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Research Article

STRATIGRAPHY FACIESES AND SEDIMENTARY ENVIRONMENTS OF QOM FORMATTION SOFIYAN REGION, NORTH WESTOF IRAN

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ABSTRACT
Qom formation which has the same age with Oligocene _ Miocene shows considerable expansion in northern regions of Sofiyan. This formation which has the thickness of 358 m, is generally formed of thick bedded Limestones. The lower boundary of Qom formation is covered but its upper boundary is determined disconformity with Upper Red formation. The constitutive facies of this formation are consisting of: calcareous conglomerate, marl and thick bedded to thin bedded Limestones. The following microfacieses are determined in these deposits: Bioclastic Packstone, Algal Grainstone, Rudstone, Floatstone, Bioclastic Packstone, Bioclastic Wackstone, and Bioclastic Wackstone – Packstone which are deposited in four substructure of Lagoon, back Reef, Reef, front Reef and open marine and formed template of carbonate shallow marine with rimed Ramp type of sedimentary environments of Oligomiocene sea of Sofiyanregion.

Keywords: *Stratigraphy, Sedimentary Facies, Sedimentary Environment, Qom Formation, Sofiyan, Iran*

INTRODUCTION
Geology of northwest of Iran and Azerbaijan is relatively complicated. Most geologists believe that there are similarities between geologic characteristics of this area with Alborz Mounts and sometimes with central Iran zone. Therefore expansion of stratigraphy units and Azerbaijan formation in North West of Iran is very similar to central Iran and Weston Alborz (Agha-Nabati, 2006). Like central Iran regions, Neogene formations are formed frequently in this region that one of the most important units is Qom formation. Qom formation has been of geologists' interest from long ago because of presence of oil resources in some parts of it. Detailed studies are done about stratigraphy and paleontology of this formation in most parts of Iran but the study of facieses and sedimentary environments about this formation is limited. Significant expansion of this formation is seen in Sofiyan region in northwest of Tabriz, East Azerbaijan province in north west of Iran. For this study the field sampling was conducted from cross –section of Qom formation in northern mounts of Sofiyan at N 38́16́ longitude and E 45° 58́latitude.The access to sampling field becomes possible from transit road of Tabriz –Marand from Sofiyan city with split towards north and over several kilometers (Figure 1).

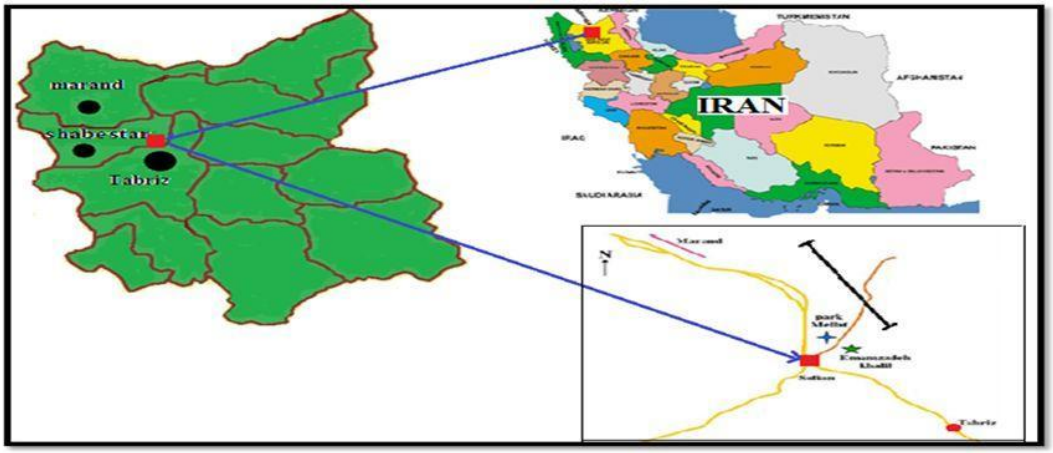

Figure 1: Geographic location of study area and access roads to the geological section

MATERIALS AND METHODS

Research Method

After field studies with the use of square geological map of Marand (Asadian *et al.*, 1994), suitable stratigraphy shear in north of Sofiyan city was chosen and 93 samples were taken from 358 m thickness of Qom formation.

The prepared thin sections were carefully studied under the light of lithology and its components were identified and separated. After careful study of thin sections, imaging was performed from micro fossil slime stones were named based on Dunham (1962), Ambery and Colvan (1979), Wright (1992), and Redding (1996) methods. Naming those icrofacieses and sedimentary environments were done based on the models which are provided by Wilson (1975) and Flugel (2004, 2010). Finally, the results of the above steps were mapped in the form of diagrams of stratigraphic columns, vertical distribution of microscopic microfacieses and sedimentary model.

Sedimentary Environments of Qom Formattion Sofiyan Region

The study shear in this area was measured 358 m which is consist of marl, limestone and conglomerate levels and these sequences have the same age as Oligocene –Miocene. The lower boundary of Qom formation in Sofiyan region is covered but its upper boundary is determined by Upper Red formation. Upper Red formation has the same age as Miocene and is consist of conglomerate, marl and sandstone deposits. In this formation, the above mentioned limestone deposits are 217 m thick which are intermittently located on each other like rock unites.

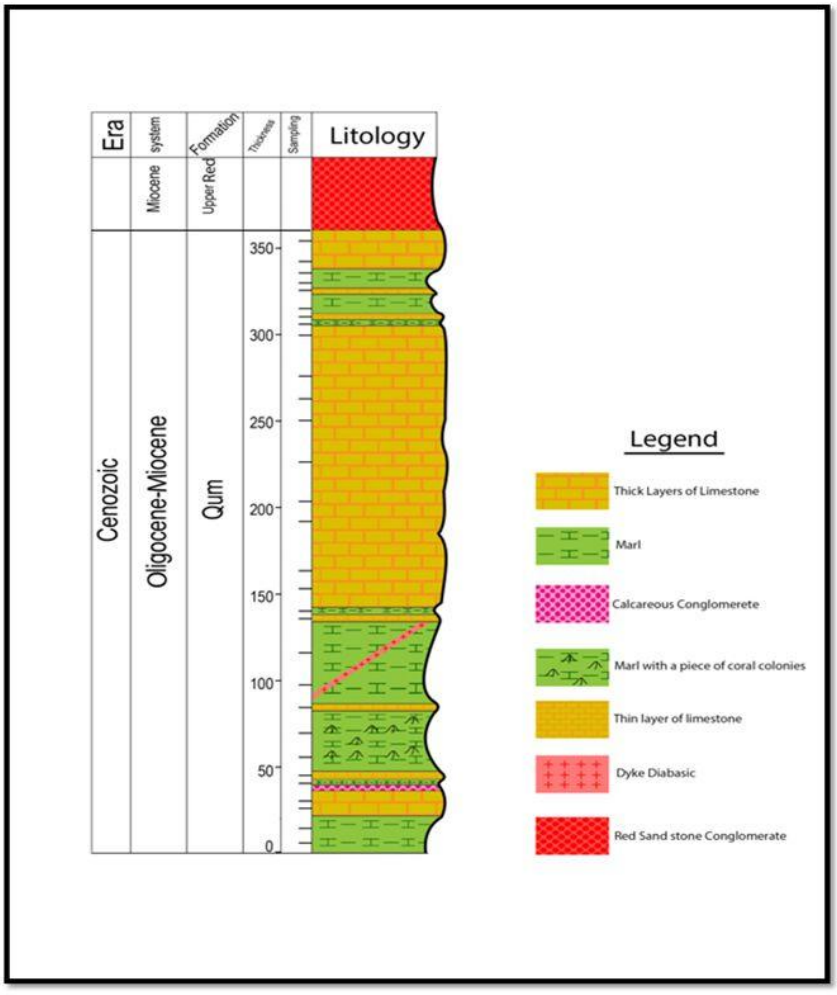

Figure 2: Stratigraphical column of Oligo-Miocene deposits in North of Sofiyan

In this rock unit, the layers are seen with different thicknesses, from thin layer to thick layer. In this shear, rock units have mild slope and also are composed of different layers of marl, lime and Conglomerate that cause different thickness layering on each other because of the difference in type and sedimentary conditions. The basal marls of light, thick bedded limestone with calcareous conglomerate inter beds and then re-expansion of calcareous marls has formed the lower part of the formation. The upper part of the formation is generally composed of thick beded lime stones which cover marl inter beds in parts near the top (Figure 2).

Microfacieses

Based on field and laboratory studies and petrography of microscopic samples, microfacieses of Qom formation in Sofiyan region are categorized in four groups of lagoon or back reef, reef, front reef and open marine.

1. A Microfacieses (Lagoon Microfacieses or Back Reef), Bioclastic Packstone

This microfacieses are consist of red algae (8-20 %), abundant small fossils like textularia (5%), miliolid (5%), rotalia (5%), filing brachiopod mussels (5-10 %), echinoid (7-10 %) and in some sections filing bryozoan mussels (5 %) (Figure 3).

This facies contains quartz and chert (5-8 %) which are located in matrix of microspar. In some parts of the sections also micrite matrix with small Alluchems are visible. Clastic streaks and Stylolite levels with combination of Iron Oxide are seen in sections of this facies (Figure 3).

The presence of broken and comminuted fossils and intermittent micrite matrix shows that theses deposits are formed in a limited environment in which water has intermittently entered. Therefore, it is determined that sedimentation environment for this microfacies is lagoon or back reef and Flugel'sIII-3 energy index (2010) is suggested for this microfacies. This facies includes thin beddedlimestone that is located in Wilson's FZ7facies belt (1975) and is comparable to Flugel's RMF20 standard microfacies (2010).

2. Group B Microfacieses (Algal Reef Microfacieses)

Algal Grainstone: Skeletalalluchems of this facies are red algalbioclasts with 20-45% frequency, miliolid, textolaria, and cibicides each one 5%, bryozoan bioclast(7-10%) and echinoid bioclast (5-7%). Quartz (3-5%) can be seen in sections of this facies. These particles can be seen in the context of microspar to psudospar and spary

The frequency of red algae and presence of bryozoan and variety of skeletal components indicates the normal condition of warm, shallow with high energy marine. The absence of micriteand presence of spary cement in different sections indicates reef environment. This facies is the most energetic facies of the study sequence and we can consider Flugel'sV-3 energy index for that. This microfacies is located in Wilson's FZ5 facies's belt and is comparable to Flugel's RMF7 standard microfacies (2010). It is equivalent to Flugel's (2010) and Wilson's SMF10 microfacies (1975).

3. Group C Microfacieses (Fore Reef Microfacieses)

C1 Microfacies –Rudstone: The constituent alluchems of this facies are red algae bioclast about 15%, bioclast of coral (25%), fossil fragments of Miliolid (3%), Textolaria (4%), bryozoan (3-4%) andechinoid bioclast (5%) which are located densely in a context of microspar (Figure 6). It is possible to see micrite and sometimes Spar in some parts of the sections.

The broken bioclast of allochems and micrite background indicate that these allochems are moved towards the front part of the Reef in Reef area and are broken because of the environment's energy and are deposited in front part of the Reef because the energy has reduced. Flugel's energy index is IV-3 for this microfacies and also it is comparable to Flugel's RMF 28 standard microfacies.

C2 Microfacies – Floatstone: This faciesis consists of red algae bioclast (15-20%) which are located in float matrix (Figure 3).

The context of this microfacies is micrite and microspar and in some parts sparite. Other allochems of this microfacies are Foraminifera bioclast like miliolid, textolaria and cibicides. Also bryozoanbioclast (6-7%) and echinoid and Crinoid filings (5-7%) have allocated the sections. We can see quartz and chert (5-8%) and also calcite streaks and stylolitein these sections.

The broken bioclast of allochems in floating matrix shows that these allochemsare moved towards front part of the reef and they are broken during the movement and after the energy has decreased they have deposited.

The Flugel'sIV-3 energy index is suggested for this facies. It is comparable to Flugel's RMF28 standard microfacies (2010).

C3 Microfacies–BioclasticPackstone: Skeletal Allochems of this facies include red algae bioclast, coral, Bryozoan, textolaria, miliolid, Rotalia, cibicides, echinoid filings and shell fragments of brachiopods.

It is also possible to see Quartz in sections of this microfacies.

These allochems are located densely in a context of microspar. In some parts of the sections, we can see micrite background. Calcite streaks are also seen in the sections.

The Broken allochems (Figure 3) in the context of microspar show that these allochems are moved and that they are broken during the movement.

The broken allochems are deposited in for part of the Reef with reduction of the energy. According to above mentioned points, Flugel's energy index (2010) is IV-1 for this microfacies.

This facies is comparable to Flugel's RMF7 standard microfacies and it is equivalent with Flugel's (2010) and Wilson's SMF13 (1975) facies.

C4 Microfacies- Bioclactic Wackestone: This facies is consist of skeletal allochems of red algae filings, bryozoan, miliolid, textolaria, cibicides, Rotaliabioclast, echinoid and Crinoid filings and also shell fragments of Brachiopods.

Non-skeletal allochems of this facies include quarts and chert and all are floating (Figure 3) inmicrospar context.

The fossils are broken and Stylolite and Calcite streaks (Figure 3) and in some parts of the section Iron Oxide can be seen.

Broken and comminuted allochems in floating matrix indicate their movement and breaking up and deposition in front part of the Reef.

Flugel's energy index is III for this facies. This microfacies is comparable to Flugel's RMF7 standard microfacies and it is equivalent to Flugel's (2010) and Wilson's SMF13 microfacies (1975).

The microfacies of group C (Front reef microfacies) are located in Wilson's FZ4 (1975) facies's belt.

4. D Microfacieses (Microfacieses of End of Continental Slope in Open Marine)

Bioclastic Wackestone- Packstone

The allochems are relatively small in this facies and detrital components of quartz and chert about 7-10% have allocated the sections.

Skeletal Allochems of this facies include red Algae (4-10%), textolaria (3-5%), bryozoan (3%), brachiopods filings (6-10%) and achinoid filings (4-7%). Its orthochem is micrite and the components are small (Figure 3).

This facies includes thin layered Limestone. Based on intermittence of small and average laminations and small particles,
Flugel's II-1 energy index (2010) is suggested for this facies. This microfacies is located in Wilson's FZ3 facies's belt (1975).
It is comparable to Flugel's RMF13 standard microfacies (2010) and is equivalent with Flugel's (2010) and Wilson's (1975) SMF18-for microfacies.

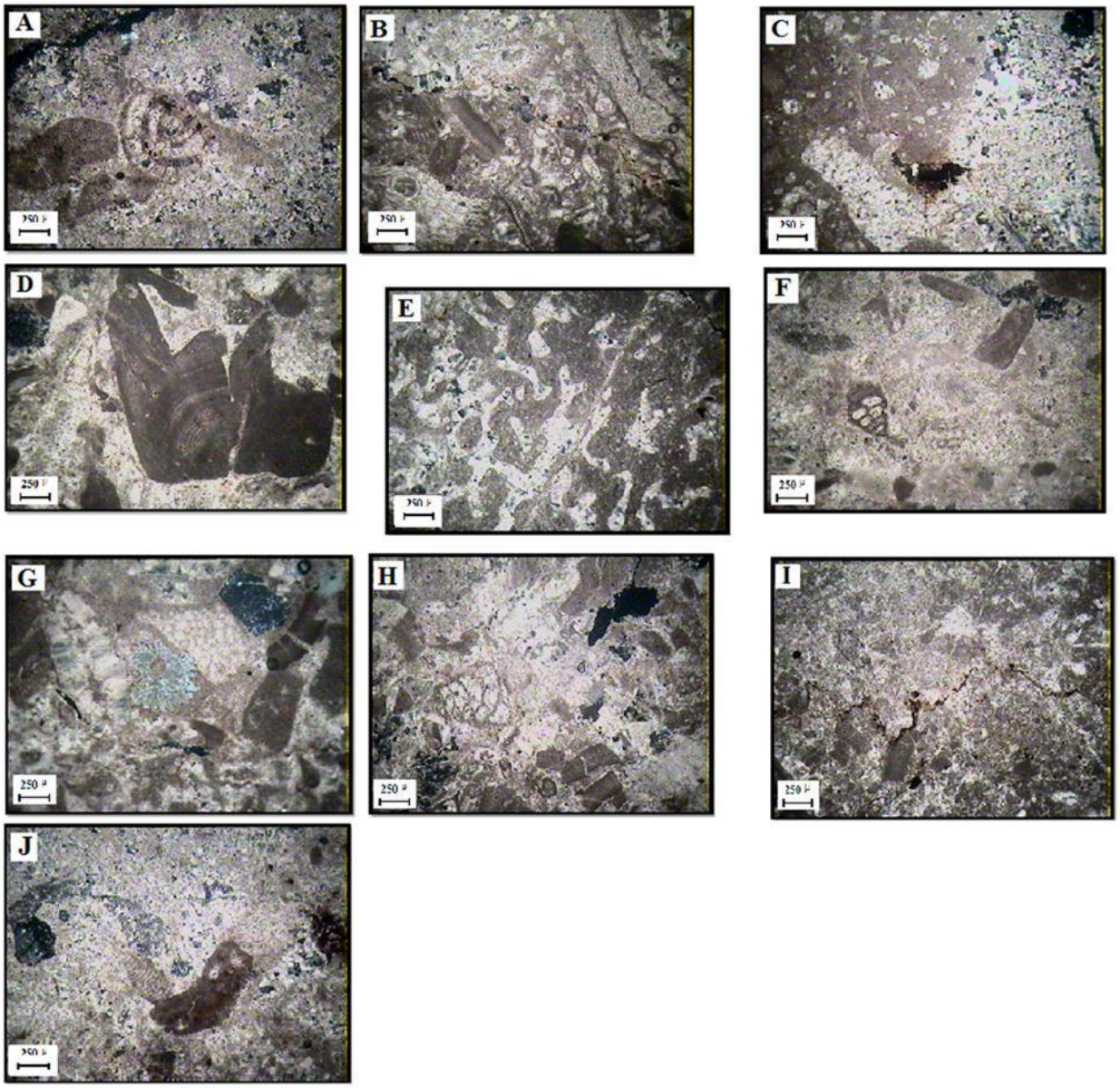

Figure 3; Bioclasticpackstonefacies with red algae and echinoid(A), stylolite and iron oxide in lagoon(B, C), algal grainstonefacies in reef environment(D), rudstonefacies with coral bioclasts(E), floatstonefacies with textolaria(F), bioclastic packstone facies in fore reef environment with echinoid bioclast(G), bioclasticwackestonefacies in fore reef environment with textolaria and red algae in microsparitic matrix(H, I), bioclasticwackestone – packstonefacies in continental slope environment(J)

Interpretation of Sedimentary Environments of Qom Formattion Sofiyan Region

In Lagoon facies (A Facies), the context is micrite that shows the change of energy and in other words we encounter energy reduction in this facies. The presence of intermittent micritematrixshows the limited environment in which water enters alternatively when it is stormy.

In reef facies (B Facies), the amount of micrite of the context is reduced and Sparycalcite cement is increased. High energy causes the gathering of abundantbioclastic particlesin this part. Therefore, the reef facies has deposited by waves line range. The presence of spar calcite cement makes clear that carbonate

clay is washed by the energy of the environment and the empty place between the allochems are filled with cement.

In fore Reef facies (C Facies), there are large amount of red algae. The large and broken particles in dense microspar context are related to Rudstonefacies (C1) and Floatstonefacies (C2) is also introduced by the presence of large bioclast of red algae which are floating in micrite context and are located in some parts of microspare context. Both of these two Facieses are indicators of high energy environment.

In C3 and C4 facieses that are related to bioclastic – packestone and bioclasticwackestone of fore Reef respectively, allochems are located in microspar and densemicrite context and floating respectively. allochems of this facies are also broken that makes the movements of them clear.

Open marine facies (D facies) is deposited in an environment with normal or relatively low energy and the main components have traversed a short distance. The type of context and the smallness of the particles indicate that this facies has deposited in the end part of the continental slope. The sedimentation model is shown in figure 4 and energy changes are shown in figure 5.

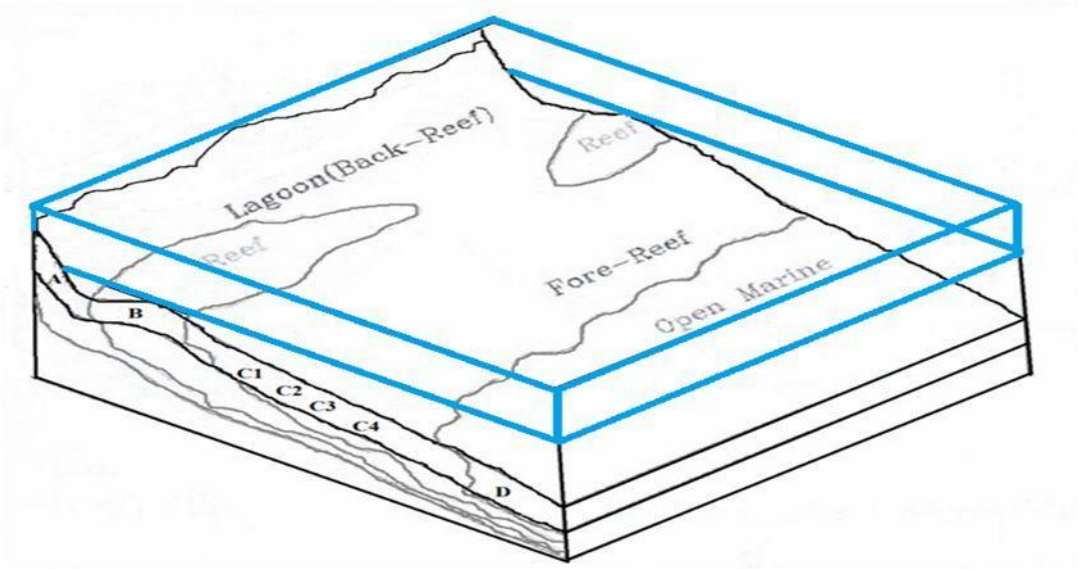

Figure 4: Block diagram of sedimentary environments of Qom formation

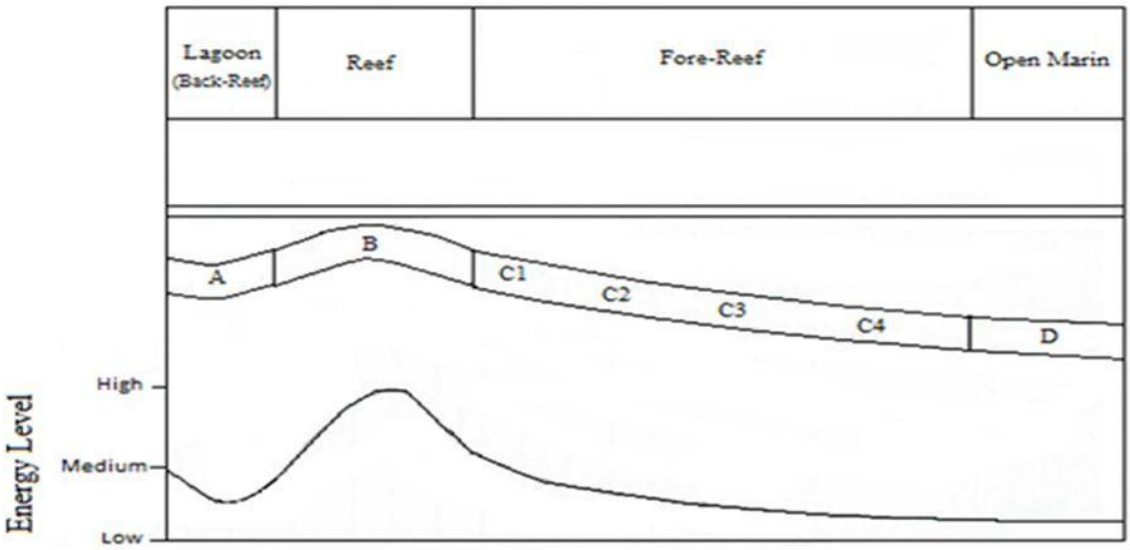

Figure 5: The Energy Changes in Oligocene – Miocene Sedimentations in North Part of Sofiyan

Vertical and Lateral Changes in facieses of Qom Formattion Sofiyan Region

Based on the separated facieses and field sampling and based on calculated real thickness, microfacies's column and changes of water depth in studied shear of north part of Sofiyan city were drawn (Figure 6).

Inmicrofacies's column, every group of elements is related to special facies and can introduce a special sedimentary substructure. So we can determine relative changes of the facieses vertically and also determine the relative changes of the depth at the time of sedimentation.

Based on the vertical changes of the microfacies that are shown in them icrofacies's column, in north part of Sofiyan, at first the condition of the open marine was predominated that gradually with regressive of the sea reef and even back reef facieses were formed and after a break time that caused the sedimentation of conglomerate layer, a thin layer of open marine facies was made and then with subsequent roll back of the sea reef and front reef facieses were formed again. After that we can see a great expansion of open marine facies.

Then with other conglomerate break time, some shallower facieses were formed intermittently with open marine facieses and after that the sea has regressive and the condition of shallow parts of the sea and Reef were predominated.

At the end of the column, tectonical changes in the area cause the repetition and alternation of regressive and transgresive changes so that Reef and open marine facieses are repeated intermittently.

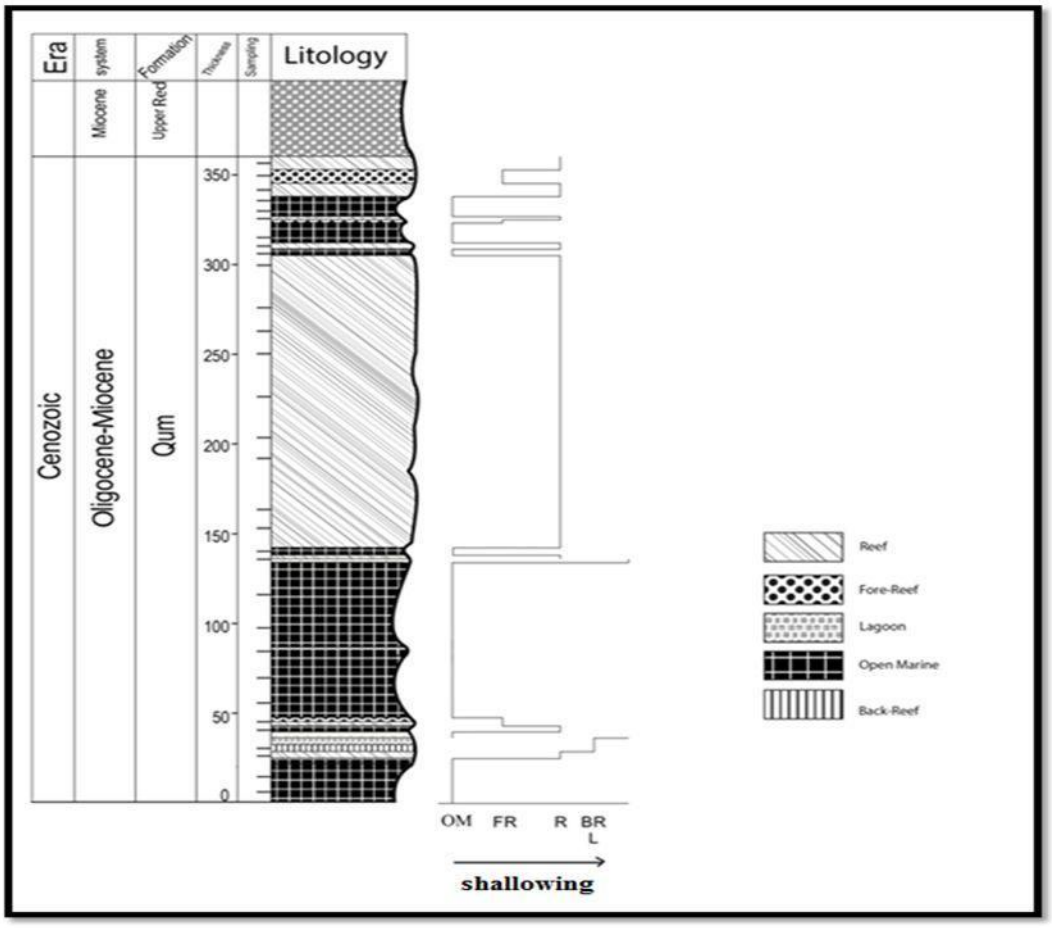

Figure 6: Microfacies Column and Sea Level Changes' Curve

Conclusion

The results of studies on Qom formation section in Sofiyan stratigraphy are as follow:

1. Based on the studies, we can see Qom formation out cropes in Sofiyan section.

2. The thickness of this formation is 358m.
3. Qom formation in north of Sofiyan include of limestones, conglomerates and marl.
4. The identified microfacieses in Qom formation limestones are: Bioclastic Packstone, Algal Grainstone, Rudstone, Floatstone, Bioclastic Packstone, Bioclastic Wackestone, Bioclastic Wackestone –Packstone.
5. Constitutive microfacieses of Qom formation in north of Sofiyan are in foursubenviroments: Lagoon, back Reef, Reef and front Reef.
6. Putting together the identified subenviroments we can discuss that the sedimentation environment ofQom formation in north of Sofiyan was shallow sea withrimmed carbonate ramp type that its Reef part has notable expansion.
7. Based on sea level changes curve, regressive and trangresive sedimentary sequences are identified in facies's column of this formation. At least 5 sequences are detectable which number 1, 3 and 5 sequences are regressive and number 2 and 4 sequences are transgresive.

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