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Characterization and Evaluation of the Potential of Limestone Jebels Bent Saidane, Bou Garnine Raous and Bridge of Fahs (North East Tunisia)

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Abstract

At Zaghouan locality, north eastern Tunisia, significant sedimentary ores took place (e.g. sand, clay, limestone…). This sedimentary ores were largely extended and covered partially by quaternary deposits. In this paper, multidiscipline approaches with petrographic, mineralogical, chemical and geotechnical analyses were involved to valorize these materials in various industrial uses.

The carbonates of the Lower Jurassic (Oust Formation) present good criteria and higher quality to be use in engineering application moreover huge reserves.

The gray carbonates of the Lower Jurassic (Oust Formation) are constituted by limestones with packstone or grainstone texture, with relatively abundant lithoclasts which are well coated by a micritic matrix. Mineralogical studies reveal the presence of calcite with a small content of quartz and dolomite. The major element compositions of this limestone show higher content in CaO, ranging from 53% to 55%, and from 94.65% and 98.21% expressed as $CaCO_3$. The limestone of Oust Formation display low amount of Al_2O_3, SiO_2 and Fe_2O_3 which ranging from 2% to 5%. Other minor elements (Na_2O and K_2O) are also detected. Geotechnical tests (e.g. Los Angles, Humid Micro Deval, Density Index) conducted on the Lower Jurassic limestone at studied area show dense materials (2,55 to 2,81 g/cm^3) and well resistant to the fragmentation.

Depending on the provenance of the limestone rock of the Oust Formation, different employments can be proposed. The Bent Saïdane and Bou Garnine Mountains can be used to produce the aggregates while Rouas Mountains for marble manufactures. Either this applications, Lower Jurassic limestone from studied area can be used in the manufacture of Portland cement when mixed with Lower Cretaceous clay from the Zaghouan locality.

Keywords: Zaghouan limestone; Oust formation; Marble stones; Cement, Aggregate; Geotechnical tests

Introduction

The sectors of construction materials, building and public works are considered an economic and social driver for Tunisia. They largely contribute to the improvement of infrastructure and the absorption of a large mass of the Tunisian labor. However, the development of these areas is dependent on the quality and quantity availability of useful substances in the various regions of the country.

In fact, useful materials have many properties inherent in their origin and in their nature. Knowing some basic characteristics specific to each commodity is required to determine the development of mixtures and their conditions of use and to prevent their blind and anarchic farms. Thus, several studies aimed at enhancing the useful substances in Tunisia are growing. These studies first began in the center and south of the country, then they are extended to the north of Tunisia especially in recent years, which aims to reduce the importation of these substances that weighs heavily on the economy country. Examples which cite an example of the work by Louhichi [1] and Trabelsi [2].

Contribution into this framework and is interested in the study of carbonate massifs Jebels Bou Garnine of Fahs Bridge, Rouas and Bent Saïdane the Zaghouan region. It mainly focuses on the characterization of carbonates of this massive petrographic point of view, chemical and physical, and to specify their possible uses in industry.

Presentation of the Study Area

Geographical and geological setting

The area Zaghouan Is located north-east of Tunisia, is 60 km south of Tunis. It is limited by the massive Jurassic MOST belonging to the north eastern terminus of the Tunisian dorsal. This geological unit is marked by the alignment, NE-SW, Enormous masses Jurassic limestone forming the heart of the anticline structures qui outcrop in the middle of Cretaceous and Tertiary cover. This brief history is a list of the main authors who worked-have on the area of Zaghouan and contributed to the discovery of order stratigraphic, sedimentological and paleontological. The work HAS Focused on the massive Fahs Bridge are Relatively FEW Compared to the work done on the massive wrinkle Zaghouan. Among thesis work, mention those of Castany [3]; Soussi et al. [4]; Soussi [5].

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The study area is in the southern portion of north eastern Tunisia 75 km from Tunis (Figure 1). The outcrops are Studied share of the southwestern portion (Rouas and Bou Garnine of Fahs) and northwest (Bent Saïdane) of the ridge.

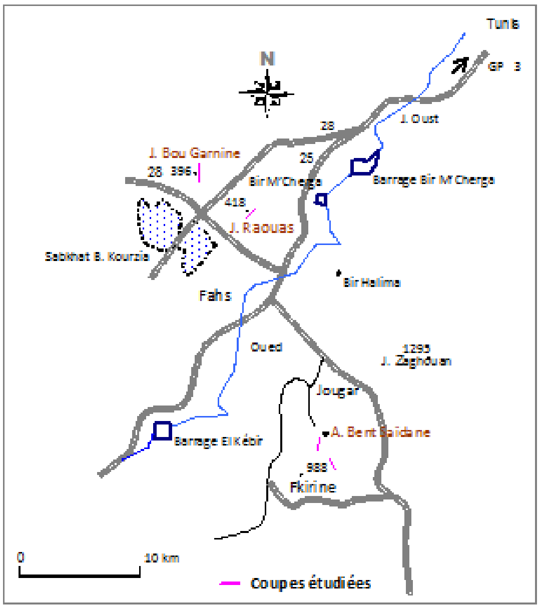

Figure 1: Location map of the study area.

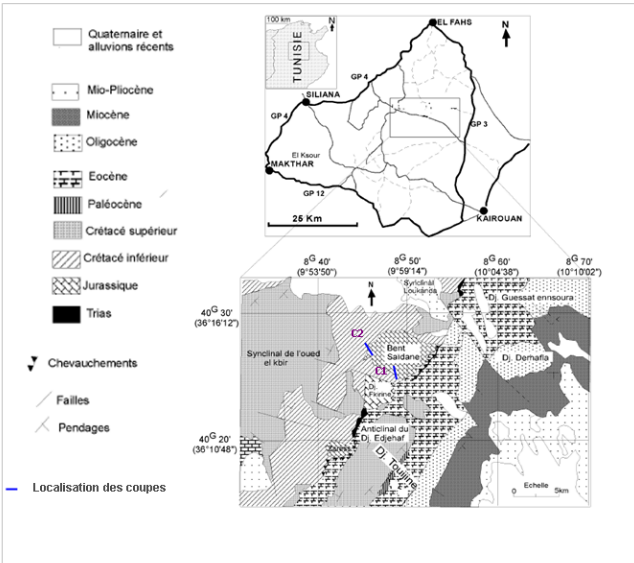

Figure 2: Extract from the geological map of Jebel Fkirine was 1/50 and location of etudieses cuts in Jebel Bent Saidane.

The massive carbonate Jebel Bent Saïdane

Jebel Saïdane Bent is located 25 km south of the town of Fahs (Figure 1). This massive shown on the geological map No. 42 of Jebel Fkirine between the coordinates X: 8G 45-8G 53' and Y: 40G 26' 40G 29'. It is the largest mass of the entire dorsal offering exceptional outcrop conditions. The highest peak of Jebel Bent Saïdane rises to 818 m. It is accessed from the Fahs Bridge through the village of Jouggar.

The massive Jebel Bent Saïdane (Figure 2) is the heart of an anticlinal structure oriented NE- SW bordered at its limit by scar Zaghouan. To the east of this structure lie the sandstone outcrops-clay of the Oligo-Miocene syncline Saouaf, while in the west, this structure is limited by the carbonate and clay outcrops of the Cretaceous.

C1 cut at the NW side of Jebel Saïdane Bent crosses the lower cretaceous clays which outcrop in the river Besserheïr (Figure 3).

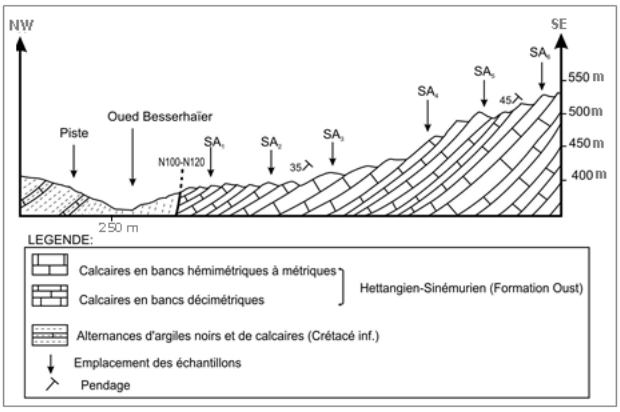

Figure 3: Geological section in the Liassic limestone of Jebel Bent Saïdane.

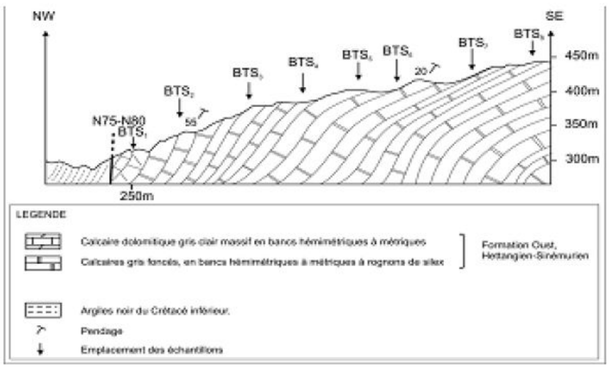

Figure 4: Geological section (NW-SE) in Liassic limestone of Jebel Bent Saïdane.

This section shows a powerful limestone series. It is a lenticular outcrops semi erecting type in erecting 35 to 45° to the north, forming a projection in the topography. Limestone is very hard. The patina is gray-dark gray and the break are - with clear presence of some millimeter pore sizes.

This unit shows alternations of UHF limestone beds and other hemimetric. The thickness of these calcium deposits exceeds 150 m. Further north, near Bent Aïn Saïdane, flush the Liassic limestone's represented by a steering unit NW-SE (section C2). This unit shows the base to the top of hemimetric benches metric alternating with UHF

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banks flush with a dip of 35° to the NW. These limestones, very hard, light gray to dark gray patina and the fracture are crossed by veinlets filled with pink or white calcite and iron oxide. The power of this series is 175 m (Figure 4).

Jebel Bou Garnine of the Fahs bridge

Jebel Bou Garnine is located in the extreme NE of the geological sheet No. 34 of Bou Arada between the coordinates X: 8 36'a G 8 G 38 ' and Y 40 51 G to 40 G 53'. It is located 18 km north of El Fahs and 19 km west of Jebel Oust. It is 1.2 km long and 0.7 km wide and rises to 396 m. This outcrop is bounded on the north by an accident rooted substantially E-W [3].

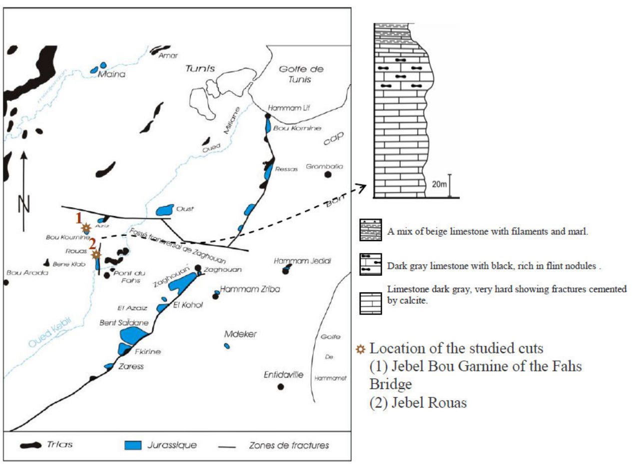

Figure 5: The main Jurassic outcrops [6] and location of the studied sections.

This massif is located in the NW ridge of Jurassic carbonate. It is a coffered dome oriented E-W, the SE flank is affected by a fault causing its collapse. This massif is completely surrounded by land quaternary [6].

Castany [3] has highlighted in this massive direct cross accidents involving its division into compartments that played vertically from each other.

The studied carbonates are Liassic age, they are part of the Oust Formation (Figure 5). This is a carbonated mass is about 120 m thick. This unit forms a projection in the topography and shows at its base UHF fractured limestone beds becoming the hemimetric summit metrics kidneys of black flint arranged parallel to the bedding plane and dimension ranging from 20 to 35 cm.

The limestones are very hard and are flush with a dip of 35° to 40° to the SW. The patina is light gray and dark gray is the break with the presence of very small pores. This unit is divided into several masses carbonate by faults N120 management, N90, N75 and N 35 arranged in tiers increasingly collapsed from SW to NE. At the top, this unit is gradually moving to marl alternations – limestone Jebel Rouas.

The massive Rouas is located 9 km northwest of El Fahs and 65 km from Tunis. This structure appears in the extreme NW of the geological sheet No. 35 of Zaghouan (Scale: 1/50 000). It is located between the X: G 8° 37' 8° G 38' and Y: 40° G 45 G 40° 47'. The outcrop which rises to 418 m is located just north of a bend of the river Meliane between two major faults trending NW-SE and E-W. Access is from the FNG 25.

Jebel Rouas is part of the massive NW of the ridge. This is an alignment N-S of Jurassic in the heart of a broad anticline faulted global orientation NNW-SSE. The Liassic limestone massif that forms a snag trained in hectometric horst bounded on the north and south by two accidents in north and south convergence.

The study cut through the Liassic limestones of the Oust Formation (Figure 6). These courses erecting flush in the SE part of the Jebel Rouas with a dip of 75° to the SW. The limestones are of pinkish color, very hard to break showing UHF benches at their base. Above, are based very hard limestone, light gray patina and dark gray to breakage forming a projection in the topography. These limestones are organized hemimetric benches metric presenting white calcite veinlets to reddish. This unit rests by abnormal contact of Cretaceous clays. The total thickness of the Liassic limestones of the Jebel Oust Training Rouas is around 90 m.

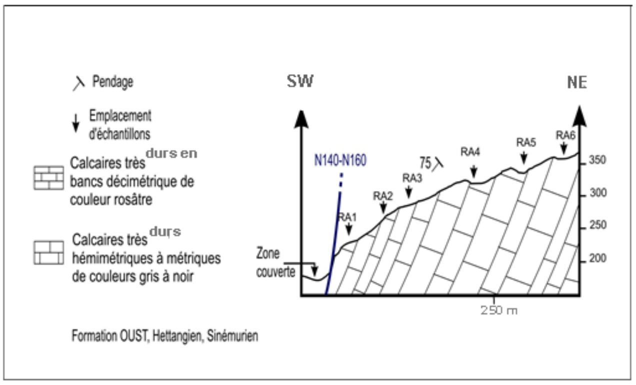

Figure 6: Geological section in the Liassic limestone of Jebel Rouas.

Characterization of carbonates Zaghouan Methodology

The study of carbonates of the Zaghouan region is based in addition, field observations, analysis of laboratory:

- The petrographic analysis of thin sections
- Mineralogical analysis by X-ray diffractometry (powder method)
- Chemical analysis by atomic absorption spectrometry
- The determination of physico-mechanical properties of Liassic limestones of the Zaghouan region (Los Angeles, Micro and Micro deval dry wet deval, real density…).

Results

Petrography

The Liassic limestone of Jebel Bent Saïdane and Sidi Ameur: These are packstones (classification Dunham), or compact biomicrites (classification Folk). This is a pelletoïdal facies with presence of rare benthic foraminifera. The binding phase is completely micritic.

On the other hand, the observed micro-cracks are filled with the sparite. The contiguous texture and recrystallization of some constituents of these limestones help minimize porosity.

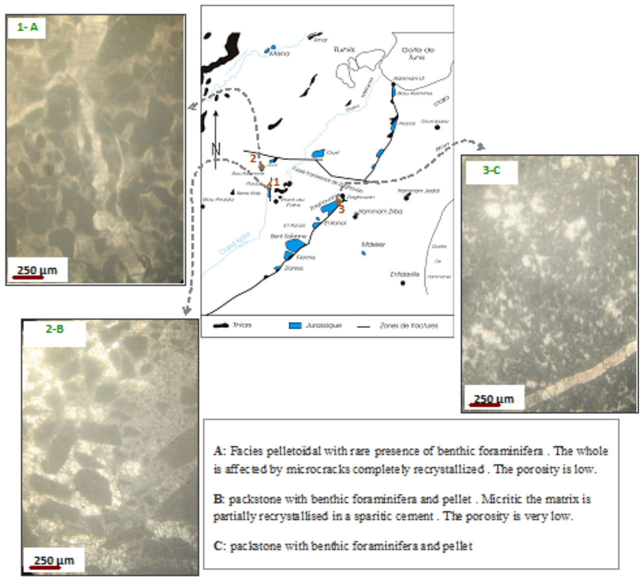

Figure 7: Microfacies major studied limestones.

a) The Liassic limestone of Jebel Bou Garnine Pont du Fahs: These are packstones to grainstones within which the pellets are observed and benthic foraminifera. These limestones are traversed by filled sparite venules. These are abundant and show a thickness of 10 to about 35 microns. The porosity is reduced.

b) Liassic limestone of Jebel Rouas: The petrographic study of the limestone shows mainly packstones containing pelletoides, oolites, the bioclastes, quartz new formation, pyrite and iron oxide veinlets in a reduced micritic matrix, furrowed many cracks sealed by the sparite. The texture is contiguous and the percentage of formed elements is between 65 and 95%. The porosity is low.

c) Conclusion: According to the classification of Dunham, Oust the Training of limestone are very compact and generally have a grainy texture.

This is a packestone showing low porosity mainly due to the phenomenon of dissolution-recrystallization during diagenesis. Porosity is intensively reduced by filling cracks and voids, pockets by crystals sparite (Figure 7). All these phenomena have helped to have hard limestone.

Mineralogy

The counting of X-ray diffraction of the crude powder of Liassic limestones of the Oust training in the various study sites generally shows an abundance of calcite together with a very small proportion of quartz. However, certain limestone beds at the base of Jebel Bent Saïdane show a mineral association composed of calcite, dolomite and quartz. The mineralogical results confirm the results of the calcimetry (98% $CaCO_3$) by the importance of the peaks of calcite (Figure 8).

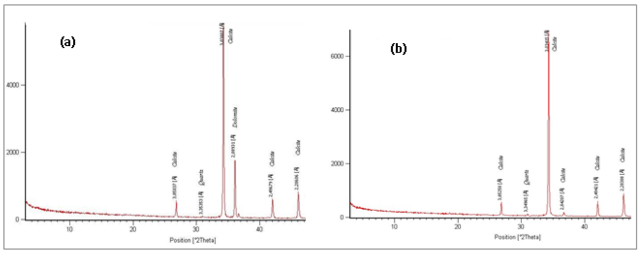

Figure 8: X-ray diffraction of the Liassic limestone of Jebel Bent Saïdane (a and b) and Jebel Bou Garnine Rouas and the Pont du Fahs (b).

Chemistry

Chemical analysis was performed on several limestone samples from the base and top of the essentially carbonated Oust Education. The average rate of CaO is in the range of 54.5% which corresponds to values higher than 97% $CaCO_3$ (Table 1).

Carbonate rocks exhibit a loss on very large fire; it exceeds 43%, which indicates the presence of high levels of $CaCO_3$. These limestones are siliceous can. The average rate of the silica is of 3.28%. This training has very low percentages of aluminum (0.45%), magnesium (0.89%) and a very low iron content (0.86%). alkali in the contents are also very low (Na_2O+K_2O<0.5%).

In conclusion, the Liassic limestones Jebels Bent Saïdane, Rouas and Bou Garnine the rich Fahs Bridge $CaCO_3$ (98%) are homogeneous, little siliceous and very poor in magnesium (Mg), Iron (Fe), aluminum (Al) and alkali (Na_2O+K_2O). These features allow classifying these among carbonate rocks very popular in industrial fields.

Results of geotechnical analyzes

The measurements of the physical characteristics of Liassic limestones studied in various sites in the region of Zaghouan show, in general, it is a very tough hard material. This is manifested by a high wear resistance (M.D.E) and fragmentation (L.A) means values vary from 10 to 21% and from 15 to 26% respectively. However, the specific weight of Liassic limestone different study sites ranging from 2.55 to 2.81 g/cm^3 shows a reduced porosity that is confirmed by a small percentage of water absorption which does not exceed the 0.7% (Table 2).

Sites	Ref	PF	CaO	MgO	SiO_2	Fe_2O_3	Al_2O_3	Na_2O	K_2O	P_2O_5
Rouas	RA5	43.32	54.32	0.33	1.02	0.11	<0.01	0.02	0.02	<0.01
	RA4	43.74	55.44	0.26	0.86	0.17	<0.01	0.03	0.01	<0.01
	RA3	43.34	54.32	0.28	1.2	0.17	<0.01	0.02	0.02	<0.01

	RA2	43.02	54.66	0.04	0.09	0.24	0.08	0.05	0.01	0.27
	RA1	42.9	54.53	0.33	0.09	0.86	0.08	0.01	0.01	0.63
Bent Saïdane	BTS 8	42.51	53.95	0.64	0.51	0.25	0.45	0.02	0.08	0.735
	BTS 7	42.82	54.58	0.32	0.6	0.11	0.15	0.02	0.04	0.640
	BTS 6	42.73	54.66	0.32	0.09	0.06	<0.01	0.01	0.01	0.564
	BTS 5	42.86	54.63	0.41	0.09	0.07	<0.01	0.02	0.01	0.710
	BTS 4	43.59	54.28	0.3	0.3	0.06	<0.01	0.02	<0.01	<0.01
	BTS 3	43.02	53.88	0.22	0.85	0.2	<0.01	0.03	<0.01	<0.01
	BTS 2	43.43	53.92	0.62	0.94	0.08	<0.01	0.02	<0.01	<0.01
	BTS 1	43,61	54.69	0.89	1.11	0.05	<0.01	0.03	0.02	<0.01
Bou Garnine of the Fahs Bridge	BG9	42.16	53.76	0.43	2.4	0.16	0.23	0.02	0.1	0.458
	BG8	42.61	54.8	0.45	1.82	0.08	0.08	0.02	0.05	0.307
	BG7	43.03	55	0.39	0.68	0.34	0.08	0.02	0.02	0.121
	BG6	43.03	54,32	0.36	0.85	0.1	0.08	0.02	0.04	0.15
	BG5	42.52	54.88	0.45	1.62	0.2	0.08	0.02	0.03	0.126
	BG4	43.22	54.88	0.33	0.68	0.18	0.08	0.02	0.01	0.55
	BG3	42.56	56	0.33	0.85	0.07	0.08	0.02	0.01	0.46
	BG2	42.11	55.44	0.3	0.94	0.17	0.08	0.02	0.02	0.46
	BG1	42.3	55.44	0.39	0.85	0.08	0.08	0.02	0.02	0.96

Table 1: Chemical Composition (%) of Liassic limestones.

Site	**Test**				
	Geotechnical Characteristics				
	Coefficient Los Angeles (%)	**Coefficient Micro-deval sec (%)**	**Coefficient Micro-deval humide (%)**	**Percentage absorption (%)**	**Particle density in g/cm^3**
Bent Saidane	17-25	6-9	13-18	0.25-0.5	2.71-2.81
Rouas	15-25	3-9	10-20	0.4-0.5	2.69-2.75
Bou Garnine of the Fahs Bridge	18-26	7-11	14-21	0.5-0.7	2.55-2.75

Table 2: Geotechnical characterization of crushing carbonates of Oust Education and the region of Zaghouan.

In the Zaghouan region, potentially exploitable massive rocks are mostly limestone of Lower Jurassic (Lias), these often recrystallized limestones compact, homogeneous texture can offer very good geotechnical characteristics.

Valuation of the rock and usability

Ability limestone Zaghouan to employment sustainability

The specifications of aggregates mainly rely on their strength. For massive rocks crushed the strength is evaluated using the following tests:

- Los Angeles (LA) for measuring the resistance to fragmentation following shock caused by falling of the steel balls in a rotating cylinder
- Micro-deval in the presence of water (MDE) measuring attrition due to aggregates of friction arranged in cells with steel beads in the presence of water
- Polished stone value (PSV), measuring the effect of a tire in the presence of an abrasive on the floor in order to assess the degree of their slipperiness.

The strength of these aggregates will be characterized only by the first two parameters (LA and MDE).

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Usage limits have been set by Hamrouni and Chammari [7] (Table 3). Based on this parameter aggregates for subbase and base layer are identical against the aggregate for the wearing course are better.

Type of output	Test		
	Los Angeles LA	Micro-deval sec MDS	Adhesiveness
Couche de fondation	<30	<8	-
Basecoat	<30	<8	-
Coating: Coated Mono. and multilayer	<25 <25	<7	>95

Table 3: Tunisian specifications for the use of road aggregates [7].

The Liassic carbonates already broken in several careers for discontinued in domes Jebels Aziz, Oust and Ressas and are commonly used as building rubble provided good medium quality aggregates. Bent to Jebels Saïdane, Bou Garnine of Fahs Bridge and Rouas these carbonates can also provide after aggregate crushing of the same quality. These are sought in particular in the courses in heavy traffic pavement surface (150 to 300 PL/J) as well as the rest of the foundations that form the structure of the pavement which is flexible or semi-rigid (Figure 9).

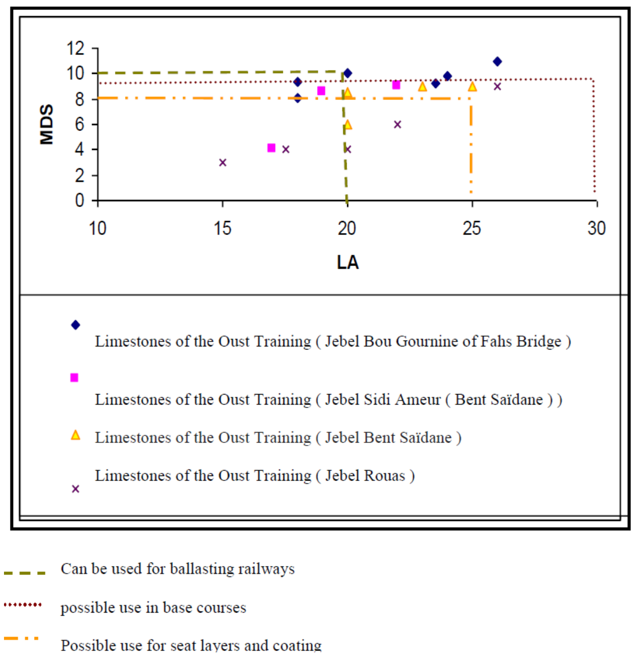

Figure 9: A correlation diagram L.A and M.D.S.

Ability limestone of the region Zaghouan for use in railway foundation layer

Regarding ballasting railways, specifications are more demanding. Indeed, the requested aggregate must be hard, angular and granulometry comprised between 25 mm and 50 mm.

In the technical specifications for the supply of ballast and gravel (No. 695C of 1978), the steering equipment of the National Society of French Railways (SNCF), imposes a number of coefficients, the most critical is the overall hardness coefficient (DRG) defined by the values LA and dry Deval. The value of this coefficient is determined from a chart prepared by the SNCF.

Ability limestone Zaghouan in the making of aggregates for concrete

Aggregates constitute the skeleton of concrete. We use the particle size ranging from 4 to 20 mm. For 1 m^3 of concrete are usually used 1.9 tons of aggregates [8].

The characteristics of the aggregates used in concrete, as defined either by the AFNOR 18301 or by Dupain et al., appeal especially to the mechanical properties of materials. The quality of concrete is closely linked to the strength parameter to fragmentation (L.A). Thus one can define three subdivisions [2] (Table 4):-

-ordinary concrete: LA<40%

- Quality concrete: LA<30%

- Exceptional concrete: LA<25%

Studied sites	Physical parameters	
	L.A (%)	M.D.E (%)
Characteristics of aggregates for concrete (Trabelsi, 1989)	≤ 40	≤ 35
Jebel Bent Saidane	17-25	13-18
Jebel Bou Garnine of the Fahs Bridge	18-26	14-21
Jebel Raouas	15-25	10-20
L.A=The Angels; M.D.E=Micro wet deval		

Table 4: Ability of Liassic limestone in the making of aggregates for concrete.

By comparing the values of the geotechnical characteristics of the limestones of the Oust Training with the specific characteristics of aggregates for concrete, it emerges that the limestones of Jurassic massive studied are able to provide good aggregates for concrete not only ordinary but also quality.

Ability limestone Zaghouan in the making of plates marbrières

According to the standard AFNOR B.1000, there is a relationship between the hardness, density and the repture load compression. These give a more complete classification of rocks; it is based on a hardness scale of 14 ranging areas. Only the rock of hard areas "ranging from 8 to 14 may be considered" marbrières stone.

Locality	Reference sample	True density (g/cm^3)	Water absorption (%)	Compressive Strength Kg/cm^2
Jebel Raouas	JR1	2,82	0.15	1310

Jebel Raouas	JR2	2,75	0.20	1225

Table 5: Geotechnical characteristics of the marble stone Jebel Raouas.

According to this standard can be deduced that the Liassic limestone of Jebel Rouas contain obviously marbrières rocks; their hardness ranging between 10 and 11 and they can be classified as "marbrières rocks" to hard consistency to cold (Figure 10). This performance of the rock has been confirmed by geotechnical data (Table 5) and thus gives it the quality of being ranked among the marbrières prayers. And marble stone studied can be exploited in various fields (linings, external floors…).

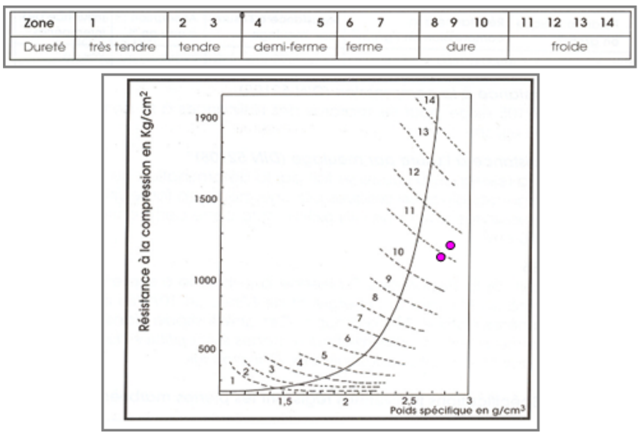

Figure 10: Location of the samples studied in the scale of hardness according to the AFNOR standard B10 001.

The raw material for stone use is in the filling of large faults that cross the Liassic limestone of Jebel Rouas the direction E-W. It is pink or white calcite, formable, (Faux onyx) usable for decoration (Figure 11).

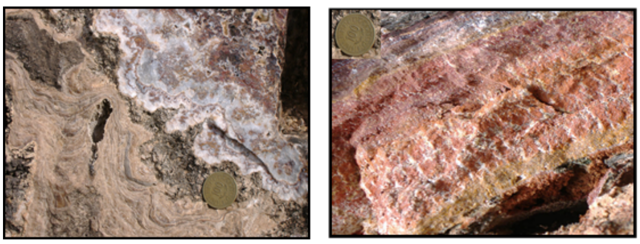

Figure 11: Faux onyx provenant du Jebel Rouas.

Application of limestone in the field of hydraulic binders industry

The main constituents of portland cements are CaO, SiO_2, Al_2O_3 and Fe_2O_3. These components are used to calculate a number of modules that are considered the most critical selection criteria [8].

The hydraulic module (MH)=$CaO/SiO_2+Al_2O_3+Fe_2O_3$

$1.7<MH<2$

The silicic Module (MS)=$SiO_2/Al_2O_3+Fe_2O_3$

$2.4<MS<2.7$

A range of between 1.2 et 4 is tolerated;

The module alumino-ferric (MAF)=Al_2O_3/Fe_2O_3

$1.5<MAF<2.5$

A range of 1 to 4 is tolerated;

The degree of saturation (DS): $CaO/2.8\ SiO_2+1.1\ Al_2O_3+0.7\ Fe_2O_3$

*ordinary cement: $0.9<DS<0.95$

*High strength cement: $0.5<DS<0.98$.

The silicic module (MS) must be greater than or equal to 2.4.

For hydraulic lime is defined another determining module. This is the hydraulicity index (i).

$i=Al_2O_3+SiO_2+Fe_2O_3/CaO+MgO$ $(0.45<i<1)$

The average chemical composition of Portland cement is shown in the Table 6.

Content (%)	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O+K_2O
Maximum	25	9	5 (6)	67	3 (5)	3 (4)	1.3
Minimum	19	2	1	62 (60)	0	1	0.2

Table 6: Average chemical composition (%) of artificial cements [8].

We have made mixtures of marl and clay from the Lower Cretaceous Jebel Oust with Liassic limestone of Jebel Bent Saïdane.

The limestone blends and clays are similar to those adopted by the majority of Tunisian cement namely limestone mixtures composed of Cretaceous and clays training El Haria, compounds mixtures Ypresian limestone and clays Souar training and mixtures composed of Oxfordian limestone and marl to tithoniques lower Cretaceous.

To a degree of saturation (DS) equal to 0.95, is mixed 72% of Liassic limestone marl and 28% of lower Cretaceous [9,10]. The composition of the mixed flour and the silica and alumino-ferric modules are contained in the Tables 7 and 8.

Reference sample	Component mixture	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	$CaCO_3$
Marne (Lower Cretaceous)	M	43.41	17.10	7.12	2.58	9.8	2.92	0.67	12

Table 7: Average Chemical Compositions (%) marls used in the mixture of raw limestone powder-clay for the manufacture of clinker.

Reference samples	Component mixture	SiO_2	Al_2O_3	Fe_2O_3	Mg	CaO	K_2O	Na_2O	$CaCO_3$
BTS1 (limestone)	C1	1.11	-	0.05	0.89	54.69	0.02	0.03	98
BTS2 (limestone)	C2	0.94	0.45	0.08	0.62	53.92	-	0.02	97
BTS3 (limestone)	C3	0.85	-	0.2	0.22	53.88	-	0.03	97
BTS4 (limestone)	C4	0.86	-	0.06	0.06	54.28	-	0.02	97

Table 8: Average Chemical Compositions (%) marls used in the mixture of raw limestone powder-clay for the manufacture of clinker.

Studied limestones are generally suitable for use in the production of hydraulic binders (Table 9). Potential areas for this type of material exposed in all study ranges [11-14]. Mixtures of these limestones with marl and clay rich in Al_2O_3 and Fe_2O_3 can meet the standards required by the specific modules calculated. Mixtures of Liassic limestones and Cretaceous clays gave lime modules ranging from 2 to 2.09 silicic modules between 1.84 and 1.9 and modules alumino-ferric ranging from 2.26 to 2.4.

Formations	Ref. I.	CaO	MgO	SiO_2	Al_2O_3%	Fe_2O_3	K_2O	Na_2O	Calcaire	Marne	MH	MS	MAF
M'Cherga Oust	M C1	41.89	1.37	13.27	4.86	2.07	0.24	0.84	0.72	0.28	2.06	1.9	2.4
M'Cherga Oust	MC2	41.12	.19	13.37	5.04	2.13	0.86	0.22	0.72	0.28	2	1.86	2.36
M'Cherga Oust	MC3	41.53	0.88	12.89	4.86	2.15	0.82	0.24	0.72	0.28	2.08	1.84	2.26
M'Cherga Oust	MC4	41.82	0.94	12.89	4.86	2.04	0.82	0.23	0.72	0.28	2.09	1.87	2.38

Table 9: Average chemical composition in (%) mixtures made the values of the modules and proportions of limestone and clay.

Regarding cement, adding corrective materials such as silica sand and/or iron ore is sometimes essential in order to overcome the deficit in SiO_2 and Fe_2O_3 [15].

Ability of limestone Zaghouan region for the manufacture of quicklime

Quicklime is none other than pure limestone calcined at high temperature. The product of this calcination consists of CaO called "quicklime" after giving hydration slaked lime.

Mixed	MC1	MC2	MC3
DS	0.95	0.92	0.95
MS	1.9	1.86	1.84
I	0.46	0.49	0.46

Table 10: Calculation Result characteristics modules mixtures (limestone+clay) for the manufacture of hydraulic lime.

It appears that a mixture of limestone Lias, whose characteristics are given in Table 7 and Lower Cretaceous marl whose composition is reported in Table 8, allow to have a good quality hydraulic lime corresponding to an index of runoff (i) less than 1 (Table 10).

Conclusion

In the region of Zaghouan Area (Jebels Bent Saïdane, Rouas and Bou Garnine of Fahs Bridge), age Jurassic limestone outcrop extensively at the base of the geological series [16]. The most rich facies $CaCO_3$ match the limestone of the Oust training, lower Jurassic age, the contents can exceed 97% [17]. The results of analyzes of the Liassic limestones Jebels Raouas Bent Saïdane and Bou Garnine Pont du Fahs (North East Tunisia) show that they are able to provide good aggregates for concrete and road surfaces, binders hydraulic (Portland cement, hydraulic lime), of marble and ornamental rocks [18-23]. It is therefore Limestone deposits that can replace quarries located in the vicinity of Tunis that are exhausted voice or have to stop producing for environmental reasons.

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