



Primary mineralogy, Oxygen and Carbon isotopes in Permian strata, Eastern-Central Iran

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Abstract

Sr compositions and $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ were used to determine the original mineralogy and diagenetic trend of the Permian strata of Jamal Formation in Tabas area, Eastern-Central Iran. Permian limestone contain high Sr content (884-2054 ppm) and mostly are recrystallized particularly the presence of oomoldic porosity). These evidences suggest original aragonite mineralogy for these limestones. The $\delta^{18}\text{O}$ values of bulk carbonates Jamal Formation range from -6.8 ‰, PDB to -9 ‰, PDB (Mean - 8.5 ‰, PDB) throughout section whereas variations in $\delta^{13}\text{C}$ values are very low from + 3.5 ‰, PDB to + 4 ‰, PDB (Mean + 3.5 ‰, PDB). The $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ concentrations indicate that these carbonates affected by burial diagenesis.

1. Introduction

The section under study is located in 5 km north of the type section of Jamal Formation, nearly 52 km east of Tabas town, Iran. Approximate coordinates of base of section is 57° 20' E longitude, 33° 21' N latitude. Tabas area is structurally located in Central Iran block (Alavi, 1991). Stocklin et al. (1965) were first to describe the Type section of Jamal Formation in South-wall of Kuh-e-Mahdi, southern promontory of Kuh-e-Jamal. Afterwards, Upper Paleozoic biostratigraphy of Tabas basin has been introduced by Ruttner et al (1968), and further developed by Kahler (1974), Kahler and Kahler (1979), Jenny-Deshusses (1983), Partoazar (1995) and Yazdi (1996). Recently, biostratigraphy and sedimentary environment of Jamal formation were described by Taheri (2001). Most of previous studies have been conducted on biostratigraphy or sedimentary environment features of carbonates in Jamal Formation however, no geo-

chemistry analyses have been carried out. Objectives of this paper are 1) to review stratigraphy of Jamal Formation 2) to analyze geochemical data ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$ and Sr) in order to recognize original mineralogy and diagenetic trend during in Permian time.

2. Methods

A total of 175 samples were taken from Jamal Formation for petrographic studies and among those collected samples the number of 30 and 10 samples selected for geochemical and isotopic analyses, respectively. All thin-sections were stained with potassium Ferro-cyanide and alizarin-red solutions (Dickson,1965). To determine Sr content about 0.25 gr of whole-rock powders of 30 samples of limestone were dissolved in 1 N HCL and were analyzed by atomic absorption spectrometer at the Geology Department, of Shahid Beheshti University, Tehran, Iran. The precision of the analysis is ± 1 ppm. For oxygen and carbon isotope analysis about 15 mg of whole-rock powders of 10 selective limestone were analyzed with mass spectrometry (Micromass, 602D) at the Geology Department, University of Tasmania, Australia. The relative precision of analysis for both of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ is $\pm 0.1\%$.

3. Stratigraphy and carbonate microfacies

In section studied, Jamal formation unconformably overlies shales and sandstones of Sardar Formation. The upper contact of Jamal Formation with Lower Triassic vermiculate limestone of Sorkh Shale Formation is faulted. Jamal Formation is divided into 9 stratigraphic units that composed of alternating fossiliferous limestone and oolite with horizons of very thin dolomitic limestone. Detailed petrographic investigations led to the recognition of several microfacies which constitute four paleoenvironmental belts, including open marine, bar, lagoon and tidal flat. Obtained data from interpretation of these facies suggest that carbonate sediments in Jamal Formation were probably deposited in a ramp setting.

3.1. Tidal flat microfacies.

The tidal flat sediments are composed of fenestral lime mudstone with some silt-size quartz. The presence of birdeye structure in this microfacies shows intertidal and supratidal environments (Fulk, 1982). Dunham (1970) considered this facies as lowest intertidal where trapped air between the grains of irregular shape leads to the development of birdeyes.

3.2. Lagoon microfacies.

The lagoon microfacies are characterized by: 1) Bioclastic packstone/ grainstone (consist of skeletal grains such as calcareous green algae (dasycladacean), benthic foraminifers, gastropod, brachiopod and bivalve: suggesting deposition in relatively

restricted lagoonal environments adjacent to tidal flats). 2) Bioturbated bioclast wackstone (including benthic foraminifers, ostracods and bivalves, indicative of central part of lagoon). 3) Oncoid bioclast grainstone/peloid bioclast grainstone (composed of oncoïd, peloid and skeletal grains of brachiopod, benthic foraminifer and echinoids). These microfacies were deposited in lagoon margin toward oolitic shoals and suggests a higher-energy conditions.

3.3. Bar microfacies

These microfacies composed of two subfacies 1) Ooid grainstone (consist of mostly recrystallized and well sorted ooids with little amounts of skeletal grains that consistently affected by tidal waves). 2) Intraclast ooid grainstone (suggesting deposition in shoal areas with high energy called seaward shoal).

3.4. Open marine microfacies

The open marine microfacies include only thin-bedded bioclast wackstone/ packstone and consist of some faunas such as brachiopods, echinoids and benthic foraminifers. The existence of thin bedding indicates low rate of sedimentation. This microfacies was formed at seaward end of carbonate platform.

4. Original mineralogy and Sr compositions

In order to determine original mineralogy both petrographic studies and geochemical analyses are very beneficent. Generally, sort and abundance of principal carbonate minerals depend on factors such as Mg/Ca ratio, salinity, temperature and pCO₂ (Rao, 1996). The degree of changes a carbonate rock during diagenesis is in relation with its original mineralogy as diagenetic potential in low Mg-calcite and aragonite is much higher than that of low Mg-calcite. The concentrations of Sr increase with increasing aragonite content (Rao and Adabi, 1992). Marine calcite typically contains about 1000 ppm Sr, whereas co-precipitated aragonite has about 10,000 ppm Sr (Kinsman, 1969). Sr contents of Jamal Formation carbonates range from 844 to 2054 ppm (Mean 1095 ppm). One of the characteristics of the carbonates of this Formation is recrystallization, particularly the presence of oomold in oolites. Many former aragonitic cement (and aragonite bioclast and ooids) were calcitized in a thin-film/replacement-front mechanism so that there is some degree of retention of original texture (Tucker and Wright, 1990). Oomoldic porosity and dropped nuclei have been observed to support a former aragonite mineralogy (Sandberg, 1983; Wilkinson et al, 1985). Brand and Veizer (1980) demonstrated that recrystallization of aragonite results in lack of Sr. High Sr composition in bulk carbonates of Jamal Formation and petrographic evidence suggest an original aragonite mineralogy for these limestone.

5. $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ compositions and their diagenetic trend

In recent decades, much research has been done on $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ concentrations of limestone and calcareous shells. Many factors can influence $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values including **1)** Temperature (O'Neil et al, 1969 and Spaeth et al, 1971) **2)** Salinity (Craig and Gordon, 1965 and Lloyd, 1964) **3)** Original mineralogy (Gonzalez and Lohmann, 1985) **4)** The $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ composition of ambient water (Schidlowski, 1987) **5)** Diagenesis (Gao and Land, 1991; Allen and Matthews, 1982; Hudson and Coleman, 1978) and other factors. Lighter $\delta^{18}\text{O}$ values can be referred to as increasing of temperature (Hudson, 1977). On the other hand, diagenesis processes generally lower the original $\delta^{18}\text{O}$ compositions (Brand and Veizer, 1981). Unlike $\delta^{18}\text{O}$, temperature has fewer effects on $\delta^{13}\text{C}$ concentrations. Isotopic carbon values usually have no change during diagenesis except when carbonates are exposed to subaerial processes (Heydari et al, 2001). Bulk rock $\delta^{18}\text{O}$ values of Jamal Formation increase from -9‰ , PDB at the base of Late Early Permian (Bolorian) Units to -6‰ , PDB at the top of the same units and remain relatively consistent at a value about -8‰ , PDB in Middle and Upper Permian Units. Bulk carbonate $\delta^{13}\text{C}$ concentrations have minor changes from the base to the top of section as range from 3.5‰ , PDB to 4‰ , PDB (Fig. 2). Increasingly lighter $\delta^{18}\text{O}$ values and invariant concentrations of $\delta^{13}\text{C}$ in carbonates of Jamal Formation are consistent with burial diagenesis. During burial diagenetic regime due to increase temperature $\delta^{18}\text{O}$ compositions decrease whereas those of $\delta^{13}\text{C}$ no change.

6. Conclusion

The present study indicates that deposits of Jamal Formation have formed in four facies belts including tidal flat, lagoon, bar and open marine. Dominant original aragonite mineralogy is suggesting for high Sr contents and moldic porosity. These limestones have low $\delta^{18}\text{O}$ compositions and invariant values of $\delta^{13}\text{C}$ suggesting burial diagenesis.

7. References

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