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The study of unreported igneous body, and its economic interest at Abu Zerriq area, north Al–Kufrah region, SE–Libya

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ABSTRACT

This research deals with mineralogical and petrological investigation of an igneous intrusion located at Abu Zerriq area, with a distance of about 160 Km north to Al Kufrah town. Although the occurrence of igneous activities has not been reported before in this area, field inspections, followed by examination of thin sections under polarized microscope, have shown that this outcrop represents an igneous intrusion that comprises concentric rings of basalt and rhyolite. The basalt mainly is composed of laths of calcic plagioclase, relicts of altered olivine (partly serpentinized), quite abundant pyroxene crystals, and needle-like and anhedral opaque mineral (probably ilmenite).
The economic interest of these rocks as a source of aggregates for construction is an important objective in this study. In order to determine the compressive strength of the rock samples, rock strength tests have been carried out. The results of these tests indicate that the studied rocks have high compressive strength, and they are much recommended for the purpose of civil constructions. The relatively large size of the material in this igneous body, and its close proximity to the constructed road, considerably increase its mining interest.

1. Introduction

In this research, field inspections and laboratory examinations have been done on number of rock samples collected from an outcrop located at Abu Zerriq area, which is situated between 679738; 2834727 on the west side and 680271; 2835534 on the north side (Fig.1). The results of these examinations show that this outcrop represents an igneous intrusion that mostly composed of basalt.

In general, the igneous rocks in the southeastern part of Libya have been subjected to many studies. Most of these studies were only on the Arkenu and Al'Awaynat areas (Atherton et al. (1991), Flinn et al, 1991, Said et al,.2000 and Oweiss et al,. 2007). Some volcanic activities have taken place in Tertiary age, developing volcanic interruptions in many localities. These are mostly basaltic outcrops of average round shape, occupying relatively large areas and forming plateaus of very flat and smooth surfaces (Bellini and Massa 1980).

However, the occurrence of the igneous body of the current investigation has not been mapped or published before in this area. One of the objectives of this research is the economic interest of the reported igneous intrusion as a source of aggregates for construction. Rock mechanics is a principal subject in geotechnical engineering, with applications in construction of civil infrastructures, and transportation routes. As Al-Kufrah-Abu Zerriq road has been seriously damaged within a relatively short period due to the use of unsuitable aggregates, knowledge of rock mechanics is indispensable.

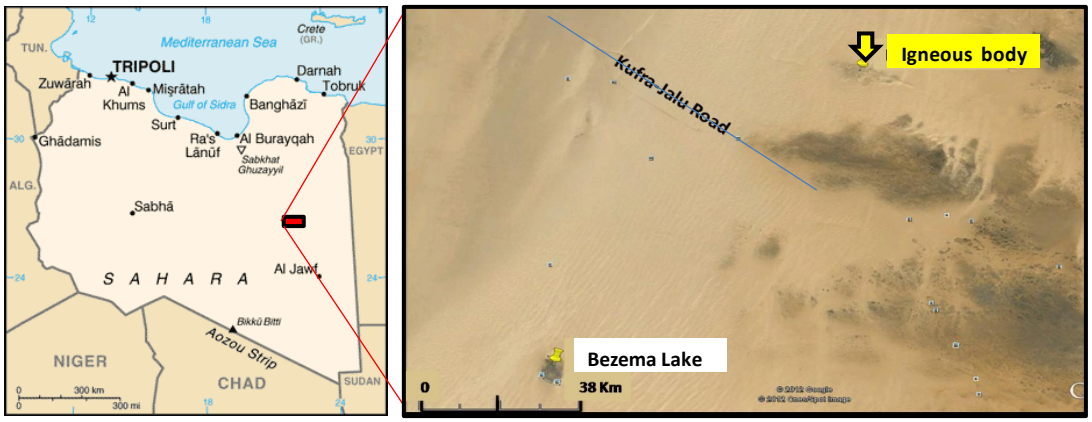

Fig. 1: Location map and landsat image of the study area.

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2. Field Study

In general, the outcrop is ring-shaped in relief, with respect to the surrounding rocks. The outcrop of this intrusion has been weathered down and has a rounded-shaped expression of approximately 1 Km in diameter (Fig. 2). It comprises a number of low mounds and cones that are partially covered by Quaternary sand deposits. The mounds and cones are highly variable in size and range from 6 to 20 m in height.

Field inspections, have shown that this outcrop represents an igneous intrusion that comprises concentric rings of basalt and rhyolite. According to the field investigation, this outcrop represents an igneous intrusion that mainly composed of black to gray colored, fine to very fine grain, hard to very hard, basalt. The rhyolite is characterized by is by, greenish light gray color, showing distinctive greenish well rounded grains of size ranging from 0.5 to 5 mm in diameter. In addition, very thin layer of limestone of thickness ranges from five to 15 cm has been observed in the outcrop. It is mainly composed of calcite and contains quite abundant plate-like substance of undeterminable character. This substance is very soft and may have an organic origin. It looks like some sort of a resin.

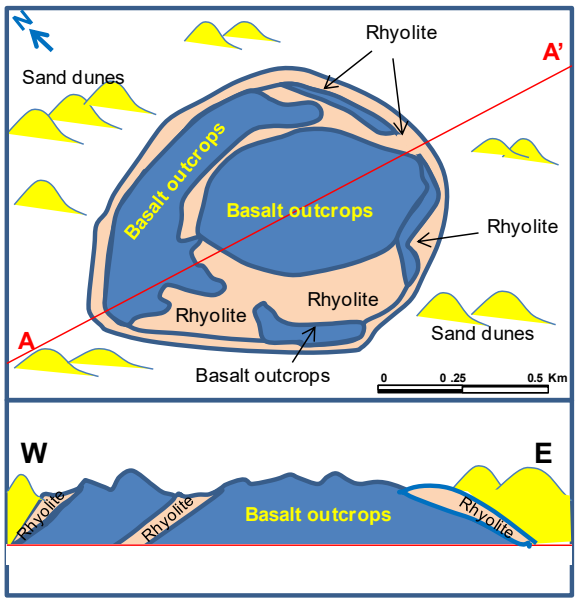

Fig. 2: Hand sketch and cross section shows the structure of the studied igneous body.

The dark grey, very strong rock identified at the field as basalt. It occurs in the mounds in the center of the intrusion (Fig. 3). The outer ground surface of the mounds is covered with black cobbles and small boulders mixed with a light orange windblown sand.

3. Microscopic Description

During the field investigation, number of rock samples is collected from the outcrop. Several thin sections are prepared in the Waha Oil Company Laboratories. The study of these thin sections has been done under polarized microscope.

Fig. 3: Outcrop of fresh black basalt with gray weathered surface.

The petrographical description of these rocks is as following:

Weathered Basalt: The rock is composed of clay mineralized plagioclase crystals showing flow and intersertal texture and containing abundant needle-like opaque mineral (probably ilmenite). In addition, couples of amygdules filled with clay mineral are present (Fig. 4a).

Basalt: This rock is similar in origin as the above but it is coarser grained, fresher and composed of laths of calcic plagioclase, relicts of altered olivine (partly serpentinized), quite abundant pyroxene crystals, and needle-like and anhedral opaque mineral (probably ilmenite) (Fig. 4b).

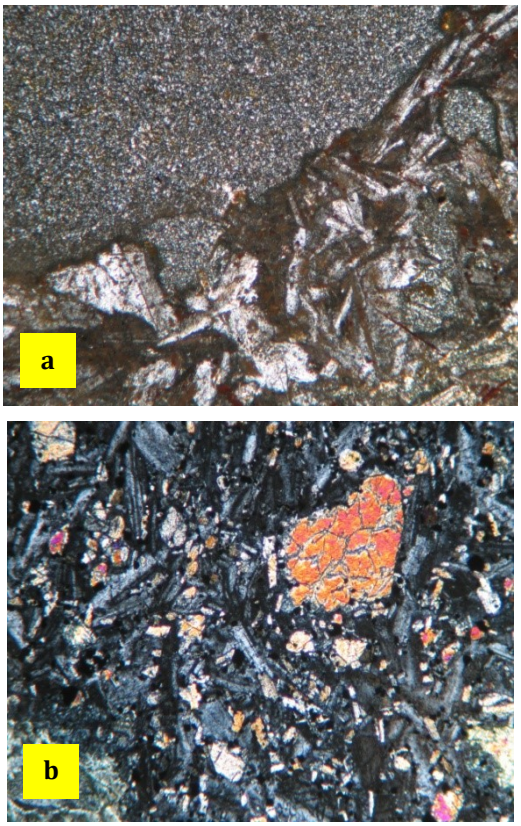

Fig. 4.(a)**:** Thin section of weathered basalt, and (b): Thin section of the fresh basalt.

4. Economic Interest as a Source of Aggregates

Generally, each rock type can exhibit considerable variation in compressive, tensile, and shear strengths (Table 1). In most rocks, the main factors controlling rock hardness are porosity, grain size, and grain shape. Sedimentary rocks generally have high porosity, and their grains are less tightly held together. As a result, they are generally low in rock hardness. Igneous rocks generally have lower porosity and tight grains, which make them harder. However, fine-grained igneous rocks, such as basalt are generally higher in rock hardness than that of coarser grained igneous rocks, such as granite. Generally, igneous rocks compressive strength range from 80 to 320 MPa, which is classified as strong to very strong (Attewell & Farmer 1976).

In general, rock mechanics is a principal subject in geotechnical engineering, with applications in construction of civil infrastructures, and transportation routes. As Al-Kufrah-Ab Zerriq road has been seriously damaged within a relatively short period due to the use of unsuitable aggregates, knowledge of rock mechanics is indispensable. In order to determine the compressive strength of the rock samples, rock mechanics experiments have been carried out in this research. The results of these experiments indicate that the studied rocks have high compressive strength, and they are much recommended for the purpose of civil constructions.

Table 1: Typical igneous and metamorphic rock parameters (from Attewell & Farmer 1976).

Typical Rock Types	Compressive Strength (MPa)	Tensile Strength (MPa)	Shear Strength (MPa)	Bulk Density (Mg/m$^{3)}$	Porosity %
Granite	100-250	7-25	14-50	2.6-2.9	0.5-1.5
Diorite	150-300	15-30	NA	NA	NA
Diabase	100-350	15-35	25-60	2.7-3.05	0.1-0.5
Gabbro	150-300	15-30	NA	2.8-3.1	0.1-0.2
Basalt	100-300	10-30	20-60	2.8-2.9	0.1-1.0
Gneiss	50-200	5-20	NA	2.8-3.0	0.5-1.5
Marble	100-250	7-20	NA	2.6-2.7	0.5-2
Slate	100-200	7-20	15-30	2.6-2.7	0.1-0.5

However, the laboratory test made in the J&P Company laboratories on more than 30 rock samples indicates that these rocks have Los Angeles Abrasion range from 13 to 94 (J&P, 2001). This test has been widely used as an indicator of the relative quality or competence of various sources of aggregate having similar mineral compositions. The relatively large size of the material in this igneous body, and its close proximity to the constructed road, considerably increase its mining interest. The latest calculations show that some 800000 cubic meters of high strength rocks are needed to reconstruct the new Kufrah- Abu Zerriq road, and the only aggregate source that can possibly deliver the entire volume of rock required is the basalt intrusion with an estimated volume of about 1100000 cubic meters.

5. Conclusion

The results of this research report occurrence of igneous activities for the first time in the area of Abu Zerriq, north of Al Kufrah town, southeast Libya. The mineralogical and petrological studies of this igneous intrusion indicate that it is mainly composed of basalt. Furthermore, in this research, the economic importance of the rocks of the igneous intrusion is considered. Results of field investigations combined with laboratory tests demonstrate that the studied rocks are suitable as a source of aggregates for road construction. The relatively large size of the intrusion, and their location near to the constructed road, are two factors considerably enlarge its economic interest.

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