Geochemical Study of Late Cretaceous Sediments in Kuh-e- Dezdarar Section, in Central Zagros of Iran

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ABSTRACT

Tarbur Formation is formed in Kuh-e- Dezdarar section that is situated in south of Chahar Mahal and Bakhtiari Province with thickness of 115m and contains all of Calcareous and Dolomite sediments. The elemental analysis results and their plotted beside together shows that primary mineralogy of Tarbur Formation limestones contain in that section is aragonite and plotted amounts Mn about based on Sr/Ca indicated one close diagenetic environment with low water and rock ratio in this Formation. Geochemistry studies of Tarbur Formation Dolomites shows that, Mg,Fe and Mn values in dolomitic samples are more than calcic samples, whereas Ca,Na and Sr values in calcic samples are more than dolomitic samples that is related to Preferential Succession of Fe and Mn elements Instead of Mg in dolomite crystal network and Preferential Succession of Na and Sr elements Instead of Ca in aragonite crystal network.

Key words: Tarbur Formation, Geochemical Study, Kuh-e- Dezdarar, Iran

Introduction

The study area is located in Chahar Mahal and Bakhtiari province, involve central Zagros, with Geographical coordinates with 50,10,15 at east Longitude and 32,09,10 at North latitude and accessibility ways to the section, is possible through Dashtak road from the Bazoft Village (figure1).

Methods:

In this study, It was used elemental geochemical studies to identifying primary mineralogy and determination of diagenetic process effective to this Formation. For this studies, 50 samples involves 30 samples of limestone and 20 samples of dolomite were selected for analysis elemental geochemistry studies. powder samples by dental drill, to determine the amounts of major and minor elements by atomic

Fig. 1: Map showing the location of the study areas in in Kuh-e- Dezdarar Section, Iran.
absorption (AAS) were tested at the Laboratory of Geochemistry.

In this method, 0 / 30 grams of powdered samples was soluted by 7CC of 1 M HCL acid, and after 2 hours, the solution is smoothed and volume increase to 55 CC. Then main elements include Ca and Mg values, be measured with atomic absorption device based on the percentage and sub-elements include Fe, Mn, Na and Sr be measured based on ppm. After the analysis and testing, results obtained with cutting and other study areas were compared by other researchers.

Description of studies:

The importance application of Geochemical studies on the carbonate rocks is determination of the primary mineralogy composition, sedimentary environment, Paleotemperature, rate of alteration, separating different diagenesis environments and diagenetic process [24,1,6]. Identification of primary mineralogy composition of old carbonate rocks is very important, because we can comment about temperature, paleoenvironment salinity and effects of diagenetic processes. In addition, primary mineralogy is from the main factors controlling the abundance and fine porosities, So the form of this porosities more dependent to primary mineralogy, not to carbonate granulation types. [10]. Temperature Being considered as the main controlling factor of mineralogy of carbonate sediments [3]. Different carbonate minerals are formed at different temperatures [26]. Hence, based on forming temperature of the different types of carbonate minerals, it Can be divided in three groups: tropical, temperate and polar [26]. Geochemistry of major and minor elements in carbonate rocks, is the Powerful tool in study of Specifications of this rocks [11,12,38]. So in this study, it Be examined the primary mineralogy composition and carbonate diagenetic systems of Tarbur Formation based on geochemical studies conducted on the carbonate rocks of Tarbur Formation in sample and Kuh-e-Dezdaran sections.

Geochemistry studies of Tarbur Formation limestons:

In order to determine the type of mineralogy and diagenetic systems of Tarbur Formation carbonates, major (Mg and Ca) and minor (Fe, Mn, Sr and Na) elements measured in this carbonates, and with against plotted of them, were compared whit other different researchers limits that was presented to determination of Aragonitic and Calcitic mineralogy. It is drawn up and at the time, with a range of and by to determine the mineral of Aragonite and Calcite. All major and minor elements data’s with the values of maximum, minimum and their average is in Table 1.

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Major and minor elements:

1 - Strontium (Sr):

Based on the results presented by researchers Sr amounts is between 8,000 to 10,000 ppm in the Holocene carbonate samples (Bulk) in tropical regions [18], while Sr is between 1600 to 5000 ppm (average 3270) in the recent samples in temperate areas [26,28,27]. Sr values in carbonates is related to the mineral composition directly such that it increases when the amount of abiotic aragonite mineral composition increase and decrease with increasing abiotic aragonite mineral composition [19,26]. In addition, Sr concentration in carbonates show a direct relationship with the sea water temperature [19]. The Sr values has decreased significantly during meteoric dia genesis of old carbonates [40]. Maximum amount of strontium in abiotic calcite network is 1000 ppm [37]. Further amounts of Sr in calcite network is result of low effect diagenetic processes and transition of Sr from aragonite to calcite by inheritance. Strontium levels in the calcareous Tarbur Formation is between 1413 to 2289 ppm (average 1769 ppm, Table 1). The comparison between the measured Sr levels in this research Tarbur Formation, Mozdoran Formation [5] and recent tropical aragonites [18] show a similarity as result of their mineralogical similarities.

Vincent and colleagues [38] believe that high levels of strontium is related to high salinity, which is in coincide to geochemical analysis carried out by Amir Bakhtiar on the rudists in Tarbur Formation.

2 – Sodium (S):

Sodium concentration in abiotic aragonitic limestones in recent tropical area is between 1500 to 2700 (average 2500) ppm, and the amount of sodium in abiotic low-Mg calcites in temperate areas are at about 270 ppm.

[15,18,26]. Sodium concentration in carbonate rocks have been attributed to the degree of salinity, water depth, biological fractionation and kinetic effects and mineralogy of carbonates. is. In general, the concentration of sodium increases with increasing salinity [15], water depth and carbonate content of aragonite, a network failure in the carbonates [25] and growth rate. Sodium levels in Tarbur Formation is changing between 159 to 468 (average 257) ppm, (Table 1) which show a decrease in comparaison to recent carbonates. This decrease can be due to the influence of diagenetic processes in particularly meteoric dia genesis. The amount of sodium were very low in meteoric waters, due to the low distribution coefficient of sodium in the water and therefore the amount of lime will be lower in rocks affected by diagenesis [3].

3 – Manganese (Mn):

Manganese levels is less than 20 ppm in tropical aragonites (Milliman, 1974) while is more than 300 ppm in the recent temperate carbonates [26,25].

Some researchers [7,22] believe that manganese increases along with meteoric diagenetic processes, because the distribution coefficient of Mn is high in the meteoric waters so that reaches about 15ppm, in conclusion considerable amount of Mn will be entered into the calcite network. On the other hand, increased levels of manganese can be attributed to reducing the prevailing environment, because in such cases, calcite could instead some percentage of Mn in their network. Amount of Mn in the Tarbur Formation samples changes between 32 to 189 (mean 57) ppm (Table 1). The low amount of Mn is indicated the initial aragonite mineralogy [4] and on the other hand, can show the effect of mild meteoric dia genesis [3].

All samples plotted in the restriction of Tasmania Gordon aragonite limestone, which reflect the aragonitic inherent nature of Tarbur Formation.

4 - Iron (Fe):

Very little information is available about iron in aragonitic marine carbonates in the recent shallow warm waters. Iron content of biotic calcite and aragonite has increased significantly in spite of abiotic calcite and aragonite.

This increase is mainly due to biological fractionation. Biotic aragonite is containing 50 ppm Fe while is less than 50 ppm of iron in abiotic aragonite.

Distribution range of iron in the Tarbur Formation samples are between 99 to 291 (average 175) ppm (Table 1). Vincent and colleagues believe that [38]. Iron and manganese changes similarities show the same origin and similar elements of their entry into the network of carbonates. The researchers also believe that low levels of iron and manganese in carbonates show lower salinity and low harmful substances entering the basin. A similar trend have been reported from Talehzang Formation by Zohdi.

5-The ratio of Sr / Mn vs. Mn:

During the meteoric dia genesis process reducing the amount of Sr and amount of Mn increases. This is true also in other limestones with primary aragonite combination that are affected by meteoric dia genesis.
Petrographical evidence confirming the original aragonite composition of carbonate minerals of Tarbur Formation

1 – Evaporative formats that can qualify as evidence for early aragonite mineralogy (the plate 1, image A).
2 – The same thickness of the fibrous aragonite cements that have aragonitic mineralogy basically (plate 1, the image B and C).
3 – Early dolomite (dolomicrite), which can be evidence of the mineralogy of aragonite (plate 1, image D).
4 – Rudists, which have aragonitic inner and middle shells (plate 1, image E).
5 – Mold prosity which is usually the result of aragonitic carbonate dissolution (plate 1, image F).

Figure A,D: Dolomicrite with evaporative minerals forms that represent the original aragonite mineralogy (Kuh-e-Dezdaran section, natural light, TD53 sample).

Figure B and C: The carbonate parts is covered around by the same thickness marginal cement. Basically, this cement has aragonite mineralogy (Kuh-e-Dezdaran section, natural light, TD 77 sample).

Picture E: The middle and inner shell of Rudist has been dissolved and filled by a blocky cement due to its aragonitic mineralogy (Kuh-e-Dezdaran section, natural light, TD80 sample).

Figure F: mold profity which is usually the result of aragonitic carbonate dissolution (plate 1, image F).

Separation of dolomite and limestone:

One of the factors affecting separation and detection of dolomite and limestone, beside the main elements Mg and Ca, is changes in minor elements.

Due to the substitution of strontium to calcium in the calcite crystal network, the amount of strontium in the limestone is more than dolomite.

Moreover, the distribution coefficient of strontium is low in the dolomite [37]. The amount of strontium in dolomites is less than limestones, because calcium is normally replaced by strontium and amount of calcium in the dolomites is reduced by half [25]. Other factors effecting on the separation of dolomite limestone are changes trends of strontium, sodium, manganese and iron.

Basically, the amount of strontium and sodium in the limestones is more than dolomites and the amount of iron and manganese in dolomites is more than limestones. Given these attributes, the limestone can be separated from the dolomite.

Geochemical study of dolomites:

A Valuable information about the origin of dolomite, the dolomite bearing fluids, and the
diagenetic model obtained by the measuring of major and minor elements and isotopic composition in dolomites [15,31,17]. There can be realized reaction rate between stones and water and dolomite and dolomite bearing fluids using the major and minor elements (effective distribution coefficient) [40].

**Element study:**

Since recognition of diagenetic processes in dolomites depends on the composition of dolomitized fluides [25,37], identify the major and minor elements in Dolomite can determine the composition of dolomite bearing fluids. The major and minor elements investigated in Tarbur Formation dolomites as follow, All the major and minor elements and maximum values, minimum and average of the samples presented in Table 2.

**Table 2:** Changes in major and minor elements along with maximum, minimum and average values in dolomite samples of Kuh-e- Dezdaran section.

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**The main elements:**

**Calcium and Magnesium:**

Concentration of Ca and Mg in dolomite depends on the ratio of Mg/Ca in the dolomite maker fluides [29].
The amount of calcium in the Tarbur Formation dolomites changed between 21.35 to 23.76 percent (average 22.8%) and magnesium levels between 11.66 to 12.94 percent (average of 12.29 percent). The amount of Mg in dolomite has a positive relationship with Mg / Ca ratio. Since the ratio of Mg / Ca in pure dolomites is about 0.65 [3], decrease of Mg from 12.94 to 11.66 could be due to alteration of the dolomite.

**Minor elements:**

1 - Sodium:

Na concentration in dolomite could be a sign of dolomite maker fluids salinity [8]. Caution should be paid to in use of sodium element. Dolomite can be enriched in sodium as a result of fluid or NaCl solid inclusions, Na substitution in crystal network and contamination by clay minerals [15,16,33,14,9].

On the other hand, the sodium distribution coefficient is still poorly known [8] and as a minor element acting much more fluid than the Sr during diagenesis (Veizer, 1983b). Most sodium in Tarbur Formation dolomites have an inverse relationship with Mg because as it turns instead of replacing Ca.

Na values are between 311 to 711 ppm in Tarbur Formation dolomites (average value 407 ppm), while the amount of Na in dolomites that are deposited in the sea water is between 110 to 160 ppm [38,21].

Due to the higher concentration of Na in in Tarbur Formation dolomites, probably have been deposited from a fluid basin [14].

2 – Strontium:

In order to better understand the nature of the dolomite maker fluids, Sr value assessment of dolomite can be very useful [14].

Remainder inclusion of the primary carbonates (calcite and aragonite) and strontium distribution coefficient between dolomite and diagenetic fluids are generally the main factors controlling the concentration of Sr in dolomite [8].

The amount of strontium in Tarbur Formation dolomites is changing between 68 to 403 ppm (average 248 ppm).

The amount of strontium in the dolomite is less than limestone due to lower distribution coefficient of strontium in the dolomite [15,38].

Calcium is usually replaced by Strontium in dolomites. The amount of strontium in dolomite, half the amount of calcium in the dolomite because the Sr in dolomites is half as calcite, [25].

Dolomite generally, for any loss of 5 to 15 ppm Sr, a mole of MgCO3 increases [14]. High levels of strontium in Tarbur Formation dolomites, probably is due to the aragonitic primary mineral composition of limestone that have been dolomitized [13].

Higher amounts of strontium in Tarbur Formation dolomites than average amounts of Stochiometric dolomites (50 ppm), probably is because of nonstochiometric nature of Tarbur dolomites.

3 - Iron and Manganese:

Iron and manganese in comparison with strontium, further reflecting the reducing conditions in diagenetic environment than the ionicpower of dolomite maker fluids.

So, they offer valuable information about the availability of iron and manganese levels in the dolomite maker fluids. [8,14].

Due to the fact that the distribution coefficient of iron and manganese is more than which could facilitate entrance of substantial amounts of iron and manganese to the dolomite network, however, balanced amounts of iron and manganese deposits in seawater dolomites, respectively are 30,50 and 1 ppm [38].

However, these values are not identical in other papers that have been in dolomites originating from seawater [8] and generally have more than the values provided by Veizer [38].

Tarbur Formation iron content is changing of 818 to 3695 ppm (average 1640 ppm) and manganese 56 to 288 ppm (average 190 ppm) in turn that is significantly higher than the marine dolomites that suggests a significant source for these elements in the fluid between the particles [14]. The source, is probably marl interlayers associated with the dolomite or shale and marl layers of Gurpi Formation.

besides, iron and manganese can also show the oxidant and reducing fluids, so that Fe plotted against Mn to Tarbur Formation dolomites, shows a negative trend. Parse Rysa argues the passage of liquids that are recovered from the oxidant (transitional oxidizing-reducting condition), are rich in iron, while their manganese are diluted [20].

These conditions, with the amount of iron in Tarbur Formation (average 1640 ppm) which is very more than their manganese (average 190 ppm) and these two elements are to reverse the process, fully compatible.

**Results:**

The results of elemental analysis and plotted these values together, suggest that Tarbur Formation limestones in type locality and in Kuh-e–Dezdaran section have primary aragonitic mineralogy.

Mn levels against the Sr / Ca shows a closed diagenetic environment with a low water /stones ratio.
Turbur Formation dolomites geochemical studies, indicate that the amounts of Mg, Fe and Mn in dolomites is higher than the limestones. Na, Ca and Sr amounts in calcareous samples is higher than the dolomites which attributed to the proffered replacement of Ca in dolomite crystal network and proffered Replacement of Na and Sr instead of Ca in aragonite crystal network. This method can be used to distinguish samples of dolomite from limestone. The analysis determined that dolomite maker fluids had an interchanging oxidation-reducing affinity at depths over 470 meters for dolomicrosparite and dolospire.

References


