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Depositional Environment Interpretation of Lar Formation (Upper Jurassic) Based on Study of Clay Mineralogy and Microfacies in East Azarbaijan (North Western of Iran)

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Abstract: *Microscopic and field studies on the Lar for mation in southwest of Azarshahrin Haft- cheshme anticline section is due to separate of three part of marl, marlycarbonate and carbonate in this formation .According to microfacies and macroscopic fossils in carbonate section, open marine environment were identified from a carbonate ramp. XRD test samples related to clay marl in the low and middle part indicated existence of clay mineral such as Iliite and Cholorite from clastic origin in the part of upper and middle marl and Iliite and Smectite are diagenetic origin in the lower marl. The simultaneous presence of theses minerals in the middle marl and the lack of Smectite in this section represent of temperate climate conditions are during deposition of the middle marl. The semi-quantitative analysis of the XRD is indicating of Smectitec increasing and Iliite decreasing in the lower marl part which it may represent of a warming climate and depth sea relative increase and it was consistent with sea level change global. Important digenetic processes of identified in these formations are include: cementation, primary and secondary porosity and chert nodules formations (constituents) which the secondary porosity is more than a fracture and channel types. The existence of these fractures has created a suitable underground water aquifers in this area.*

1. Introduction

Identifying and naming of studied sections components and surveys of diagenetic processes are important in the determination and study of microfacies and sedimentary environment interpretation (Flugel, 2004).

On the other hand, the clay minerals can were used in determine the sedimentary environment and deposits diagenetic historic (Jackson, 1979). Clay minerals, hydreous aluminum silicates is as layer structure and they are classified as sheet silicates (Tucker, 2001).

A unique characteristic of these minerals are including formed of the surface and subsurface different conditions. XRD analysis is important in determining the exact of clay minerals type and the semi-quantitative analysis of clay minerals (Jeong, 2004).

This paper investigated depositional environment and a digenetic conditions of the Lar Formation depositions based on study of clay minerals and microfacies in the springs anticline section in southwest of Azarshahr.

2. Material and Methods

2.1. Study Area

The Haft-Cheshmeh is located in 45° 42' 43" E and 37° 41' 80" N in east Azarbaijan province with 7495km^2 in about 18 km the southwest of Azarshahr (Fig1).This area is part of the western

Alborz- Azarbaijan (Aghanabati,2005). There are deposits of belonging to the Jurassic, Cretaceous and Quaternary outcrops in this study area(Assereto,1966).Jurassic deposits is include of marl (Delichay formation, middle Jurassic), marl and limestone (Lar formation, late Jurassic), Cretaceous deposits are consist of limestone (Tizkuh formation, early Cretaceous), shale and deposits are not named (late Cretaceous) and Quaternary deposits are include of alluvial terraces of ancient , travertine and alluvial terraces of young(Steiger, 1966)(Fig 2).

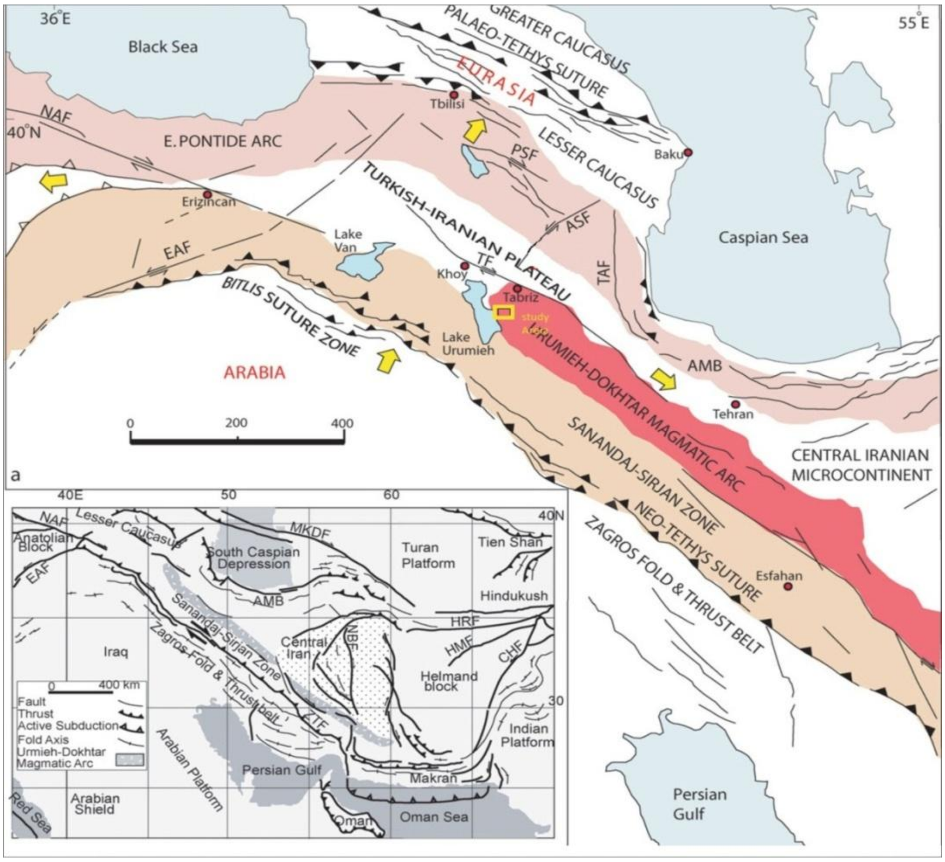

Figure1. *The study area in Iran, west Azarbaijan province*

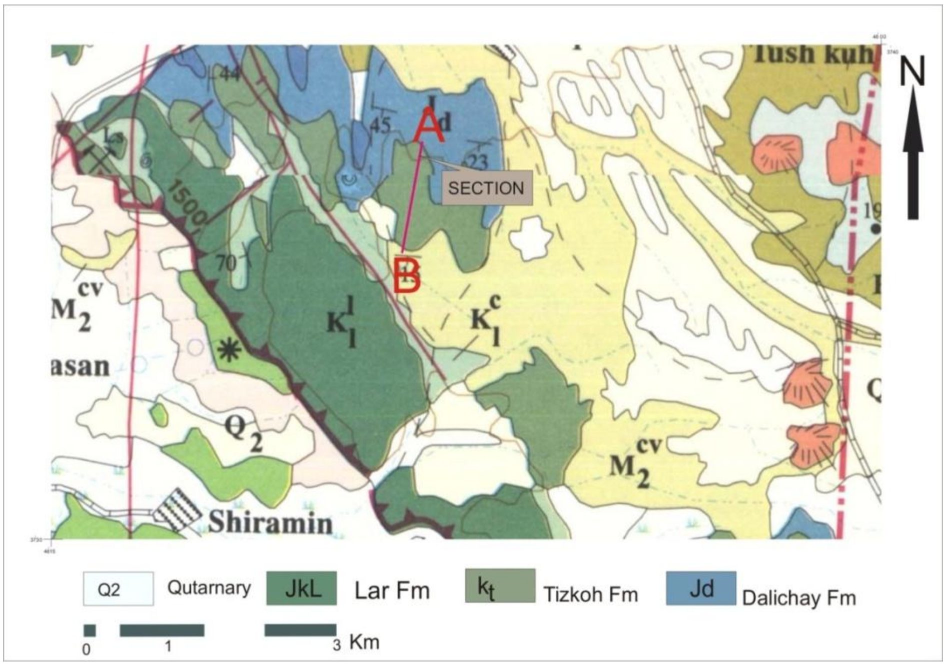

Figure 2. *Geological map of study area (Khodabandeh, 1995)*

3. METHODS

This paper was investigated based on fields and laboratory studies which these are one of the commonly methods in sedimentary geology. In the field studies, sampling of the formations are done with change of fancies and vertical of along the layers.

Hereby, eighty samples prepared of lower, middle and upper parts from the formations of study area and then the formation lithostratigraphy column has been plotted. Moreover, seventy thin sections were prepared and studied. Ten thin sections was used by Red Alizarin (Red-s) to determine of calcite and dolomite mineral also detection of iron in carbonate cement was paint by Dickson methods (1965) during burial and then thin sections petrographic of formation carbonate parts were named by Dunham method (1962).Finally, carbonate parts microfacies were determined based on Flugel facies belt and the Lar formation deposition environment was determined based on existing facies. Twenty samples for X-ray diffraction (ten samples from the lower marl and ten samples from upper marl) were selected according to the lowest carbonate amount (value). Samples analysis in laboratory was done by Simense-Difractometr 500 device in Geology Organization and Mineral Exploration of Tabriz.

4. RESULT AND DISCUSSION

4.1. The Lar Formation Lithostratigraphy

Lar formation according to late Jurassic age has large out crops in area of the Alborz-Azerbaijan and it has introduced rich of the Ammonites and Foraminifer.

According to present of fossils it sage has been determined of Late Jurassic (Oxfordian-Kymbrjyn) (Aghanabati, 2005).

Infield studies, the Lar formation thickness was determined about 250meters. Its lower boundary is located on Delichay Formation gradually and it the upper boundary is an erosion unconformable with Tizkoh formation. Lar formation sections are consists of three facies as follows:

The lower marl section thickness is about 70meters

The middle lime stone with red marls section thickness areabout80meters. Gray lime stone to upper milky section thickness is about100 meters (Figure 3)

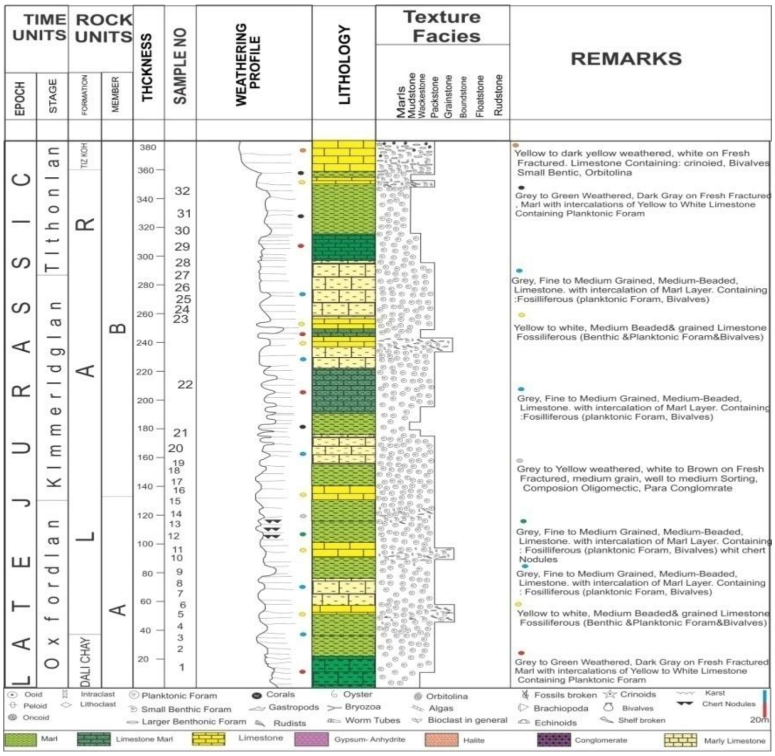

Figure3. *lithostratigraphy column of Lar formation in study area*

5. Clay Minerals

According to the XRD obtained results (Table 1) samples of related to the middle marl, peaks of smectite, illite and chlorite is observed and the lower marls are detectable peaks of smectite,illite and silica(Figure6).

Table 1. *Amount of clay minerals in removal samples that represent of Smectite relative increasing and relative decreasing of Ilite toward low of Lar formation*

Sample Number	Montmorillonite	Illit	Cholorit
1	75.45	18.02	29.01
2	69.30	21.21	31.02
3	50.23	43.20	35.04
4	49.3	48.02	37.21
5	48.1	55.22	38.20
6	47	60.22	39.51
7	46.9	64.3	39
8	46.5	64.6	37
9	45.5	64.9	38.9
10	45.2	65	40
11	43.4	67	41.2
12	42.1	67.3	43
13	40	67.9	42
14	35	68.2	43.6
15	34.6	68.7	42.3
16	34.2	689	44
17	34	70	45.9
18	33	74.2	46.9
19	32.6	74.3	47
20	31.9	74.6	48.9
21	32	73	50.6
22	33.1	73.4	53.5
23	34	74	54.8
24	32	71.7	54.9
25	31	75	55.9

26	29	71	55.6
27	30	76.6	54.8
28	29	76.9	56.7
29	28.6	79.9	56.9
30	28.4	79	54
31	28	76	70
32	27.7	75	60.5

semi-quantitative analysis of the data concern with XRD analysis is represent an increase of smectite relative and decrease of illiterelative downward Lar formation(Figure 4).

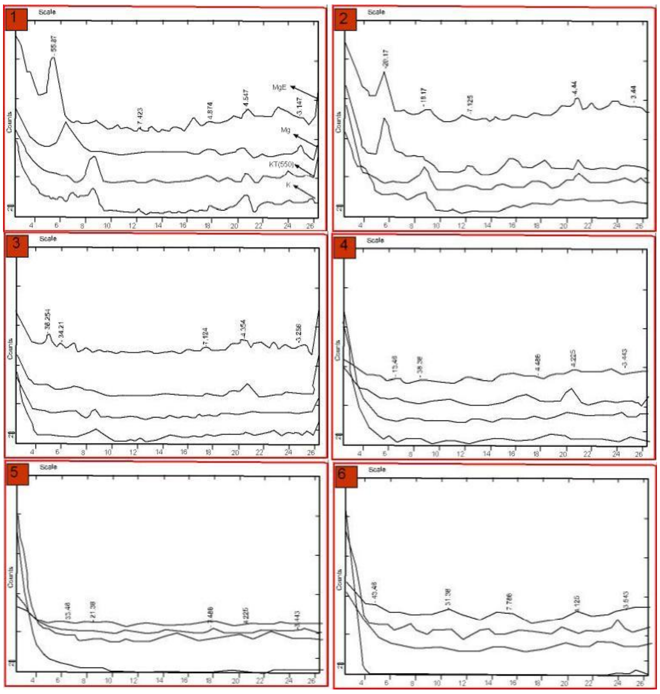

Figure 4. *XRD analysis in study area*

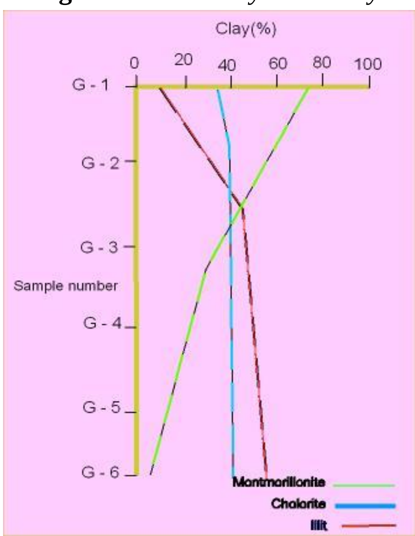

Figure 5. *semi-quantitative analysis of the clay minerals in Lar formation*

As figure 5 shows, Climate and depth of deposition of smectite in sedimentary environments is directly related to the high level of water, sea water as well as warm and moderate climates conditions with alternating grey and wet seasons that it changes frequently (Pardo et al, 1999;Adatte et al, 2004).Also, chlorite and illite with origin of detrimental is formed in low leaching condition and weathering in cold and temperate climate or cold and dry rarely (Deconinck et al,2005;Adatte et al, 2002).Tucker(2001)believes that the simultaneous presence of the smectite and illite in the depositional environment may be representing of sediments in temperate climates.

According to this imultaneous presence of the smectite minerals in the lower marl Lar formation can be concluded that the early Jurassic period is low to mode rate leaching amount (value) and the weather is warm and humid (Mess, 2007). Smectite compared with illite and chlorite deposits in the deeper parts of the basin in which sedimentation environment (Adatte et al., 2002; Deconinck et al, 2005).

According to Smectite decreased and illite relative increase the upwards parts sedimentary basins in studied section, it can be concluded that the depth of these dimentary basin has decreased upward parts of the formation (Stuben, 2002). The high rate (amount) of smectite in the lower part of the Lar formation in studied section can beat tributed to up lifting sea water level in the early Jurassic period(Razmara, 2005).This issue is confirmed by considering of the global and regional changes of sea water level(Vail et al, 1977).

6. MICROFACIES

Main components Lar formation deposits can be classified in the two components of the non-carbonate and carbonate. The most important carbonate allochemes in thin section of study identified Bioclasts the type of planktonicforaminifera.

Then on-carbonate components Lar formation can be pointed to detrimental quartz, chertandiron oxide which detrimental quartz particlesis observed in the lower marlandiron oxide, chertnodulesare observed in limestone upper and low part. According to components type and quantify were identified three microfacies of Bioclasticpackstone, Bioclasticwackstone and Mudstone.

6.1. Bioclasticpackstone

Components of Bioclastic dominant skeletal in this microfacies is type of planktonic Foraminifers which they are in a micrite matrix.This microfacies is observed in the upper part of the formation. There are others bioclastics in this microfacies that maybe pointed to parts ofthe Ammonites. This microfacies is equivalent to facies of number2 (RMF2) infacies belts Flugel (Flugel, 2004), which represents the least deep of Lar formation Part (Figure 6 a).

6.2. Bioclasticwackstone

This microfacies allocates 20% of bioclastics (planktonicforaminifera predominantly) that it is a micrite matrix. The plank tonic foraminifera in this microfacies can be pointed to Milolida and the non-carbonate components in this facies can be pointed to chert fragments. This microfacies is observed mainly in the middle and upper Lar formation. This microfacies is equivalent to facies of number3 (RMF3) in facies belts Flugel (Figure 6 b).

6.3. Mudstone

Bioclastics is less than10 % of the sample volume in this microfacies and it has a floating micrite matrix. Overall, this microfacies makes the deepest of formation carbonate part.

Limited bioclastics facies in this microfacies are include of plank tonic foraminifera and there are rich ammonite facies within the Marl. This microfacies is equivalent to facies of number3 (RMF3) in facies belts Flugel (Figure 6 c).

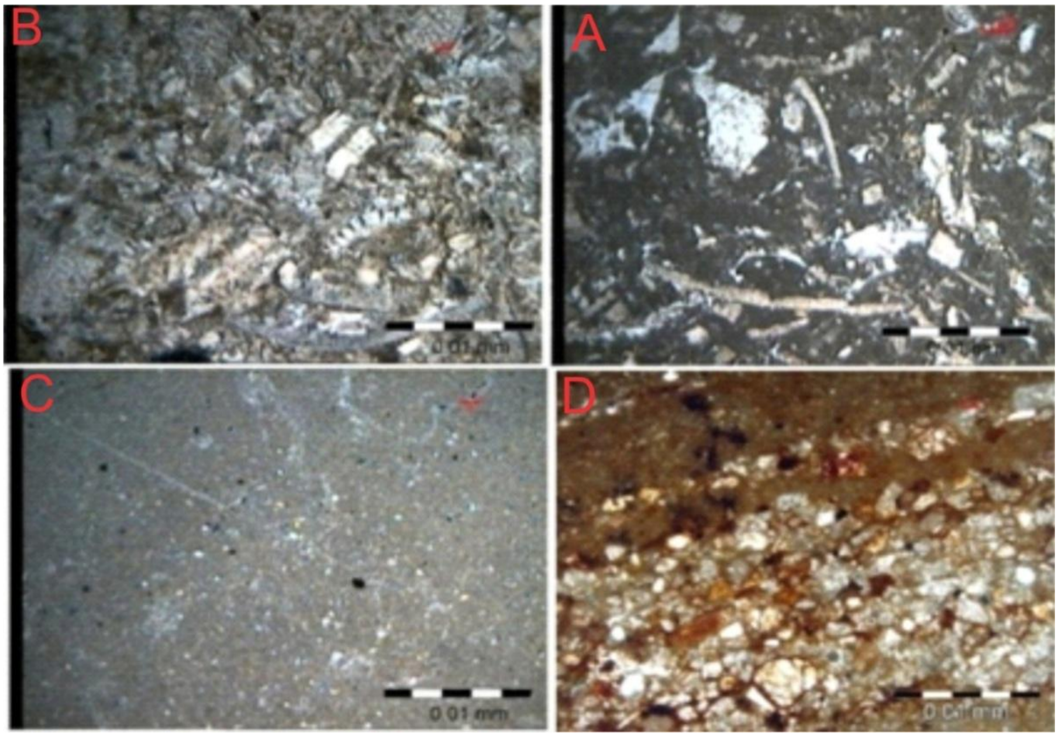

Figure 6. *a) Bioclasticwackstone b) Bioclasticpackstone c)Mudstone d) Iron oxide of developing into fractures that it is the latest*

7. Depositional Environment

According to the evidence of petrography and facies and clay minerals studies of the Lar formation marl part has deposited in the open marine and carbonate platform.

According to the Lar Formation in the study area is located between two Tizkoh and Delichay formations (Berberian,1981) and it's also important to remember that both are introduced in the western Alborzregion with an open marine and carbonate ramp (Seyed-Emami, 1996 aghanabati,2005).The Lar formation deposition in the study area can be called related to an open marine and carbonate platform that its schematic modeles shown in Figure 7.Based onFlugelfacies, facies of number 2 is represents the deposition of the formation in the middle and interior ramp andopen marine basin part. Facies of number 3 is related to the middle and outer ramp from carbonate ramp. Deposits of this formation have been introduced in Kopetdagh (Mozdoran formation) as a carbonate ramp (Addabi, 1991).

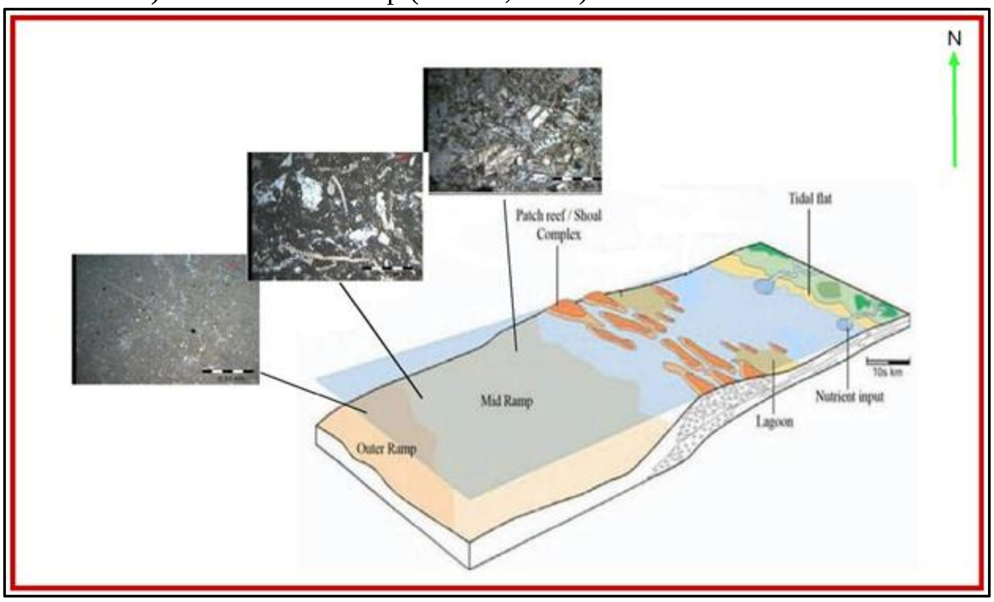

Figure 7. *The Lar formation depositional environment model in area study*

8. DIAGENESIS

Diagenetic processes of a limited is done because of semi-deep of Lar formation deposition basin that it is based on event includes:

The cementation which is consist of equal calcite cementation veincal cite cementation, dissolution and porosity of the inter-granular fracture and channel, finally processing of iron stain into the fractures chert nodules formation.

Studies of sections show which process of being is occurred in the study area and also it has been filled into the fractures (Figure 8).

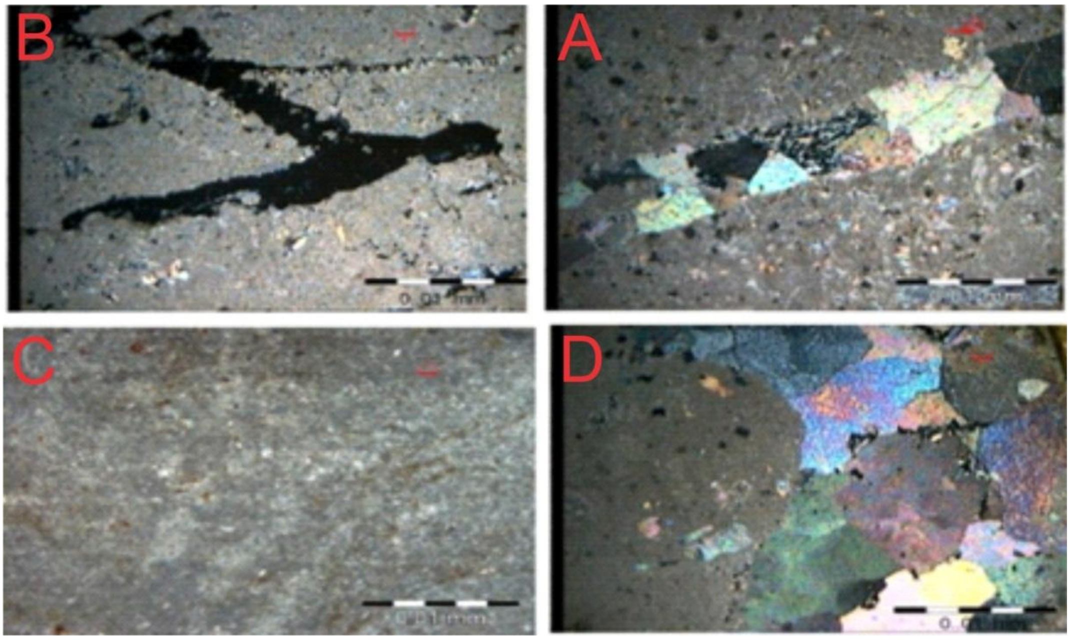

Figure 8. *The Lar formation diagenetic events a) Cementation into fractures b) Channel fractures that it is caused of permeability increasing c)diagenetic step Iron oxide of developing into fractures that it is the latest d)Equal calcite cementation that it has been advanced into fracture*

The others of digenetic processes are including the primary and secondary porosities. An inter-granular porosity is the types of primary porosity that generally, it has been filled by cement and in the case of; also, shelter porosity is observed (Tucker.2001)

Porosity due to fracture in the late diagenetic stage (Late diagenesis) occurred in the dissolution process can cause it spread and cause to be channel porosity that this process is observed clearly. Finally, it should be noted that the Lar formation is having Ferro occurrence in the late condition. The process considering to filling the fractures with constructing of chert nodules is last Diagenetic processes (Grassman, 1961).

According to the presence of illite, chlorite, smectite with detrital origin in the samples can be identified constructing of alogenicsmact it related to change and conversion of others clay minerals.

9. CONCLUSIONS

According to study on microscopic thin sections showed that Lar formation has three microfacies of bioclastic including the packstone, wackstone and mudstone which representing of deposition in the middle part of this formation, as well as it is an open marine of carbonate ramp type in sedimentary basin of Alborz-Azarbaijan.

The survey of clay minerals showed due to presence to smactit and cholorite as well as probability of alogenics mactit in this formation and their changes upward are representing the decrease of depth and climate warming.

Diagenetic processes that it is observed in the Lar formation sequence of events including: the cementation (equal calcite cement and a vein cement calcite), the appearance of chert nodules influencing of environment changes, dissolution and appearance of porosities of the inter-granular, middle-granular and shelter fracture, finally, the process of Ferro occurred within the fractures. To sum up these fractures have prepared the suitable groundwater aquifer in area of study.

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