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Sedimentary geochemistry of the sedimentary facies of the Qom Formation in the southwest of Saveh

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Abstract

The aim of this study is to analyze the chemical facies of the Qom Formation in the northwest of Tafersh based on geochemical data.
The studied area includes a part of the 1:1000000 Farmahin quadrangle geological map, which is located in the northwest of Tafresh.
The lithology of the Qom Formation in the study area consists of limestone, sandstone and marl.
Two sections were selected for sampling and for geochemical studies, 16 limestone samples were selected and subjected to primary mineralogical analysis.
The results of this study show that the carbonate rocks of the Qom Formation in the studied area are within the range of Gordon limestones and Mozdouran aragonite limestones. The similarity between rare elements in ancient and modern aragonitic carbonates indicates that the Qom limestones (shallow part of the basin) had an early aragonitic mineralogy and are within the range of Ordovician limestones with aragonitic mineralogy.

Introduction

Distinguishing between primary mineralogy of aragonite and calcite in ancient limestones is challenging. The use of X-ray diffraction method and the magnesium content of ancient limestones is not very useful in differentiating basic aragonite from calcite, because most ancient limestones have been affected by meteoric conditions or burial diagenesis and turned into low-magnesium (low-magnesium) calcite. In open diagenetic environments, low-Mg calcite remains largely stable and undergoes only minor chemical changes. Aragonite carbonates are inferior models for meteoric diagenesis compared to calcite limestones.To understand the temperature of depositional environment, diagenesis and geochemistry of carbonates, it is necessary to distinguish aragonite from calcite. The best criterion for distinguishing modern carbonate (limestone) sediments from their ancient counterparts is the change in trace element ratios between cold water and warm water sediments. This change is caused by the different proportions of trace elements in cold water and hot water limestone carbonates, which in turn affects the structure of the carbonates.

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This study was conducted with the aim of investigating the geochemical properties of sediments and the primary mineralogical composition of carbonate rocks of the study area using the changes of major and rare elements.

The studied area includes a part of the 1:1000000 Farmahin quadrangle geological map, which is located in the northwest of Tafresh city and north of Arak city. The access roads of the area include the asphalted roads of Salafchegan-Tafresh, Tafresh-Ashtian-Farmahin, Arak-Tafresh, Tafresh-Fark village and the road under construction Tafresh-Noubaran (Figure 1). The studies conducted on the Oligocene-Miocene limestones of central Iran have been significant due to the possibility of hydrocarbon deposits. Gansser proposed the term "Qom Formation" for these lithological units in 1955. During the oil exploration of the Qom formation in the south of Qom (Gansser, 1955 and Furrer and Soder, 1955), six lithological units (A-F) were identified. Sudar (1959), during a detailed study, divided unit C into 4 units. Berberian (1983) attributed the formation of the Qom Formation sedimentary basin to the subduction of the young Tethys oceanic crust beneath central Iran, which was accompanied by the opening of the back-arc and the deposition of marine sediments of the Qom Formation and alkaline volcanic processes, but he did not discuss the formation of the fore-arc basin. Nogul-Sadat (1985) conducted further research on the Qom Formation and proposed three sedimentary basins, each sedimentary cycle starting with shallow marine facies and ending with gypsum and anhydrite lagoonal facies. Karimi-Mosadegh(1999), Studied Biostratigraphy and lithostratigraphy and study of sedimentary environments of the Qom Formation in Saveh area. Preparation of geological maps 1: 250,000 Qom (Emami and Hajian, 1991), Saveh (Nogul Sadat et al., 1985), Hamedan (Sabzei and Khane, 1990) and Kabudrahang (Bolruchi and Hajian, 1979) more help to identify the conditions of the formation Qom is located in the western region of central Iran. Imendoust (2006) investigated the Qom formation in the southwest of Saveh to the southeast of Qom, and the sedimentary environment of the Qom formation was introduced as the edge of the Qom shelf. Karimi Mossadegh also studied the Qom Formation in the southwest of Saveh and west of Qom. He determined the age of the Qom Formation deposits to be Aquatanian-Bourdigalian. Daneshian and Bakhtiari (2001) identified 26 sediments and 31 types of benthic framework, identified two sections in the northwest of Saveh and suggested the age of early Burdigalian and the abundance of the area indicates a shallow sedimentary environment with a warm climate. Okhravi and Amini (1998) studied an example of mixed carbonate-pyroclastic sedimentation of Miocene in Central Basin of Iran.Vaziri and Torabi (2002) and Sierafian and Torabi (2003) separately investigated the sedimentary environment of the Qom Formation in southwestern Ardestan and northern Nain.

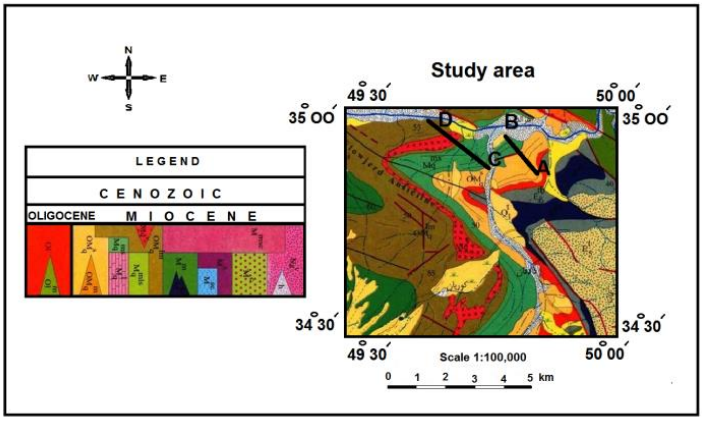

Figure 1: The position of two sections AB and CD of the studied area of Qom formation in the northwest of Tafresh in the geological map of Farmahin (Hajian, 1970).

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Methodology

In this study, two sections AB and CD were selected for sampling. The desired samples were taken to the laboratory for examination. Then the collected samples were turned into powder for chemical analysis. From each sample were crushed 200 grams into powder. The chemical mineralogy determination test was performed using the XRF method and based on the reference standard ASM E 1621 13 at a laboratory temperature of 25 degrees Celsius and a humidity level of 30%. The result of the chemical analysis of the sent sample was obtained by the XRF device based on the weight percentage of the constituent elements and compounds. Some elements cannot be identified and are less than the device measurements. The sample was heated at 900°C for one hour to measure L.O.I (lost weight).

Discussion

The figure 2 shows the changes of Fe, Mn, Na, Sr elements in the collected samples. According to this figure, the highest value is 183.6 ppm and the lowest is 100 PM. The highest amount of sodium is 876 ppm and the lowest is 640 ppm. The highest amount of manganese is 69.3 ppm and the lowest amount of manganese is 29.6 ppm. The highest amount of iron is 3254 ppm and the lowest amount of iron is 1406 ppm.

Figure 3 shows the ratio of Sr/Mn, Sr/Na elements. Based on this figure, the highest amount of sodium is 0.2622 ppm and the lowest amount is 0.1356 ppm. The highest amount of strontium to manganese is 0.5347 ppm and the lowest layer to manganese is 0.1677 ppm.

In this study, the analysis of geochemical data using the amounts of major and rare elements was used to determine the primary mineralogy of deepcarbonates. Data related to iron, manganese, sodium and strontium elements with tropical and temperate carbonate range (Milliman, 1974), tropical Ordovician carbonate with primary aragonite mineralogy (RAO, 1991), cold subpolar Permian carbonates with calcite mineralogy (RAO, 1991), in Tasmania, Australia, and the mineralogy of early aragonite in deep limestones (Mozdouran Formation) is compared.

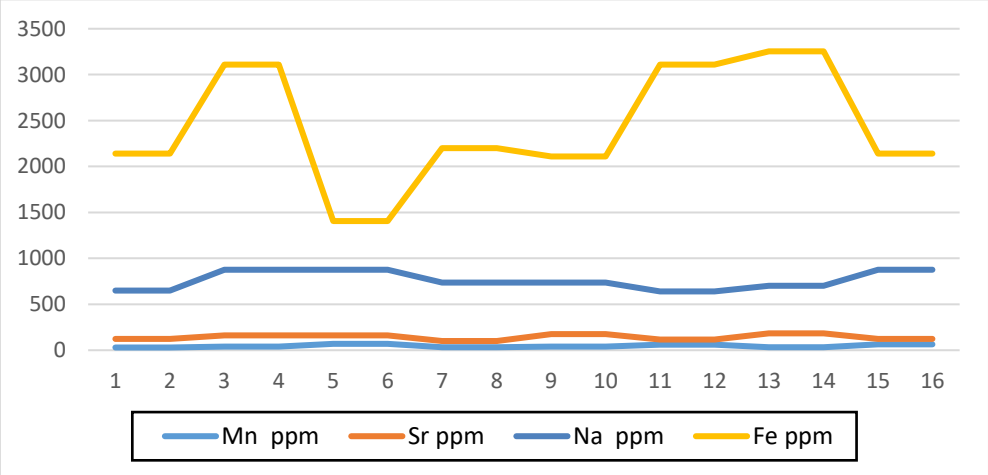

Figure 2: Diagram of changes of elements in lithological units of the studied area.

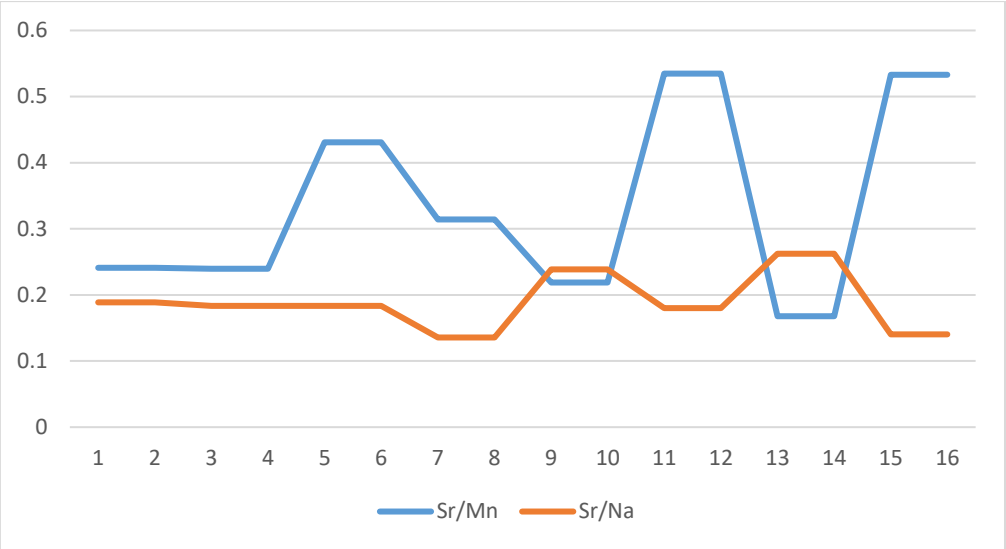

Figure 3: Diagram of element ratio changes in lithological units of the studied area.

Early aragonite mineralogy in deep limestone

According to some researchers, calcite first appeared as an important mineral in the Early and Middle Paleozoic and Jurassic, and carbonate mineralogy has changed since the Phanerozoic (Sandberg, 1975, 1983; Wilkinson et al., 1985). Major and rare elements were used to investigate the primary mineralogy of Qom limestone. Data related to the Fe, Mn, Na, Sr elements of the studied area and with the range of temperate tropical carbonates (Milliman, 1974), carbonates of the Mazdouran Formation in the Lower Jurassic, tropical Ordovician carbonate, tropical Ordovician carbonate with primary aragonite mineralogy (Rao , 1991), cold subpolar Permian carbonates have been compared with calcite mineralogy (Rao, 1991), in Tasmania, Australia, and early aragonite mineralogy in deep limestones (Mozdouran Formation).

Sr-Mn changes

The diagram of Sr-Mn changes in the studied limestone is presented in Fig. 4. The limestones of the Qom Formation in the study area have been compared with the aragonitic limestones of the Mazdouran Formation (Adabi and Rao, 1991), carbonate samples from the temperate zones of the recent age (Rao and Adabi, 1992), and aragonitic samples from the tropical zones of the recent age (Milliman, 1974). Figure 4 shows that the carbonate samples of the study area are within the range of the Gordon Ordovician tropical limestones with aragonite mineralogy. Therefore, the limestones of the study area are within the range of Ordovician limestones with aragonite mineralogy and are generally low in strontium. Qom Formation in the study area with Aragonitic limestone ranges of mercenaries (Adabi and Rao, 1991), total carbonate samples of the present -day temperament (Rao and Adabi, 1992) and Aragonitic samples of the present (A ; Milliman, 1974) is compared.

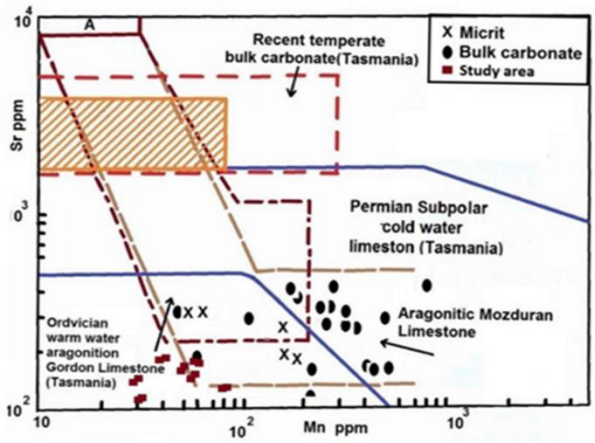

Figure 4: Comparison of Sr and Mn values in calcareous rocks of the study area related to the shallow section of the basin (Adabi and Rao, 1991).

Note that most carbonate samples are located at the bottom and some within the Aragonite carbonate range of Qom, which is probably due to the mineralogy mixture of aragonite and calcite. Some of the range and symptoms used are similar to Fig. 4. Most of the deeper carbonate samples of the basin have lower Sr values compared to their shallower aragonite equivalents (average 340 ppm). As previously stated, the Sr content in carbonates depends on their mineralogy and water depth, i.e., it decreases with decreasing aragonite content or with increasing sea surface depth. Therefore, the low Sr content in these samples is due to increasing water depth and increasing calcite mineralogy (HMC + LMC) compared to aragonite mineralogy in the shallower part of the basin (Adabi and Rao, 1996).

Na-Mn changes

Figure 5 changes Na and Mn values in Qom's limestone in the study area.

According to the figure, samples are located in the range of Tasmania's Gordon limestone with Aragonitic mineralogy. Comparison of the study area and benchmark areas shows that it is located within the Gordon Tropical Limestones of Tasmania with aragonite mineralogy.

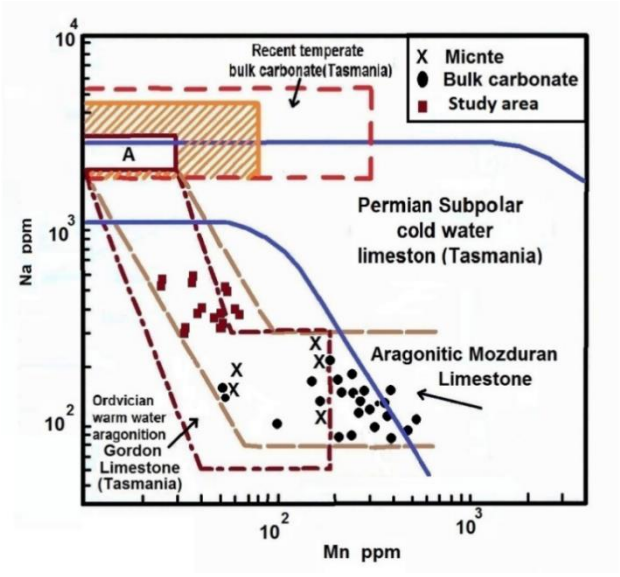

Figure 5: Changes of Na and Mn values in the limestone of the study area related to the shallow part of the basin and the symptoms used are similar to Fig. 2.

Sr-Na changes

The amount of Sr in the total carbonate samples (Bulk) of the tropical regions of the present is between 8,000 and 10,000 ppm in change (Milliman, 1974), while in the total carbonate specimens the present -day carbon regions have less range and between 1642 to 1642 to 5007 ppm (average 3270 ppm) fluctuates (Figure 2). The amount of Sr varies depending on the mineralogy of carbonates.

The amount of Sr increases with an increase in aragonite levels and decreases with increased calcite. The abundance of Sr is also directly related to the increase in seawater temperature (Morse and Mackenzie, 1990).

Usually, the semi-stable CaCO3 minerals are transformed into calcite during meteoric diagenesis or burial, and therefore the amount of Sr in diagenetic calcite depends mainly on the partition coefficient and their concentration in diagenetic solutions.

Since the distribution coefficient of Sr is less than 1 and its concentration in meteoric waters is negligible, the resulting diagenetic calcite will have a low Sr content.

The value of the Sr and in the studied area is between 100 and 183 ppm (average 141 ppm) in change (Figure 2). The Sr values of these samples are much lower than the equivalent values of their present, because the Sr decreases significantly during meteoric diagrams.

The diagram of Sr-Na changes in the studied limestone is presented in Fig. 2.

Na values in calcareous samples in the deep part of the basin are between 44 and 525 ppm (average 144 ppm) in change (Fig. 2).

Drawing of Sr-Na values in these limestones indicates a systematic decrease in the amount of both Sr and Na elements, probably due to an increase in the effect of non-marital diagnosis (Fig. 6). In this figure, a positive relationship between Sr and Na values is probably due to the similar separation coefficients of these two elements in carbonate minerals. In this form, most of the data is located

within the range of cold -water limestone rocks of the Permin, and some are located within the range of Mozdouran aragonite limestone.

Examination of carbonate rocks in the study area indicates that these samples are within the Permian subpolar limestone range (Rao, 1991). Note that most of the data are within and below the subpolar limestone range and have a low correlation coefficient.

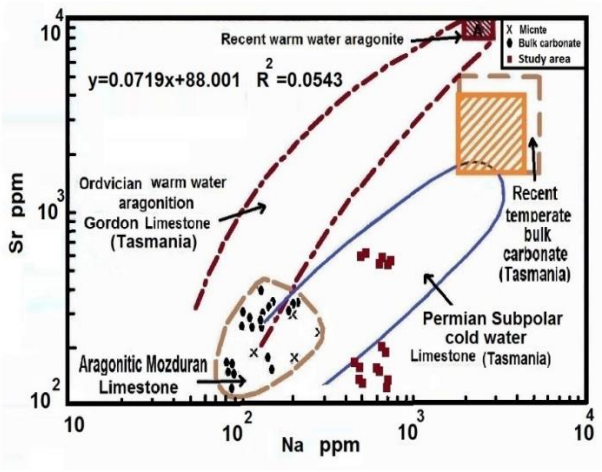

Figure 6: Sr and Na changes in limestone in the study area.

Sr/Mn changes vs. Mn

Mn values in the total carbonate specimens of the present temperature regions vary from 1 to 311 ppm (average of 69 ppm) 1. The concentration of the Mn on the limestone studied area is between 29.6 to 69.3 ppm, average of 64.25 ppm (Figures 5 and 6). Mn values increase with decreased aragonite percentage (Rao and Adabi, 1992) and increase with the effect of meteoric water. The concentration of the Mn also decreases with increased sedimentation rate (Pingitore et al., 1988; Mucci, 1988). Usually in carbonate near the beach due to the abundance of Mn and Fe (amini and rao, 1998).

The changes of Sr/Mn and Mn (Fig 7) in the limestone samples of the Qom Formation in the target area show that they are in the range of warm water aragonite limestone belonging to the Ordovician (Adabi and Rao, 1991) and the aragonite limestone of the Mazdooran Formation (Rao and Adabi, 1992).

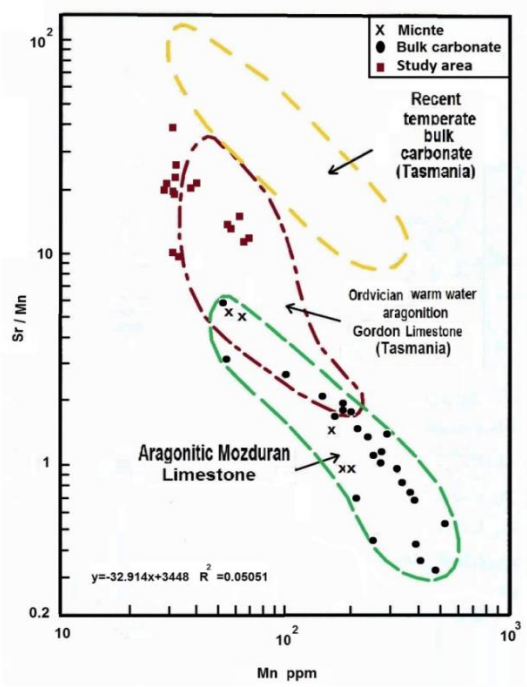

Figure 7: Sr/Mn changes against Mn in Qom Formation Limestones (shallow basin) compared with the total carbonate specimens of temperate regions and tropical Aragonite limestone (Gordon) (Rao, 1991).

Sr/Na changes vs. Mn

Figure 8 indicates Sr/Na changes against Mn in Qom Formation Limestone in the northwest of Tafresh.

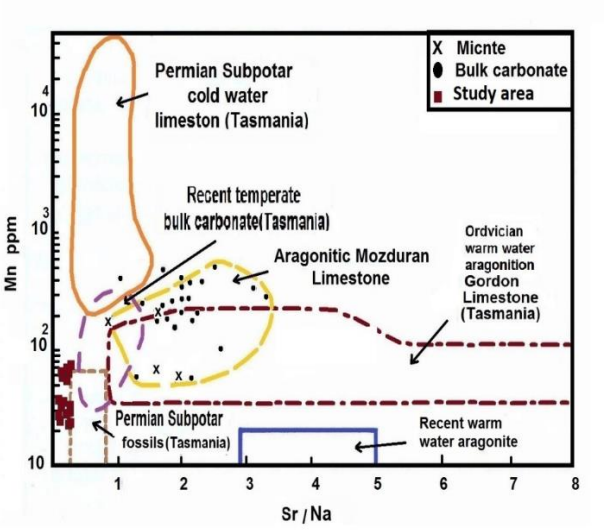

Figure 8: Sr/Na changes vs. Mn in limestone in the study area Related to the shallow basin.

Most data related to Qom limestone in the study area above the semi-polar limestone (Rao, 1991), and near the total carbonate specimens of the recent age Tasmania (Rao and Adabi, 1992). This indicates a mixed calcite-aragonite mineralogy in these samples.

Relationship of destructive elements in the shallow areas of the basin

Fe and Mn Relationship

Iron values in Qom Formation Limestone in the study area are between 1406 and 3254 ppm (average 3033 ppm) in change. There is very little information on the amount of iron in the shallow marine carbonate aragonite of the present hot water. In the studied limestone, due to the increase in the effect of meteoric diagrams, iron values increase with increased Mn values (Fig. 9).

Iron concentration is usually increased by increasing the percentage of insoluble residue (IR) in acid, as iron may be added to the solution through the dissolution of insoluble residue in acid. Therefore, it is best to skip carbonate specimens that contain non - acidic materials (> 15 %). In carbonate facies, it is usually the possibility of the presence of non-carbonate elements, which are more expressive of destructive origin. For this purpose, in this study, the relationship between Fe and Mn changes is presented in Figure 9.

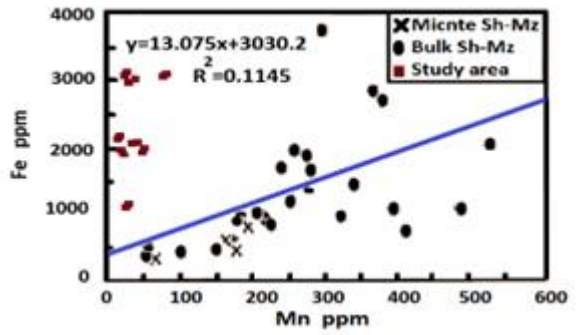

Figure 9: Fe and Mn changes in calcareous rocks of Qom

An examination of the relationship between iron and manganese values in limestones of the Qom Formation shows that they have a low correlation coefficient.

Sr/Mn to Mn ratio

The changes of strontium to manganese versus manganese are shown in Figure 10. Some limestone data are inside and some are under the range of Gordon Aragonitic limestone, which is due to the low Sr value compared to the Mn.

The reason for this could be due to the mixed calcitic and aragonitic mineralogy in these limestones. A comparison of the study area and the reference areas shows that in the study area, some samples in the Permian cold-water limestone range have calcitic mineralogy and a low correlation coefficient. The similarity between the minor elements of the ancient and present-day aragonitic carbonates confirms that the Qom limestones (the shallow part of the basin) also had an early aragonitic mineralogy.

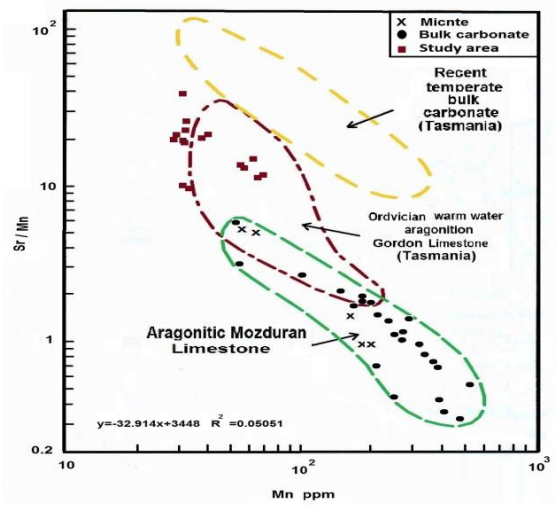

Figure 10: Sr/Mn changes against Mn in the limestone of the study area (shallow section of the basin).

Sr/Na Changes to Mn

The changes in manganese versus the strontium to sodium ratio are shown in Figure 11.

Note that Qom data (the study area) is located at the bottom of the Aragonitic Gordon limestone and away from the total carbonate samples of the

present-day temperate regions. The area is located in the Ordovician limestone area with Aragonitic mineralogy.

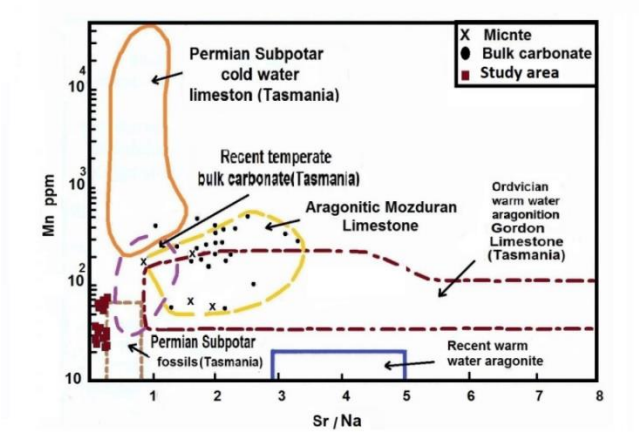

Figure 11: Sr/Na changes against Mn in the limestone of the study area (shallow section of the basin).

Conclusion

The Qom Formation sediments in the studied section with a thickness of 473 meters include thin, medium to thick bedded and massive limestones. This sedimentary sequence is placed with erosional discontinuity on Eocene volcanic rocks and is finally covered by alluvium.

In this study, using major and minor elements, the primary mineralogy of limestones was used to identify the primary mineralogy of ancient carbonates.

Elemental information (Fe, Mn, Na, Sr) was investigated and compared with the ranges of present-day carbonates in the regions. The results of this study show that the carbonate rocks of the Qom Formation in the studied area are within the range of Gordon limestones and Mozdouran aragonite limestones. The similarity between rare elements in ancient and modern aragonitic carbonates indicates that the Qom limestones (shallow part of the basin) had an early aragonitic mineralogy and are within the range of Ordovician limestones with aragonitic mineralogy.

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