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# Primarily Assessment of Mamuniyat Formation Sandstones for Glass Industry, Idri Area, SW Libya

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**الملخص:**

في هذه الدراسة أُجْرِي تقويم جيوكيميائي للحجر الرملي لتكوين المومنيات لصناعة الزجاج في منطقة إدري بجنوب غرب ليبيا. استنادا على ثماني عشرة عينة من الحجر الرملي باستعمال تقنية قياس الطيف الكتلي البلازمي. أشارت بيانات التحليل الكيميائي إلى أن الصخور الرملية لتكوين المومنيات في منطقة الدراسة مناسبة لثلاثة أنواع شائعة من صناعة الزجاج (مثل الزجاج الجيري، وزجاج الرصاص، والبوروسيليكات أو الزجاج المقاوم للحرارة).

**الكلمات المفتاحية:**

صناعة الزجاج، تكوين المومنيات الرملي، منطقة إدري، ليبيا.

**Abstract**

In this study, we conducted a geochemical assessment of the Mamuniyat Formation sandstones for glass industry in Idri area, SW Libya. Eighteen sand stone samples were subjected to the inductively coupled plasma-mass spectrometry (ICP-MS) technique. The chemical analysis data suggests the Mamuniyat Formation sandstones in the study area are suitable for three common types of glass industry (i.e. sod - lime glasses, lead glasses and borosilicate or heat resistant glasses).

**Keywords:** Glass industry, Mamuniyat Formation sandstones, Idri area, Libya.

## 1. INTRODUCTION

A glass is an inorganic nonmetallic material that does not have a crystalline structure[1]. Glass is principally made up of SiO2 (59-80%) with varying degree of CaO (5-12%), Na2O (12-17%), Al2O3 (0.5-3%), BaO, K2O and MgO. The high melting point of glass is due to the presence of SiO2. The melting point and melt viscosity of the glass is modified by the addition of oxides[2].

Glass is classified into five common types; I) Sod - lime glasses, II) Lead glasses, III) Borosilicate or Heat resistant glasses, IV) High pure silica glasses, V) Specialty glasses[3]. Massa and Collomb[4] were the first described the Mamuniyat Formation from outcrops on the Al Qarqaf Arch. The studied section of the study area is located in northwest of Idri, that belongs to the western part of the Qarqaf uplift and to adjoining northern flank of the Murzuk Basin southwest of Libya (Fig. 1). The stratigraphic sequence of the studied area has been examined in one traverse, this traverse has been divided into six units, and these units composed mainly of sandstones with intercalations of a few siltstone beds (Fig. 2). Most geological publications on the Mamuniyat Formation deal with the structural geology, stratigraphy, sedimentology petroleum geology, mineralogy and geochemistry (e.g., [5,6,7,8,9]). This work is the first assessment of Mamuniyat Formation for glass industry in the Idri area, southwest Libya.

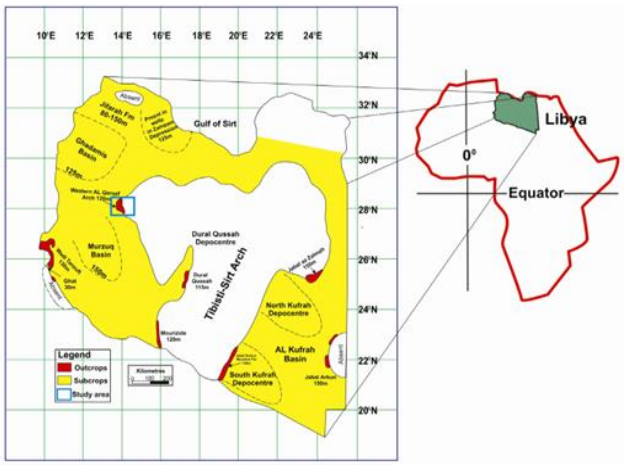


**Figure 1. Location map of the study area and distribution of the Mamuniyat Formation in Libya[10].**

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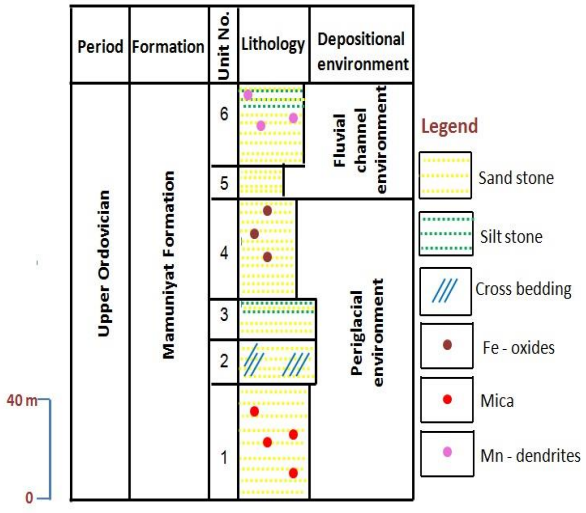


**Figure 2. Lithostratigraphic column of the Mamuniyat Formation sandstones in Idri area.**

## 2. METHODOLOGY

Samples were collected from surface outcrop of the Mamuniyat Formation in Idri area, SW Libya. Eighteen samples from six units (three samples of each unit).The analysis technique were done in the Nuclear Materials authority of Egypt which represents the following:

Bulk geochemical analysis for major oxides was performed using the inductively coupled Plasma-mass spectrometry (ICP-MS) technique.

## 3. RESULTS & DISCUSSION

The chemical analyses data are given in (Tables 1 and 2) show the Mamuniyat Formation sand stones have high SiO2 contents ( 81.6%, in average) and low TiO2, Al2O3, Fe2O3, MgO, Na2O, K2O and CaO contents. The chemical classification of sediments is not well developed; various authors have proposed few classification schemes for clastic sedimentary rocks or sediments based on their chemical compositions (e.g., [3, 5,10,11]). According to the diagrams of Crook[5], the studied sandstones are classified mainly as sublitharenites and quartz arenites (Fig. 3). The diagram of Crook[5], where the Mamuniyat Formation data plot in the quartz rich field (Fig.4). The specification of sand stone for glass industry are shown in (Table 3) reveals the Mamuniyat Formation sandstones are suitable for the following types:

1. Soda - lime glasses include (glass jar, window glass, float glass, ligth bulbs and containers).
2. Lead glasses include (alkali-free lead glasses, thermometer tubing, and lead technical and lead tableware).
3. Borosilicate or Heat resistant glasses include (borosilicate, pyrex, fibers, E- glass fibers, S- glass fibers, TV panel glass and flat panel).

Generally, high pure silica glasses type is not match with required standard of glasses while specialty glasses type is according to the customer order specifications

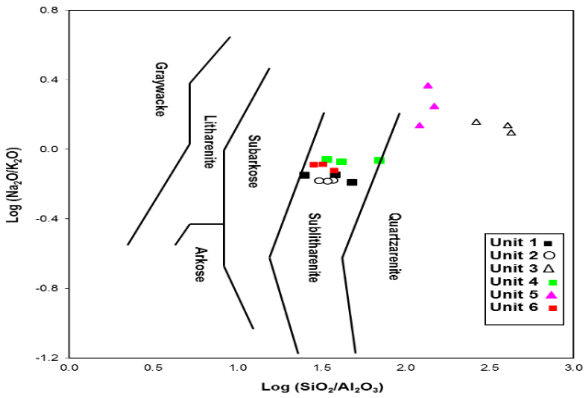


**Fig.3. Chemical classification of the Mamuniyat Formation sandstones usinglog(SiO2/Al2O3)-log(Na2O/K2O) diagram[5].**

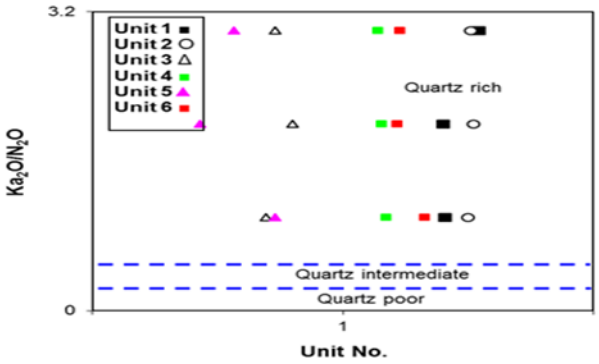


**Fig. 4. Chemical classification of the Mamuniyat Formation sandstones using K2O/Na2O ratio[5].**

**Table 1. Chemical analysis data (major oxides in wt. %) of the Mamuniyat Formation.**

| Formation | Mamuniyat | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Unit | 1 | | | 2 | | | 3 | | |
| Sample No. | 1a | 1b | 1c | 2a | 2b | 2c | 3a | 3b | 3c |
| $SiO_2$ | 72.71 | 71.32 | 70.66 | 65.44 | 65.88 | 64.52 | 98.00 | 98.20 | 97.27 |
| $TiO_2$ | 0.60 | 0.73 | 0.91 | 0.67 | 0.63 | 0.64 | 0.12 | 0.06 | 0.08 |
| $Al_2O_3$ | 2.91 | 1.88 | 1.47 | 1.76 | 1.93 | 2.11 | 0.37 | 0.23 | 0.24 |
| $Fe_2O_3$ | 3.37 | 3.46 | 4.00 | 3.73 | 3.08 | 3.61 | 0.07 | 0.04 | 0.07 |
| MnO | 0.13 | 0.17 | 0.16 | 0.13 | 0.10 | 0.11 | 0.01 | 0.01 | 0.01 |
| MgO | 3.50 | 3.67 | 3.55 | 5.67 | 5.22 | 6.00 | 0.10 | 0.05 | 0.10 |
| CaO | 6.35 | 7.41 | 7.92 | 10.23 | 10.00 | 10.84 | 0.19 | 0.12 | 0.18 |
| $Na_2O$ | 2.05 | 1.93 | 1.53 | 1.21 | 1.33 | 1.10 | 0.13 | 0.10 | 0.11 |
| $K_2O$ | 2.88 | 2.70 | 2.36 | 1.81 | 2.02 | 1.66 | 0.09 | 0.08 | 0.08 |
| $P_2O_5$ | 0.06 | 0.09 | 0.09 | 0.12 | 0.11 | 0.09 | 0.04 | 0.05 | 0.06 |
| Cl | 0.11 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.05 | 0.05 | 0.05 |
| $SO_3$ | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.08 | 0.11 | 0.10 |
| L.O.I | 5.11 | 6.00 | 6.73 | 9.12 | 8.96 | 9.71 | 0.90 | 0.87 | 1.10 |
| Total | 99.83 | 99.50 | 99.51 | 100.02 | 99.39 | 100.50 | 100.15 | 99.97 | 99.45 |

**Table 2. Chemical analysis data (major oxides in wt. %) of the Mamuniyat Formation.**

| Formation | Mamuniyat | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Unit | 4 | | | 5 | | | 6 | | |
| Sample No. | 4a | 4b | 4c | 5a | 5b | 5c | 6a | 6b | 6c |
| $SiO_2$ | 78.68 | 79.19 | 79.36 | 97.08 | 97.23 | 97.88 | 78.62 | 79.05 | 79.27 |
| $TiO_2$ | 0.93 | 0.89 | 0.80 | 0.11 | 0.17 | 0.13 | 0.61 | 0.55 | 0.50 |
| $Al_2O_3$ | 1.90 | 1.14 | 2.33 | 0.80 | 0.71 | 0.66 | 2.09 | 2.45 | 2.78 |
| $Fe_2O_3$ | 7.11 | 6.93 | 6.25 | 0.10 | 0.09 | 0.07 | 3.95 | 3.92 | 3.90 |
| MnO | 0.06 | 0.06 | 0.04 | 0.03 | 0.03 | 0.03 | 0.10 | 0.09 | 0.08 |
| MgO | 1.09 | 1.00 | 1.11 | 0.09 | 0.08 | 0.10 | 2.33 | 2.17 | 1.91 |
| CaO | 1.20 | 1.11 | 1.27 | 0.19 | 0.26 | 0.21 | 3.23 | 2.67 | 2.11 |
| $Na_2O$ | 3.32 | 3.42 | 3.51 | 0.11 | 0.21 | 0.16 | 2.22 | 2.71 | 3.00 |
| $K_2O$ | 3.89 | 3.95 | 4.00 | 0.08 | 0.09 | 0.09 | 2.94 | 3.29 | 3.68 |
| $P_2O_5$ | 0.12 | 0.11 | 0.08 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 |
| Cl | 0.06 | 0.06 | 0.04 | 0.05 | 0.05 | 0.05 | 0.09 | 0.09 | 0.08 |
| $SO_3$ | 0.07 | 0.07 | 0.05 | 0.13 | 0.20 | 0.11 | 0.06 | 0.06 | 0.06 |
| L.O.I | 1.33 | 1.29 | 1.31 | 1.15 | 0.95 | 0.77 | 4.11 | 3.35 | 2.94 |
| Total | 99.76 | 99.22 | 100.15 | 99.97 | 100.11 | 100.31 | 100.40 | 100.45 | 100.36 |

**Table 3. Approximate composition (major oxides in wt. %) of some commercial glasses[12,13].**

| Types of glass | Commercial glasses | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $B_2O_3$ | MgO | $K_2O$ | SrO | BaO | $ZrO_2$ | PbO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| High puriy silica glasses | Fused glass | 99 | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| | Vycor | 96 | _ | _ | _ | 4 | _ | _ | _ | _ | _ | _ |
| Soda - lime glasses | Glass jar | 74 | 1 | 5 | 15 | _ | 4 | _ | _ | _ | _ | _ |
| | Window glass | 72 | 1 | 10 | 14 | _ | 2 | _ | _ | _ | _ | _ |
| | Float glass | 73 | 1 | 13 | 13 | _ | _ | _ | _ | _ | _ | _ |
| | Ligth bulbs | 74 | 1 | 5 | 14 | _ | 4 | _ | _ | _ | _ | _ |
| | Containers | 73 | 2 | 10 | 14 | _ | 3 | 0.2 | _ | _ | _ | _ |
| Lead glasses | Alkali-free lead glasses , | 63 | 2.6 | _ | _ | 13.6 | 10.3 | _ | _ | _ | 2.1 | 8.5 |
| | Thermometer tubing | 73 | 6 | _ | 10 | 10 | _ | _ | _ | _ | _ | _ |
| | Lead technical | 66 | 1 | 0.7 | 6 | 0.6 | _ | 10 | _ | 0.5 | _ | 16 |
| | Lead tableware | 56 | 1.3 | _ | 5 | 0.6 | _ | 7 | _ | _ | _ | 30 |
| Borosilicate glasses | Borosilicate | 76 | 3.7 | 0.8 | 5.4 | 13.5 | _ | 0.4 | _ | _ | _ | _ |
| | Pyrex | 81 | 2 | _ | 4 | 12 | _ | _ | _ | _ | _ | _ |
| | Fibers | 54 | 14 | 16 | _ | 10 | 4 | _ | _ | _ | _ | _ |
| | E- glass fibers | 55 | 15 | 20 | _ | 10 | _ | _ | _ | _ | _ | _ |
| | S- glass fibers | 65 | 25 | _ | _ | _ | 10 | _ | _ | _ | _ | _ |
| | TV panel glass | 72 | 2.5 | 5 | < 11 | _ | 2.4 | < 7 | < 7 | < 6 | _ | _ |
| | Flat panel | 70 | 10 | 6 | | 10 | | _ | 3 | 1 | _ | _ |

## 4. CONCLUSIONS & RECOMMONDATIONS

The main conclusions and recommendation of this work are as follows:

1. High SiO2 content and low of the rest of oxides characterizes the chemical composition of Mamuniyat Formation.
2. According to glass standard, the Mamuniyat Formation sandstones in the study area are fitting for soda - lime glasses, lead glasses and borosilicate or heat resistant glasses.
3. We recommend more studies related to the use of sandstones in various industries especial in glass industry, because there are huge reserves in Libya.

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