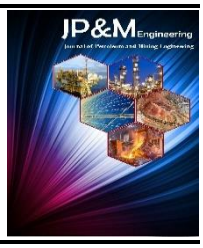
JP&M Engineering
Journal of Petroleum and Mining Engineering



Characterization of Calcium Carbonate Rocks, East El Minya Deposits for Possibility Uses as Industrial Raw Materials

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Abstract

This study deals with prospecting and evaluation of the calcium carbonate rock deposits the East El-Minya, near the Nile Valley-Upper Egypt for a proper industrial use. The study covered the area located between the following points: G10 (28º 22′ 14″ N- 30º 48′ 42″ E), G4 (28º 10′ 21″ N- 30º 47′ 34″ E), N1 (28º 22′ 03″ N- 31º 07′ 03″ E), N10 (28º 09′ 58″ N- 30º 48′ 20″ \E) and N2 (27º 53′ 33″ N- 30º 57′ 52″ E). Channel samples were collected from trenches and quarries for valuation. Each sample was prepared by crushing and grinding for different types of analyses which were carried out using XRF for chemical composition and the brightness of the materials were also measured. The obtained results show that the studied area for limestone observed in the Middle Eocene deposits and has high quality compassion; purities and whiteness. According to the obtained results, the limestone deposits are suitable for chemical industry and others industrial uses where the specification needed for these industries exist.

Keywords

Limestones; calcium carbonate rock; industry uses; Egypt; East El-Minya.

Introduction

Calcium carbonate (Limestone), as a sedimentary calcareous rock, mostly composed of calcite with some gangue minerals such as quartz, feldspar, iron oxides and mica. Limestones ore considered as a very important industrial mineral and the major industries which consume limestone are: cement production, extraction metallurgy (iron and steel making), manufacturing (glass, ceramics, blackboard chalk, food processing, paper making as a filler and a coating pigment, leather, insulation and pH control), agriculture (fertilizers, fungicides, animal feed), construction/architecture (mortar, cement, whitewash, building stone, concrete wares as paving-stones, tubes, sewage-tanks), plastics (plasticised and rigid PVC, unsaturated polyesters, polypropylene, polyethylene, rubber, foamed latex carpet-backings, sealants and adhesives), environment (flue gas desulphurisation, drinking water treatment, waste water treatment and forest and lake liming for the neutralisation of acid rain) purposes [1, 2]. The constituents of Limestone ore as a raw material for different industrial uses play a significant role in the cost-effectiveness. The most significant constituents of limestones as above mentioned are calcium oxide (CaO), alumina (Al2O3), iron oxide (Fe2O3), magnesium (MgO), and silica (SiO2) [1, 3]. Industrial specifications of calcium carbonate (%) for some different uses are shown in Table 1 [4-10]. Some research work has been carried out on the evaluation of Egyptian carbonate rocks for construction purposes include geotechnical analyses of limestone specimens from north to south Egypt. The first comprehensive work was performed by Tame and Edet, on the suitability of Egyptian limestone for cement manufacture [11–15]. Calcium carbonate (Limestone) rocks cover wide areas throughout Egypt map forming ridges and plateaus. In the majority of these areas the limestone rocks found on the surface or in shallow depth to include significant reserves of high grade material [16].

Limestone purity was classified according to the weight percentage of $CaCO_3$, CaO, MgO, SiO_2 and Fe_2O_3 as indicated in Table 2 below [17].

Deposits of limestone in the Nile Valley extent nearly from north to south along the Valley comprising Manfalut, El-Minya, Samulut and Mokattam Formations. While its deposits in Canal Governorates lie in three areas; Gebel Aukhedu, El-Shallufa and El Sadat. Also, the limestone rocks deposits found in west Alexandria in the Abu Sir, Sidi Krier, Borg El-Arab and El-Hammam. Several economic limestone deposits are also found in North Sinai, for example; Al Geham, Rissan Aneiza, El-Mestan - Umm Mofrouth, Gebel El-Raghaway, Gabal El Maghara and others [16]. The work here deals with the calcium carbonate mineral exploration for

different industrial uses. The study area occupies eastern parts of the Nile bank at El Mania Governorate. It is located between latitudes 28º 04' 00" and 28º 25' north and from Nile Valley to longitudes 30º 35'.

Table 1 Chemical properties and brightness of commercially available calcium carbonate [4-10].

Properties	Paint		Paper		Plastic		Food & pharmaceutic	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
$CaCO_3$ (%)	97.80	92 - 99.35	98.46	96 - 99.35	97.97	92 - 99.35	98.29	97 - 99.5
CaO (%)	54.80	51.55 - 55.67	55.17	53.79 - 55.67	54.89	51.55 - 55.67	55.07	54.35 - 55.75
MgO (%)	0.42	0.15 - 1.2	0.45	0.15 - 1.2	0.46	0.15 - 1.2	0.29	0.24 - 0.42
SiO_2 (%)	0.72	0.05 - 4.5	0.11	0.05 - 0.4	0.46	0.05 - 4.5	0.11	0.1 - 0.12
Fe_2O_3 (%)	0.04	0.01 - 0.1	0.04	0.01 - 0.1	0.04	0.01 - 0.1	0.06	0.011 - 0.1
Brightness (%)	92.8	78 - 99	96.7	93.5 - 99	92.7	75 - 98.1	96.5	90 - 99
No. of datasheets	100		35		88		34	
Properties	Ceramic		Rubber		Adhesives & sealants		Agriculture & animal feed	
	Mean	Range	Mean	Range	Mean	Range	Range	Mean
$CaCO_3$ (%)	99.05	98.8 - 99.35	97.37	92 - 99.35	97.48	92 - 99.35	95.55	92 - 99.35
CaO (%)	55.50	55.36 - 55.67	54.56	51.55 - 55.67	54.62	51.55 - 55.67	54.09	51.55 - 55.67
MgO (%)	0.27	0.22 - 0.38	0.62	0.15 - 1.2	0.54	0.15 - 1.2	0.66	0.22 - 0.96
SiO_2 (%)	0.08	0.06 - 0.12	0.82	0.05 - 4.5	1.14	0.05 - 4.5	1.28	0.06 - 4.5
Fe_2O_3 (%)	0.03	0.02 - 0.044	0.04	0.01 - 0.1	0.02	0.01 - 0.1	0.01	0.037 - 0.1
Brightness (%)	95.6	95.3 - 96	90.6	75 - 98.5	91.0	75 - 98	81.8	70 - 95.5
No. of datasheets	14		51		65		14	

Table 2 Classification of the Limestones ore by purity.

Purity classification	CaCO3 % wt.	CaO % wt.	MgO % wt.	SiO2 % wt.	Fe2O3 % wt.
Very high purity	>98.5	>55.2	<0.8	<0.2	<0.05
High purity	97-98.5	54.3-55.2	0.8-1.0	0.2-0.6	0.05-0.1
Medium purity	93-97	52.4-54.3	1.0-3.0	0.6-1.0	0.1-1.0
Low purity	85-93	47.6-52.4	>3.0	<2.0	>1.0
Impure	<85.0	<47.6		>2.0	

Geography, Geology and Geomorphology of The Study

Geography

The study area is accessible through a net of asphaltic roads and desert tracks, which almost cross the area parallel to the Nile Valley. The main highway in the area is Aswan Cairo asphaltic road as well as new military desert asphaltic roads extends from Cairo to El Mania crossing the eastern desert. Several asphaltic roads and desert tracks connect with these roads i.e. Al Shiekh Fadel - Ras Garb asphaltic road. It connects between the main towns of Upper Egypt from Cairo to Aswan and Red Sea. A number of secondary paved roads are also branched from the main high way. Also the area covered by numerous unpaved roads and desert tracks [18-23]. *Geology* - The exposed limestone rocks in this area belong to the Lower, the Middle Eocene, and the Quaternary sediments [18]. The Eocene sediments, which, form the most of the studied area around the Nile banks of El Mania was described and studied by many authors [18-23].

Geomorphology

Geomorphic units include; High Mountains:- The high mountains are represented by Gabal El-Abid, Gabal Qarara, Gabal Daba, Gabal El –Ahmar, Gabal El Teir. The maximum elevations, 278 m at Gabal Daba, which is western end of El-Mirier, scarp. All these mountains consisted of limestone, marl and clay rocks of Eocene age; Wadies**:-** The wadis intersecting the studied area east El-Minya from north to south are; Wadi El Mhashm, Wadi El Harafish,Wadi Sariria, Wadi Garf El Deir, Wadi El-Tahnawy and Wadi Omarn. All these wadies flow toward the Nile; Fanglomerate: - The fanglomerate is of limited extension present in some localities overlooking the Nile valley crossing the Eocene and laid down on the flood plain area. It consists of boulder and gravels of limestone, chart and quartz of rounded to sub rounded with matrix of reddish brown coarse sands; Flood plain and cultivated land: - The flood plain varies in width from place to another. The flood plain is made up of sand and gravel. The cultivated land included the Nile mud and silt of the flood plain adjacent to the River Nile. It varies in width from few kilometers at east Beni Mazar and Maghagha area. The level of the cultivated land varies in elevation from 25 m to 80 m [19-23].

Methods and Exploration Procedure.

This study is based on the collected samples from four measured stratigraphic column sections within the area under investigation as the following: A 29 channel samples were taken from excavating trenches and quarries along the limestone plateau of the Samalut Formation East of El-Minya in the South toward East of Samalut in the North (Figure 1).

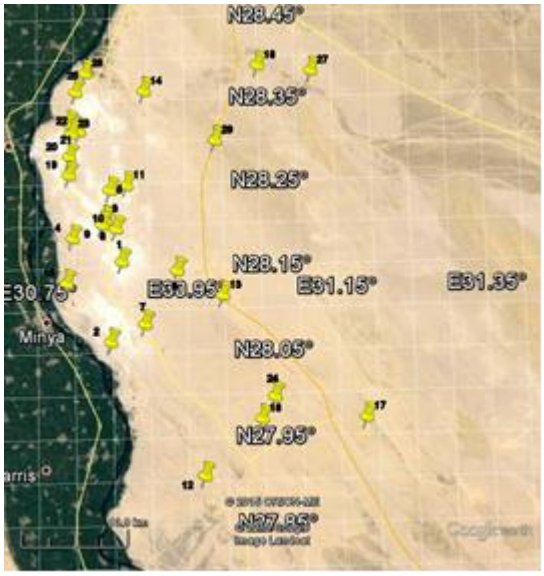

Figure 1 A plan of the area under investigation.

Results and Discussions

The chemical analysis of calcium carbonate rocks from XRF results are indicated in Tables 3 and 4.

As seen from these Tables (3 and 4) above the majority of the study area occupies eastern parts of the Nile bank at El-Minya Governorate, that embraced between latitudes 28º 04' 00" and 28º 25' north and from Nile Valley to longitudes 30º 35' the limestone deposit ranked as a high to very high purity type. For more detailed explanation, the assay contour map technique was used to present the results for each assay item of limestone constituents. By using GIS-Arc view software the limestone assay results were presented in Fig. 2 (1- CaO; 2- $CaCO_3$; 3- K_2O; 4- Na_2O; 5- P_2O_5; 6- Cl; 7- SO_3; 8- LOI; 9- Fe_2O_3; 10- Al_2O_3; 11- MgO; 12- SiO_2). As indicated in Figure 2 (1 to 12) below. Figure 2-1 shows the percentage of average assay of CaO content in limestone deposits. Whenever, as we go towards the NE of the area, the CaO % increases to reach 55.8%. We find CaO % content in the majority of limestone deposits in the area under investigation about 55.3 %. Figure 2-2 shows the percentage of $CaCO_3$ content in limestone deposits. The $CaCO_3$% content in limestone deposits as indicated in the contour map; Figure 2-2 shows that, an average assay of $CaCO_3$ % was about 98.6% and increases in the direction towards the NE of the area up to 99.5%. As indicated in Figure 2-3, K_2O% in limestone deposits covered the most of the area was about 0.03 %. Also this Figure shows that, as the $CaCO_3$ % increased the average assay of K_2O%, however, ranges from 0.01 % to 0.1 % by weight.

Figure 2-4, shoes the percentage of the average assay of Na_2O content in limestone deposits. As seen from the Figure, that, the percentage of Na_2O varied from 0.05 % at both of NW and SE of the investigated area to 0.1 % at NE and SW.

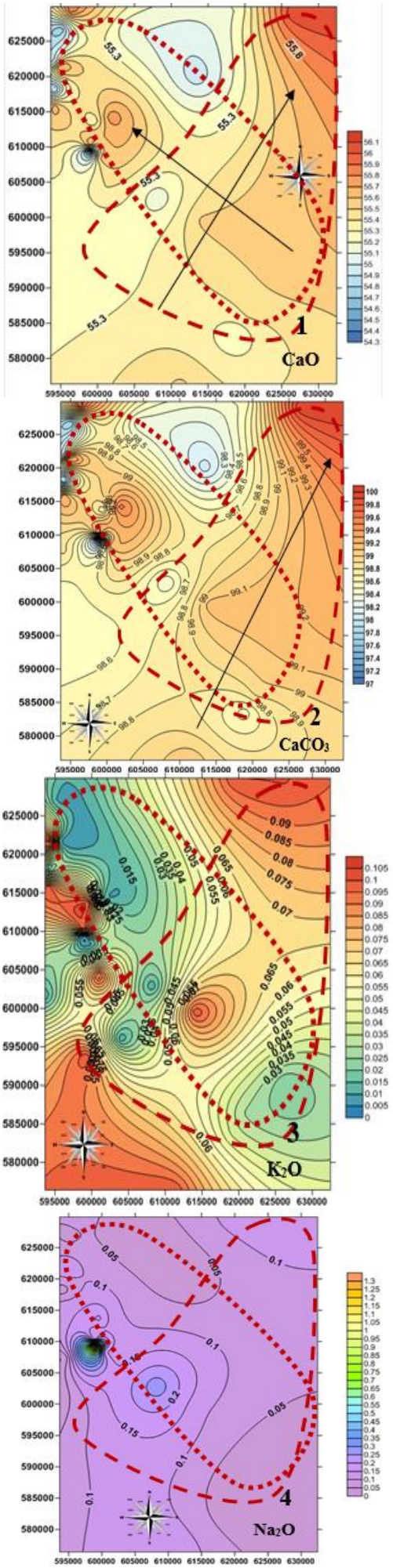

Table 3 Chemical analysis results of calcium carbonate samples obtained by XRF.

Location		Section No	Thickness	SiO_2 %	Al_2O_3 %	Fe_2O_3%	Mn O %	Mg O %	Ca O %	Na_2O %	K_2O %	P_2O_5 %	C l %	SO_3 %	L.O.I. %	$CaCO_3$ %
Lat.	Long.															
28° 08′ 37″	30° 51′ 31″	1	8.0 7.0	0.1 0.45	0.1 0.1	0.05 0.14	0.01 0.01	0.32 0.30	55.47 55.02	0.20 0.12	0.1 0.1	0.01 0.00	0.04 0.01	0.58 0.1	43.03 43.56	99.00 98.20
28° 02′ 58″	30° 50′ 34″	2	8.0 4.0	0.19 0.06	0.1 0.1	0.11 0.05	0.01 0.01	0.32 0.27	55.21 55.23	0.12 0.14	0.1 0.1	0.01 0.01	0.1 0.1	0.07 0.15	43.61 43.71	98.54 98.57
28° 11′ 41″	30° 50′ 15″	3	9.0	0.1	0.1	0.03	0.01	0.29	55.67	0.14	0.1	0.01	0.01	0.1	43.64	99.36
28° 10′ 21″	30° 47′ 34″	4	8.0 25.0	1.0 1.0	0.09 0.06	0.08 0.02	0.01 0.01	0.01 0.01	55.60 55.49	0.01 0.01	0.03 0.02	0.07 0.01	0.01 0.01	001 0.01	43.15 43.52	99.25 99.04
28° 13′ 44″	30° 50′ 38″	5	8.0 7.0	0.03 0.1	0.1 0.1	0.07 0.02	0.01 0.01	0.33 0.30	55.19 55.65	0.27 0.20	0.1 0.1	0.02 0.01	0.08 0.04	0.24 0.03	43.33 43.56	98.50 99.32
28° 07′ 54″	30° 55′ 57″	6	4.0	0.03	0.01	0.01	0.01	0.07	55.12	0.29	0.01	0.01	0.33	0.25	43.59	98.39
28° 04′ 11″	30° 53′ 19″	7	3.0	0.02	0.01	0.01	0.01	0.07	55.26	0.15	0.01	0.01	0.17	0.63	43.42	98.64
28° 11′ 34″	30° 50′ 15″	8	4.0	0.03	0.01	0.01	0.01	0.07	53.97	1.71	0.01	0.01	1.94	0.14	41.90	96.34
28° 11′ 16″	30° 49′ 08″	9	4.0	0.02	0.01	0.01	0.01	0.06	54.80	0.88	0.01	0.01	0.99	0.12	42.80	97.82
28° 10′ 57″	30° 51′ 05″	10	3.0	0.03	0.01	0.01	0.01	0.06	55.53	0.18	0.01	0.01	0.20	0.18	43.67	99.12
28° 14′ 03″	30° 51′ 59″	11	4.0	0.02	0.01	0.01	0.01	0.07	55.78	0.12	0.01	0.01	0.14	0.03	43.58	99.57
27° 53′ 33″	30° 57′ 52″	12	10.0	0.1	0.1	0.04	0.01	0.31	55.52	0.14	0.1	0.01	0.1	0.1	43.73	99.09
28° 06′ 06″	30° 59′ 33″	13	8.0	0.1	0.1	0.03	0.01	0.47	55.52	0.12	0.1	0.01	0.1	0.04	43.66	99.09
28° 20′ 50″	30° 53′ 27″	14	20.0 21.0	1.0 1.0	0.12 0.09	0.06 0.03	0.01 0.01	0.01 0.01	54.51 55.67	0.01 0.01	0.04 0.03	0.02 0.06	0.01 0.01	1.59 0.01	42.83 43.66	97.30 99.36
28° 07′ 10″	30° 47′ 04″	15	15.0 18.0 18.0 20.0	1.0 1.0 1.0 1.0	0.37 0.12 0.11 0.52	0.17 0.06 0.05 0.27	0.01 0.01 0.01 0.01	0.01 0.01 0.01 0.01	54.59 55.35 55.79 55.75	0.01 0.01 0.01 0.01	0.01 0.01 0.01 0.01	0.05 0.02 0.00 1.00	0.01 0.01 0.01 0.01	0.01 0.01 0.01 0.01	42.97 43.34 43.76 42.93	97.43 98.79 99.57 99.50
28° 09′ 58″	30° 48′ 20″	16	30.0	1.0	0.07	0.03	0.01	0.01	55.36	0.01	0.03	0.01	0.75	0.01	43.50	98.81
27° 57′ 24″	31° 10′ 45″	17	15.0 19.0	1.0 1.0	0.25 0.04	0.08 0.01	0.01 0.01	0.01 0.01	55.29 55.62	0.01 0.01	0.05 0.02	0.05 0.01	0.01 0.01	0.01 0.01	43.36 43.70	98.68 99.27
27° 57′ 25″	31° 02′ 29″	18	3.0 4.0	1.0 1.0	0.44 0.08	0.17 0.03	0.01 0.01	0.01 0.15	55.13 55.30	0.01 0.01	0.06 0.03	0.03 0.01	0.01 0.10	0.04 0.01	43.16 43.37	98.40 98.70
28° 14′ 52″	30° 47′ 20″	19	6,0	0.01	0.1	0.05	0.01	0.32	55.66	0.13	0.1	0.01	0.1	0.1	43.55	99.34
28° 16′ 13″	30° 47′ 22″	20	5.0	0.07	0.03	0.05	0.01	0.05	54.71	0.02	0.01	0.01	0.01	0.03	43.40	97.65
28° 18′ 14″	30° 47′ 21″	21	4.0 8.0	0.1 0.1	0.1 0.1	0.04 0.04	0.01 0.01	0.33 0.34	54.12 55.45	0.16 0.14	0.1 0.1	0.01 0.01	0.00 0.1	0.1 0.49	39.54 43.79	96.60 98.97
28° 18′ 01″	30° 48′ 11″	22	4.0	0.01	0.01	0.01	0.01	0.06	55.69	0.12	0.01	0.01	0.14	0.07	43.71	99.41
28° 17′ 51″	30° 47′ 35″	23	12.0 2.0	0.1 0.1	0.1 0.1	0.03 0.04	0.01 0.01	0.31 0.41	55.75 55.25	0.14 0.12	0.1 0.1	0.01 0.01	0.1 0.1	0.1 0.40	43.64 43.56	99.18 98.61
28° 22′ 31″	31° 02′ 44″	24	10.0	0.08	0.1	0.05	0.01	0.40	55.22	0.12	0.1	0.02	0.1	0.1	43.77	98.56
28° 20′ 51″	30° 47′ 54″	25	5.0 4.0 3.0 5.0	1.0 1.0 1.0 1.0	0.08 0.20 0.10 0.05	0.03 0.06 0.02 0.02	0.01 0.01 0.01 0.01	0.01 0.01 0.01 0.01	55.46 55.32 55.48 55.51	0.01 0.01 0.01 0.01	0.03 0.04 0.03 0.02	0.02 0.04 0.04 0.02	0.01 0.01 0.01 0.01	0.01 0.01 0.01 0.01	43.42 43.45 43.57 43.56	98.98 98.73 99.02 99.07
28° 22′ 14″	30° 48′ 42″	26	5.0	0.14	0.07	0.02	0.01	0.08	55.90	0.07	0.01	0.01	0.01	0.02	45.00	99.77
28° 22′ 03″	31° 07′ 03″	27	15.0 20.0	0.11 0.20	0.1 0.1	0.07 0.03	0.01 0.01	0.3 0.28	56.06 56.11	0.13 0.13	0.1 0.1	0.04 0.05	0.1 0.1	0.1 0.1	43.20 43.10	99.99 99.99
28° 05′ 53″	30° 59′ 59″	28	2.0	0.1	0.1	0.04	0.01	0.30	55.22	0.12	0.1	0.01	0.1	0.61	43.42	98.56
28° 17′ 09″	30° 59′ 10″	29	20.0	1.0	0.19	0.12	0.01	0.01	54.93	0.01	0.05	0.02	0.01	0.57	43.0	98.04

Table 4 Average weighted mean of Chemical analysis of calcium carbonate samples from XRF results.

Location		Section No	Thickness	SiO_2 %	Al_2O_3 %	Fe_2O_3%	Mn O %	Mg O %	Ca O %	Na_2O %	K_2O %	P_2O_5 %	C l %	SO_3 %	L.O.I. %	$CaCO_3$ %
Lat.	Long.															
28° 08′ 37″	30° 51′ 31″	1	15.0	0.26	0.1	0.09	0.01	0.31	55.50	0.16	0.1	0.005	0.03	0.36	43.27	98.63
28° 02′ 58″	30° 50′ 34″	2	12.0	0.15	0.1	0.09	0.01	0.30	55.22	0.13	0.1	0.01	0.1	0.1	43.61	98.55
28° 11′ 41″	30° 50′ 15″	3	9.00	0.1	0.1	0.03	0.01	0.29	55.67	0.14	0.1	0.01	0.01	0.1	43.64	99.36
28° 10′ 21″	30° 47′ 34″	4	33.0	1.0	0.06	0.03	0.01	0.01	55.52	0.01	0.02	0.02	0.01	0.01	43.43	99.09
28° 13′ 44″	30° 50′ 38″	5	15.0	0.06	0.1	0.05	0.01	0.31	5541	0.24	0.1	0.01	0.06	0.14	43.44	98.90
28° 07′ 54″	30° 55′ 57″	6	4.0	0.03	0.01	0.01	0.01	0.07	55.12	0.29	0.01	0.01	0.33	0.25	43.59	98.39
28° 04′ 11″	30° 53′ 19″	7	3.0	0.02	0.01	0.01	0.01	0.07	55.26	0.15	0.01	0.01	0.17	0.63	43.42	98.64
28° 11′ 34″	30° 50′ 15″	8	4.0	0.03	0.01	0.01	0.01	0.07	53.97	1.71	0.01	0.01	1.94	0.14	41.90	96.34
28° 11′ 16″	30° 49′ 08″	9	4.0	0.02	0.01	0.01	0.01	0.06	54.80	0.88	0.01	0.01	0.99	0.12	42.80	97.82
28° 10′ 57″	30° 51′ 05″	10	3.0	0.03	0.01	0.01	0.01	0.06	55.53	0.18	0.01	0.01	0.20	0.18	43.67	99.12
28° 14′ 03″	30° 51′ 59″	11	4.0	0.02	0.01	0.01	0.01	0.07	55.78	0.12	0.01	0.01	0.14	0.03	43.58	99.57
27° 53′ 33″	30° 57′ 52″	12	10.0	0.1	0.1	0.04	0.01	0.31	55.52	0.14	0.1	0.01	0.1	0.1	43.73	99.09
28° 06′ 06″	30° 59′ 33″	13	8.0	0.1	0.1	0.03	0.01	0.41	55.52	0.12	0.1	0.01	0.1	0.04	43.66	99.09
28° 20′ 50″	30° 53′ 27″	14	41.0	1.0	0.14	0.04	0.01	0.01	55.10	0.01	0.06	0.05	0.01	0.29	43.26	98.36
28° 07′ 10″	30° 47′ 04″	15	71.0	1.00	0.28	0.14	0.01	0.01	55.41	0.01	0.01	0.30	0.01	0.01	43.25	98.90
28° 09′ 58″	30° 48′ 20″	16	30.0	1.0	0.07	0.03	0.01	0.01	55.36	0.01	0.03	0.01	0.75	0.01	43.50	98.81
27° 57′ 24″	31° 10′ 45″	17	34.0	1.0	0.13	0.04	0.01	0.01	55.47	0.01	0.04	0.03	0.01	0.01	43.55	99.01
27° 57′ 25″	31° 02′ 29″	18	7.0	1.0	0.23	0.09	0.01	0.02	55.23	0.01	0.04	0.02	0.06	0.02	43.27	98.57
28° 14′ 52″	30° 47′ 20″	19	6.0	0.01	0.1	0.05	0.01	0.32	55.66	0.13	0.1	0.01	0.1	0.1	43.55	99.34
28° 16′ 13″	30° 47′ 22″	20	5.0	0,07	0.03	0.05	0.01	0.05	54.71	0.02	0.01	0.01	0.01	0.03	43.4	97.65
28° 18′ 14″	30° 47′ 21″	21	12.0	0.1	0.1	0.04	0.01	0.33	54.97	0.15	0.1	0.01	0.07	0.36	42.37	98.18
28° 18′ 01″	30° 48′ 11″	22	4.0	0.01	0.01	0.01	0.01	0.06	55.69	0.12	0.01	0.01	0.14	0.07	43.71	99.41
28° 17′ 51″	30° 47′ 35″	23	14.0	0.1	0.1	0.03	0.01	0.32	55.68	0.14	0.1	0.01	0.1	0.14	43.63	99.11
28° 22′ 31″	31° 02′ 44″	24	10.0	0.08	0.1	0.05	0.01	0.40	55.22	0.12	0.1	0.02	0.1	0.1	43.77	98.56
28° 20′ 51″	30° 47′ 54″	25	17.0	1.0	0.1	0.03	0.01	0.01	55.45	0.01	0.02	0.02	0.01	0.01	43.50	98.96
28° 22′ 14″	30° 48′ 42″	26	5.0	0.14	0.07	0.02	0.01	0.08	55.90	0.07	0.01	0.01	0.01	0.02	45.00	99.77
28° 22′ 03″	31° 07′ 03″	27	35.0	0.16	0.1	0.05	0.01	0.29	56.09	0.13	0.1	0.04	0.1	0.1	43.15	99.99
28° 05′ 53″	30° 59′ 59″	28	2.0	0.1	0.1	0.04	0.01	0.30	55.22	0.12	0.1	0.01	0.1	0.61	43.42	98.56
28° 17′ 09″	30° 59′ 10″	29	20.0	1.0	0.19	0.12	0.01	0.01	54.93	0.01	0.05	0.02	0.01	0.57	43.0	98.04

Figure 2 (5-8) shows that, the average assays for P_2O_5%, Cl %, SO_3% were 0.02, 0.15 and 0.06 respectively, while, the loss in ignition (L.O.I) was 43.5%.

Figure 2 (9-12) indicates that, the average assays of the following Fe_2O_3, Al_2O_3, MgO and SiO_2% were 0.04, 0.09, 0.2 and 0.3% respectively.

Classification of the limestone by purity

In comparison to the listed results of the analysis of limestones purity as shown in Table 2 above, the purity of El-Minya Governorate limestone deposits could be classified as very high purity, high purity, medium purity, low and impure as shown by the listed results in Table 5 [17].

As seen from the results indicated in Table 5, limestone deposits purity in the area under investigation varied from very high-to-high pure limestone.

Brightness percentage measurements.

Elected representative samples were prepared to measure brightness percentage of limestone deposits in study area and the results indicated as seen in Table 6.

As illustrated in Table 6 which gives a wide area of limestone deposit at El-Minya Governorate (El-Minya, Jabal AT Tayr Al Qibli, E and N- E AS Saririyyah) has brightness percent greater than 94 %, especially, at El-Minya area, whenever the brightness of limestone reached 95 % with an average bed thickness of 16.2 m.

Physical Characteristics

The physical examination of limestone samples collected from the area under investigation indicated that, the limestone are free from chart, organic matter and pyrite, iron sulfides, quartz and uniform in texture and color. These physical characteristic allow limestone at El-Minya Governorate to be proper to many of commercial industrial uses.

Limestone Industrial uses

According to the obtained results, the limestone deposits are suitable for many of commercial industrial uses. Table 7 below shows deferent commercial industrial uses for limestone deposits located at El-Minya Governorate.

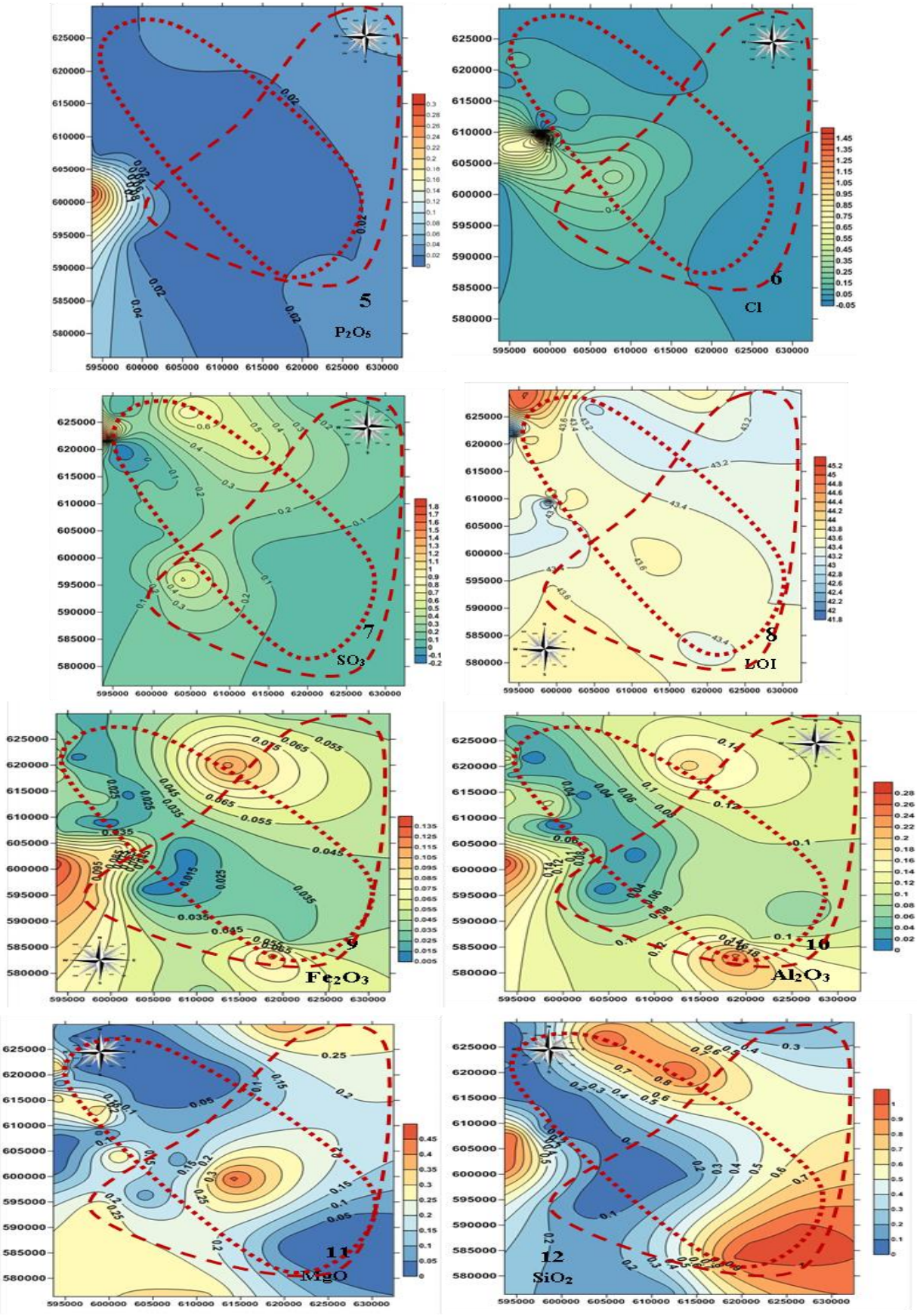

Figure 2 Assay contour map (1- CaO; 2- $CaCO_3$; 3- K_2O; 4- Na_2O ;5- P_2O_5; 6- Cl; 7- SO_3; 8- LOI ;9- Fe_2O_3; 10- Al_2O_3; 11- MgO; 12- SiO_2)

Table 5 Limestone purity classification of the area of the study (El-Minya Governorate).

Location		Section No	Thickness, m	$CaCO_3$ %	Category				
Lat.	Long.				Very high purity	High purity	Medium purity	Low purity	Impure
28º 08′ 37″	30º 51′ 31″	1	35.0	99.99	X	--	--	--	--
28º 02′ 58″	30º 50′ 34″	2	10.0	99.09	X	--	--	--	--
28º 11′ 41″	30º 50′ 15″	3	12.0	98.54	--	X	--	--	--
28º 10′ 21″	30º 47′ 34″	4	8.00	99.15	X	--	--	--	--
28º 13′ 44″	30º 50′ 38″	5	15.0	98.88	--	X	--	--	--
28º 07′ 54″	30º 55′ 57″	6	9.00	99.36	X	--	--	--	--
28º 04′ 11″	30º 53′ 19″	7	15.0	98.68	X	--	--	--	--
28º 11′ 34″	30º 50′ 15″	8	6.00	99.34	X	--	--	--	--
28º 11′ 16″	30º 49′ 08″	9	14.0	99.38	X	--	--	--	--
28º 10′ 57″	30º 51′ 05″	10	12.0	98.16	--	X	--	--	--
28º 14′ 03″	30º 51′ 59″	11	10.0	98.56	X	--	---	--	--
27º 53′ 33″	30º 57′ 52″	12	20.0	98.04	--	X	--	--	--
28º 06′ 06″	30º 59′ 33″	13	41.0	98.34	--	X	--	--	--
28º 20′ 50″	30º 53′ 27″	14	71.0	98.54	--	X	--	--	--
28º 07′ 10″	30º 47′ 04″	15	33.0	99.11	--	X	--	--	--
28º 09′ 58″	30º 48′ 20″	16	30.0	98.81	--	X	--	--	--
27º 57′ 24″	31º 10′ 45″	17	34.0	99.00	--	X	--	--	--
27º 57′ 25″	31º 02′ 29″	18	7.0	98.54	--	X	--	--	--
28º 14′ 52″	30º 47′ 20″	19	17.0	98.95	--	X	--	--	--
28º 16′ 13″	30º 47′ 22″	20	4.0	97.65	--	X	--	--	--
28º 18′ 14″	30º 47′ 21″	21	5.0	99.77	X	--	--	--	--
28º 18′ 01″	30º 48′ 11″	22	4.0	99.57	X	--	--	--	--
28º 17′ 51″	30º 47′ 35″	23	5.0	97.65	--	X	--	--	--
28º 22′ 31″	31º 02′ 44″	24	4.0	99.41	X	--	--	--	--
28º 20′ 51″	30º 47′ 54″	25	4.0	98.39	--	X	--	--	--
28º 22′ 14″	30º 48′ 42″	26	3.0	98.64	X	--	--	--	--
28º 22′ 03″	31º 07′ 03″	27	4.0	96.34	--	--	X	--	--
28º 05′ 53″	30º 59′ 59″	28	4.0	97.82	--	X	--	--	--
28º 17′ 09″	30º 59′ 10″	29	3.0	99.12	X	--	---	--	--

Table 6 Brightness percent in the study area at El-Minya Governorate.

Location			Section No	Thickness, m	$CaCO_3$ %	Category		Brightness %	
Lat.	Long.	Area				Very high purity	High purity	Brightness %	Average %
28º 08′ 37″	30º 51′ 31″	El-Minya	G1	15.0	98.88	--	X	94.67	95.00
28º 02′ 58″	30º 50′ 34″		G2	12.0	98.54	--	X	94.28	
28º 11′ 41″	30º 50′ 15″		G3	9.00	99.36	X	--	94.47	
28º 10′ 21″	30º 47′ 34″		G4	30.0	98.81	--	X	95.36	
28º 13′ 44″	30º 50′ 38″		G5	15.0	98.68	X	--	95.39	
28º 14′ 52″	30º 47′ 20″	Jabal AT Tayr Al Qibli	G6	6.00	99.34	X	--	95.48	94.25
28º 16′ 13″	30º 47′ 22″		G7	5.0	97.65	--	X	94.93	
28º 18′ 14″	30º 47′ 21″		G8	12.0	98.16	--	X	93.35	
28º 20′ 51″	30º 47′ 54″	E and N- E AS Saririyyah	G9	4.0	97.65	--	X	92.87	94.33
28º 22′ 14″	30º 48′ 42″		G10	5.0	99.77	X	--	95.50	
Average									94.79

Table 7 Commercial industrial uses for limestone deposits located at El-Minya Governorate.

Area	Average Thickness, m	Average $CaCO_3$ %	Average Brightness %	Category	Uses								
					Building stone	Industrial uses*							
						1	2	3	4	5	6	7	8
El-Minya	16	98.82	95.00	High to Very high purity	√	√	√	√	√	√	√	√	√
Jabal AT Tayr Al Qibli	7.7	98.36	94.25	High purity	√	√	√	√	√	√	√	√	√
E and N- E AS-Saririyyah	4.5	98.83	94.33	High to Very high purity	√	√	√	√	√	√	√	√	√

**1- Paint; 2- Paper; 3- Plastic; 4- Food & pharmaceutic; 5- Ceramic; 6- Rubber; 7- Adhesives & sealants; 8- Agriculture & animal feed*

Conclusions

From the achieved results, it could be concluded that:

- The limestone deposits located at El-Minya Governorate Areas (El-Minya, Jabal AT Tayr Al Qibli, E and N- E AS-Saririyyah) could be considered as potential source of high-grade calcium carbonate.
- The evaluated limestone deposits have chemical and physical properties are proper for different industrial uses such as Paint, Paper, Plastic, Food & Pharmaceutic, Ceramic, Rubber, Adhesives & Sealants an Agriculture & Feed.
- Orientation of limestone deposits to the industrial uses instead of building materials increase its benefit and value.

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