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GEOCHEMICAL EVALUATION OF THE AL FAIDIYAH FORMATION FOR INDUSTRIAL USES: A CASE STUDY OF THE AL FATIAH QUARRY, NE LIBYA

Osama R. Shaltami[1], Saad K. El Ebaidi[1], Fares F. Fares[1], Farag M. EL Oshebi[1], Hwedi Errishi[2] and Abobakar E. Algomati[3]

[1]*Department of Earth Sciences, Faculty of Science, Benghazi University, Libya*

[2]*Department of Geography, Faculty of Arts, Benghazi University, Libya*

[3]*Department of Engineering Geology, Faculty of Science Engineering, University of Bright Star*

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Corresponding author :
Faresfathi2222@gmail.com

A B S T R A C T

The purpose of this work is to evaluate Al Faidiyah Formation in Al Fatiah quarry for industrial uses, NE Libya. The bulk samples were analyzed for major oxides using by (ICP-MS) inductively coupled plasma-mass spectrometry technique. The analysis was done in the Nuclear Materials authority of Egypt. The chemical analysis data showed that the calcite mineral is the main carbonate mineral in study area. Al Faidiyah Formation contains high pure limestone, and is suitable for many industries (i.e. manufacturing process, chemical industry, neutralizes acids, construction process and steel industry).

Introduction

Al Jabal Al Khdar is a highland area which encompasses the northern most part of Cyrenaica north east Libya, it is consists of Upper Cretaceousto Tertiary marine deposits, but Jurassic and Lower Cretaceous marine deposits are known from the exploratory oil wells. The Al Jabal Al Khdar is more than 200 km long and 75 km wide. Al Faidiyah Formation represents a portion of Al Jabal Al Akhdar region. Al Faidiyah Formation was introduced by Pietersz (1968) it ranges in age (Aquitanian–Burdigalian).Shaltami *et al.*,(2018) determined the isotope age for Faidiyah Formation, the age derived from the Sr ratios is Early Miocene (Middle Aquitanian, 21.40-22.13 Ma). This Formation was deposits in shallow marine environments (Klen,1974) while Shaltami *et al.*, (2018a and 2021b) reported Al Faidiyah Formation was deposited in continental shelf. Limestone has many industrial uses and can be used as mined or processed into a wide variety of products. It is the raw material for a large variety of construction, agricultural, environ- mental, and industrial material (Chu and Nel.,2019). Limestone's most common use is as a crushed construction material, serving as a base for roads and ballast in railroads, but it also combines with crushed shale in a kiln to make cement and serves as an aggregate material in concrete. Limestone's usefulness stems from its strength and density (Harben P.W., 1999). In this study Al Fatiah quarry has been studied and consists of Al Faidiyah Formation (Fig.1).

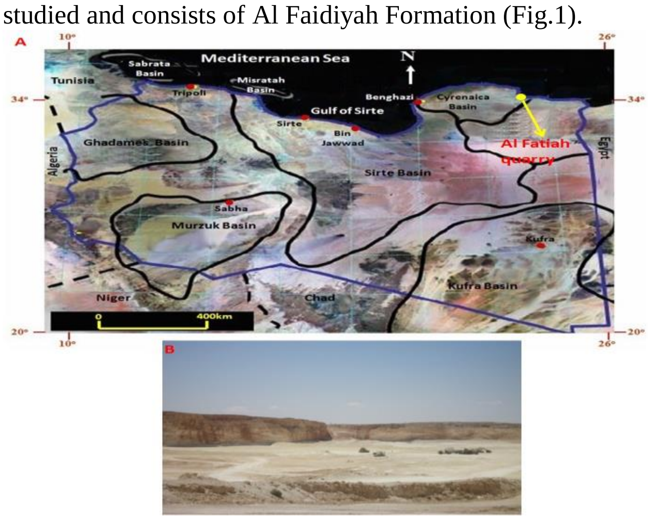

Figure. 1: Composite image showing **(A**) Satellite image of Libya showing the studied quarries (after Shaltami, 2012),**(B)** General view of Al Fatiah quarry.

The Lithostratigraphic column of Al Faidiyah Formation in the studied quarry is shown (Fig.2). According to Shaltami *et al.*, (2018) the absolute age of Al Faidiyah Formation is the Early Miocene (Middle Aquitanian).El

Ebaidi *et al.*, (2015) conducted an evaluation of raw materials in Al Fatiah quarry. They found that the raw materials are suitable for cement industry.

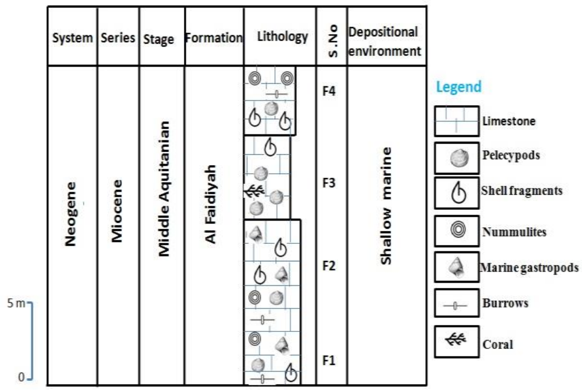

Figure. 2: Lithostratigraphic column of Al Faidiyah Formation in Al Fatiah quarry.

Materials and Methods

Four samples were collected from the studied quarry. Bulk geochemical analysis for major oxides was performed using the inductively coupled plasma-mass spectrometry (ICP-MS) technique. The chemical analysis was carried out in the Nuclear Materials authority of Egypt.

Preparation

1- Grinding the sample to become powder (flow like) and weight it 25 g.
2- Sample must be drained of moisture.
3- Each sample must be numbered and placed in a special bag.
4- Compression of sample.
5- Analysis by (ICP-MS).

Many authors agree to the efficiency of this method for major oxides determination (Al Jaboury and McCann, 2008).

Results

Table (1) shows the chemical analysis data of the studied samples. The samples have low MgO/CaO ratio (~0.02), which suggests that the studied samples are not dolomitized (Magdalena O. and Maciej J., 2014). The triplot of $FeCO_3$-$CaCO_3$-$MgCO_3$ (Fig. 3) indicates that calcite mineral is the main carbonate mineral in the studied samples.

Table. 1: Chemical analysis data (major oxides in wt.%) of the studied samples

Sample No	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3	Cl	$CaCO_3$	$MgCO_3$	$FeCO_3$
F1	1.49	0.02	0.54	0.43	0.03	1.12	54.87	0.03	0.14	0.01	0.15	0.02	98.06	2.33	0.5
F2	1.33	0.02	0.41	0.50	0.02	1.41	55.80	0.03	0.09	0.01	0.21	0.02	99.6	2.7	0.7
F3	1.18	0.04	0.73	1.72	0.01	0.91	53.92	0.06	0.11	0.01	0.05	0.04	96.3	1.9	2.7
F4	0.97	0.01	0.23	0.57	0.03	1	55.53	0.03	0.06	0.01	0.25	0.02	99.24	2.3	0.9
Average	1.24	0.02	0.48	0.81	0.02	1.11	55.03	0.04	0.10	0.01	0.17	0.03	98.34	2.3	1.2

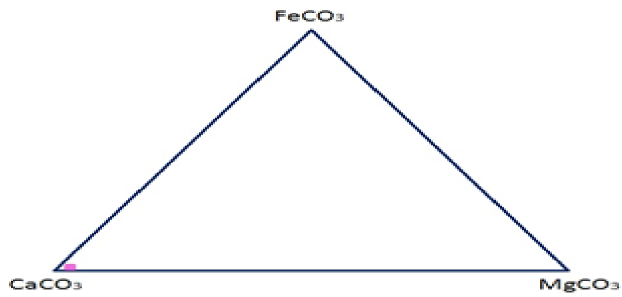

Figure. 3: Triplot of FeCO3- CaCO3-MgCO3 showing the carbonate minerals in the studies samples (fields after Krajewski *et al*., 2001).

Limestone uses

Table (2) shows the classification of limestone based on chemical composition. Clearly, the studied samples are classified as high pure limestone in average (98.34, $CaCO_3$). Moreover Al Faidiyah Formation is considered as a good source for high pure limestone in the Table (3) According to the specifications and uses of limestone, Al Faidiyah Formation is appropriate for many industrial uses:

1. Manufacturing process includes (animal feeds, carpet backing, glass, paint, plastic, paper, rubber, sugar, tooth paste, agri- culture,ceramics, fertilizer and pharma-ceutical.

2. Chemical industry process includes (soda ash, ammonia and lime).

3. Neutralizes acids process includes (water sewage treatment and controlling the acidity of soil).

4. Construction process includes (cement and aggregates).

5. Iron and steel industry **Table. 2:** Chemical classification of limestone (after Lorenz and Gwosdz, 2003).

Table. 2: Chemical classification of limestone (after Lorenz and Gwosdz, 2003).

Categories of limestone	Chemical Composition ($CaCO_3$ in wt. %)
Very high purity	>98.5
High purity	97 – 98.5
Medium purity	93.5 – 97
Low purity	85 – 93.5
Impure	<85

Table. 3: Specifications for quarried limestone for some important end uses (after Lorenz and Gwosdz, 2003).

End uses of limestone	Chemical Composition (%)								
	$CaCO_3$	CaO	$MgCO_3$	MgO	SIO_2	Al_2O_3	Fe_2O	Na_2O	K_2O
Metallurgy (iron, steel, nonferrous metals)	90 - 95	> 50.4	< 10	< 2.5	< 1.6	< 1	< 2	< 0.5	< 0.5
Glass manufacture	> 98	> 55.2	Not deleterious		< 2	0.3 - 1	0.01 - 0.3	< 0.05	< 0.05
Mineral wool manufacture	> 85	> 47.5			Not too high				
Paint, sealing (limestone) material	98 - 95	> 55	Low						
Food, cosmetica, tooth paste, pharmaceutica	> 98	> 54.9							
Animal feeds	95 - 98	53.2 - 54.9	Low	Low	< 3	Low	Low	Low	Low
Fertilizer	70 - 90	39.3 - 50.4	Low	Low	< 1	Low	Low	Low	Low
Sugar production	90 - 98.5	50.4 - 55.2		< 4	< 1	> 1.5		> 0.05	
Soda manufacture (Solvay)			3 - 6	1.5 - 3	< 3				
Ceramics	96 - 98	49.9 - 53.8	1-8	0.5 - 4	< 2		< 0.3		
Treatment of potable water	80 - 98	47.6 - 53.8	Low						
Agriculture	80 - 95	47.6 - 50.4	Advantageous		Low	< 1		< 0.05	
Pulp and paper	> 93	52.1	< 4	< 2			< 0.01	Low	
Rubber	98.5	> 55.2	Low						
Plastics	< 98.5	> 55.2	Low		< 1	Low		< 0.5	
Lime (quick lime)	> 95	> 53.2	< 5	< 2	Low	< 0.9		Low	
Calcium ammonium nitrate	> 85	> 47.6	Not deleterious		< 10	Not deleterious			
Portland cement	> 90	> 50.4		2.5 - 6	Low				

Conclusions of the work

Three points were concluded:

1. Al Faidiyah Formation samples in Al Fatiah quarry is not dolomitized.
2. Al Faidiyah Formation is classified as high pure limestone.
3. Al Faidiyah Formation is suitable for manufacturing process, chemical industry, neutralizes acids, construction process and steel industry.

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