Sequence Stratigraphy Based on Facies and Sedimentary Environments of Triassic Elika Formation in North of Tabriz, Iran

Rahim Mahari
Department of Geology, Tabriz Branch, Islamic Azad University, Tabriz, Iran

Abstract: Studied area is located in northen Tabriz (Northwest of Iran). Thickness of Triassic sedimentary rocks in this region is 855 meters. The base of these rocks is isocline with Permian units and the top have angular unconformity with Miocene sediments. These sedimentary rocks can be divided into carbonate and terrigenous facies. Based on the microscopic and field studies five facies can be recognize in carbonates. These facies relates to supratidal, intertidal, lagoon, barrier and open marine environmens. Terrigenous part includes massive polymictic carbonate conglomerate. This conglomerate generated in type-scott of braided Rivers. Based on facies cycle, three sequences are distinguished in this sedimentary record. The lower boundary of the first sequence is SB2 and upper boundary of the third sequence is SB1.

[Rahim Mahari. **Sequence Stratigraphy Based on Facies and Sedimentary Environments of Triassic Elika Formation in North of Tabriz, Iran.** *Life Sci J* 2012;9(2s):64-70] (ISSN:1097-8135). http://www.lifesciencesite.com. 11

Key words: Triassic, Facies, Sedimentary Environment, Sequence Stratigraphy, Tabriz.

1. Introduction

Stahl considered existence of Triassic rocks in Alborz as possible for the first time. Glaus called Triassic rocks of Alborz as Elika formation. Cutting pattern of the formation is measured in the right edge of Elika valley and 5 km from the Elika village (north of Tehran).Elika formation in cutting pattern is included 95 m thick beds of limestone and shaly limestone (the vermicular) at bottom and 200 m of dolomite and dolomitic limestone at above. Moro is a region where its sedimentary rocks is considered equivalent to Elika. Studied section in this research is outcropped in 29 km to north of Tabriz (North West of Iran) beside a secondary road leading to Sohrol historic church (Figure 1).

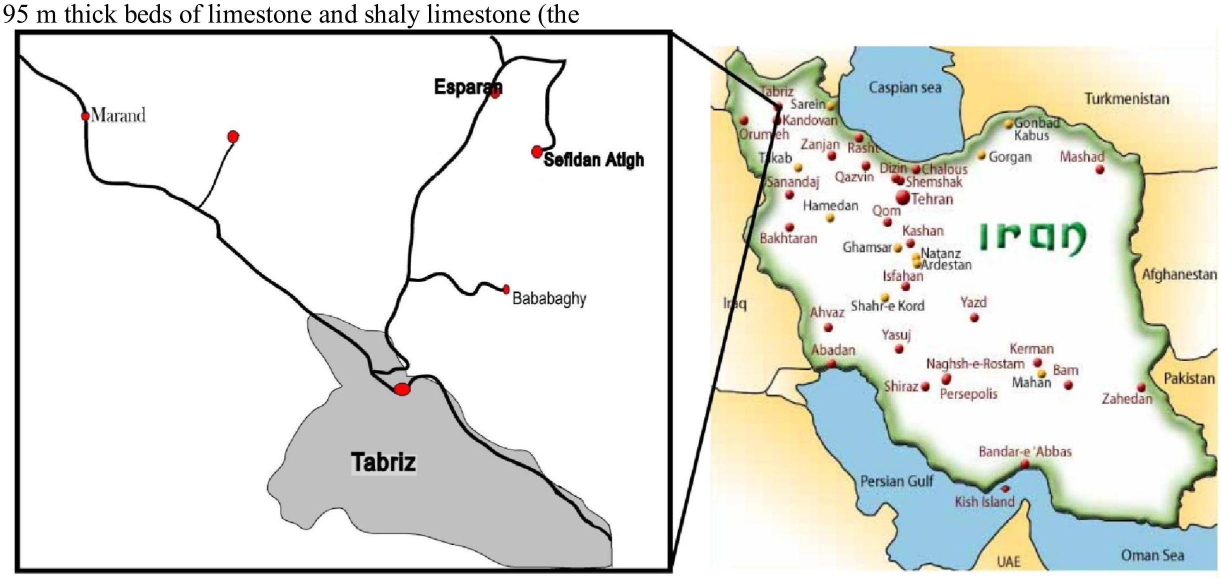

Figure 1- Map of access paths and location of the studied section

Triassic sedimentary rocks outcrop in the north of Tabriz has 855 m thick. The sedimentary units are consisted of marl and limestone as well as Shale layers, thin layer to tick layer dolomites and polymictic conglomerate layers. These deposits are laid isocline on Permian sediments. Upper border has angular discontinuity with red Miocene conglomerate deposits.

2. Research method

This paper aimed to introduce facies, sedimentary environments and determining sedimentary sequence of Triassic deposits in the north of Tabriz. Sedimentary facies have been separated based on microscopic studies and field study. Dunham method is used for naming carbonate facies. Provided sedimentary environments are determined by considering changes of vertical and lateral facies. Sedimentary sequences have been isolated based on the fundamentals of sequence stratigraphy.

2.1. Lithostratigraphy

In studied section, Elika formation is located isocline on permian deposits. Triassic deposits are started with a meter of medium bed and dense limestone. The deposits can be divided into two groups of carbonate and destructive. Carbonate deposits can be divided into two parts. The underside is made of limestone. The undersides of limestone are bioturbated. Two marly layers with dark brown shale middle layer are deposited over the bioturbation layers. Marly limestone with full fossil layers contains bivalve fossil are located on these sediments. Most of these deposits are alternation of thin layer limestone and medium to thick layer limestone. In some cases of these calcareous sediments, foraminifera are observed. Upper part of carbonate deposits are included dolomitic beds. These deposits are often alternation of thin bed limestone and medium and thick bed limestone. The layer is upper, the thickness of beds increase. Among carbonate sediments, three within-formation conglomerate layers are composed. The destructive part with erosion boundary is located on underlying carbonate deposits. The deposits with angular discontinuities are covered by Miocene conglomerate. Figure 2 shows the stratigraphic column of the Triassic deposits of the studied section.

2.2. Facies and Sedimentary environment

Carbonate deposits are divided into the following five main facies based on microscopic and field study.

1- **Facies and sedimentary environment of the open sea**

These facies are divided into two sub-facies based on content of carbonate mud called O1 and O2. O1 (Echinoderm Lime Mudstone): the background of facies is composed of micrite. Micrite partly recrystalized to microspar. Allochems are echinoderm and bivalve fragments. The main feature of this facies is bioturbation.

O2 (Bivalve Wackestone-Mudstone): Allochems are echinoderm and bivalve fragments that are increased compared to O1. Allochems are into the micrite. This facies include marls and thin bed limestone as well as dark brown medium beds of shale. Features such as bivalve fossils (Figure a3) and echinoderm (8), a lot of carbonate mud (micrite) (9, 10) marl-shale alternation (Figure b3) thin bed calcareous shale (11) and the lack of exit water effects are identified open sea environment.

2- **facies of barrier environment**

The barrier facies (B) is composed mainly of ooid. Other allochems are pelloid, intraclast, bivalve fragments (figure 4) and gastropod. The compact sedimentary fragments are located into spary cement. Contact between the fragments is pointted, linear and concave-convex. These facies are recognizable micrite, ooid and geoptal fabric. A lot of ooid and spary cement shows that fragments are formed in high-energy environment. Formative ooids and geoptal (figure 4) show the effect of climatic events. Intraclast (figure 4) and pelloid have been deposited in channels between barriers. Today, the original location of depositing ooid in the Persian Gulf is tidal deltas.

3- **Facies of lagoon environment**

This facies is divided into three sub-facies called L1, L2 and L3 based microscopic and field studies. Low diversity of fossils, remains of organisms resistant to salinity (16), frequency of micrite and light marls with no fossil show limited environments with high salinity i.e. lagoon.

L1 (Coarsening Upward Gastropod Packstone): Allochem that composed these facies are gastropod, palsypod fragments, rounded mictitic fragments and grapestone. These fragments are in the micritic matrix. The underside of facies is finer grained and more compact. Toward upside, the size of allochems is increased but their percentage is decrease. This trend shows increasing biological sedimentary and reducing chemical sedimantary. Upperside of facies is cluttered because of bioturbation. Allochems of these facies are strongly micritic (figure 5a)

L2 (Finning Upward Gastropod Packstone): the fragments of these facies including gastropod, bivalve fragments, echinoderm fragments, grapestone and pelloid in the matrix of micrite. Toward upside, the size and percentage of allochems is reduced and carbonate mud amount is increased. Allochems of these facies are strongly micritic. The existence of out of water effects in pseodoform of evaporitic minerals and gravitational cement (Figure 5b) under two sub-facies (L1 and L2) shows that these sediments were formed in closed environments where water is alternately inserted into them (like when storm).

L3 (Marl and Marly Limestone with Bioturbation): the facies are included yellow laminated marl without fossils to marly limestone containing intact bivalve fossils and gastropod. At the top and bottom of these deposits, very thin bed marl and bioturbation limestone is located. Bioturbation is as curved horizontal effects with length of 4 to 6 cm that their ends moved out of layer. There are no out of water effects in these facies. Marly sediments without fossils are formed in oxygen and salty waters.

4- Intertidal facies and sendimentary environment

The development of these deposits in the region is significant. Between-tidal facies are divided into six sub-facies I1,I2, I3, I4, I5 and C (figure 6).

I1(Boundstone): This facies is composed of micritic and alternative algal laminations. A small percentage of gastropods, calcisphere and intraclast are observed in this facies. Today, in Persian Gulf, algal covers are formed just in the tidal environment. The characteristics of this facies are related to tidal environment are: the algal materials, *fenestral fabric,* forms results of dying, such as finely dry leaves, crinkled laminations and evaporitic minerals format that can be seen in the Persian Gulf.

I2 (Intraclastic Bioclast Packstone): Allochems of this facies are echinoderm fragments, bivalve fragments, pellois, intraclast and rarely foraminifera that are located compactly and without orientation in the middle of micrite. Fragments size decreases upward. Intraclast is one of features of intertidal environment.

I3 (Bioclast Wackestone-Packstone): in this facies, gastropod, calcisphere, ostracod fragments and echinoderm fragments are desposited in the matrix of mictrite. The orientation of ostracod fragments shows performance of oriented flows like tide on the sediments. In addition, Allochemical facies (Wackestone to Packstone) are shown intertidal environment.

I4 (Pelloid Wackestone): in I4, there are echinoderm fragments, ostracod, calci sphere, intraclast, foraminiferal fragments and evaporitic minerals mold. The existence of intraclast and evaporitic minerals molds are shown intertidal environment.

I5 (Intraclastic Wackestone): this facies is included intra-formation conglomerate. In the thin sections of gastropod, echinoderm fragments, calcisphere and evaporitic minerals pseodomorphs can be observed. Filed outcrop is included fine upward layers that sometimes ripple marks can be seen among them. Today, this type ripple marks are also formed in coasts. Over some layers, cross laminations and cross bedding can be observed. These structures are storm layer's characteristics.

C (Intraclastic Bioclast Packstone-Mudstone): this facies are shown desposites of tidal channels. Allochems that are formed this facies include starched intraclasts, micritic bivalve shell fragments, ostracod fragments and gastropod fragments that are reduced upward. Stretched allochems show orientation. This facies is characterized by erosional base.

5- Supratidal facies and sedimentary environments

Supratidal deposits are specified by S (Lime Mudstone) facies. This facies includes thin bed to very thin bed deposits. The characteristic of these deposits is mud cracks (17, 23), crinkled laminations (figure 7) and evaporitic mineral pseodomorphs (17). Allochems that rarely be observed in this facies include intraclast, ostracod fragments, gastropod fragments and bivalve fragments. As mentioned earlier, coarse clastics are over the carbonate deposits. The last carbonate deposits are thick bed dolomite. On these deposits, 13 meters mass conglomerate coarse upward are deposited by matrix and carbonate sedimentes.

The maximum diameter of these fragments is 50 cm. The deposits with angular disconformity are located under conglomerate and sandstone deposits of Miocene.

3. Sedimentary model

According to regular changes of carbonate facies, it can be concluded that these deposits were formed in a ramp-type carbonate platform. Accordingly, the evolution of the ramp can be divided into two phases. In first phase, barrier facies and lagoons behind the barrier are not developed. Therefore, deposits are formed in a ramp matched to Ahr model(24). In the second phase, there are also barrier and lagoon deposits. The deposits were formed in a ramp matched to Burchette and Wright models(25). According to facing South Caucasus and Alborz microplate to Eurasia (26) and the regression of sea, coarse clastic deposits are also formed. The existence of these sediments and lack of sedimentary structures is specified type- scott braided river environment. In this type of rivers, gravel sediments near to the origin, masive and horizontal (Gm facies) are formed in wide and shallow channels (Se Facies). Changes of the size of these deposits are due to area's tectonism and uplift.

3.1. Sequence stratigraphy

Based on facies changes and depth of facies as well as considering type of under boundary of type-2 three sequence (type-2 under boundary sequence or SB2), deposits of Elika formation in the north of Tabriz have been specified.

Sequence 1

The sequence is composed of TST and HST facies. TST facies category includes O1, O2, I1 and I2. Dark brown shale of O2 facies specifies maximum flooding surface (mfs). On the surface, HST facies category consists of I1, I4, L2, C and S facies are located. The channel facies (C) shows sea level stability and long-term waves actions on the HST ancient coastline. The lower boundary of this sequence is formed due to isocline of S facies deposits and Permian deposits and lack of dissolution and erosion of SB2 (7). So, this sequence considers as type-2. The upper boundary of this sequence is SB2, which specified by S facies.

Sequence 2

According to lower boundary (SB2), the sequence is type-2. Facies of second sequence are TST and HST. TST facies include I5 and B. in today ramp with wave's energy and low tides, TST sequences are mainly formed of packstone and wackstone sediments. Grainstones can only exist in form of regional underwater hills(bars). Due to the expansion of lagoon deposits in this area and the out of water effects (geoptal and formative ooids), it can be concluded that grainestones were formed in barriers and in high-energy conditions during the TST. Maximum flooding surface (mfs) is determined by barrier facies (B). This sequence includes the destructive deposit. The third sequence is FSST facies. The FFST facies are determined according to conglomerate deposits. Due to erosional boundary of carbonate deposits with destructive deposits, it can be concluded that coarse clastic deposits were formed in result of severe sea regressed with regional uplift. Therefore, under boundary of SB1 sequence and this sequence is type-1. This facies includes massive carbonate conglomerate. The upper part of these deposits is coarser. The upper boundary of sequence according to the angular disconformity between the Triassic and Miocene deposits and lack of deposits between these two times is SB1. The curve of sea level changes in the region shows two phase of progress during the Triassic. The first two progresses in curve of global sea level changes (28) are matched to the first sequence. The third phase of progress can be matched to second sequence. The third sequence also matched to represented regression in curve of global sea level changes (Figure 9).

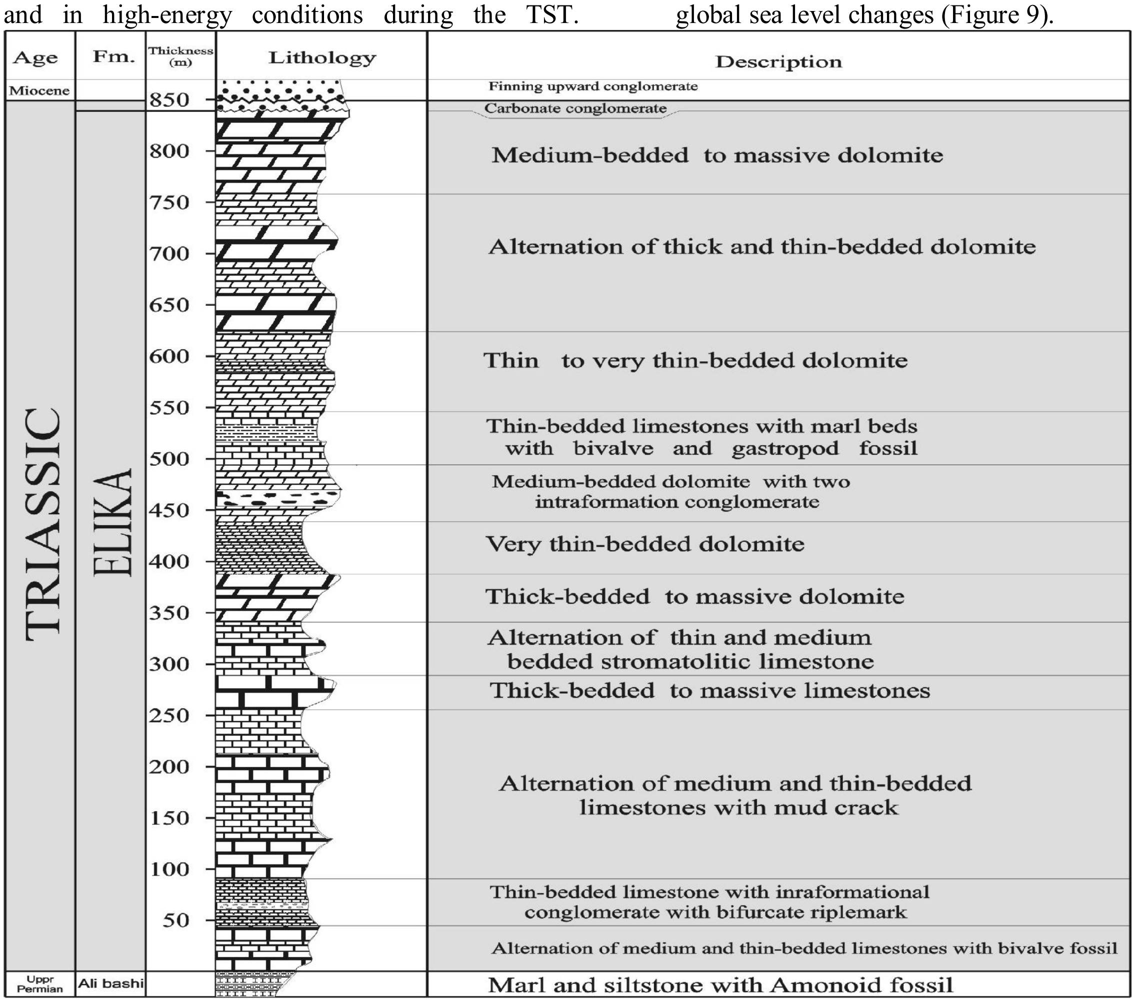

Figure 2- Stratigraphic column of Elika Formation deposits in the North of Tabriz

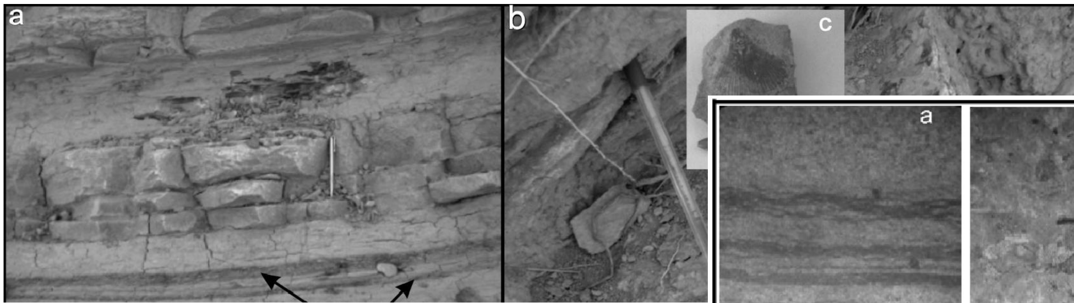

Figure 3- Open marine deposits (a) interabeds of shale in marl are shown with arrow. (b) full-fossil layers filled with intact bivalve fossils (c) sample of a bivalve fossil in full-fossil layers

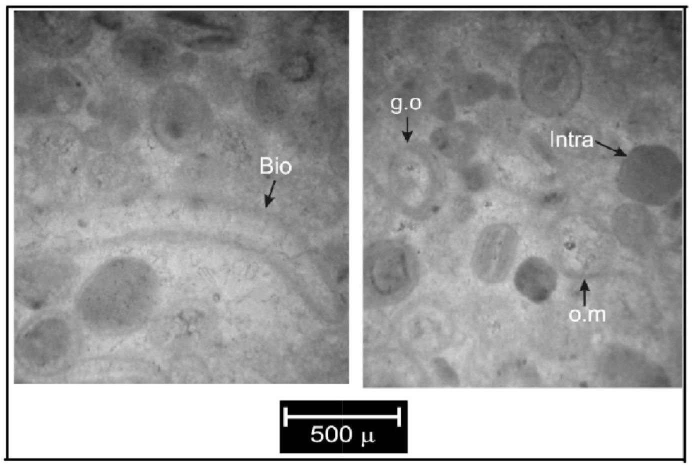

Figure 4- Microscopic image of B facies (Bio). Fragments of bivalve shell coating on mictite that its underside is composed of shelter cement. "Intra" is intraclast that shows remain sediments of channel bed. O.m. (formative ooid) and g.o (geoptal ooid) show the effect of atmospheric processes. These components are used in spary cement and compact texture.

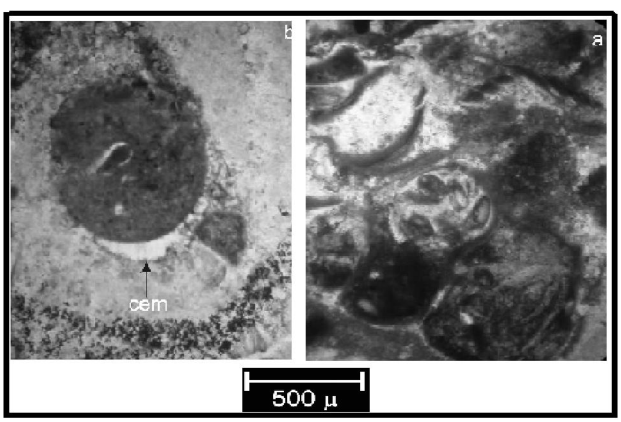

Figure 5- Microscopic image of lagoon deposits: (a) compact texture of allochems that are strongly micritic (b) the formation of gravity cement under a piece of micritic gastropod.

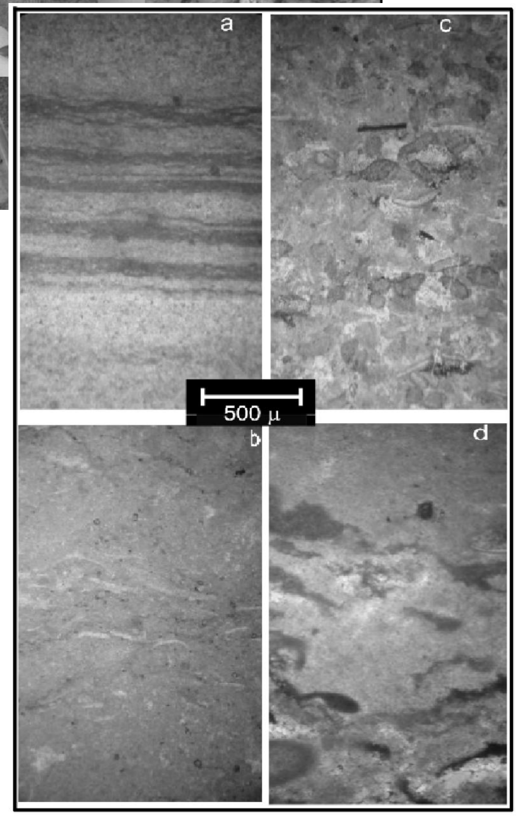

Figure 6- (a) algal laminations under facies I1 (b) compact texture and frequent pelloid of sub-facies I2 (c) the relative orientation of ostracod fragments of sub- facies I3 (d) sub- facies C

Figure 7- The color of chrinkled very thin layers and laminations in high tidal sediments (sub-facies S)

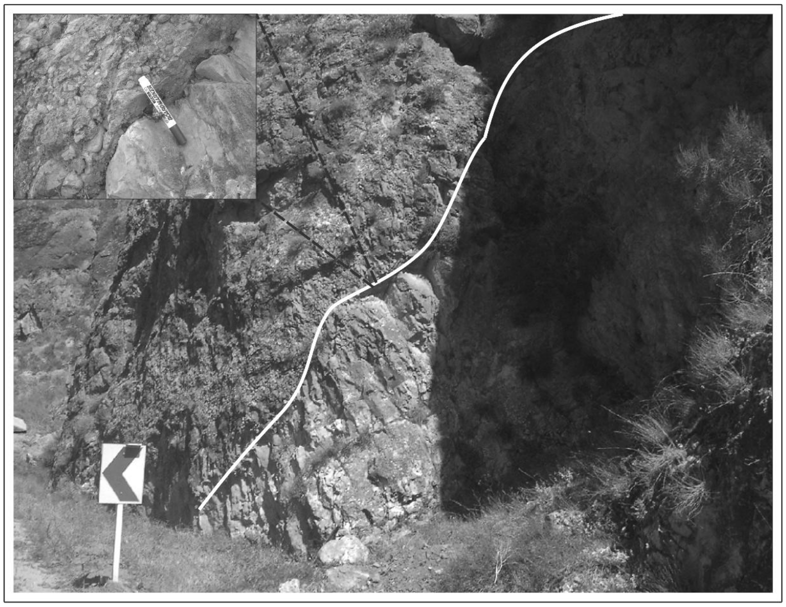

Figure 8- Figure 8: Erosional boundary of massive conglomerate (top) and dolomite (below) of Elika formation in the North of Tabriz

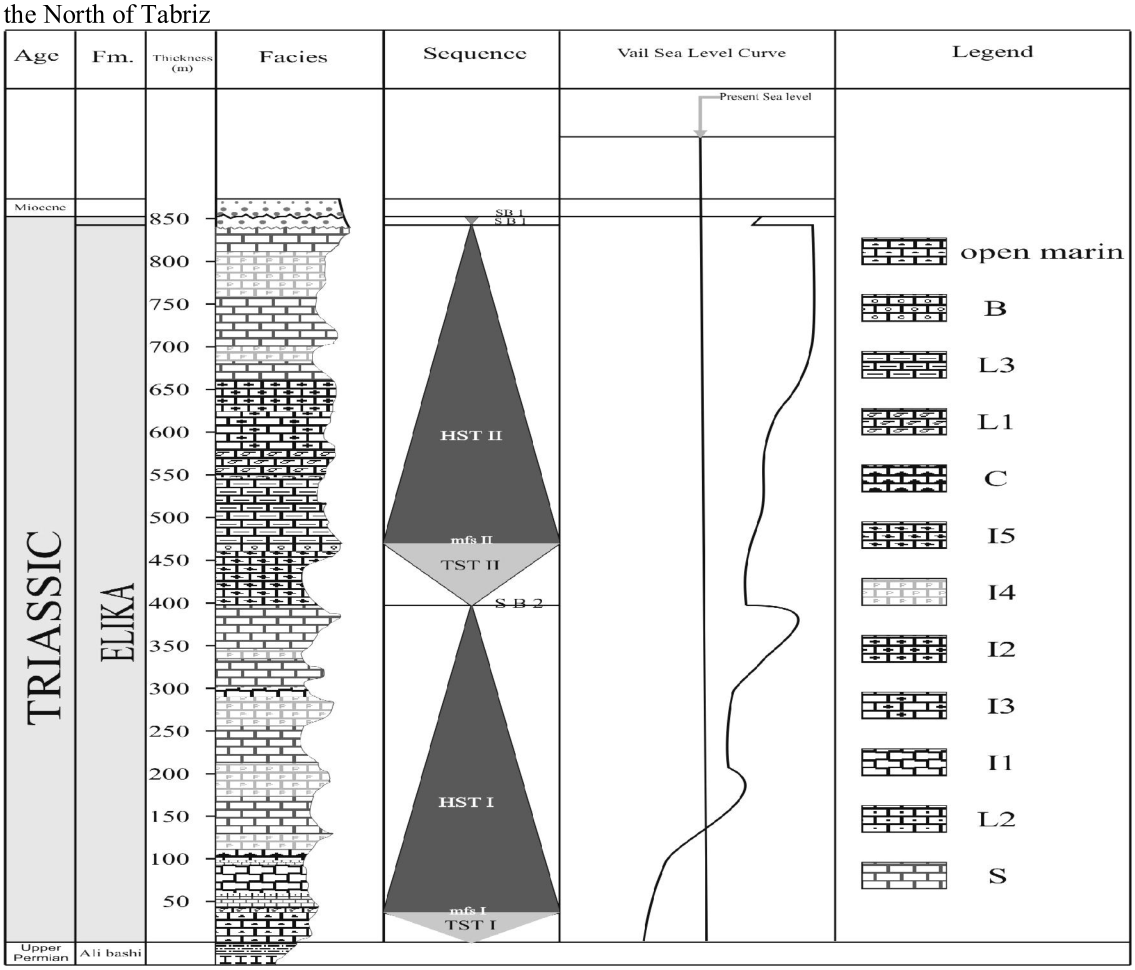

Figure 9- Facies column, sedimentary sequences of Elika formation in the North of Tabriz

4. Conclusion

In the North of Tabriz, 855 meters of Triassic sedimentary rocks are outcropped. Although the boundary of the Triassic deposits is considered as isocline with Permian sediments, the study of sedimentary sequences shows the existence of a disconformity (SB2). These deposits with angular disconformities are covered with miocene conglomerate desposits. Based on field and laboratory studies, mentioned deposits can be divided into two parts, carbonate and clastic. Five main facies related to open marine environments include barrier, lagoons, intertidal and supratidal environments are determined in carbonate deposits. Clastic facies are deposited in type-scott braided River. Based on study on facies, three type-2 sedimentary sequences can be specified. The lower boundary of the first sequence is type-2 (SB2) and the upper boundary of the third sequence is type-1 (SB1). The first and second sequence is consistent lower with curve of sea level global changes but the third sequence is comparable with the upper part of the curve.

References

1- Stahl, A.F., Heidelberg (Winter), Hft 8, **V.5**, 46 P, (1911).
2- Glaus, M., Eclogae. Geol. **No.2**, P 407, (1964).
3- Abich, H. Von., Wien (Holder), **12**, P 49, (1878).
4- Stepanov, D.I, Golshani, F, Stocklin, J., Geol. Surv. Iran, Rep, **No.3**, P 69, (1969).
5- Seyed Emammi, K
6- Dunham, R.J., AAPG. Mem, **1**, P 108-121, (1962).
7- Lasemi, Y., Facies, Sedimentary environment and Sequence stratigraphy of sedimentary rocks of Upper Precambrian and Paleozoic in Iran, Geol. Surv. Iran, (1999).
8- Reading, H.G., Sedimentary Environments, Blackwell Science, (1996).
9- Calvet, F., Tucker, M.E., Sedim. Geol., **57**, P 185-198, (1988).
10- Faulkner, T.J., Geol. J., **23**, P 85-100, (1988).
11- Einsele G, Ricken, W., Cycles and Events in Stratigraphy, P 23-47, (1988).
12- Halley, R.B., J. Sedim. Petrol., **47**, P 1099-1120, (1977).
13- Mazzullo, S.J., J. Sedim. Res., **47**, P329-397, (1977).
14- Jahani, D., Sedimentary basin analysis of Elika formation in central and eastern Alborz, Islamic Azad Univ. Iran., (2000).
15- Purser, B.H., Tidal deposits: a casebook of recent examples and fossil, Springer-Verlag, (1977).
16- Tucker, M.E, Wright, V.P., Carbonate sedimentology, Blackwell Scientific Publication, (1990).
17- Hardie, L.A., Q. J. Colorado Sch. Mines, **81**, P 37-57, (1986).
18- Sellwood, B.W., Shallow marine carbonate environments. In sedimentary environments 2nd edn (Ed. by H. G. Reading), Blackwell Scientific Publications, (1986).
19- Purser, B.H., The Persian Gulf: Holocene carbonate sedimentation and diagenesis in a shallow epicontinental sea, Springer-Verlag, P 471, (1973).
20- Johnson, H.D, Baldwin, C.T., Shallow siliciclastic seas. In: Sedimentary environments 2nd edn (Ed. by H. G. Reading), Blackwell Scientific Publications, P 229-282, (1986).
21- James, N.D., Shallowing upward sequence in carbonates. In: Facies models (Ed. by R. G. Walker), Geosciences Canada, (1979).
22- Adabi, M.H., Atlas and glossary of primary sedimentary structures, Arian Zamin, P 124, (2003).
23- Tucker, M.E., Sedimentary petrology an introduction to the origin of sedimentary rocks, Blackwell Science, (2001).
24- Ahr, W.M., Trans. Gulf Coast Ass. Geol., **23**, P 221-225, (1973).
25- Burchette, T.P, Wright, V.P., Sedm. Geol., **79**, P 3-57, (1992)
26- Golonka, J., Palaeogeography, Palaeoclimatology, Palaeoecology, **244**, P 297-307, (2006).
27- Caputo, R., Global and Planetary Change, **57**, P 417-423, (2007).
28- Vail, P., Mitchum, R.M., Jr & Thomson III, S., Seismic stratigraphy and global changes of sea level. In : Seismic stratigraphy applications to hydrocarbon exploration (Ed. by C. E. Payton), Mem. Am. Ass. Petrol. Geol, **26**, Tulsa, (1977)

9/6/2012