The Uses of Exposed Raw Materials in Construction: A Stratigraphical and Geochemical Outcome of Zallah Sheet

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Abstract

The Zallah Sheet (NH 33 – 16) area is studied by the Industrial Research Center, and it has a large industrial significance. Throughout the detailed study conducted on the chemical analysis of the sedimentary rocks, the main use of these rocks in construction and building materials includes all of the dimension blocks, natural aggregates, crushing aggregates, concretes, and paving road-stones. However, the manufacture of refractory bricks and Portland cement where the main components of available limestone and clay raw materials. A recalculation for the chemical analyses has been used to determine the limestone and clay percentages for manufacturing Portland cement. The raw materials mentioned above are existing in the following formations (from oldest to youngest); Rawaghah Member of the Bishimah Formation (Ypresian), Al Jir Formation (Lutetian), Thmed al Qusur Member of the Wadi Thamat Formation (Priabonian) and Qarat Jahannam Member of Maradah Formation (Aquitanian - Burdigalian).

Introduction

The study area comprises sedimentary rocks and the construction industry has the basic need for rocks and minerals and if society continues to ask for higher standards of housing, roads and infrastructure development, then the demands for constructional raw materials will continue to

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increase. The primary function of the raw materials in Zallah area is in construction and building stones. Demand for aggregates, concrete, road embankments, bridges and building are essential requirement and important.

Location of the Study Area

The study area located nearly in the central part of Libya between Latitudes 28° 0' N and 29° 00' N; Longitudes 16° 30' E 18° 00' E. with an area 16250 km^2 (Figure 1).

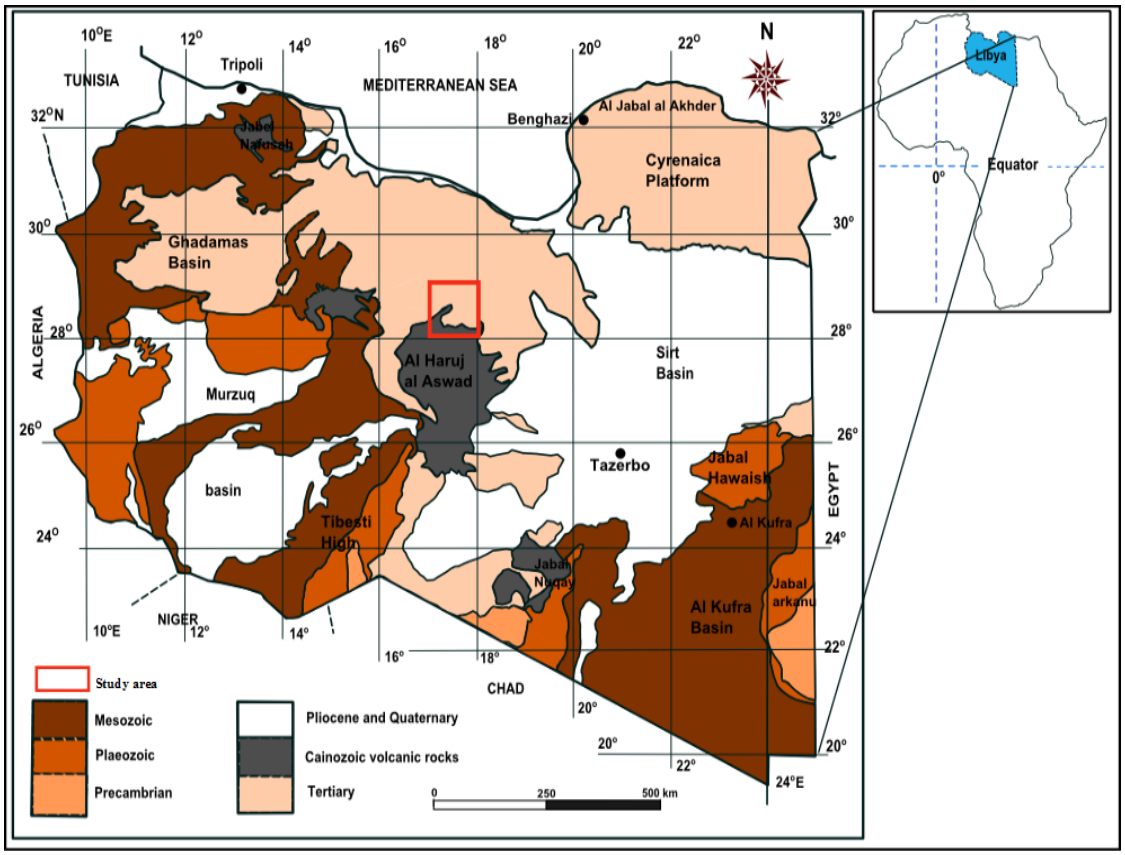

Figure (1) Map of Libya showing different sedimentary basins and the location map of the study area (i.e. Zallah sheet NH 33 – 16).

(Modified after Rusk, 2001 and Ramos, et al., 2006).

Stratigraphy of the Study Area (Zallah)

The reviewed Zallah exposed sections consists largely of four superposed formations from bottom to top: Rawaghah Member of Bishimah Formation (Ypresian), Al Jir Formation (Lutetian), Thmed al Qusur Member of Wadi Thamat Formation (Priabonian) and Qarat Jahannam Member of Maradah Formation (Aquitanian-Burdigalian). Lithostratigraphic chart of the sedimentary formations is shown in Figure 2, (Vesely, 1985).

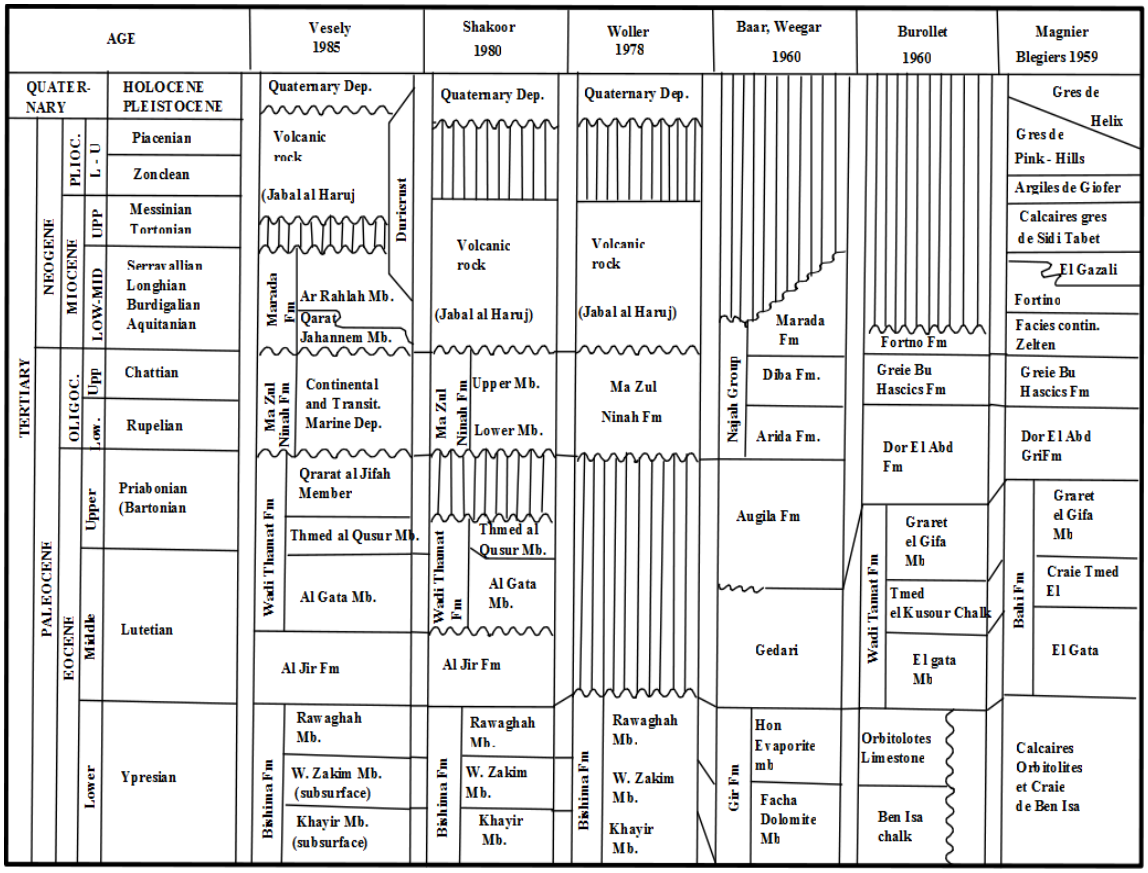

Figure (2) Nomenclature chart of the sedimentary formations in the study area (Vesely, 1985)

Wadi Thamat Formation

This formation introduced by Desio (1935) and lately subdivided into three members, the lower Al Gata, the middle Thamed al Qusur and the upper Qrarat El Geifa members by Vesely (1985). These members are separated from each other by conformable surface. The lower boundary is conformable with Al Jir Formation but unconformable with the overlying Oligocene Continental and transitional marine deposits as exposed at Dur Bu Zanad in Zallah area or Qarat Jahannam Member of Maradah Formation in places.

Al Gata Member

This member is cropped out in the northeastern part (Qarat Ar Raqubah), as well as in the southeastern part and large portion of the west half of the area, with a maximum thickness of 100 m. Lithologically, it consists of marlstone and claystone with thin gypsum intercalations. The marlstone which usually preserved in the lower part of the section is dolomitic in most cases (Figure 3).

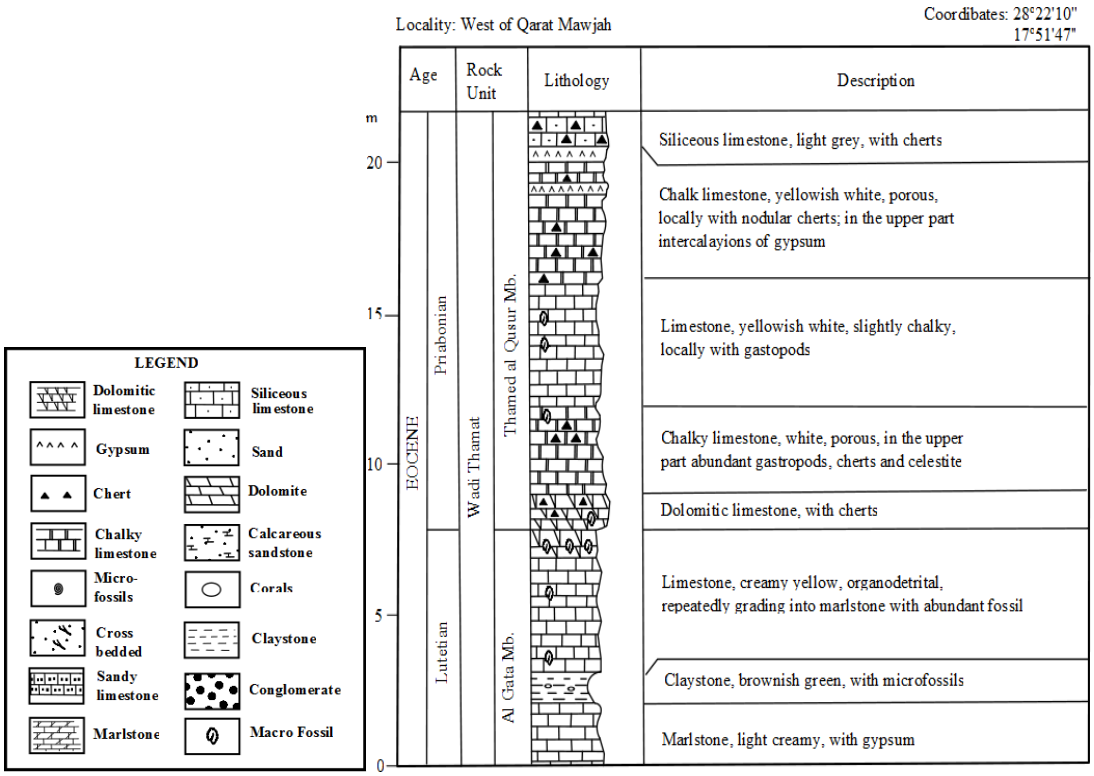

Figure (3) Columnar section of the Wadi Thamat Formation (after Vesely, 1985).

The claystone facies is greenish gray in color with the diagnostic microfossil namely *Dictyoconoides cooki*, which is indicating Lutetian age, whereas, the gypsum intercalation is usually wide and saccharoidal texture Vesely (1985).

Thamed al Qusur Member

It is exposed in the north-northwest and eastern part of the area with a total thickness reaches 40 m. Lithologically, it consists of limestone, chalky with chert nodules in part, and becoming dolomitic in the lowermost part (Figure 3). The bioclasts are predominated by Molluscks and green algae, with foraminifers, ostracodes and corals. The age of this member is Priabonian, as indicated by the presence of the coral *Plocophyllia bartai*, as well as and its stratigraphic position.

Qrarat El Jifah Member

It is exposed in the eastern and northern part of the map with intermitted small patches in the south, with a total thickness reaches 150m. Lithologically, it is dominated by carbonate sequence of limestone and dolomite in part glauconitic and sandy or argillaceous, locally cross bedded with benthonic foraminifera and ostracoda. The macrofossils are mainly of Mollusks and echinoids. However, few vertebrate remains are also present. Based on the stratigraphical position and the correlation with Wadi Bu ash Shaykh sheet this member is dated Late Miocene.

Bishimah Formation

The formation was introduced by Jordi and Lonfat (1963) as two units, Khtar Marl and Rouaga chalk. Vesely (1985) divided this formation into three members, Khayari, Wadi Zakim and Rowaghah members. Only Rowaghah Member is exposed in the western part of Zallah sheet Vesely (1985). The maximum thickness of this formation reaches 30 m. Lithologically, it consists of dolomite, dolomitic limestone with rare argillaceous limestone (Figure 4). This carbonate section locally interrupted with siliceous lenticular cherts. The bioclasts are mostly recrystallized or leached, making the identification impossible task. Hence, based on the stratigraphical position and the correlation with the neighbor Al Washkah sheet the Ypresian age is given to this member.

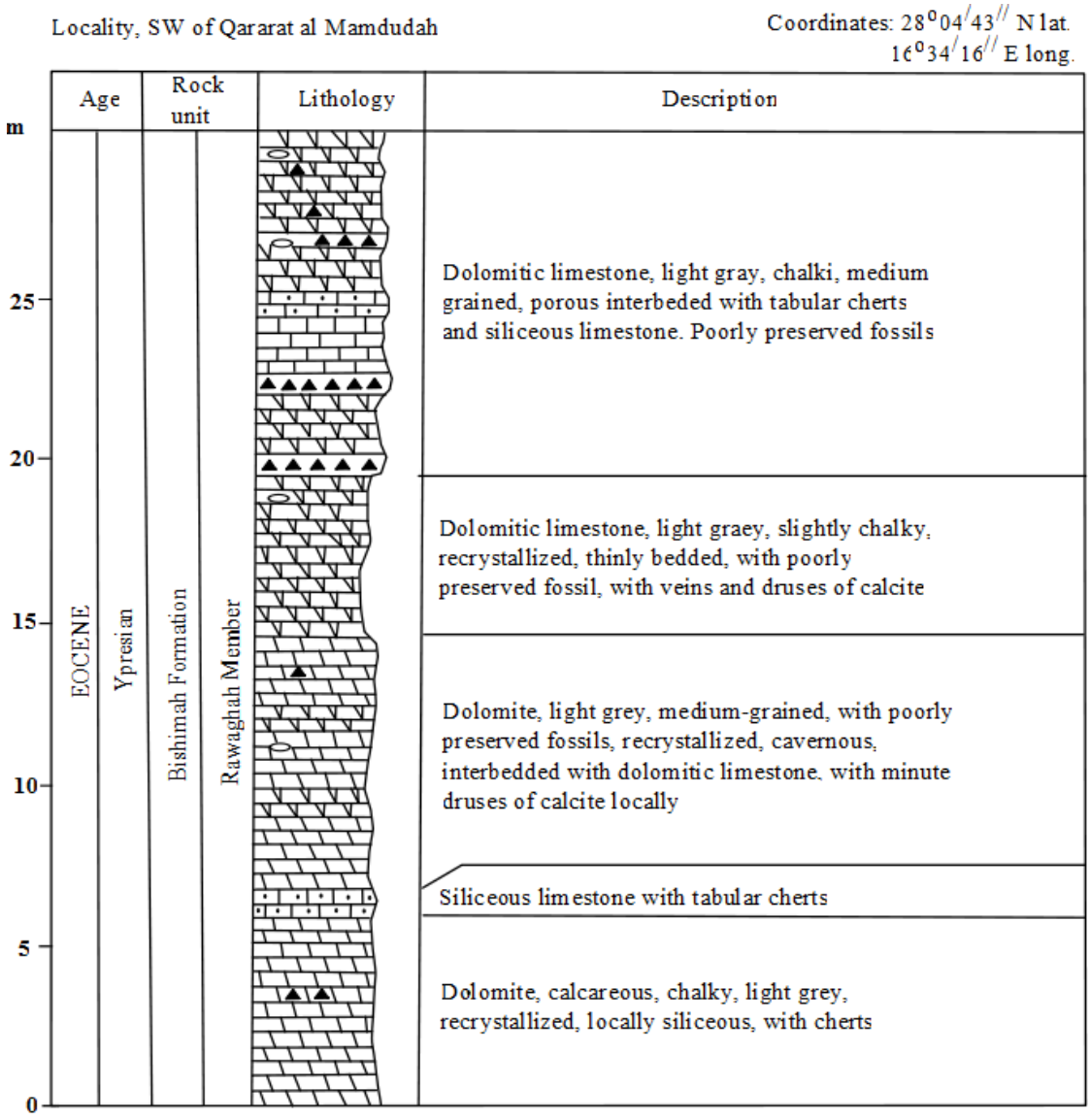

Figure (4) Columnar section of the Bishimah Formation (after Vesely, 1985).

Al Jir Formation

It was introduced by Burollet (1960) as Gir Gypsum. Later Mijalkovic in 1977 named it as Al Jir Formation. In Zallah area, it cropped out in western part as dolomite-evaporate facies (i.e. chalky dolomitic limestone to limestone interbedded with chalky limestone and evaporites) with thickness up to 60 m southeast of Wadi as Shurfa (Figure 5). However, in the northeastern corner of the area this formation becomes limestone

facies with thickness ranges from 50 to 70m. The presence of the larger foraminifera Dictyoconoides cooki and Orbitolites complanatus indicates Lutetian age.

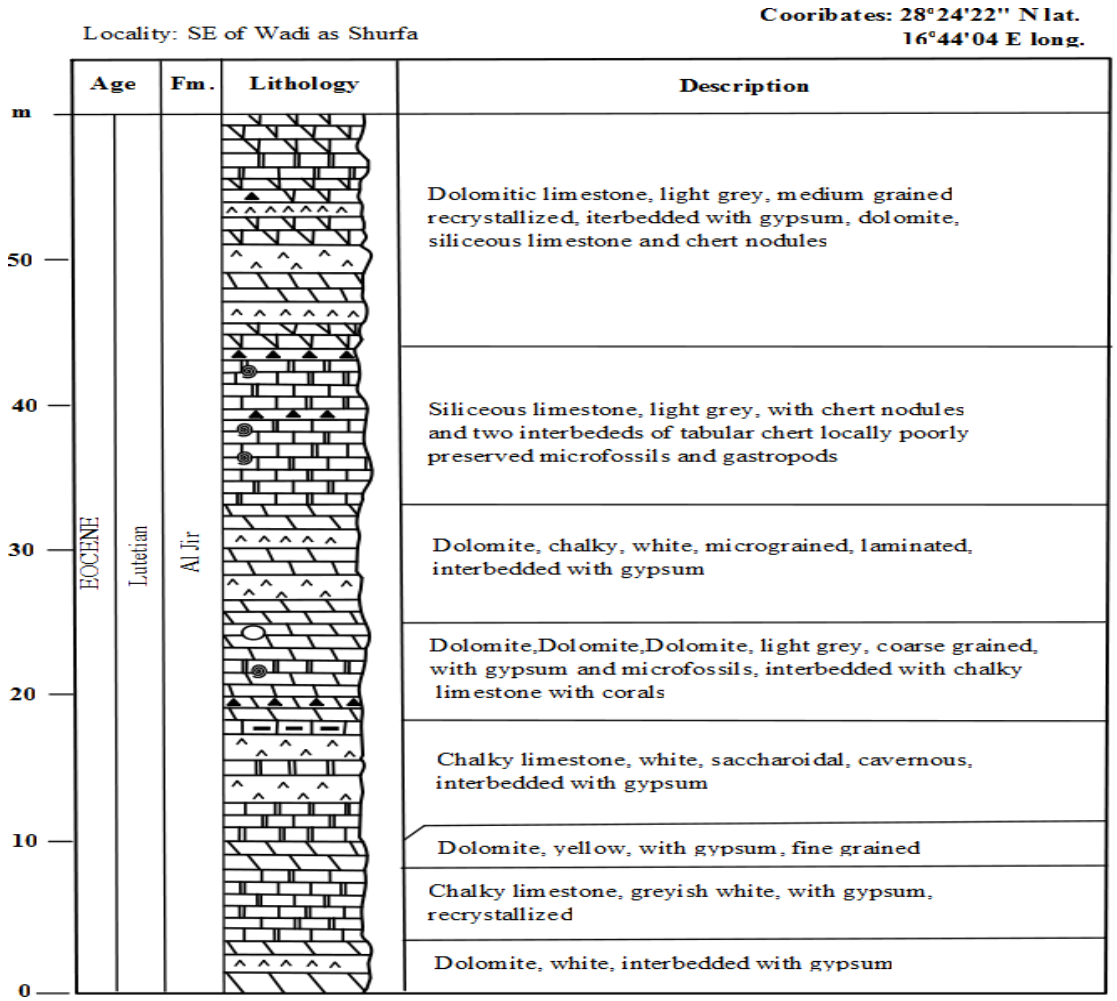

Figure (5) Columnar section of the Al Jir Formation (after Vesely, 1985).

Maradah Formation

This formation introduced by Desio (1935). Later in 1985, Mastera divided this formation into two members; Qarat Jahannam Member which is widely exposed along Zallah trough in Zallah area. Lithologically, it is dominated by siliciclastic deposits with cross bedded sandstone at some horizons interbedded with sandy limestone or dolomite (Figure 6). Based on the presence of the foraminifera *Borelis melo*

Aquitanian-Burdigalian age is given. This member is conformably overlain by Ar Rahlah Member which is only exposed in the north central edge of Zallah sheet as small patches. This Member is dominated by carbonate deposits (i.e. dolomitic limestone and sandy limestone). Due to the lack of any datable fossils except *Borelis melo*, Ar Rahlah Member is dated on the stratigraphic basis and by correlation with the neighbor sheets where datable fossils are present and Aquitanian-Serravallian age is given.

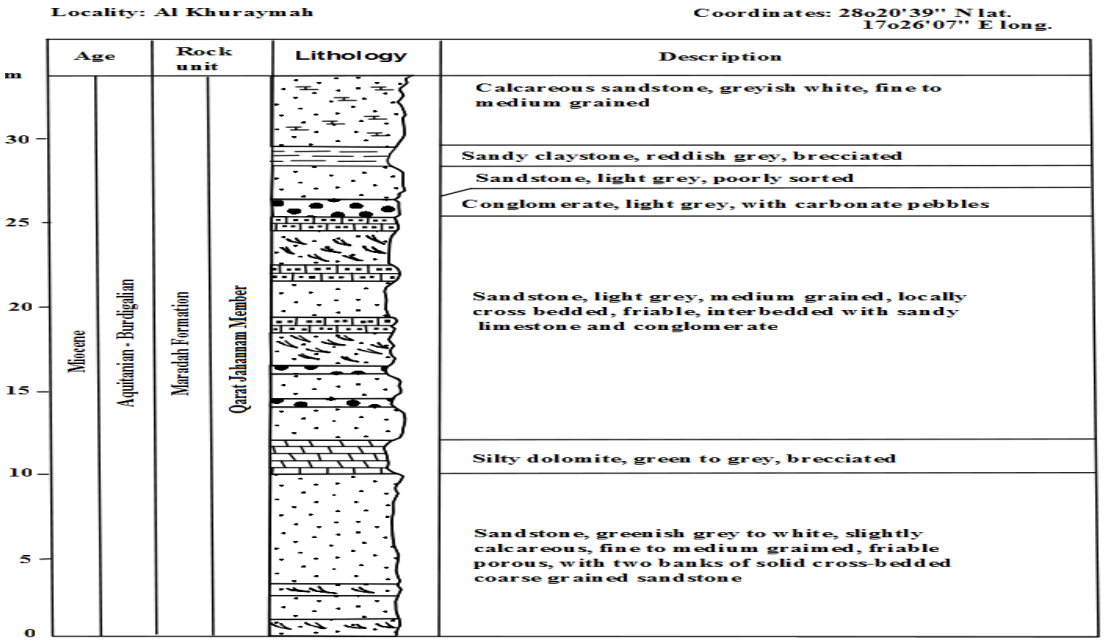

Figure (6) Columnar section of Qarat Jahannam Member of the Maradah Formation (after Vesely, (1985).

Geochemical Data Evaluation

Chemical analyses (Table 1) of some samples in the study area (Zallah sheet) where the chemical data are plotted in ternary system and shows various qualities of rocks and classified as medium purity limestones such as Al Jir Formation to impure limestones (Harries, 1979), as noted in Thamed al Qusur in Wadi Thamat Formation and Qarat Jahannam

Member in Maradah Formation. In addition the Zallah area contains dolomitic limestones (< 50 % $MgCO_3$) in some places especially in Al Jir Formation, and sandstones with intercalated clay. The resulting of the chemical analyses is illustrated in the ternary plots (Figures 7 and 8).

Table (1): Shows typical composition (wt. %) for the raw materials in Zallah area (Note: Sample localities see figure 9)

sample#	SiO_2	CaO	Al_2O_3	SiO_2%	CaO%	Al_2O_3%	$CaCO_3$	MgO	$MgCO_3$
1	4.47	33.84	2.43	10.97	83.06	5.96	60.39	14.76	30.88
2	18.37	21.36	3.17	42.82	49.79	7.39	38.12	16.3	34.10
3	0.68	32.77	0.08	2.03	97.73	0.24	58.48	19.08	39.92
4	2.11	52.34	0.55	3.84	95.16	1.00	93.41	0.99	2.07
5	1.82	30.44	1.23	5.43	90.89	3.67	54.32	18.98	39.71
6	2.6	38.68	0.47	6.23	92.65	1.13	69.03	12.19	25.50
7	19.07	20.84	3.48	43.95	48.03	8.02	37.19	13.14	27.49
8	12.44	26.32	2	30.52	64.57	4.91	46.97	15.37	32.15
9	54.03	1.01	17.39	74.60	1.39	24.01	1.80	3.72	7.78
10	16.91	25.36	0.82	39.24	58.85	1.90	45.26	13.49	28.22
11	96.45	0.29	0.85	98.83	0.30	0.87	0.52	0.05	0.10
12	94.66	1.01	0.55	98.38	1.05	0.57	1.80	0.23	0.48
13	2.2	30.17	0.99	6.59	90.44	2.97	53.84	18.08	37.82
14	1.35	32.77	0.34	3.92	95.10	0.99	58.48	16.66	34.85

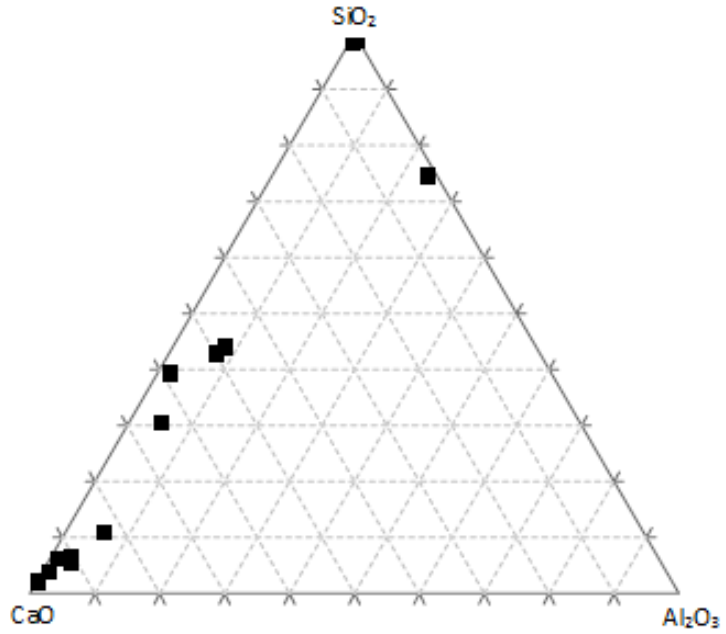

Figure (7) SiO_2-CaO-Al_2O_3 Ternary plot showing the interbedded of limestone and sandstone rocks in Zallah area.

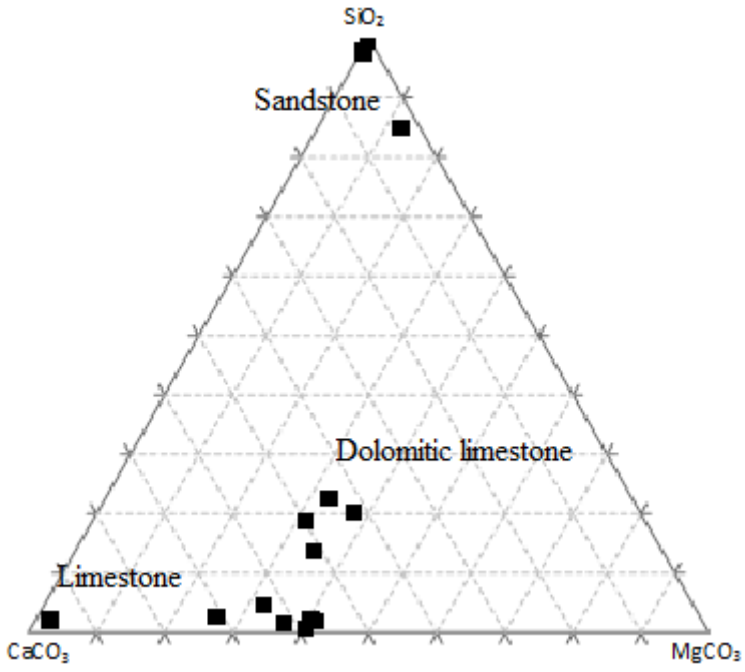

Figure (8) SiO_2-$CaCO_3$-$MgCO_3$ Ternary plot of the different carbonate rock types in Zallah area

Industrial raw Materials and Uses

The most prevalent raw materials available in the study area are limestones and dolomitic limestones, sandstones, clay, gypsum and anhydrite, celestite, iron and natural quaternary deposits (gravels and loose sands). These raw materials can be fully utilized for an extremely wide variety of construction purposes. Plastic clays (commonly montmorillonitic clays) where found in Al Gata and Qrarat al Jifah members. Clays could be used if mixed with lime and sands in manufacturing of bricks and other structural clay products such as tiles, hollow blocks and sewer pipes. Carbonate rocks are suitable for production of cement, crushed aggregates, concrete, as well as dimension stones if considered will occupies important places in the construction of prestigious buildings. Durable mortar also could be made by mixing siliceous lime and clay, also are widely used in road constructions. This study relied primarily on data collection from a geological map sheets located in Sirte – Jufra region (including Zellah Sheet). The authors have been interpreted the chemical analyses available in selected horizons within the concerned study area and assembled to learn the basic components of the rocks and minerals, those of important economic feasibility are taken into consideration. These data have been taken in a simple task to form a map illustrating the available important natural resources of minerals and raw materials in the study area (Figure 9).

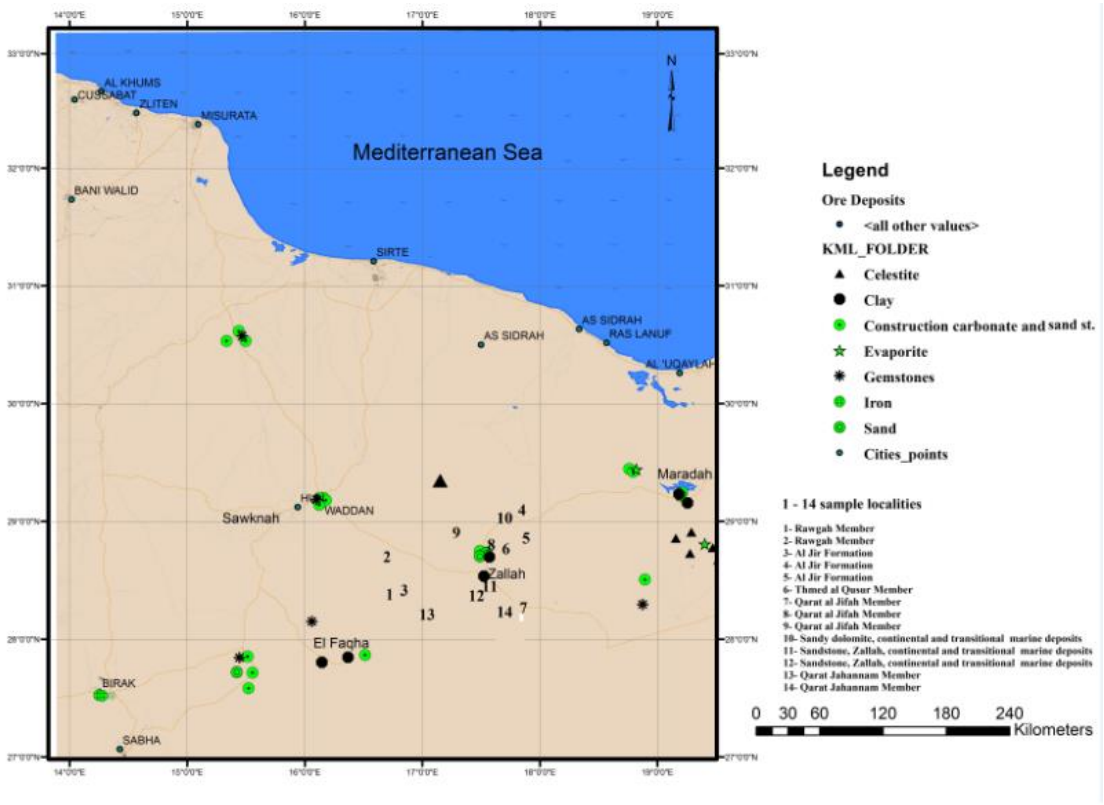

Figure (9) An economical map showing the most important natural resources of the minerals and raw materials available in the Sirte - Jufra area

Conclusions

This study is based on the assemblages of the geological formations and the chemical analysis data in the study area of Zallah sheet. The Geological formations of the Zallah sheet are containing sedimentary and igneous rocks. These rocks are of great importance in construction uses; aggregates (crushing and natural), dimension stones, hollow bricks, cement industry, road construction, wall decoration, tiles and glass industry.

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استخدامات المواد الخام الاولية في البناء: حصيلة دراسة طبقية وجيوكيميائية تفصيلية للوحة زلة

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الخلاصة

تعتبر المنطقة المخرطة من قبل مركز البحوث الصناعية ذات أهمية صناعية كبيرة. ومن خلال تقييم الدراسة التفصيلية التي اجريت علي التحاليل الكيميائية للصخور الرسوبية والمتواجدة بمنطقة الدراسة .

أفادت الدراسة ان الاستخدام الرئيسي لهذه الصخور يكمن في استثمار مواد البناء المتمثلة في قوالب البناء، الحصي الطبيعي والصناعي المستخدم في كل من الخرسانة ورصف الطرق، وكذلك الطفلة التي يمكن الاستفادة منها في صناعة الطوب الحراري. بالإضافة لإمكانية استخدام كل من الحجر الجيري والطفلة كمواد خام رئيسية في صناعة الاسمنت، وهذا من خلال التحليل الرقمي للنتائج الكيميائية المتوفرة سابقا. تتواجد المواد الاولية المذكورة أعلاه في التكوينات الجيولوجية التالية من الأقدم الي الأحدث: عضو رواغة بتكوين البشمة (بريسيان)، تكوين الجير (لوتيتيان السفلي)، عضو ثمد القصور (بريبونيان) بتكوين وادي ثامت، وعضو قارة جهنم (اكويتنيان – بورديقاليان) بتكوين مرادة.

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