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Mineral Status and Future Opportunity

PURE LIMESTONE

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CONTENTS

List of Contents	I
List of Figures	II
List of Tables	II
List of Appendices	III
1. Introduction	1
2. Uses of Pure Limestone	1
3. Location	1
3.1. Qatrana	1
3.2. Sultani Area	2
3.3. Al-Hasa Area	2
3.4. El-Lubban Area	2
3.5. El-Hallabat Area	2
3.6. Jurf Ed Darawish	2
3.7. Siwaqa-Damekhi	2
3.8. Wadi Al-Abyid	2
4. Geological Setting	4
4.1. Wadi Es-Sir Limestone Formation	4
4.2. AL Hisa Phosphorite Formation	4
4.2.1. Sultani Phosphorite Member (SP)	4
4.2.2. Bahiya Coquina Member (BC)	4
4.2.3. Qatrana Phosphorite (QP)	5
5. Reserve of Pure Limestone	5
6. Deposit Properties	5
6.1. Mineralogical Properties	5
6.2. Chemical Properties	6
6. 3. Physical Properties	6
7. Background	6
8. Mining Aspects	7
8.1. Mining Companies	7
8.2. Production of pure limestone	7
9. Investment Opportunities	7
9.1. Ground Calcium Carbonates Industry	8
9.2. Cement Industry	8
9.3. Magnesia Industry	8
10. References	8
Appendices	10

List of Figures

Figure (1): Locations of pure limestone deposit.	3
---	----------

List of Tables

Table(1): Pure limestone locations.	3
Table (2): The estimated reserves of pure limestone in different areas.	5
Table (3): The average content of major oxides in each location.	6
Table (4): Physical properties of pure limestone in each location.	6
Table (5): Pure limestone productions quantities during the years (2008-2012).	7

List of Appendices

Appendix (1): Geological map shows the location of the companies that exploiting pure limestone.	11
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Pure Limestone

1. Introduction

Pure limestone is among the most important non-metallic raw material used for industrial and agricultural purposes. It should have the following qualifications:

CaCO₃ > 93%,
SiO₂ < 3%,
MgO < 1.2% (and higher for certain products),
Fe₂O₃ < 1.5 (and lower for certain products),
S, P₂O₅ and alkaline salts as low as possible

Pure Limestone is a form of lime rock shell containing large cross bedding because of the accumulation of (Oysters) as a result of the accumulation of solid parts after the death of organisms; these bivalves consist mainly of calcium carbonate and may contain some impurities such as silica and marl.

2. Uses of Pure Limestone

Calcium carbonate can be used in very wide industries, the important uses are:

- In the metallurgical industry as a fluxing agent for the smelting and refining of iron, aluminum and copper.
- In the chemical industry in the production of lime, calcium carbonate, alkali compounds, calcium carbide, magnesium oxides and soda ash.
- In industries of white cement, iron and steel, glass, paper, sugar-refining, water purification, sewage and waste treatment, and gas de sulphurisation.
- Agricultural uses in soil conditioning, fertilizers and animal feeds.
- As filler material in paints, rubber, filling used in the manufacture of paints, paper, rubber, as well as interference in the pharmaceutical industry and many other industries.

3. Location

Most of Pure limestone deposits are located in the central part of Jordan (From Siwaqa to Jurf Ed-Darawish) Figure (1). Table (1) Show the coordinates of these locations. The other two locations are located east and north east of Amman. The following description of each location:

3.1. Qatrana

Pure limestone is exposed on the surface at Qatrana area which is located 80 to 100km south of Amman. Pure limestone refers to the Al Hisa Phosphorite Formation (Bahiyya Member) of the Upper Cretaceous (Campanian-Maestrichtian). The thickness of limestone beds range from a few meters up to 40m.

3.2. Sultani Area

Pure limestone is also exposed on the surface at Sultani area, which is located 17km south of Qatranna. The thickness of limestone beds range from (10-45m).

3.3. Al-Hasa Area

A huge resource of pure limestone was found in Al-Hisa area, Al-Hasa area is located about 140km south of Amman and 50km south of Qatrana town. The thickness of limestone beds range from 4-41m.

3.4. El-Lubban Area

This area is located 20km southeast of Amman; pure limestone refers to the Al-Hisa Phosphorite Formation and is exposed on the surface. The exploitable beds have an average thickness of 5.5m.

3.5. El-Hallabat Area

This area is located 75km northeast Amman. The deposit occupies a portion of the Upper Cretaceous sequence of sediments, consists mainly of marine limestone, marls and chert of Wadi Es-Sir Limestone Formation (Turonian age). Pure Limestone is exposed on the surface with thicknesses ranging between 1-37m.

3.6. Jurf Ed Darawish

The pure limestone deposits of Jurf Ed Darawish are located 30km south of Al-Hasa town. The thickness of limestone beds range from 11-40m and belong to AL-Hisa Phosphorite formation.

3.7. Siwaqa-Damekhi

The pure limestone deposits of Siwaqa-Damekhi deposits is located 70km south of Amman and 20km north and northeast of Qatrana town. These deposits are within the Al-Hisa Phosphorite Formation. It's ranging in thickness between 3-42m.

3.8. Wadi Al-Abyid

The pure limestone deposit of Wadi Al-Abyid is located 120km south of Amman and 25km South of Qatrana town. These deposits are within the Al-Hisa Phosphorite Formation. It's ranging in thickness between (10-26 m).

Table(1): Pure limestone locations.

Area	Coordinates			Map Sheet
	East	North		
1	Qatrana			Jabal Al Mutarammil
	1 ^{1st}	254000-260000	1057000-1063000	
2	2 ^{2nd}	254000-261000	1033000-1057000	Siwaqa
	Siwaqa Al Damkhe		245000-256000	
3	Sultani Wadi A-Abyid			
	1	Sultani	238000-240000	1051000-1054500
	2	Wadi Al-Abyid	243000-245000	1046000-1048000
4	Al Hisa		231000-237000	1023000-1029000
5	Jurf Ed Darawish			
	1	Southern part	225000-227000	1005000-1006000
	2	Northern part	224150-226300	1008000-1011000

1st: The first stage2nd: The second stage**Figure (1):** Locations of pure limestone deposit.

4. Geological Setting

Limestone can be found in many different geological formations in Jordan, but the most important is Wadi Es-Sir Limestone and Al-Hisa Phosphorite Formations.

Pure limestone in all the studied localities refers to the Al-Hisa Phosphorite formation (Bahiya coquina member) with exception to the limestone of Al-Hallabat area which refers to the Wadi Es-Sir Limestone formation. Pure limestone almost exposed on the surface with variable of thickness and degree of purity. The following is the lithological description of the two formations:



4.1. Wadi Es-Sir Limestone Formation

This formation consist mainly of dolomitic limestone and dolomite in the middle part, with massive to medium bedded limestone include fossiliferous beds in upper part. The thickness of this formation is range from 70 – 90m.

4.2. AL Hisa Phosphorite Formation

The Al Hisa Phosphorite Formation was dated as Campanian to Maestrichtain age, it is usually divided into three members, and these are from bottom to top:

- Sultani phosphorite member
- Bahiya coquina member
- Qatrana phosphorite member

4.2.1. Sultani Phosphorite Member (SP)

The lower member of Al Hisa Formation is about (15–20m) thick and consists mainly of phosphatic chert, phosphatic limestone, micritic limestone, marl and phosphatic marl, the top is taken as the base of oyster-rich shelly limestone of the Bahiya coquina above.



4.2.2. Bahiya Coquina Member (BC)

Bahiya coquina member of Al Hisa Phosphorite Formation is a middle member between Sultani phosphorite and Qatrana phosphorite.



The Bahiya coquina crops out over a large part of study area except small parts covered by Qatrana phosphorite, it consists of oyster-rich shelly limestone in the form of large scale cross-bedded units causing the large lateral changes in thickness (3 – 40 m).

The Bahiya coquina proved to be useful as a marker horizon during mapping; it forms a prominent cap rock on many hills of the study area. Large scale cross-bedding of variable directions and lenticular morphology are prominent features of the Bahiya coquina.

Marl, which is inter bedded with limestone, chert and Bahiya coquina is pinkish yellow to creamy color.

Coquina beds are white to light grey occasionally with vuggs and veins filled with calcite (fractures, small to medium size of shell fragment, purification of coquina beds increased by decreasing of shell size fragments).

4.2.3. Qatrana Phosphorite (QP)

The heterogeneous lithologies comprise soft granular and pelloidal phosphate, phosphatic chert, phosphatic limestone (micritic and Shelly packstone textures) marly limestone and marl with concretions of chert and micritic limestone. It ranges in thickness from (1–20m).

5. Reservoirs of Pure Limestone

Table (2): The estimated reserves of pure limestone in different areas.

Area	Reserve (Mt)	Cut-off grade (CaO %)
Qatrana	31.5	>54.3
Al-Hasa	460	>52.2
El-Lubban	30	>54.96
El-Hallabat	69	>54.19
Sultani	286	>52.56
Al Abiad	90	>53.0
Jurf Ed Darawish	11	>53.5
Siwaqa-Damekhi	388	>53.3

6. Deposit Properties

6.1. Mineralogical Properties

Mineralogical analyses were carried out by x-ray diffractometer for boreholes samples.

The x-ray determination identified calcite as major mineral constituent and quartz as traces due to impurities such as marl in pure limestone layers.

6.2. Chemical Properties

Table (3): The average content of major oxides in each location.

Area	CaO%	Fe ₂ O ₃ %	MgO%	Al ₂ O ₃ %	SiO ₂ %
Qatrana	54.26-50.86	1.14-0.09	2.08-0.15	0.6-0.02	3.8-1.5
El-Lubban	55.4-54.3	0.04-0.02	0.2-0.00	1.0-0.08	1.5-0.5
El-Hallabat	53.6-53.0	0.45-0.18	0.76-0.31	0.48-0.01	1.86-1.7
Al-Hasa	54.87-48.16	0.52-0.02	2.72-0.2	0.98-0.13	9.94-0.02
Siwaqa-Damekhi	53.95-47.56	0.48-0.1	0.51-0.10	0.96-0.1	3.23-1.5
Sultani	54.07-52.56	0.34-0.2	----	----	4.0-0.34
Al Abiad	53.77-51.19	0.41-0.08	0.21-0.14	1.06-0.12	4.75-1.27
Jurf Ed Darawish	53.66-42.32	0.25-0.11	3.52-0.23	0.59-0.12	5.89-1.67

6. 3. Physical Properties

Table (4): Physical properties of pure limestone in each location.

Area	Whiteness%
Qatrana	95.68-75.91
El-Lubban	----
El-Hallabat	----
Al-Hasa	97.4-75.62
Siwaqa-Damekhi	90.3-82.10
Sultani	95.5-93.7
Al Abiad	87.8-64.0
Jurf Ed Darawish	85.9-70.7

7. Background

Several studies were carried out by NRA on pure limestone of different localities in Jordan, in addition to that and within the geological survey project, four maps sheet were prepared, these maps encompassed the areas of pure limestone deposits. These studies are as follows:

- El-Hiyari, M. in 1985 in his study the geology of Jabal Al-Mutramil map sheet produced a geological map sheet at a scale of 1:50.000 which encompassed the area of pure limestone deposits which is located east of Qatrana town.
- Tarawneh, B. 1985 in his study the geology of Al-Aina map sheet produced a geological map sheet at a scale of 1:50.000 which encompassed the area of pure limestone deposits which is located west of Al-Hisa town.
- Barjous, M. 1988 in his study the geology of Siwaqa map sheet produced a geological map sheet at a scale of 1:50.000 which encompassed the area of pure limestone deposits which is located west and east of Al- Damekhi town.
- Shawabkeh, K. 1991 in his study the geology of Adir map sheet produced a geological map sheet at a scale of 1:50.000 which encompassed the area of pure

limestone deposits which is located west of Sultani town and west of Al- Abyad town.

- Muneizel and et al, during the years 1996-1997 and within the pure limestone project carried out an exploration program on the pure limestone in the areas of Al-Hisa, Sultani, Qatrana, and Siwaqa, this study include drilling boreholes, samples analyses and reserve calculation.
- Madanat, M an Ghannam, A., In 2003 and within the pure limestone project carried out an exploration program on the pure limestone in the areas of west Sultani, Abyad, Jurf Ed-Darawish and west Siwaqa, this study include drilling boreholes, samples analyses and reserve calculation.

8. Mining Aspects

8.1. Mining Companies

The following companies that exploiting pure limestone and the geological map in Appendix (1) shows the location of these companies.

Company	Mine location
Jordan Carbonate Co.	Al-Jeeza
Jordan Magnesia Co.	Qatrana
Sufian Nusair Assoc.	Qatrana
The Arab Co. for white Cement	khalidiah
Khaled Shamayleh Co.	Siwaqa

8.2. Production of pure limestone

Production of pure limestone is steady rise during the years 2008 – 2012 (Table 5), due to the increase of demand by industries for domestic and export.

Table (5): Pure limestone productions quantities during the years (2008-2012).

	2008	2009	2010	2011	2012
Pure limestone (ton)	1.839.525	2.352.297	558.518	187.217	1.984.441

9. Investment Opportunities

Currently, pure limestone is mined, produced and exploited for the use of White Cement, and calcium carbonate industries.

- Investment is open in Pure Limestone in different localities in Jordan to produce Calcium Carbonate and in White Cement industry.
- Local companies in Al-Qatrana and Al-Hisa areas are producing Pure Calcium Carbonate at production capacity around 450,000 ton/year.
- The Pure Limestone in El-Hallabat is currently extracted by Jordanian-Syrian Company for White Cement production.

There are some quarries for local companies in (Qatrana – Al Hisa - Jeza) to produce calcium carbonates in capacity around 480000 Ton/Year in 2004 most of the production is used for carbonates, cement, paints industries and half of this production is being exported as shown in the previous table.

The pure limestone which is available in large quantities in middle part of Jordan (From Siwaqa to Jurf Ed Darawish in south) has a high purity that qualifies it to be used in different industries.

9.1. Ground Calcium Carbonates Industry

Jordan carbonate company produce around (23) kinds of natural and treated carbonates in order to fit the different industries as a filler material or primary in paints, rubber, paper, ceramics, and plastic, glass,. The company exports around 90% from its production because of the quality and purity of Jordanian pure limestone. So there is a good opportunity for industrial investment in calcium carbonates by developing paint, plastic and polymers industries in Jordan and Middle East.

9.2. Cement Industry

In white cement industry pure limestone should have $\text{CaO} > 52\%$. The insistent need for pure limestone deposit are due to the increasing prices of cement and the development of construction industries, so the investment opportunity will be increased in this industry.

9.3. Magnesia Industry

Magnesia industry is based on using pure limestone as agent to precipitate magnesium hydroxide from Dead Sea water through chemical treatment to produce magnesium oxide, now there is a good opportunity for investment in Magnesia industry.

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Appendices

Appendix (1): Geological map shows the location of the companies that exploiting pure limestone.

Appendix (1): Geological Map Shows the location of Companies that have Mining Rights in Pure Limestone Deposit



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