مجلة كلية الآداب بالوادي الجديد- مجلة علمية محكمة- إبريل ٢٠٢٥

Basalt in Bahariya Depression- Western Desert
(A Study in Applied Geomorphology)

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ABSTRACT:

Basalt rocks are found in limited locations in Egypt, including basalt in Bahariya Depression. The study area has not received a geomorphological study of basalt rocks in particular. Therefore, the importance of research in studying basalt rocks in Bahariya Depression was a study in applied geomorphology due to its practical importance in the field of industry and multiple fields in line with the state's interest in the process of sustainable development. Bahariya oasis is located in the western desert of Egypt at about 160 km west of Minya city. It has Elongated shape, was affected by tectonic activity, its exposed thick succession ranging from upper Cretaceous to Miocene in age. The depression is characterized by its flatness except for several isolated hills. These hills are Al-Hafuf, mount Hamada, and Matila Radwan in the southwest, and mount Al-mu'aysira and Mandisha in the north, where the Edges extend around the depression and affect the direction of wind movement. **Main locations of Basalt rocks** are in: Gebel El Hefhuf, Mandisha occurrence, El-agoz hill, Mayesra occurrence and Basalt hill occurrence. There are many **associated landforms to Basalt rocks**: sills, Doming in the upper sill, flows in el-hefhuf and Dykes

Mineralogical and Geochemical discrepancies between the two batches could have originated from various petrogenetic processes including one or more of the following in the study. we propose that these chemical variations are linked to a mixture of superimposed processes involving mantle source, partial melting, and fractionation path.

Significance of Basalt Fiber: known as "the green industrial material of the XXI-century", combines ecological safety, natural longevity and many other properties. Its applications are surely innovative in many industrial and economic fields, from building and construction to energy efficiency, from automotive to aeronautic, its good mechanical and chemical performances. Hence Basalt Fiber has gained increasing attention as a reinforcing material especially compared to traditional glass and carbon fibers, and significance of Basalt fiber as a new reinforcing material.

Keyword: Basalt rocks- Bahariya Depression - Significance of Basalt- Applied Geomorphology

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Firstly: Introduction

Tertiary sedimentation in Egyptian territory was interrupted by extensive volcanic activity and crustal movements, which were responsible for the formation of the Red Sea Graben. Magma penetrated the Oligocene and older rocks hundreds of kilometers apart in many localities. This resulted in the formation of isolated Basaltic dykes, sheets and volcanic cones. A detailed presentation of these occurrences was studied. It is almost certain that the active magma of all the tertiary volcanoes of lower Egypt was Basaltic. Nevertheless, the types of eruptions varied from pure effusive and mixed to highly explosive and even cryptovolcanic. Although these Basalts may not be precisely contemporaneous, they constitute a mappable rock unit frequently taken as the upper limit of the Oligocene succession in Egypt.

Tertiary Basalts occur in several locations in Egypt (fig. 1), which shows the distribution of tertiary Basaltic rock, mainly in the eastern desert (Cairo-Suez District, Wadi Hodein, South Quseir, Abu Zaabal And East Samalut) and in the western desert (Gabal Qatrani, Baharyia Oasis, Northeast Of Gilf Kebir And North Gebel Uweinate). Intraplate Basaltic volcanicity occurs in both continental and oceanic. Magma generated in the intraplate continent differs in composition from the oceanic crust, which is attributed to the variable composition of the continent.

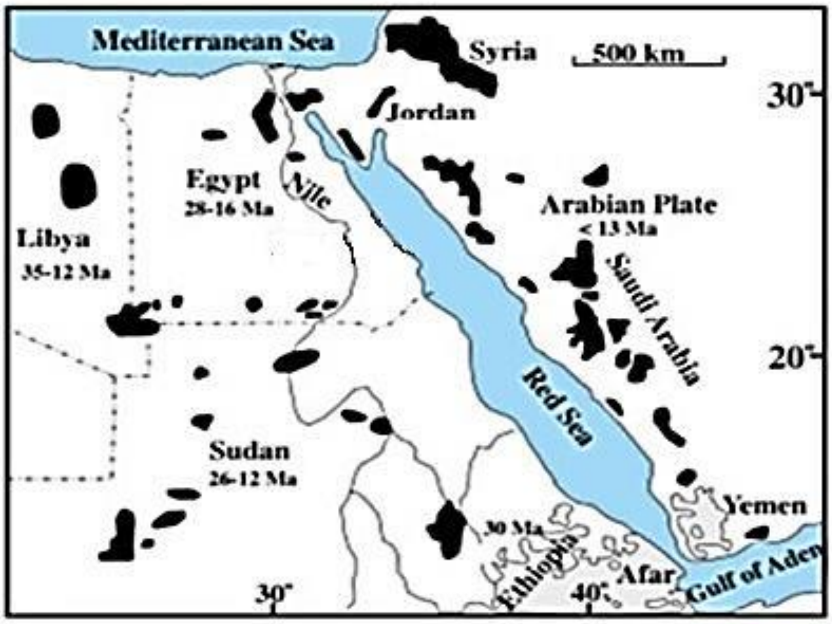


Figure 1: Distribution of tertiary basaltic rocks after
H.Schandelmeier, P.O.Reynolds:1997

❖ Study area:

Bahariya depression is located west of the Nile River in the heart of the western desert, about 180 km west of the Nile and 160 km from Fayoum. It is located 370 km southwest of Cairo and differs from other depressions in the western desert in that it is surrounded on all sides by high edges. It is the smallest depression in the western desert in terms of area. Astronomically, the depression is located between latitudes °27 '48and 30°52' north, and between longitudes 35°52 and °29 '10 east, with a total area of 2,220.1 km2. Its maximum length is 94 km, and its maximum width is 42 km (fig.2).

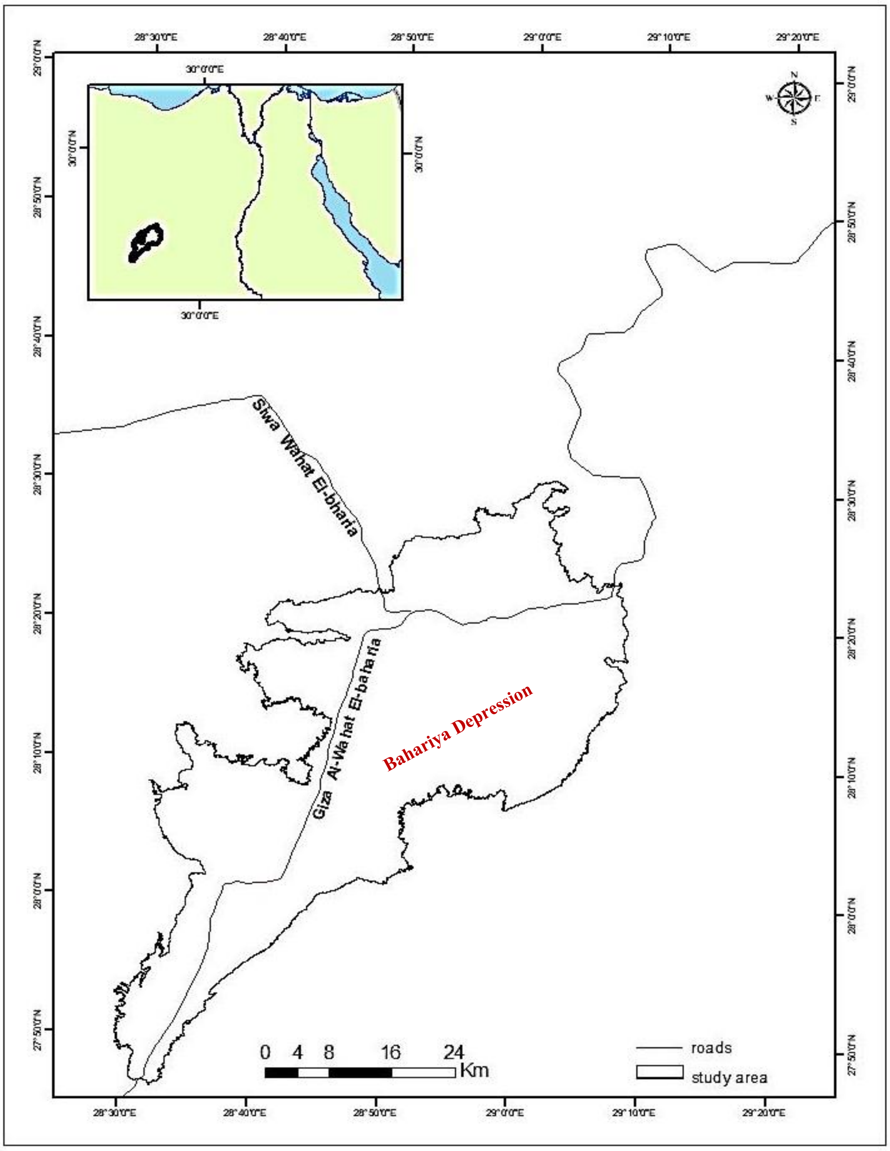


Fig. (2) Location of Bahariya Depression

❖ Reasons for choosing the topic:

- Diversity and geomorphological variation of the region, which calls for a detailed geological and geomorphological study .
- Lack of geographical or geological studies highlighting the Basaltc forms in the depression.
- Availability of study sources, including maps, satellite imagery, previous studies, and others.
- Possibility of conducting field studies due to the ease of access to most parts of the region and movement within it.

❖ study objectives:

- A detailed study of the geological map of the region and identification of the tectonic movements that the region has undergone and the geological structures they have left behind, such as folding, faulting, and others.
- Study the topographic map of the region in detail and identify how depression was formed.
- Highlight the relationship between the lithological and structural characteristics of rocks and landforms.

❖ **Data sources**: The researcher relied on more than one source of data in her study, which can be divided as follows:

- **Previous studies**: Bahariya oasis has been the subject of a large number of studies, which can be classified as follows:

Geological studies: there are a large number of geological studies that have addressed Bahariya oasis region., The most important of these are:

- a study (Ball & Beadnell, 1903) that addressed the geology and topography of Bahariya oasis region, and dealt with the creation of a topographic map with a scale of 1:250,000. It also addressed the study of the stratigraphic sequence of the exposed rocks in the depression.

- A study (Hume, 1919) that examined the stratigraphic sequence of the Eocene plateau on the northern edge of Bahariya depression.

- A study (Andrew, 1937) that described the volcanic flows of the late tertiary period in Bahariya oasis and their similarity to volcanic flows in Egypt.

- A study (Faris et al, 1956) that addressed the stratigraphic sequence and volcanic flows in the depression.

- A study by (El-Badry, 1970) addressed the rock sequence of Bahariya oasis and concluded that the cretaceous period is characterized by great diversity in rock composition and structural conditions. The study also addressed tectonic movements and the sedimentary environment of the cretaceous sequence in Bahariya oasis region.

- (El-Bassyony, 1970) this study examined the geology of iron ore deposits in the new area and divided the exposed rocks in the area into six lithological units on a 1:100,000 geological map. It also identified the different strata that comprise them, the oldest of which was Bahariya formation, followed by the hayz formation, followed by the hafouf formation.

- (Amer, 1973) a study addressed the geology and mineralogy of Bahariya oasis and its iron ore deposits, conducting a comprehensive study and drawing a structural map of the northeastern corner of africa to clarify the relationship between the structural position of Bahariya oasis and the general structural position of central and northeastern Africa. The study also addressed the iron ore regions (Al-Jadida, Grabi, Nasser, And Al-Hara).

- A Study (El-Bassyony, 1978) addressed the structure of the northeastern plateau of Bahariya oasis.

- A study (Franks, 1982) proposed a model for the stratigraphic sequence of upper cretaceous deposits in Bahariya oasis.

- A study by (El-Mansy ,1983) addressed the sedimentary and mineral characteristics of Cretaceous (Upper Cretaceous) deposits in the surface sectors of Bahariya oasis and concluded that the effects of tectonic movements (folds and faults) led to the creation of sedimentation areas with different geochemical characteristics.

- A study (Mohamed, 1986) dealt with new additions to the mineralogy and geochemistry of the sedimentary sequence from the upper cretaceous to the Eocene in Bahariya oasis.

- A study (Sokkar, 1991) this study examined the geomorphology, geology, and mineralogy of the limestone deposits in the area between al-wahat al-Bahariya and al-Farafra. It concluded that geological conditions, in addition to climatic factors, played a major role in the formation of the karst phenomena prevalent in this area.

- A study (Madani, 1995) examined the Basalt rocks in the northern part of Bahariya oasis, focusing on the Basalt rocks on jabal al-hafouf, mandisha, al-ma'isra, tal al-ajuz, and tal al-Basalt in order to understand the tectonic situation and the evolution of Basalt in the region, and a model was developed for this purpose.

- A study (Moaod, 2000) dealt with the geology and sedimentology of limestone rocks bearing iron ore in the northeastern plateau of Bahariya depression.

B. Geographical studies: Geographical studies of Bahariya depression are somewhat scarce, with the depression being addressed in:

- A study: (Mahsoub ,1975), Bahariya depression – a study in regional geography.

this master's thesis addressed the region as one of the distinctive geographical regions and included a study of the region's geology and topography, as well as a presentation of the most important climatic elements in the region, in addition to the various human aspects that characterize the depression.

- A study: (Al-kayali ,1979) Bahariya depression – a geomorphological study.

a master's thesis that addressed the geology of the depression, surface sediments, surface forms, and the drainage system of the depression. The study concluded by discussing the formation of Bahariya depression and is considered the most comprehensive geomorphological study in this regard. It referred to some surface forms, but did not expand on these points due to its focus on the drainage system and surface sediments at the bottom of the depression.

- A study: (klio ,2000) Hummocks in Bahriya depression a geomorphological study. this study addressed the phenomenon of Hummocks appearing on the surface of the plains, through their distribution areas, morphometric dimensions, analysis of some of their sediments, and exposure to their forms and stages of development.

- a study: (Abdullah ,2005) geomorphology of nabak in Bahariya oasis depression. this study addressed the phenomenon of nabak through the distribution of its areas, its morphometric dimensions, an analysis of its sediments, and an attempt to identify its stages.

- A study: (Baghdadi ,2005) landforms resulting from wind action in Bahariya depression - a geomorphological study. This master's thesis addressed the natural characteristics of the depression and wind-induced geomorphological processes, then examined the landforms affected by wind erosion and those resulting from wind deposition, and concluded with a study of human interaction with these wind-induced landforms.

- A study: (Baghdadi, 2007) Bahariya oasis region and the proposed nature reserve. this research addressed the natural and human characteristics of Bahariya depression and studied the areas proposed to be declared nature reserves and the means and methods of managing them.

(Mahsoub &Hhamad , 2010) western desert oases in Egypt: studies in environment and development. this is one of the most important studies on the oases of the western desert in terms of their natural and human characteristics and the environmental problems they face, including Bahariya oasis depression.

- (Anbar ,2015) climate and environmental hazards in Bahariya oasis depression: a study using remote sensing techniques and geographic information system applications. thesis submitted to the department of geography, faculty of arts, Cairo university. Addressed the natural environmental characteristics of Bahariya depression in terms of its geological, topographical, hydrological, and biological characteristics, studied the factors affecting the climate in the region, analyzed the climatic elements in the depression, and studied the environmental and climatic hazards in the depression, including landslides.

- a study by (Abdullah ,2019) geomorphological hazards in Bahariya oasis depression. PhD thesis submitted to the department of geography, faculty of arts, Mansoura University, dealing with applied geomorphology using remote sensing and geographic information systems. The researcher addressed the natural characteristics of the depression and then the hazards resulting from the movement of materials on the slope and the most important solutions to address them. The study also examined the geomorphological hazards associated with salt marshes and the most important solutions to them, as well as the hazards resulting from the movement of sand formations and their impact on urban areas, agricultural land, roads, and water wells. In addition, the study examined the hydrological characteristics of the depression and the hazards associated with groundwater and ways to address them.

❖ **Maps and satellite imagery**: Maps: the study relied on a set of maps, including geological, topographical, and geomorphological maps, as follows:

- Geological maps: 1:500,000 scale maps covering the study area (two plates: al-Bahariya and al-Farafra), produced by the Egyptian general petroleum corporation, conoco, 1986 edition.
- Geomorphological maps:
- Maps on a scale of 1:500,000, covering the study area (two plates: al-Bahariya and al-Farafra), produced by the groundwater research institute - water research center, ministry of public works and water resources & academy of scientific research and technology, first edition 1998.

- Topographic maps: maps with a scale of 50,000:1, numbering eight plates: Al-Qara Al-Hamra, Jabal Gharabi, Al-Bawiti, Jabal Al-Tibaniya, South Jabal Gharabi, Qal'at Siwa, Al-Hiz, And Ain Khoman, produced by the military survey department, 2004 edition.
- Field study: field study was divided into several stages as follows:
- This was the exploratory visit stage, which aimed to form a general idea of the natural phenomena and general features of the region, as well as to identify the possibility of transportation and the road network for accessibility, in order to determine the feasibility of conducting a detailed field study of the region. This stage took two days, from february 12 to 14, 2023.
- This was the actual field study phase, during which most of the fieldwork was completed. This phase took place after most of the scientific material related to the study area had been collected, and it was carried out in three stages. The first stage lasted six days, from april 10 to 16, 2023, while the second stage lasted three days, from march 4 to 7, 2024. The third stage also lasted three days, from july 22 to 25, 2024, in addition to recording field observations and findings.
- During this stage, the researcher used topographic and geological maps, a compass, and a gps device to determine locations in relation to latitude and longitude and elevation relative to sea level. She also used a 50-meter linen measuring tape and a camera, taking many photographs and recording the most important ones in the research text.

Secondly: Geology of Bahariya oasis depression

Study of the geology of Bahariya depression is important, as it is a major factor influencing the geomorphology of the surface.

An integrated surface mapping and subsurface study of Bahariya depression aided the regional subsurface interpretation. It indicated that four major ene-oriented structural belts overlie deep-seated faults in this part of the ‘tectonically stable’ area of Egypt. The rocks of Bahariya area were deformed in the late Cretaceous, post-middle Eocene, and middle Miocene- and subsurface data indicated an early Mesozoic phase of normal faulting.

The late Cretaceous and post-middle Eocene deformations reactivated the early normal faults by oblique slip and formed a large swell in Bahariya region. The crest was continuously eroded whereas its peripheries were onlapped by Maastrichtian and tertiary sediments. The tectonic evolution of Bahariya region shows great similarity to the deformation of the 'tectonically unstable' area of the northern western desert where several hydrocarbon fields have been discovered. This similarity may indicate that the same phases of deformation could extend to other basins lying in the 'tectonically stable' area, such as the Asyut, Dakhla, Nuqura, and El misaha basins. (Adel r. Mustafa, et al., 2003, p.91). The geology of the study area will be examined through the following topics:

1) Geological formation.
2) Geological structure.

1) Geological formations: it is clear from the geological map (fig.3):

Bahariya oasis is located in the western desert of Egypt at about 160 km west of the Minya city in the Nile valley. It has elongated shape, was affected by tectonic activity along the syrian arc fold system, and shows two opposite plunging anticlines: Ghorabi in the north and El-Heiz in the south, and El-Hufhuf syncline in between, trending NE-SW (Sehim, 1993). The geology of the oasis has been dealt by many authors: (Ball and Beadnell, 1903; Said, 1962; el-Akkad And Issawi, 1963; Tanner And Khalifa, 2010).

It's exposed thick succession ranging from upper Cretaceous to Miocene in age. The upper cretaceous is represented by Bahariya formation, El-Heiz formation, El-Hufhuf formation and khoman chalk formation. The Eocene is mainly carbonate rocks with iron ores represented by Naqb El-Sillim, Qazzun and El-Hamra formations.

The Oligocene is unconformably overlie cretaceous – Eocene succession, formed of clastic facies and lava flows of Oligocene-miocene age. Bahariya depression comprises change in lithology can be traced as we move towards south western direction.

Bahariya formation outcrop the lower Cenomanian, characterized by cross-bedded and color-banding at the base of the formation, and composed of ferruginous sandstones, siltstones, and shales with maximum thickness up to 170 m at Gabal El-Dist (fig. 4a). It is weathered into conical-like hills and capped by Basalt sills.

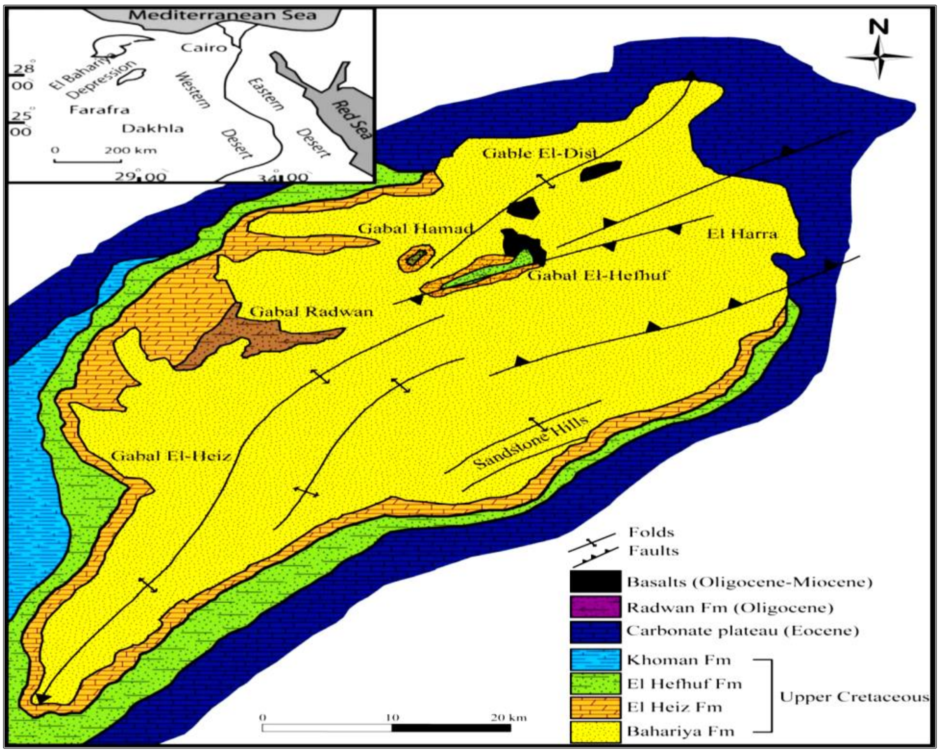
El-Heiz formation consists of shale, sandy clays, calcareous sandstone, up to 40m in thickness at the south of the depression, outcrop the upper Cenomanian, (El-Akkad And Issawi, 1963).

El-Hefhuf formation (campanian) consists of cherty dolostone with chert nodules at the base, which overlie El-Heiz formation.

Eocene Naqb El-Sillim formation is dolomitic and nummulitic limestones, unconformably overlies Bahariya formation and overlain by Qazzun and El-Hamra formations. El-hamra formation is represented by mixed carbonate-clastic lithologies (fig. 4f).

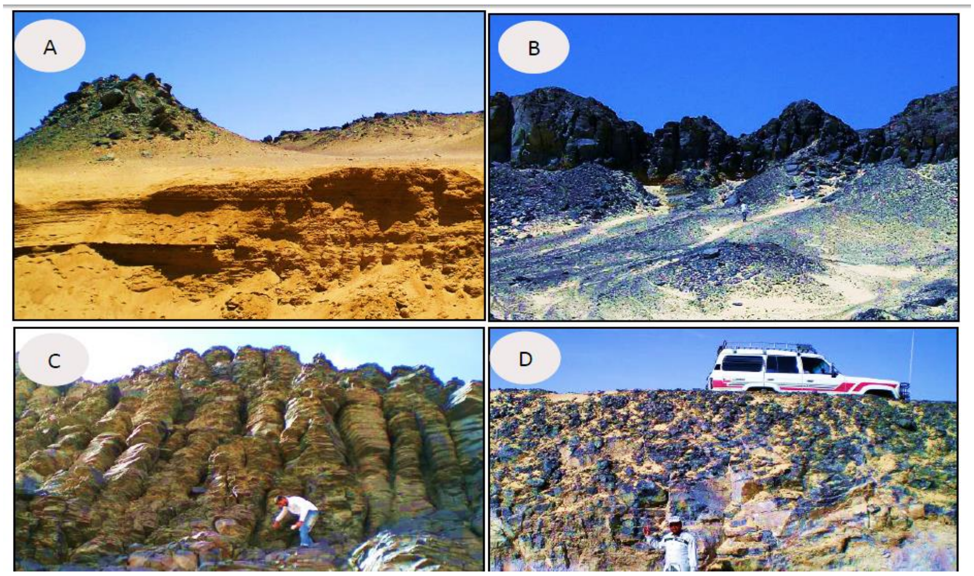
Oligocene is represented by radwan formation occurring as small outcrops, composed mainly of quartz arenite and quartizitic sandstone.

Oligocene-Miocene volcanic rocks occur mainly as sills, dikes and lava flows, are just restricted in the northern part of Bahariya depression, and have dated between 22 and 16 ma (Meneisy And El-Kaleubi, 1975). Volcanic activity is contemporaneous with the red sea rifting and the uplifting of the Afro-Arabian dome (Abdel Meguid et al., 1992). The volcanic rocks are represented by five main separate localities of Gabal Mandisha, Gabal El-Hefhuf, Gabal Mayesra, Al-Agoz Hill, Gabal El-Marssos. Bahariya volcanic rocks are alkaline magma type, classified into three types amygdaloidal Basalt (oldest) intruded by dolerite and followed porphyry olivine Basalt covering the amygdaloidal Basalt in Gebel El-Hefhuf. Gabal mayesra and Mandisha characterized by absence of porphyritic Basalt and deeply weathered. They are dark grey to black color, structurally controlled and characterized by sheets and columnar joints sometimes, these joints form hexagonal and regular shapes (fig. 4b, c & d). Petrographically, Basalts are composed of plagioclase, pyroxene, olivine and opaques as accessory minerals (fig. 4e). Chlorite and epidote occur as secondary minerals due to alteration. They show textures as porphyritic, amygdaloidal, ophitic and subophitic.



Source: (based on El-Akkad and Issawi, 1963). (after: El-Desoky *et al.*,2021).

Fig. 3 : Geologic map of the Bahariya Depression, Western Desert, Egypt



source: after : el-desoky *et al.,* (2021)

Fig.4: Photographs showing **(a)** Nonconformity contact between basalt and sandstone (Cenomanian) of Bahariya Fm at Gabal Mandisha. **(b)** Basaltic flows are overlying Bahariya Fm at Gabal Al-Agoz. **(c)** Close-up view of columnar basalts in the Gabal Mandisha **(d)** Basalt flow with vertical and horizontal joints from Nagb Siwa (Quzzeih)

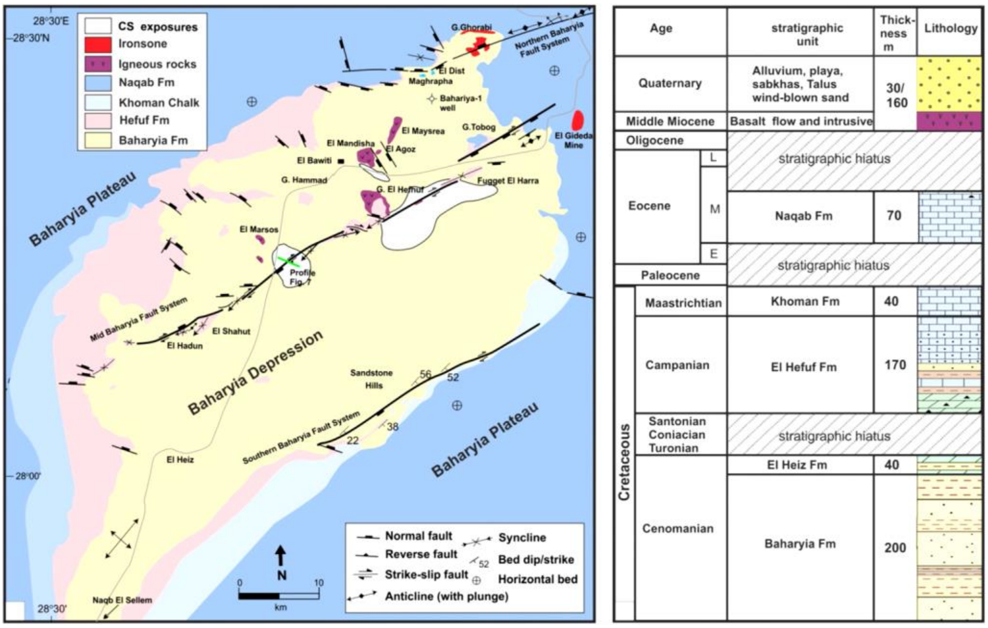
2: Geological structure:

Bahariya depression has been affected by many structural phenomena, a total of 93 mapped faults belong to two sets (fig. 5).

The main set is oriented east-west to east-northeast (N70°–90°W And N50°–80°E), and a subordinate set is oriented northwest (N40º–60°W) (figure 6a). The two have different senses of slip. The E-W to ene-oriented faults had two phases of movement (to be discussed below). They consist of right lateral strike-slip faults in addition to two reverse faults (figure 6e), whereas the Nw-oriented faults have normal slip. The measured data from 14 fault surfaces indicated a steep angle of fault dip that usually exceeded 60º (figures 6b,e).

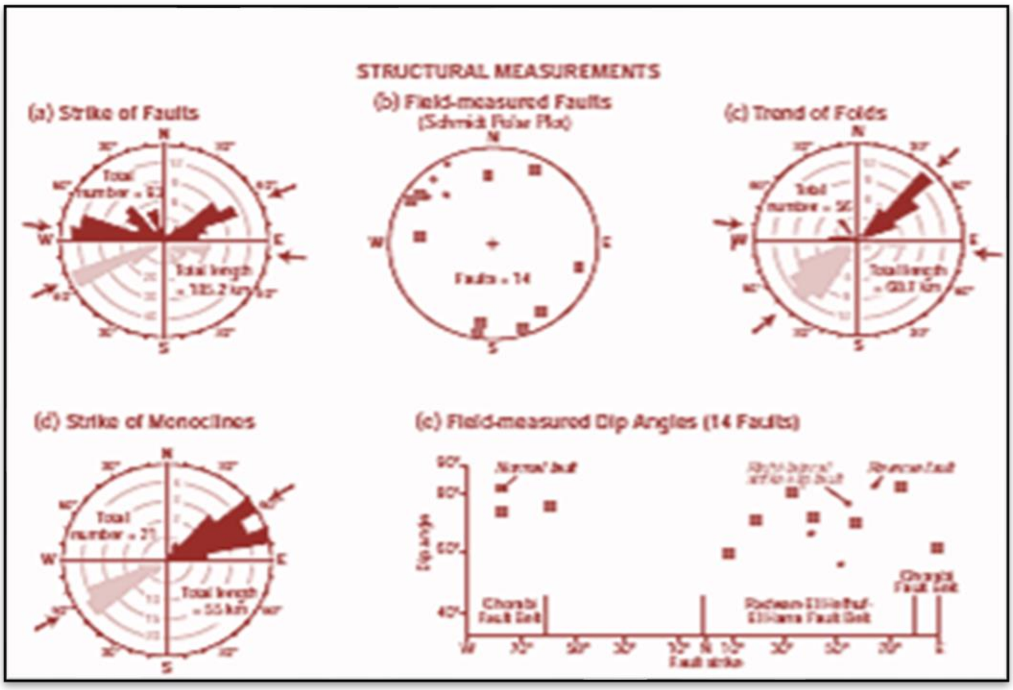
A total of 56 folds mapped in Bahariya depression have a predominantly northeasterly (N30°–70°E) orientation and a n40-50°e preferred orientation (figure 6c). The largest are at Gebel El Hefhuf and in the area between El Heiz And Ain Khoman (fig. 6). The mapped folds generally have a right-steppeden echelon arrangement that indicates deformation by a dextral shear couple (wilcox et al., 1973).

A total of 21 monoclinal segments was mapped in the study area and shows a predominantly East North easterly orientation (figure 6d). Two major monoclines occur—one in the southeastern part of Bahariya depression (sandstone hills monocline) and the other in the northeast of the Farafra depression (North Farafra monocline) . The steep flank of the sandstone hills monocline dips as much 56°se, whereas that of the north Farafra monocline dips at up to 16°nw and affects the exposed palEocene and Eocene rocks. The two monoclines overlie deep-seated faults.



Suorce: After(: Khalaf,2020)

Fig. 5 **a**/**b** The geological map and the stratigraphic section of the Bahariya depression (after Said 1962; El Aref et al. 2006)

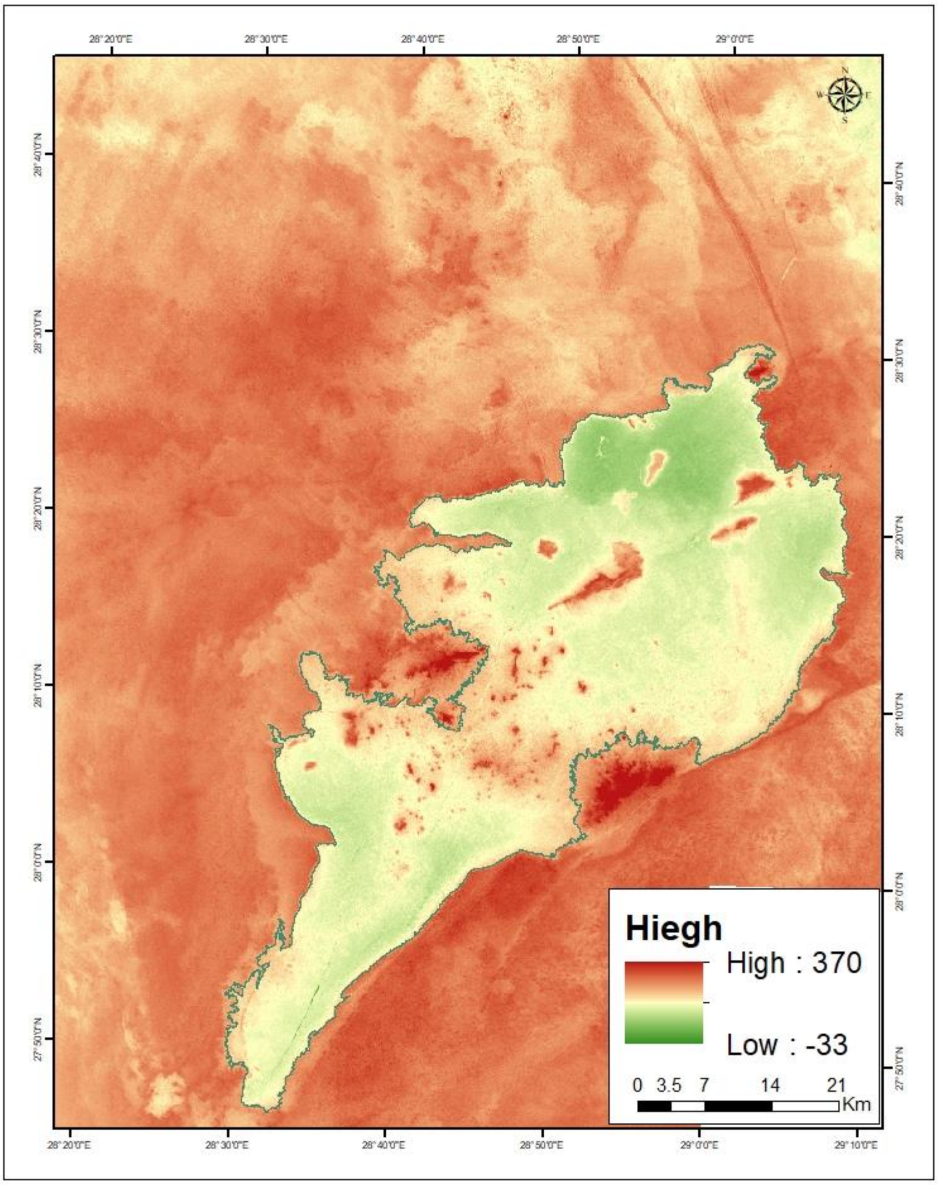


Source: Moustafa et al.,2003

Figure 6: Attitude statistics of surface structural elements in the Bahariya depression. (a) Strike summary plot showing fault frequency distribution (black) and cumulative length distribution (gray); (b) Schmidt plot of measured fault attitudes (lower-hemisphere equal-area projection);(c) Strike summary plot of fold axis frequency distribution (black) and cumulative length distribution (gray); (d) Strike summary plot of monocline axis frequency distribution (black) and cumulative length distribution (gray); (e) Dip-angle versus fault-orientation diagram illustrating the regional distribution of the faults depicted in (b) above

Third: Landforms in Bahariya Depression.

The land of the depression is characterized by its low elevation and proximity to groundwater in general for the depression and specifically for its northern part, where the population and urban concentration is located. This part has a lot of saline lands (Sabkhas), which are considered environmental problems for development of various types in the depression. Meanwhile, we find an elevated area, which is the peak of Mount Metila (Radwan), near the western edge of the depression.



Source: Researcher's work based on DEM downloaded from the US Geological Survey (USGS) usin Arc Map 10

Fig. (7) Digital Elevation Model of the Bahariya Oasis Depression

The depression is characterized by its flatness except for several isolated hills that are avoided by urban centers fig. (7). These hills are Al-Hafuf, mount Hamada, and Matila Radwan in the southwest, and mount Al-mu'aysira and Mandisha in the north, where the edges extend around the depression and affect the direction of wind movement. It is considered the least affected depression by sands, unlike (siwa - al-khargah - al-dakhla) which are more affected by sands, according to (Hasib, Hamad, 2010,1112).sand formations are also one of the significant hazards facing and threatening the depression, as they hinder development programs. The road from the entrance of the neighborhood - Al-Qabala, and the black mountain road, as well as the extension of the main road from the area south of the depression towards Farafra, and stable sectors appear in rocky areas where sand is scarce, as at the beginning of the Al-Bawiti - Airport well road and the sectors close to residential areas, the Al-Bawiti - Al-Qasr road (Baghdadi, 2005, Pp. 283-24), the following are the surface forms in the depression:

A- Edges of the depression.

The depression differs from other depressions in the western desert due to its surrounding high steep edges towards its bottom, which are cut by several dry wadi channels that descend into the depression floor. Its height ranges between 300 meters at the eastern edge and 175 meters at the western edge (Fathy 2000, p. 57). The eastern edge is characterized by morphological simplicity, being nearly regular in its curves, with its elevation near Ain Jaleed south of ain al-hara swamp. It is interrupted in some locations by small valleys, and at latitude 28°10', this edge becomes less distinct and lower compared to its extension north of the previous latitude. Small conical hills appear above it (Mahsoob, 1992, p. 148).

As for the western edge of the depression, it is characterized by significant fragmentation, with the northernmost tip having low edges and the least slope. The western edge curves in a large semicircular arc that ends about 25 km later with a recessed head. Here, the edge reaches its highest elevation of 175 meters above the bottom of the depression, then the edge turns to connect at its southernmost end with the eastern edge, completely closing off the depression (Hamdan, 1984, p. 397).

B - Isolated hills .

Several isolated hills are scattered throughout the depression, including Tal Al-Magharfa near the northwestern edge of the depression, which reaches a height of about 251 meters and is characterized by its flat summit. Directly next to it is Tal Al-Dust, with a height of about 251 meters, consisting of sandstone covered by Eocene limestone. To the south of them is Tal Mandisha, with a height of about 200 meters, which is a large, dark-colored mass due to Basalt flows. To the northeast is tal Ma'ira East of Al-Bawiti, with a height of about 204 meters and a flat surface. Among the larger hills is Tal Al-Hafouf, which is a narrow elevation of limestone covered by Basalt flows and some diorite rocks, with a height of about 290 meters.

C. Sandy deposits.

The depression is characterized as the lowest of the western desert depressions in terms of sandy deposit shapes, consisting of quartz and feldspar. This is due to its basin-like shape and its nearly complete encirclement by edges that acted as a protective shield against the encroachment of sand, in addition to the distance of the depression from the main paths of massive sand dunes such as Ghard Abu Mahreq to the east or the great sand sea to the west of it. These sandy covers have a high moisture content due to the proximity of the groundwater beneath them (Al-Dosouki, Al-Saadani, et al., 2018, P. 224).

As a result of wind deposition, the phenomenon of "nabak" occurs, which consists of accumulations of sand around grasses and desert plants. It forms when the wind carrying sand encounters vegetative obstacles. Nabak spreads in the depression on the edges of the salt flats and in low-lying areas close to wells and water springs. It appears in the form of small fields in al-hara, mandisha, and al-zabu in the northern part of the depression, and in riss, tabl amoun, and Al-Haiz in the southern part of the depression, where safari workers cut branches and twigs from sand-fixing shrubs for use in heating and cooking (Abdullah, 2005, p. 103).

D. Salt flats

Salt flats are considered one of the most important surface forms in the bottom of the depression, consisting of a group of small shallow basins such as the Al-Hara basin in the northeast of the depression, Mandisha basin, the Al-Bawiti basin, and the al-qasr basin in the north, the Riss basin in the southeast, and the Al-Haiz basin in the southwest. The bottoms of these basins are occupied by saline marshes, known as salt flats, characterized by the flatness of their surface. Most of them are found around ponds and marshes.

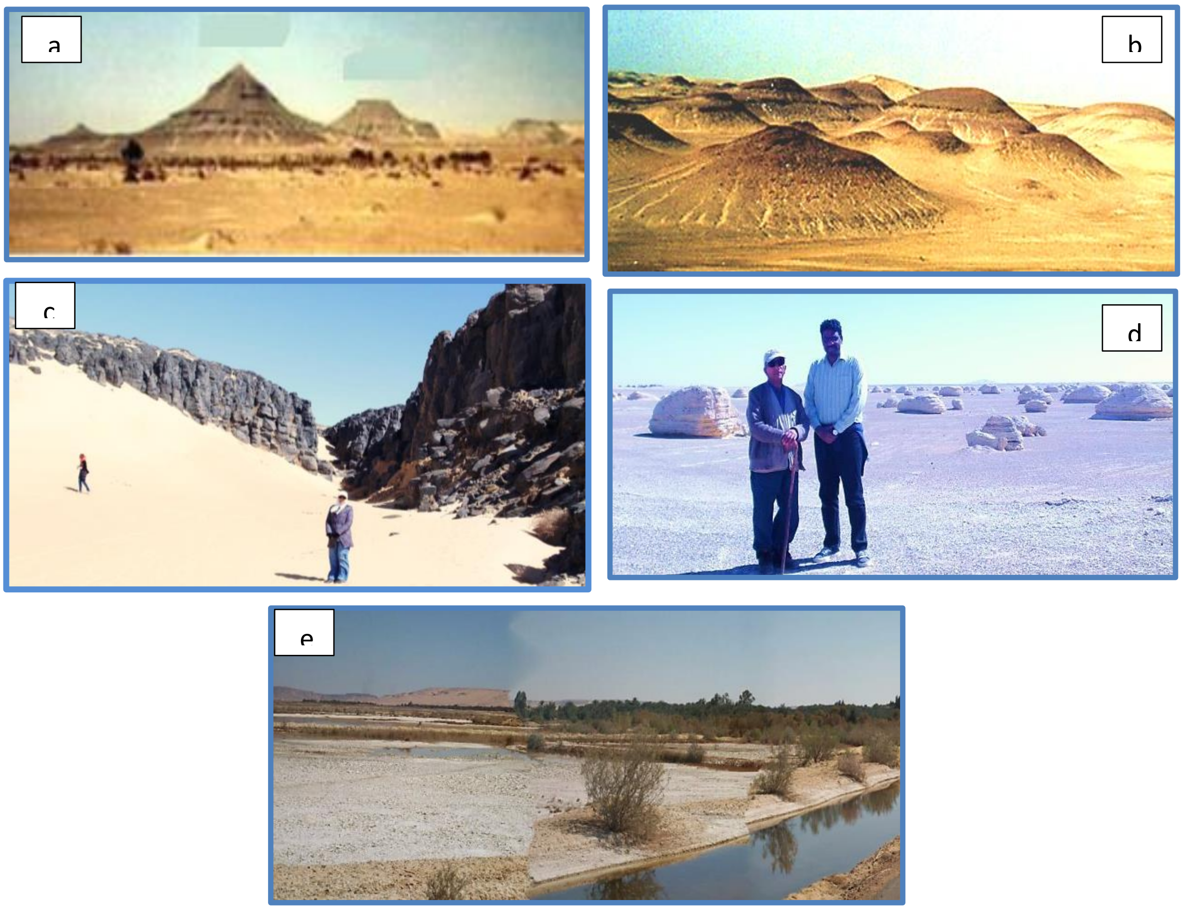


Fig. (9) (a) Dest& Maghrfa hill, (b)Dom Hills in Naqp are, (c) sand dunes in Bahryia depression, (d)Hommucks in Elheiz field (e) Abd-Elmagid sabkha during winter.

E- **Hummocks**

It is located to the east of Farafra - Bahariya road and south of ain tablamoun, where it approaches the eastern edge of the depression. The second field is the Hummocks field in the western area, located to the west of the Farafra - Bahariya road in a large depression that is separated from the previous depression by a group of isolated hills from the southeast. The third field is Hummocks field at the southern edge of the depression, located south of the depression to the east of the Farafra - Bahariya road. Humans have eliminated most of its Hummocks after leveling the land, and only a very limited number of Hummocks remain on the western margin of this field (kilo, 2000, p. 3, 9).

After the previous presentation of the surface forms in the depression, it becomes clear that the depression includes many shapes that give it unique features distinguishing it from other depressions, the areas of the Black Hills covered by Basaltic flows known as the black desert. There are also the hill of dust and the Mugharah in the depression, in addition to mount Mandisha.

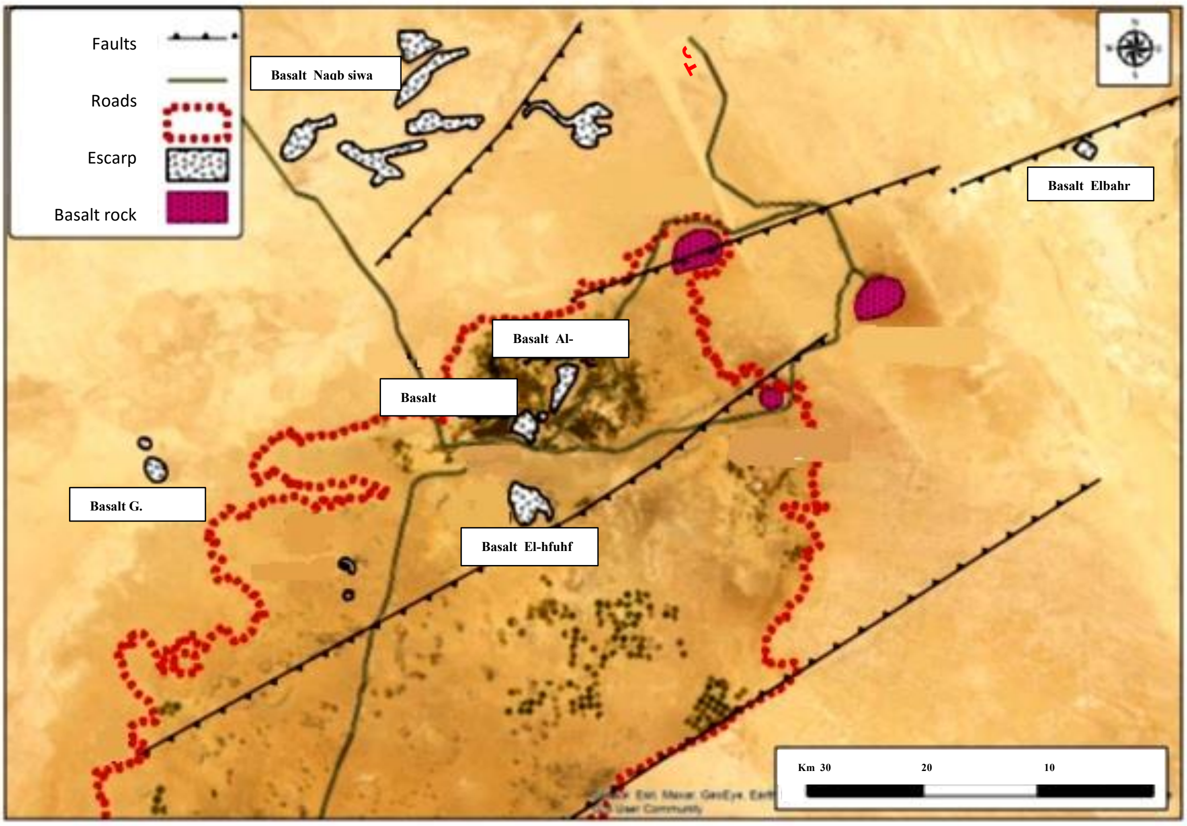
Fourth: Main locations of Basalt rocks and their associated landforms in e Bahariya oasis :

As shown in fig. (9), several small outcrops of Basalt occur in the northern and central parts of Bahariya depression. The Basalt in Gebel El Hefhuf is a large sill intruded at the contact between Bahariya and el heiz formations. Basaltic rocks in the other localities may be remnants of the same sill. A WNW-oriented dolerite dike and a small laccolith also occur in Gebel El Hefhuf. Basalt flows overlie Eocene rocks to the north and northwest of Bahariya depression (El-Etr and Moustafa, 1978) and to the east (Amer, 1973). Petrographically, the volcanic rocks are olivine Basalts (El-Akkad and Issawi, 1963). They were assigned an Oligocene age by Ball and Beadnell (1903) and El-Akkad and Issawi (1963) based on their stratigraphic position and their similarity to the Basalts of the Abu Roash, Gebel Qatrani, and El Bahnasa areas. However, potassium-argon dating by Meneisy and El kalioubi (1975) and Meneisy (1990) indicated an age of 15 to 20 ma (Middle Miocene) (Adel, et al., 2003).

1- Main Locations of Basalt Rocks Distributed as Follow:

A- El hefhuf occurrence

The Basaltic rocks of Gebel El-Hefhuf are located to the south of gebel mandisha, and occupy the northeastern part of Gebel El-Hefhuf the Basalt covers an area about 7.4 km³, and occurs in the forms of sills. Flows and dykes. Gebel Eel-Hhefhuf forms elongated and narrow double plunging syncline cored by lower senonian el-hefhuf formation and flanked by the Cenomanian Bahariya formation. This synform hosts many complex meso-folds of curved axial traces. The major syncline extends in an ene direction semi-parallel to the main dextral wrench fault crossing through the depression. The syncline is located to the north of this fault and faces the wrench fault by steep limb, while the northern limb is rather gentle. The folding was inatiated during the cretaceous tectonization while Basaltic activities are of Oligocene age.



Source: (Khalaf et al., 2019, p. 858)

Fig. (9) Distribution of volcanic rocks in the study area

B-Mandisha occurrence

Gebel madisha is located 5 km to the northeast of bawiti capital and about 3 km to the north of Gebel El-Hefhuf (encl. 1). It appears as ovaloid hill of about 3.1 km^2 in area. The Basaltic rocks occur in the forms of sill and dykes. Gebel Mandisha showing a large number of extensional faults which extend in two main direction; n30w and n60-65w. The two fault systems affecting both Bahariya formation and the overlying Basalt.

C-El-agoz hill

El-Agoz Hill is an isolated hill located to the east of Gebel Mandisha and occupy an area about 400 m^2. The previous workers (el-kaluobi 1974, and youssef 1982) considered this hill as a part of gebel mandisha. El-agoz hill is separated from Gebel Mandisha through a nw fault. The dip of the sediments underlying the Basalt and facing the fault reaches 15°. Away from such, fault, the sediments are horizontal. The Basaltic rocks form a hard flat cap overlying the friable clastics of Bahariya formation. No sediments are observed capping the hill, and in the same time they represent a sill-form (Ahmed Medany,1995).

D- Mayesra occurrence:

Mayesra dolerite sheet is located some 1.5 km northeast of mandisha occurrence. It caps a northeasterly elongated hill about 1 km^2 in area i.e., close to the area of mandisha flow. The dolerites overlain the sandstones and clays of Bahariya formation as in the case of mandisha dolerites. Jointing in mayesra dolerites is also pronounced.

E-Basalt hill occurrence:

It is the smallest hill among all the studied previous occurrences (200-300 m^2). The underlying beds at the Basalt hill are sandstones and clays of Bahariya formation. They assume green to faint red color being hard in nature and con-tein "limonite" patches and interstitial quartz fillings. (Amer, 1973) noticed the same feature but no emphasis was given to explain its origin. As will appear later in the next chapters, the connection between the development of limonitic patches, quartz fillings and the Basalts is evident (Sohair, 1982, p-28-29).

2- Associated landforms to Basalt rocks in Bahariya oasis:

Basalts landforms can be classified as follow:

A- <u>sills</u>

- **Sills in El-Hefhul**

Two sills are observed in the northern part of Gebel El-Hefhuf, the lower sill is highly altered whereas the upper sill is fresh the lower sill has a brownish earthy appearance and bounded by clastics of Bahariya formation. It ranges between 1 to 1.5 meter in thickness. The upper sill is exposed to the surface and cap Bahariya formation. It is highly altered in the lower part in contact with Bahariya formation, and remained fresh upwards.

- **<u>sill in Mandisha</u>**

The Basaltic sill of Gebel Mandisha is well observed from distance as a hard black cap overlying soft clastics of Bahariya formation .One tier and two tiers of vertical arrangement are observed. One -tier is observed in the northern and eastern parts of Gebel Mandisha, in which a well formed colonnade rests above the clastics of Bahariya formation and attained about 8 to 12 height). The colonnade tier has nearly four-sided bounding joints with weathered rounded bodies of about 80 cm to 120 cm in diameter. It is noted that, the colonnade tier.

B- <u>Doming in the upper sill</u>

The upper Basaltic sill in el-hefhuf area exhibits pronounced domes, which are highly observed through the rounded shapes of the false-bedded Basalt. The sedimentary beds of El-Heiz and Eel-Hhefhuf formations are locally preserved on the shells of some of these domes keeping the domal feature of the underlying Basalt .Complete domes on the top of the sill show positive land forms with sags in-between. The crest of such domes is flat, while the flanks dip in average of 25° to 40°. The domes are of circular and oval appearance with diameter distance of 100 to 200 meters and about 15 to 30 meters height

.

C- flows in el-hefhuf

Flows are detected for the first time in Gebel El-Hefhuf careful delineation of the flows are traced using the aerial photographs coupled with field analysis the area of the flow is restricted to the center of Gebel El Hefhuf displaying well pronounced layered appearance (Madny.,1995). from the field observations, two main pulses of flows are recognized the lower pulse starts with lower extensively altered amygdaloidal Basalt which is greenish brown in color and ended by Basaltic rock of black color about 1 to 3 meters thick. The upper pulse nearly resemble the lower one in which it starts with highly altered amygdaloidal Basalt about 5 meters or more, and capped by thin fresh Basalt of about 1.5 to 4 meters thick.

D- Dykes

- **Dykes in El-Hefhuf**

two dykes are traced for the first time in gebel el-hefhuf. These dykes are observed in the eastern part of Gebel El-Hefhuf cutting through the clastics of Bahariya formation. One dyke has nearly n-s direction and about 2 meters thick. It is highly altered into brown clay minerals. The second dyke is oriented in a n-s direction and is about 3 meters thick. The dyke is curviplaner in shape , and is not associated.

- **Dykes in Mandisha**

Dykes of Gebel Mandisha were found in central and western parts. Based on petrographic analysis, two main episodes of dyking are differentiated. **The first** episode is considered as the main feeders and these dykes almost have Nw-Se direction. The dykes of **the second** episode are parallel to the main feeders, thinner and of minor extension relative to the previous one. The main dyke, is about 31 meters in width and extends for about 800 meters in a n60° w direction. The lower part of this dyke cuts through Bahariya formation, and is highly altered relative to the upper levels of the Basalts. The sill close to the dyke exhibits dome like structure.

The second dyke reaching 1.5 meter in width and extends for about 60 meters in a n70° w direction. This dyke crosses the clastics of Bahariya formation. **The third dyke** has n750 w trend and has 10.5 meters width and of 100 meters extension. This dyke is characterized by the presence of "liesegang phenomenon", in which a concentric alternative bands of white and brown colors were observed. The width of the white bands ranges between 3 to 10 cm while the width of the brown bands ranges between 1.5 to 3 cm. This phenomenon is a quaternary feature in which the Basaltic rocks were subjected to surface fluvial weathering. Chemically, the white bands show high concentration of Al. and Ca and low concentration in Fe, while the brown zones have high concentration of Fe and low concentration of Al and ca. It can be concluded that, during the weathering process, iron was leached from certain zones and some reprecipitated in concentration within another zones under suitable condition. **Another dyke** of considerable thickness, 15 meter width, is traced in the central part of Gebel Mandisha. This dyke is regarded as one of the main feeders and it is clear that, the dyke is roofed by the main sill.

Fifth: petrography and mineral chemistry of Basalt rocks in the depression

Bahariya volcanoes encompass two main lava types:

Basalts and dolerites. The former characterize the lava flows of marssous hill (batch 1), whereas the latter form the main subvolcanic intrusive sills of El -Hefhufe, Mandisha, El Agouz, and Mayesra Hills (batch 2). The Basaltic samples are characterized by glomeroporphyritic assemblages of olivine (ol) and clinopyroxene (cpx) set in a fine-grained groundmass consisting primarily of plagioclase microlites and opaque phases, displaying intersertal, pilotaxitic, and fluidal texture (fig. 9a/b). Olivine crystals occur either as highly fractured subhedral bipyramid or microgranular grains with corroded and resorbed borders lacking reaction rim (fig. 10a) .clinopyroxene is colorless to pale brown under plane polarized light and forms subhedral crystals, with oscillatory zoning, or less commonly, sector zoning (fig. 10b).

The matrix is enriched in ilmenite/ titanomagnetite grains having microgranules and needle-like outlines .rocks constituting the dolerites are holocrystalline, coherent, and fine to medium-grained size with granular texture.they comprise olivine, clinopyroxene, and tabular plagioclaseassociated with opaque grains. Needles of apatite and fe–ti oxides are also present as microphenocrysts. Olivine phenocrysts commonly form either anhedral crystals with alteration along fractures and borders (fig. 10c) or euhedral bipyramid shape with sieve interiors (fig. 10d), especially in maysera sill. Clinopyroxene crystals appear as subhedral phenocrysts and form ophitically and subophitically intergrowth with plagioclase (fig. 10e). Sometimes, they include minute mafic minerals exhibiting poikilitic and sieve texture (fig. 10e). Clinopyroxene phenocrysts show lamellar twinning (fig. 10f) and encircle the olivine grains portraying El -Hefhufe sill (fig. 10g). The latter is characterized by chilled margin (200 μm) containing acicular grains of clinopyroxene(~ 1 mm) and plagioclase (fig. 10g) /h)>

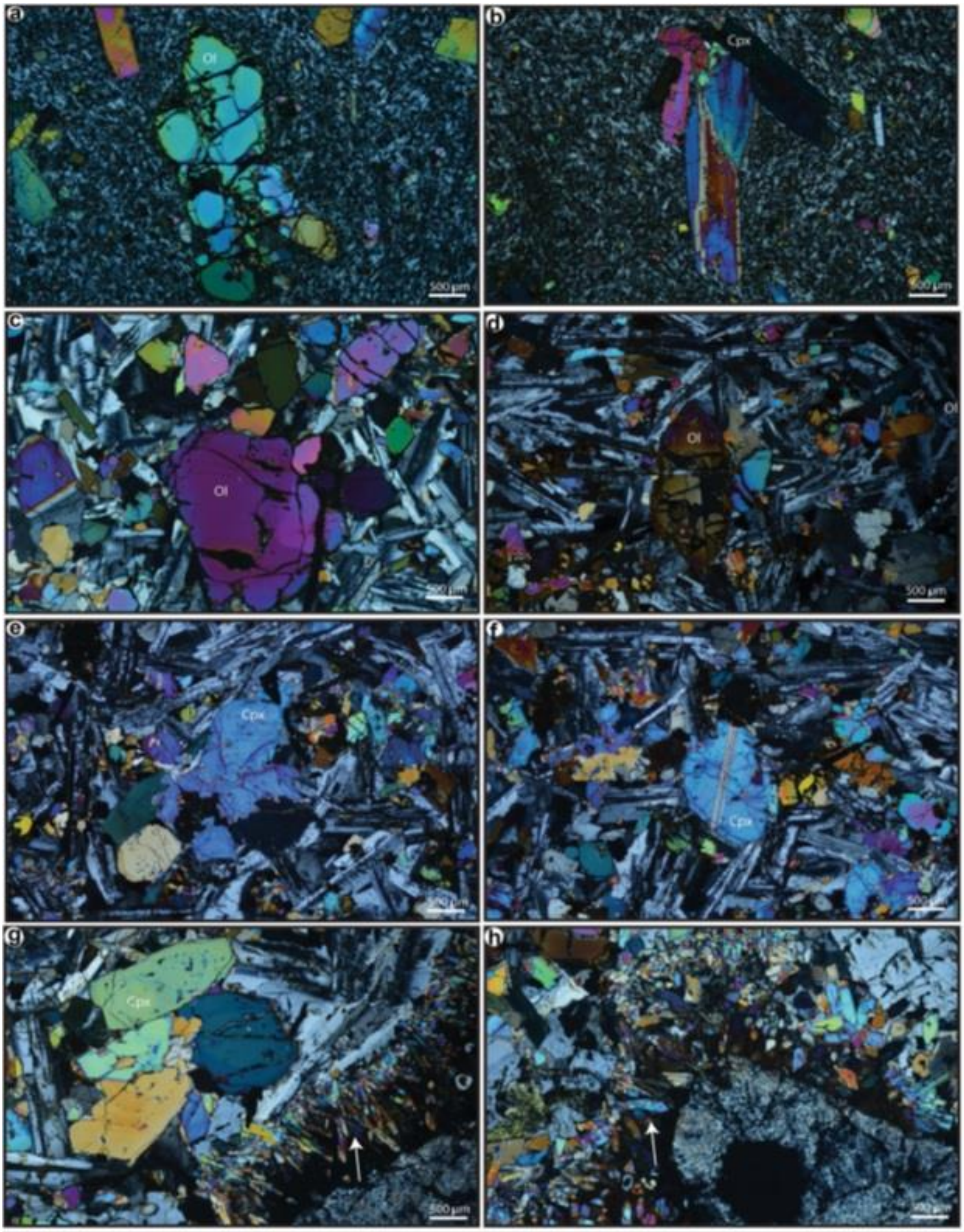
Table ( ) Chemical Analysis of Volcanic Rocks in Bahariya Oasis

Table 1 Major–trace elements of Neogene Bahariya volcanoes, Western Desert, Egypt

Element	Batch 1					Batch 2							
	MBB1	MBB2	MBB3	MBB4	MBB5	HB1	HB2	HB3	HB4	HB5	BM1	BM2	BM3
SiO_2	48.82	48.77	48.86	48.84	49.02	49.73	49.09	50.34	50.28	50.50	49.99	49.96	49.96
TiO_2	2.13	2.12	2.11	2.12	2.14	2.02	1.96	1.89	1.95	1.95	1.95	1.95	1.92
Al_2O_3	13.72	13.58	13.54	13.60	13.78	13.29	13.32	13.47	13.41	13.40	13.59	13.58	13.45
FeO	11.12	11.26	11.23	11.33	11.19	10.87	10.95	10.81	10.92	10.85	10.80	10.81	10.95
MnO	0.137	0.139	0.140	0.140	0.138	0.135	0.134	0.133	0.133	0.133	0.132	0.133	0.136
MgO	8.25	8.34	8.37	8.31	8.10	7.85	7.89	8.46	8.42	8.42	7.81	7.89	8.04
CaO	8.83	8.74	8.80	8.81	8.84	8.53	8.50	8.61	8.65	8.65	8.44	8.25	8.38
Na_2O	3.70	3.84	3.78	3.89	3.87	4.06	4.02	3.62	3.70	3.68	3.86	4.03	3.85
K_2O	1.54	1.57	1.54	1.60	1.58	1.38	1.35	1.36	1.32	1.35	1.45	1.56	1.48
P_2O_5	0.61	0.60	0.60	0.61	0.61	0.50	0.50	0.42	0.43	0.45	0.43	0.44	0.44
L.O.I.	1.65	1.50	1.58	1.31	1.34	2.03	2.48	1.58	1.23	1.23	1.86	1.91	1.80
Total	100.5	100.5	100.5	100.5	100.6	100.4	100.2	100.7	100.4	100.6	100.3	100.5	100.4

Element	Batch 2											
	BM4	BM5	MB1	MB2	MB3	MB4	MB5	AG1	AG2	AG3	AG4	AG5
SiO_2	50.17	50.16	49.80	49.89	49.78	49.87	49.98	50.26	50.27	50.09	50.25	50.21
TiO_2	1.90	1.91	1.89	1.85	1.92	1.92	1.86	1.94	1.97	1.92	1.93	1.95
Al_2O_3	13.57	13.59	13.68	13.60	13.13	13.38	13.29	13.41	13.57	13.41	13.42	13.20
FeO	10.88	10.87	10.79	10.92	10.88	10.97	10.86	10.94	10.91	11.06	10.95	11.02
MnO	0.133	0.134	0.132	0.135	0.133	0.132	0.131	0.137	0.135	0.137	0.136	0.137
MgO	8.00	7.96	7.71	7.85	7.92	7.74	7.81	8.19	8.04	8.29	8.24	8.35
CaO	8.23	8.32	8.26	8.46	8.79	8.54	8.74	8.64	8.69	8.61	8.68	8.85
Na_2O	3.93	3.89	4.02	3.94	3.81	3.87	3.83	3.51	3.50	3.50	3.51	3.40
K_2O	1.58	1.48	1.46	1.43	1.39	1.47	1.47	1.72	1.74	1.72	1.71	1.49
P_2O_5	0.43	0.43	0.47	0.46	0.45	0.46	0.46	0.44	0.45	0.45	0.45	0.43
L.O.I.	1.71	1.73	2.19	2.18	2.28	2.27	2.14	1.49	1.48	1.61	1.46	1.55
Total	100.5	100.5	100.4	100.7	100.5	100.6	100.6	100.7	100.8	100.8	100.7	100.6

Source: Khalaf.2020



Source: Khalaf.2020

Fig. (10) petrological an imaging microscope of volcanic rock samples in the depression

From above : the mineralogical and geochemical discrepancies between the two batches could have originated from various petrogenetic processes including one or more of the following: (1) two distinct initial melt compositions, before reaching crustal depths, giving an intricate polymagmatic character, (2) diverse depths of melting, (3) dissimilar fractionation histories, (4) magma mingling, and (5) different assimilation processes. Some of these mechanisms have affected the studied volcanoes in various proportions, as evidenced by disparity in major and trace element contents between batches 1 and 2. Hence, we propose that these chemical variations are linked to a mixture of superimposed processes involving mantle source, partial melting, and fractionation path.

Vi: Importance of Basalt rocks & production process

1- Importance of Basalt rocks

- Basalts are composed of plagioclase, pyroxene, and olivine minerals. Basalt used as natural volcanic pozzolans materials; represent large interest of researches as a real alternative to replace ordinary portland cement. The present work was performed on six samples of experimental cement clinker, one with ordinary raw materials (limestone & shale) as a reference sample, and five others with various substance (limestone & Basalts), which show the possibility of the utilization of natural pozzolan for maintainable construction material. The chemical, mineralogical composition and texture produced clinkers were determined by scanning electron microscopy, x-ray diffraction and differential thermal analysis. It is concluded that the produced clinkers which made from Basalt are coincidence ordinary portland cement clinker. They are characterized by increasing in setting time, compressive strength and resistance to sulfate attack (Francis & Luther King, et al.,2014, p.135).
- Basalt is well known as a rock found in virtually every country around the world. Its main use is as a crushed rock used in construction, industrial, and highway engineering. However, it is not commonly known that Basalt can be used in manufacturing and made into fine, superfine, and ultra-fine fibers. Comprised of single-ingredient raw material melt, Basalt fibers are superior to other fibers in terms of

thermal stability, heat and sound insulation properties, vibration resistance, and durability.

- Basalt continuous fibers offer a completely new range of composite materials and products. As it is well known, Basalt is the name given to a variety of volcanic rock, known principally for its resistance to high temperatures, strength, and durability, widely diffused all around the world, in which sio2 accounts for the main part, followed by $Al_2 O_3$, then Fe_2O_3, FeO, CaO, and only acidic type Basalts satisfy the conditions for fiber preparation. Actually, Basalt can also be formed into a continuous fiber having unique chemical and mechanical properties, so that it is ideally suited for demanding applications requiring resistance against high temperatures, insulation properties, acid and solvent resistance, durability, mechanical strength, low water absorption.
- Basalt products have no toxic reaction with air or water, are non-combustible and explosion-proof. When in contact with other chemicals, they produce no chemical reactions that may damage health or the environment.

2- **Properties:**

Basalt fibers are new unique and economic products with superior properties compared to similar ones currently in use, such as glass fibers. These fibers, as a basis for composites, open a new chapter in 21st century material science. In thermal conductivity, products made from Basalt fibers are three times as efficient as those made from asbestos and superior to glass and mineral fibers. The application temperature of products made from Basalt fibers is significantly higher (from -260°c to 900°c)

- **Physical properties**:

(strength, elasticity), Basalt fibers considerably exceed mineral and glass fibers. Due to the elasticity of their micro- and macrostructure, Basalt fibers are vibration-resistant compared to similar products. This property is particularly important in mechanical construction and civil engineering. For example, when buildings are erected near highways, railways, and underground, while vibration cushions made of mineral and glass fibers experience damage and ultimately disintegrate, Basalt slabs are vibration-resistant and, therefore, more durable.

- **Chemical properties**:

Basalt fibers are more resistant to aggressive media, such as acids and alkalis. Therefore, pipes made from Basalt fibers may be used in chemical production for transporting hot acids, in the construction of sewage systems, and for the transportation of aggressive liquids and gases, loose materials, etc .

- **Dielectric properties:**

Basalt plastics, in particular, the volume resistance of Basalt fibers are 1 to 2 orders of magnitude higher than those of fiberglass. Basalt fibers can be used in various branches of industry fully replacing cancerous asbestos and to a considerable degree glass fibers and metals. Why is it better to use a heater of Basalt superfine fibers compared to fiberglass insulation? The most effective way to reduce the loss of heat energy is good insulation. Regardless of the use of structural and technological solutions, you would like to use a light, durable, and harmless product. These are the characteristics for different types of thermal insulation chambers (ovens, sterilizers, etc.) Have fibrous insulation materials used in conjunction with reflective insulation (foil). The fibrous insulation materials that have gained widespread industrial use include fiberglass and, more recently, such "exotic material" as Basalt fiber, which, due to the introduction of modern technologies, has reduced production costs and improved quality, leading to increased usage in various industries. Basalt super fiber is produced from natural mountain magmatic rocks of gabbro-Basalt types: Basalt, diabase, gabbro, amphibolite, and esite by melting the material at a temperature of (+) 1400-1500°c and blowing it at a high temperature (+) 1600°c with a high gas flow (300-400 m/s) to create discrete basic staple fibers. Basalt fiber insulation is one of the super modern materials of the twenty-first century, combining ecological purity, natural durability, and fire safety (incombustibility). The temperature range of application for Basalt fibers ranges from (-) 260°c to (+) 900°c, while glass fibers range from (-) 60°c to (+) 450°c. The hygroscopicity of Basalt fibers is less than 1%, while that of glass fibers is up to 10-20%. Industrially produced glass fibers, especially in neutral compositions, can absorb significant amounts of moisture in humid air. This affects their physical and technical properties and durability, eventually leading to the destruction of the fibers.

3- **Production process :**

In many ways, Basalt fiber technology production is similar to glass fiber one, but it requires less energy. This aspect, together with an easy availability of raw material all over the world, justifies the lower cost of Basalt fibers compared to glass fibers.

Bahariya formation is extruded from Basalt rocks through a melting process without the application of additives. Quarried Basalt rock is first crushed, then washed and moved into melting baths in gas-heated furnaces. Under temperature of 1460-1500°c. Here, the process is simpler than glass fiber processing because the Basalt fiber has a less complex composition. Molten Basalt flows from furnace through a platinum-rhodium bushing with 200, 400, 800 or more holes and the fibers can be drawn from the melt under hydrostatic pressure. Then a sizing is applied to the surface of the fibers by a sizing applicator to impart strand integrity, lubricity and resin compatibility. Finally, a winder allows to realize some large spools of continuous Basalt filament. Basalt fiber: an ancient material for innovative and modern application, middle-east (Francis, 2014,pp. 308-312).

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مجلة كلية الآداب بالوادي الجديد- مجلة علمية محكمة- إبريل ٢٠٢٥

البازلت في منخفض الواحات البحرية بالصحراء الغربية
(دراسة في الجيومورفولوجيا التطبيقية)

ملخص:

تتواجد صخور البازلت في مواقع محدودة في مصر، من ضمنها البازلت في منخفض البحرية، ولم تحظى منطقة الدراسة بدراسة جيومورفولوجية لصخور البازلت على وجه الخصوص، ومن ثم كانت اهمية البحث في دراسة صخور البازلت في منخفض البحرية دراسة في الجيومورفولوجيا التطبيقية لما له من أهمية تطبيقية في مجال الصناعة ومجالات متعددة تواكبا مع اهتمام الدولة بعملية التنمية المستدامة. ويقع منخفض البحرية في الصحراء الغربية بمصر، على بُعد حوالي ١٦٠ كم غرب مدينة المنيا. على شكل مستطيل، وقد تأثر بالنشاط التكتوني، ويتميز بتعاقب صخور كثيف مكشوف، بتتابع جيولوجي يتألف من صخور الكريتاسي الأعلى حتى صخور الأوليجوسين ليغطى سطح الأرض نوعان رئيسيان من الصخور هما صخور الحجر الجيري وصخور الحجر الرملي إلى جانب الطفوح البازلتية. يتضمن قاع المنخفض انتشار العديد من الظاهرات الجيومورفولوجية مثل التلال المنعزلة التي تغطي- الطفوح البركانية ورواسب خام الحديد ، بالاضافة السبخات والبلايا والكدوات والعيون والآبار. تنتشر الصخور البركانية داخل منخفض الواحات البحرية في أربع مواقع رئيسة وهي (جبل منديشة، جبل الهفهوف، جبل معيسرة ، تل المرصوص) وتتواجد هذه الصخور بصفة عامة في المنطقة الشمالية من المنخفض وتتواجد على هيئة سدود رتدفقات بكرانية كما تتمثل في المظهر العمداني. وتنتشر المخاريط عديمة الجذور أعلى جبل منديشة ومعيسرة وتتميز بالشكل المخروطي وتتراوح أقطارها بين 50 - 12 متر وارتفاع الحواف بين 15 - 2 متر، وعادة ما تكون دائرية الشكل والقليل منها بيضاوي ، كما تتواجد كومات الحمم المتصلبة والمعروفة بأسم التملوس في جبل منديشة ومعيسرة مصاحبة للتدفقات البركانية باهوهو، وتظهر كدوات أو روابي الحمم اللافية باهوهو في جبل الهفهوف، ويهيمن المظهر العمداني على السدود البركانية أعلى التلال التي تغطيها الطفوح البركانية كما تنتشر القواطع البركانية أعلى جبل منديشة ومعيسرة وشرق التل المرصوص. وتوجد اختلافات معدنية وجيوكيميائية بين العينات التي تم تحليلها ناتجة عن عمليات صخرية مختلفة. ونقترح أن هذه الاختلافات الكيميائية مرتبطة بمزيج من العمليات المتراكبة التي تنطوي على مصدر الوشاح، والذوبان الجزئي، ومسار التجزئة.

وتوجد أهمية كبيرة لألياف البازلت: التي تُعرف بـــ "المادة الصناعية الخضراء للقرن الحادي والعشرين"، فهي تجمع بين السلامة البيئية وطول العمر الطبيعي والعديد من الخصائص الأخرى. وتُعدّ تطبيقاتها مبتكرة بلا شك في العديد من المجالات الصناعية والاقتصادية، من البناء والتشييد إلى كفاءة الطاقة، ومن صناعة السيارات إلى صناعة الطيران، بفضل أدائها الميكانيكي والكيميائي الممتاز. ولذلك، حظيت ألياف البازلت باهتمام متزايد كمواد تقوية، خاصةً مقارنةً بألياف الزجاج والكربون التقليدية. وتتجلى أهمية ألياف البازلت كمواد تقوية جديدة.

الكلمات المفتاحية: صخور البازلت – منخفض البحرية – أهمية البازلت – الجيومورفولوجيا التطبيقية.