

The stratigraphic column of the study sections

In this stage of the research, the stratigraphy columns of the regions were provided and compared to each other. The explanation of each column is as follows: In the Bastak region, Jahrom construction with 40 m thickness (in Eocene) is located with a disconformity under Asmari construction and at the upper boundary of Asmari construction there is Gachsaran construction with 80 m thickness (in the end of Miocene) (Fig.3) (Adams and Bourgeois 1967). In the Saadi stratigraphy column, the thickness of the whole Jahrom construction is 80 m, Asmari 100 m and Razak 80 m in the Eocene to Miocene period (Fig. 4). In the Yasouj region, the Pabdeh construction is located with Marl lithology of 70 m thickness. The lithology of Asmari construction sediments in this boundary is massive limestone with 269 m thickness (Fig.5). In the Arjan plain, the thickness of Pabdeh construction in the section under study is 70 m (in Oligocene) and Asmari construction is 290 m thick

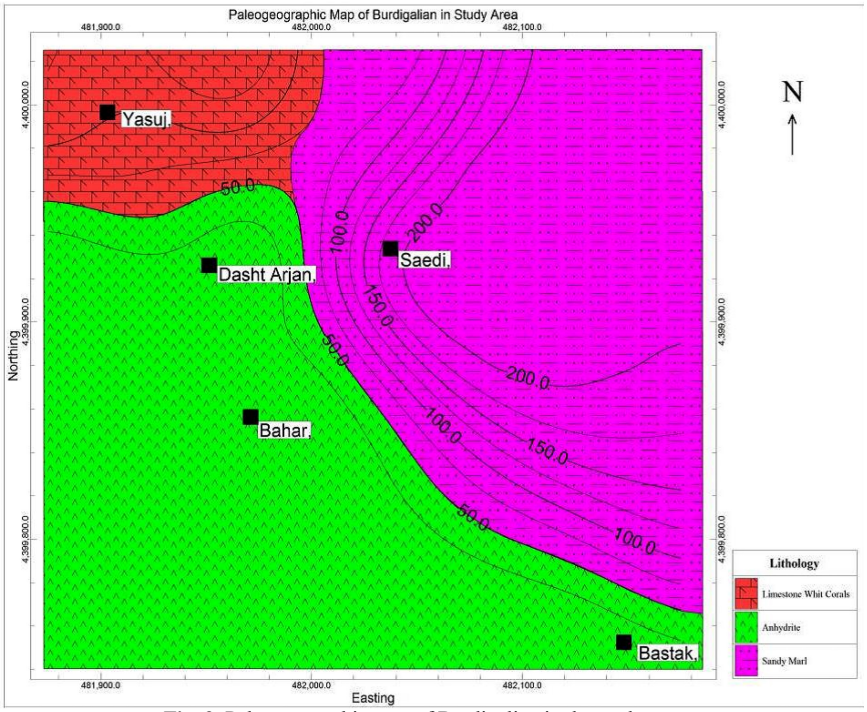

Fig. 9. Paleogeographic map of Burdigalian in the study areas.

(in Oligocene and Miocene) and its upper limit is Gachsaran construction with 80 m thickness (at the

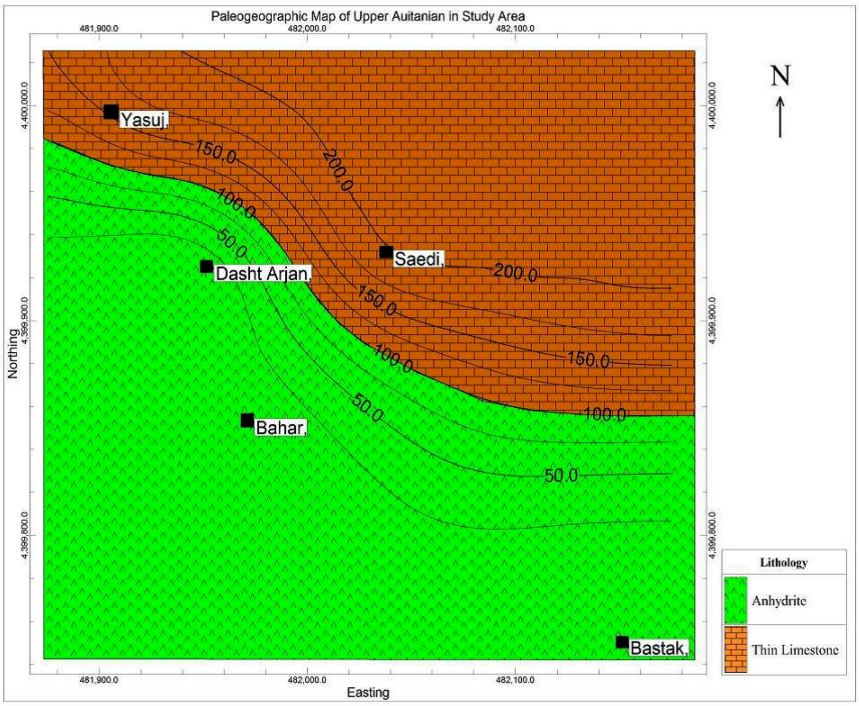

Fig.10. Paleogeographic map of Aquitanian (upper Miocene) in the study areas.

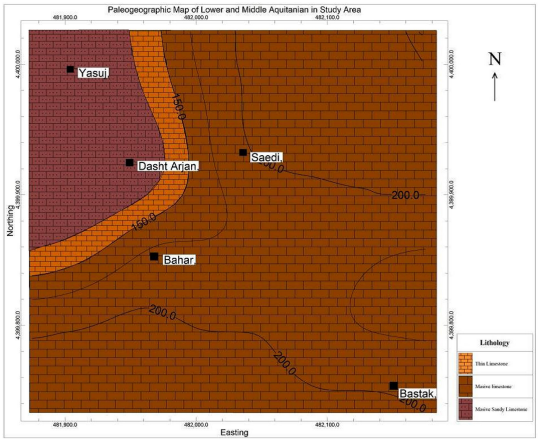

Fig. 11. Paleogeographic map of Aquitanian (lower and middle Miocene) in the study areas.

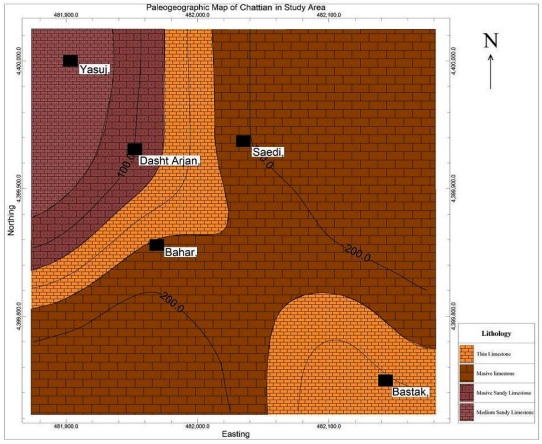

Fig. 12. Paleogeographic map of Chattian (upper Oligocene) in the study areas.

end of Miocene) (Fig.6). In the Bahar anticline region (Fig.7) the Pabdeh construction shale (Eocene) with 60 m thickness is the upper boundary of Asmari construction and Gachsaran construction with 80 m thickness is in the end of Miocene.

3D fence diagram

Given the data in the 3D fence diagram, the sections were depicted and the thickness of constructions was compared to each other in this stage (Fig. 8).

CONCLUSION

Considering the lithostratigraphic and tectonic assessments of the study area and the sequential facies series and the function of orogeny phases in the study area, the relation between the tectonostratigraphy units introduced for Eocene-Oligocene and Miocene sediments with sequential facies series related to the mentioned sediments is noticeable and convergence is observed (Figs. 9—21). For example, the sequential boundaries show convergence in most cases with tectonostratigraphic boundaries; for instance, in the

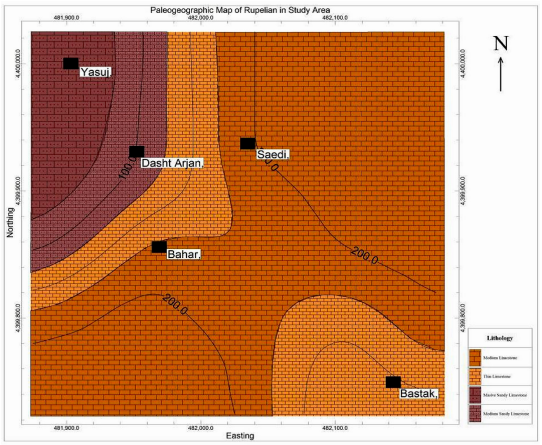

Fig. 13. Paleogeographic map of Rupelian (lower Oligocene) in the study areas.

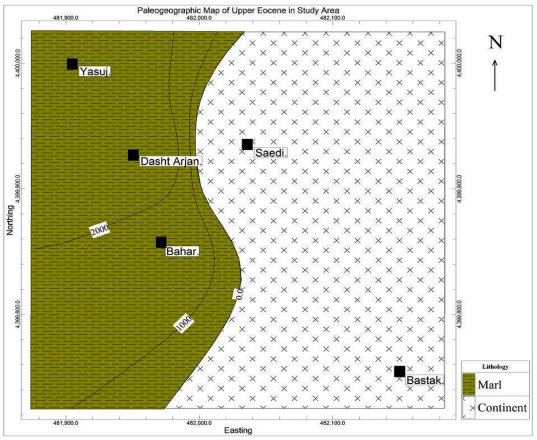

Fig. 14. Paleogeographic map of upper Eocene in the study areas.

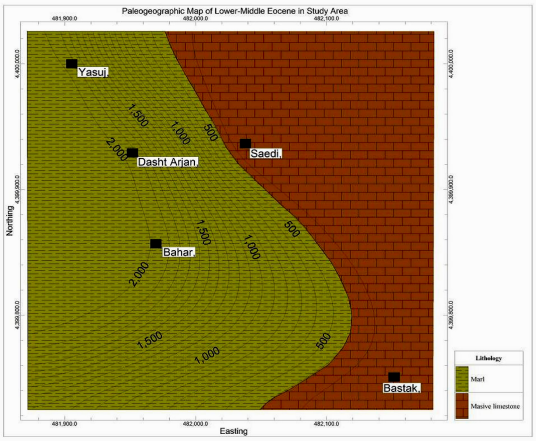

Fig. 15. Paleogeographic map of lower and middle Eocene in the study areas.

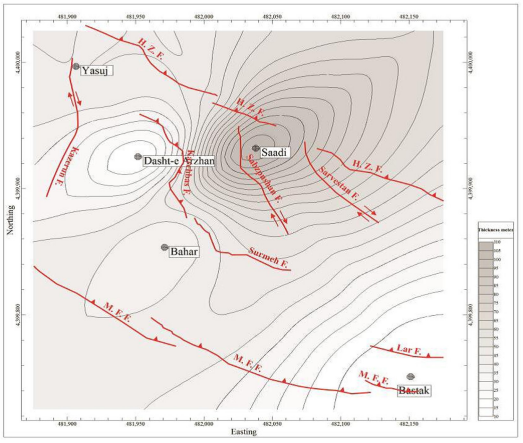

Fig. 16. Isopach map of upper Miocene (Burdigalian) together with the faults of the present time.

Eocene-Oligocene boundary due to the function of Pyrenean orogeny phase disconformity is clear between the facies of Asmari and Jahrom constructions. Moreover, this shows that at that time the sediments have exited the water. This issue can be attributed to Tethys Alpine orogeny phases. Moreover, the process of facies series LST (Low Stand System Tract) conforms to the beginning of evaporation sediments of Gachsaran, which was introduced in the Miocene tectonostratigraphic unit. Of course, the noticeable point is cases where there is no convergence, the local tectonics has played its own role. For instance, in the Eocene-Oligocene boundary, when this non-convergence is observed, the performance of local subsidence is verifiable. In addition, the performance of faults in a local form causes Disturbance and divergence in sea level changes in a local form, which is exactly observable and measurable in the stratigraphic equipment.

This issue is quite obvious in the Bahar anticline region. For instance, the alternation of lime and marl facies related to Jahrom and Pabdeh constructions from Bahar anticline toward Bastak and northwest of Bandarabbas is exactly due to of the subsidence and is a result of function of faults in that zone. In

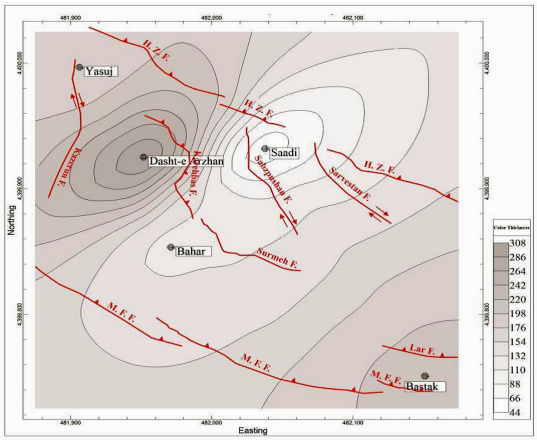

Fig. 17. Isopach map of lower and middle Miocene (Aquitanian) together with the faults of the present time.

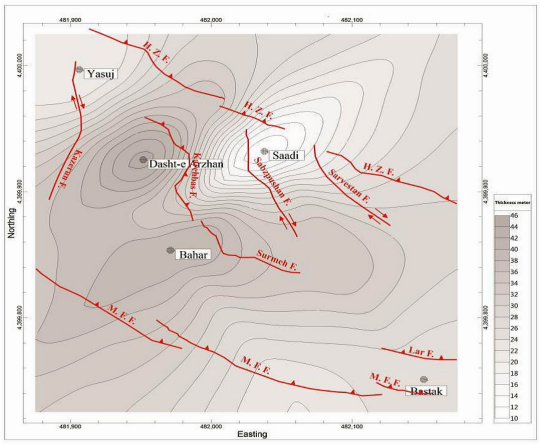

Fig. 18. Isopach map of Chattian (upper oligocene) together with the faults of the present time.

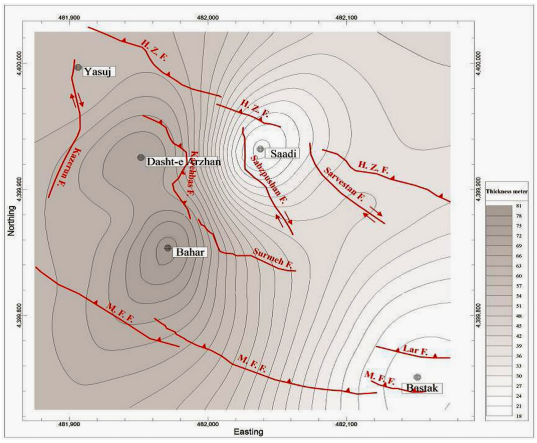

Fig. 19. Isopach map of Rupelian (lower Oligocene) together with the faults of the present time.

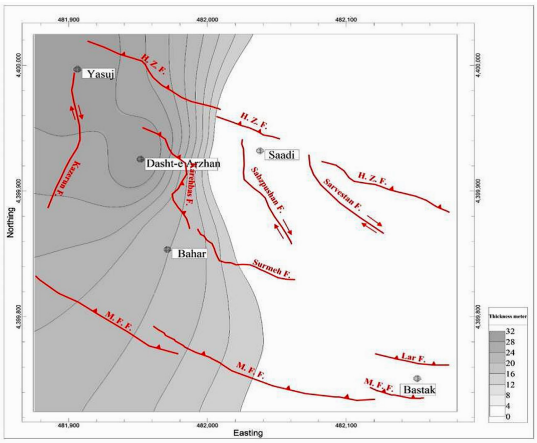

Fig. 20. Isopach map of upper Eocene together with the faults of the present time.

these areas both stratigraphic and sequential investigations show lack of convergence due to subsidence function and the faults of the region. This has caused disturbance and divergence in the sea level changes in a local form in these areas. Also, the performance of salt domes have played an important role in the mentioned changes.

Considering the tectonic studies of stratigraphic sections of the study area and studying the litho-stratigraphic and biostratigraphic sections and other parameters such as assessment of orogeny phases in the study areas, totally three tectonostratigraphic units were identified and introduced for the study areas which are as follows : (1). The techtonostratigraphic unit Eocene, (2). The tectonostratigraphic unit Oligocene, (3). The tectonostratigraphic unit Miocene.

Eocene tectonostratigraphic unit

This tectonostratigraphic unit includes Jahrom and

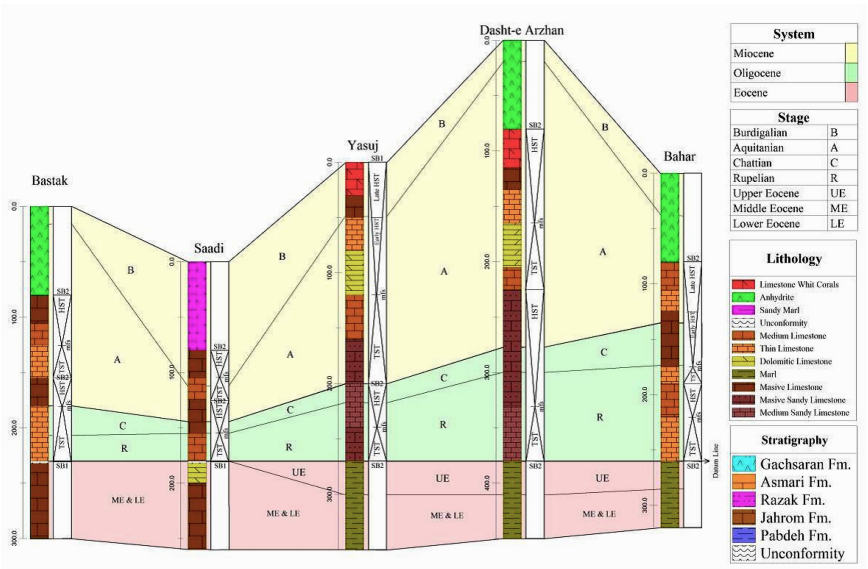

Fig. 21. Eocene-Miocene stratigraphic correlation.

Pabdeh constructions in terms of stratigraphy in the area under study. In terms of lithology, it includes limestone and dolomite in Jahrom construction and shale in Pabdeh construction. In terms of sedimentation basin, the related constructions includes the calm environment. Of course, in this time in Tethys basins the function of Pyrenean orogeny phase is important . The equivalent of this orogeny phase is observed in the Eocene facies of Jahrom construction; such that in the upper boundary of middle Eocene with Oligocene, lack of sedimentation at the time of upper Eocene in most points of Jahrom is indicative of land drainage function of this orogeny phase in the study area. The mentioned orogeny phases can be considered as the continuity of closure of Neo-Tethysrecurrences that continue to Oligocene as well. In other words, in thelime and dolomite facies of Jahrom construction to the age of these introduced sediments can be considered as between Laramide and Pyrenean orogeny phases. Of course, in some areas in Zagros and the study area where deepening of the basin has occurred and shale and marl sediments of Pabdeh constructions have facies, due to this deepening, the function of Pyrenean phase is not observable. In other words, exit from water has not occurred. This issue can be attributed in some points to local Subsidence as well. On the whole, the mentioned tectonostratigraphic phase to Paleocene-Eocene can be identified and introduced. The noticeable point is that in terms of structural division of Zagros basin, the introduced tectonostratigraphic phase is in the folded Zagros structural zone, which can be also introduced as the faulted folded zone.

Oligocene tectonostratigraphic unit

This tectonostratigraphic unit includes the facies of Asmari construction in terms of stratigraphy. This construction is considered as an old oil reservoir rock in Zagros due to Hydrocarbon storage. In terms of lithology, it includes limestone and lime dolomite . The lower boundaries of this construction (Asmari) are Pabdeh and Jahrom constructions. The boundary between Asmari and Jahrom constructions is clear as erosin disconformity which is due to Pyrenean orogeny phase function. In the upper boundary, it is observed as continuous with Gachsaran construction.

The mentioned tectonostratigraphic to the age of Paleocene-Eocene can be identified and introduced. In other words,the beginning of evaporation sediments of Gachsaran construction can be introduced as the upper boundary of this tectonostratigraphic phase. The existence of numerous fractures and cracks and fissures in this tectonostratigraphic unit shows the tectonic compressive powers of Asmari construction reservoir.

Miocene tectonostratigraphic unit

This tectonostratigraphic unit begins with Gachsaran construction retrogression, which continues at different points of Zagros and the areas under study to Mishan and even aAghajari constructions. Thementioned tectonostratigraphic unit is related to the last Alpine orogeny phases. These progression and retrogression trends conform to sequential facies series and are quite obvious; for instance, the progression of carbonate sediments of Membergoori. The end of the mentioned tectonostratigraphic unit (Miocene) can be considered as the beginning of Post-Danian orogeny phases series. This orogeny phase has continued to the present time.

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