DIAGNOSIS OF THE CURRENT STATE OF THE GRANITE COLUMNS REMNANTS AND SUGGESTING THE TREATMENT METHODS [IN THE AREA OF MERIT AMUN, AKHMIM, EGYPT]

BY

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ABSTRACT

[AR] **تشخيص الحالة الحالية لأعمدة الجر انيت المتبقية وطرق العلاج المقترحة في منطقة ميريت آمون ، أخميم ، مصر**

تم استخدام الجرانيت في المسلات والمباني والتماثيل في مصر القديمة ، وتمت دراسة أعمدة الجرانيت باستخدام [PLM] و [XRD] و [XRF] و [SEM]، وأظهرت نتائج الدراسة أن المياه الأرضية الممزوجة بمياه الصرف الصحي تسببت في تلف الجرانيت، و يعتمد الضرر أيضًا على قدرة المياه الأرضية على الارتفاع من خلال مسام وشقوق الجرانيت نتيجة عوامل التلف السابقة وعند الارتفاع يكون منسوب المياه الجوفية -0. 5 م والنشاط الإشعاعي في الهواء والماء والتربة والصخور وأشعة الشمس في الموقع الأثري له دور مهم في التلف ، بالإضافة إلى النشاط الإشعاعي الناتج عن الاستخدامات في الحياة مما يزيد من تأثير النشاط الإشعاعي المؤثر على تلف الحبيبات المعدنية للجرانيت في الموقع ، والتي تؤدي إلى تسريع عمليات التلف ، كما تمت دراسة المواد الموصى بها و التي يمكن استخدامها لتقوية ومعالجة الجرانيت.

[EN] Granite was used in obelisks, buildings, and statues in ancient Egypt. Granite columns were studied using [PLM], [XRD], [XRF] and [SEM]. The results of the study showed that the ground water mixed with sewage water caused granite damage, which also depends on the ability of ground water to rise through the pores and cracks of the granite as a result of previous damage factors and rise the ground water level is -0.5 m. The radioactivity in the air, water, soil, rocks and sunlight at the archaeological site has an important role in the damage, in addition to the radioactivity resulting from the uses in life, which increases the effect of the radioactivity affecting the mineral grains of the granite at the study site, which leads to acceleration of deterioration processes. Additionally, the recommended materials that can be used to consolidate and treat granite were studied.

KEYWORDS: Granite, Merit Amun, columns, Radioactive, electrical methods, decay, treatment

I. INTRODUCTION

Granite, gabbro, diorite, syenite, diorite, and basalt are primary igneous rocks resulting of cool magma, and are classified according to their percentage of silica content. Gabbro and basalt are the largest known basal rocks. The grains of the Aswan granite are described as very coarse to coarse-grained; and the minerals of granite are quartz, microcline[1],biotite and oligoclase, as well as small proportions of hornblende and minor minerals, mostly apatite, sphene, zircon, and iron oxides. Granite is located in the Shallal area to the southof Aswan, and there are other quarries along the eastern bank of the Nile, between Aswan and Sohail Island[2].

The level of silicon dioxide content in igneous acidic rocks is around65% to 75% in granite, in intermediate rocks it is in between 52% to 65%, whereas cyanite and diorite group, and base rock is 45% to 52%, as the gabbro group[3].

The content of uranium helps in studying the geochemical behavior, yet it is almost impossible to do this in some cases, especially if the rocks are affected by infiltration. In a later stage of hydrothermal activity, some of the uranium will be removed by humidity, whereas some amount is removed through weathering due to the heterogeneous distribution of uranium in acidic rocks such as granite[4].

Recently, attention has been paid to the level of radioactivity resulting from natural granite used in some structural elements, such as roofs and tiles[5]. Some rocks have a small percentage of radioactivity due to minerals that contain radioactive elements, such as uranium, thorium and potassium-40, and because granite contains some of these minerals, it gives a greater percentage of radioactivity compared to other rocks, as all granite minerals contain some of the radioactive minerals, for example, white or red feldspar contain potassium-40, biotite and black hornblende contain potassium-40, uranium and thorium with some small percentages such as zircon, and apatite on uranium and thorium[6]**[TABLE 1].**

Radio-element	The Concentration 2.	The Radiation -type 3.	The Radiation- level. (Bq/kg of the rock)
Uelement	[1-10 p.p.m]	[α, β&γ]	[12.5 – 125]
Thelement	[5-30 p.p.m]	[α, β& γ]	[20-120]
40K1element	[4 % as K_2O]	[β& γ]	[100]

[TABLE 1]: The ratios of concentrations of radioactive elements and the different types and levels of radiation[7].

[1]JOHN 2017: 110.

[2] ABD-ELKAREEM et Al. 2017:1-19.

[3] SHRIVASTAVA 2009: 68-84.

[4] ABED et Al. 2022: 473.

[5] KOBEISSI 2008: 1279-88.

[6] GAAFAR 2022: 120.

[7] LANGMUIR 1995: 2.

Radiation energy transport as, particles or waves, and include many kinds such as infrared (IR), visible light (VL), ultraviolet (UV), and microwaves (MW). Granite was a stone of great importance in the past in Egypt, as it was used to decorate stone buildings, it was known as an archaeological granite located in Aswan governorate, southern Egypt[8].

II. Radioactivity of Minerals

Many minerals can absorb radioactive isotopes from the surrounding environment[9], resulting in a high level of the radioactivity of those rocks, and the presence of clay minerals and rocky clay increase radioactivity as a result of absorbing those radioactive elements[10], and alpha decay can be represented schematically as follows[11].

$$_{Z}X^{A} \longrightarrow {}_{Z-2}X^{A-4} + {}_{2}He^{4}$$

X ⟶ Element

Z ⟶ Atomic number of the element according to Mendeleev's tab.

A ⟶ Atomic weight of the element

Alpha particles are emitted from the nuclei of radioactive elements at different velocities and energies, where the range of alpha particles in air vary from (3 to 10 cm). In quartz, for example, it does not exceed 38.3 microns. The number of radio nuclides reduced is according to the following equation:

$$N = N_0 \exp(-\lambda t) \qquad \textbf{(1)}$$

where N_0 is the initial numb. of the nuclei when t = 0, and N is the numb. of nuclei when t & (N/N_0) shown as a function of time, decay constant λ where the curve can be found according to tan $\alpha = \lambda$ k.

EQ. (1) can be used as a means of measuring the time that passes between the moment when the number of radioactive substances is N_0 and the moment when the number of radioactive substances is N, i.e. radioactivity provides a kind of time scale. According to EQ (1) and EQ (2),

$$1/\lambda = T/0.693 = 1.44T \quad (2)$$

The half-life of the natural radioactive elements of uranium is 4500 million years. As for radium, it is 1590 years, and protactinium is the time interval between states in which the number of radioactive nuclei is N_0 and N is:t = (1/ λ) In N_0/N = 1.44T In N0/N (3)where N represents the number of cores that are currently unchanged, and eq. (3) gives the age of certain types of different radioactive nuclei. From a practical point of view, a different radiating time range is required for each application. The naturally occurring uranium that is a mixture between the two and its half-lives is 4,500 million and 9,000 million years old, respectively.

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8 Gindyet et Al. 1998: 1–14; Abdelsalam 2002: 119–136.

9 Hamilton 1958: 697–698 .

10 Vakhnenko et Al. 2003 :247–254.

11 Awadh 2020; Otsuka et Al. 2022: 2234.

Nuclear lead is the end product of a depleted uranium nucleus, and the use of the ratio between uranium and lead derived from it in natural uranium makes it easy to determine the period during which lead accumulated[12]. Electrical resistance methods is the basic principle in the study of rocks by electrical methods by taking advantage of the relationship between their electromagnetic properties, mineral composition, moisture content, rock stress condition, and temperature. Electric and magnetic fields are also used to study the components of the earth, the history of its formation, in addition to studying the ways and stages of damage to archaeological stones[13].

The different variables of electrical resistance methods find various applications in geophysics, where the resistance of rocks is measured with special potentiometers, and the study of resistance is by passing electric current through two electrodes, where the potential difference $\Delta \cup$ can be measured at any point on the line connecting the electrodes, and where the current I in the circuit is known, so the resistance of the rock can be calculated according to:

$$\rho = K\frac{\Delta \cup}{I}$$

Where K is a coefficient that depends on the location of the electrodes on the rock, and by gradually increasing the spacing between the electrodes passes through deeper layers.

Laboratory methods can be used to study rocks by electrical means, where the moisture content in rocks can be determined, and this is done by measuring the electrical conductivity coefficient of rock samples, which is an essential indicator of electrodynamics[14].The largest general gaps in the electrical properties of minerals and rocks lie in areas of soils containing humid acids, variable minerals, and hydrated minerals, such as clays[15].

III. GRANITE DECAY COLUMN IN MERIT-AMUN REGION

Fragmentation observed in granite is the separation and cracking of layers or small portions of granite in the surface area resulting from the efflorescence of salts below the surface or as a result of melting or recrystallization. It is more fragmented than other stones or old stratified stones in its composition, and it is also considered one of the most important internal damages that occur as a result of the deposition of salts formed under or through the old surface layers as a result of the evaporation of moisture on the surface of the granite from which the columns were built. The source of the salts may be due to the dissolution of the salts or the use of chemical cleaners and processing materials, mortar, or air pollution in the area, where these salts lead to the dissolution of the granite components during exposure to rain or ground water absorption and rise of water in the granite components or through weak places, where the formation of salts and the crystallization process of salts lead to pressures under the surface of the granite, which

[12] RZHEVSKY et Al. 1971:397- 398.

[13] CASSIDY 2009: 444.

[14] RZHEVSKYet et Al. 1971: 213-217.

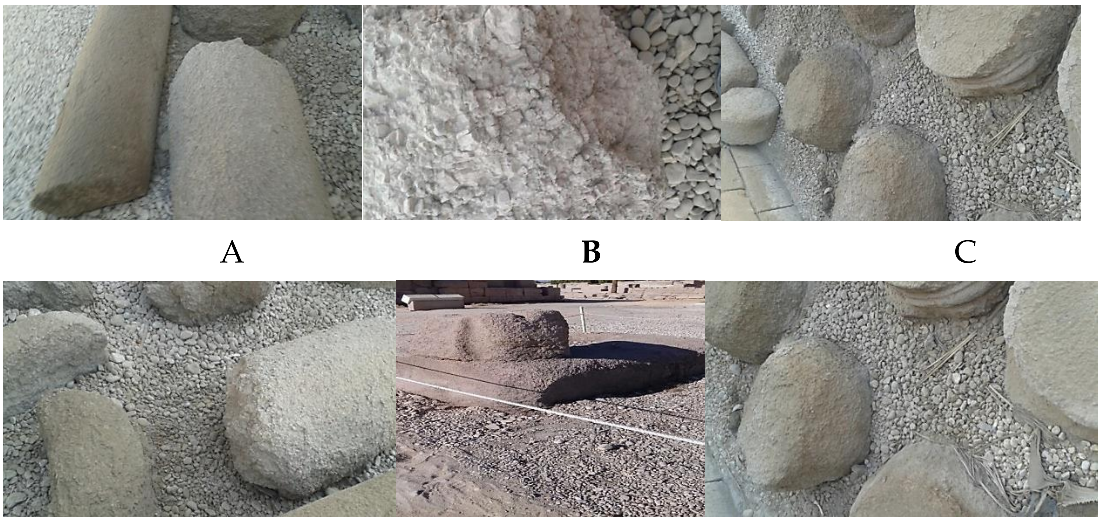
[15] OLHOEFT 1979 :286; SATHER 1990: 5; GLOVER 2015: 111.

subsequently leads to formation of small to large fractures[16]. Water is one of the most important elements that harm granite, as it affects its surface, especially those that include potassium feldspar. Granite when exposed to water turns into kaolinite (one of the clay minerals), this transformation leads to breaking the internal structure of the crystals releasing potassium and silica ion. When granite is exposed to water, this process takes a long time and eventually leads to granite damage, moreover heat accelerates this type of damage and granite is affected in the presence of environmental temperature and relative humidity quickly. Additionally the presence of iron elements can result in dirt which cause decay of granite and the presence of salts on the granite surface indicates the possibility of a decrease in salts under the granite surface.

The application of poultices is one of the best scientific methods for removing salts, which comes in addition to preventing or reducing the various sources of moisture to which granite is exposed[17]. The radiation resistance and electrodynamics of granite archaeological buildings and their contribution and role as causes of damage that affected the remaining columns of the foundations of the granite structures in the Merit Amun region **[FIGURE 1]** was studied. There granite was used in ancient Egypt to a large extent, especially in the modern state and its after math. The bases of the granite columns under study, had been exposed to sewage water, which affected the remains and bases of the granite columns, as a result of the lower level of the archaeological site's floor than the level of the surrounding land, especially the archaeological hill from the western side, and the presence of non-conforming sewage lines that increased the problem.

[FIGURE 1]: Merit Amun location (after) .©Google Earth. Accessed on 16/01/2021

[16] DELGADO 2016: 13; SANJURJO-SÁNCHEZ et Al. 2016: 20.
[17] BOSCH-ROIG et Al. 2019: 4227.



[FIGURE 2]:Damage of the granite surface: A). Remains of some granite columns, B). Exfoliation and inter granular disintegration of granite columns and their damage; C&D). Granular dissociation, E). weathering & kaolinization and F). exfoliation and scaling.

IV. MATERIALS AND METHODS

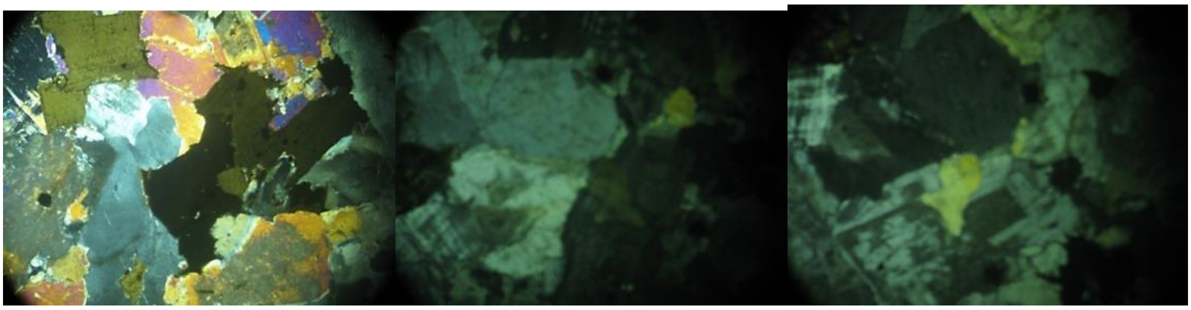
To determine the granite samples of non-destructive granite were taken from the falling decomposed granite under the columns of the granite bases which exposed to erosion and put them at plastic closed envelope and they were taken at morning of January month. These samples were studied petro graphically with polarizing microscope (PLM), and analyzed with XRF. With a survey of granite samples, mineral analyzes were performed using X-Ray Diffraction (XRD) at the Department of Physics, Assiut University, Egypt, and the diffraction data were analyzed. Scanning electron microscope (SEM) was used to study the decomposition, decay state of granite grains and the properties of granite exposed to deterioration.

V. RESULTS

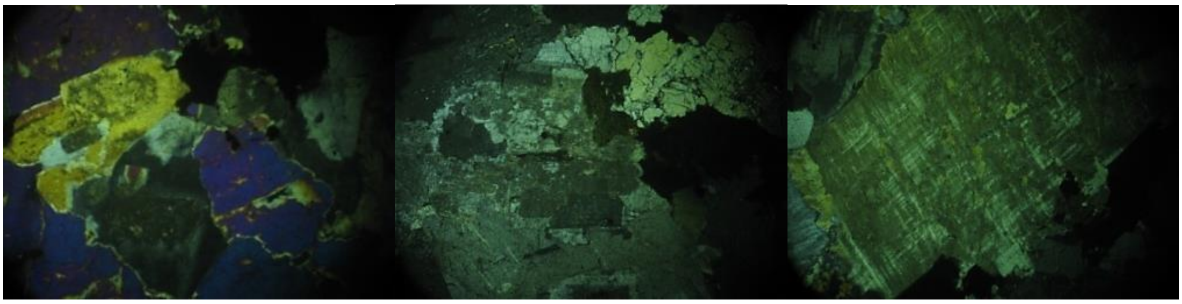
Petrographic study: Granite samples appear pink, coarse-grained and large, and a thin section of it showed that the minerals quartz and feldspar are the main component of granite such as (plagioclase, microcline, microcline pyrite), in addition to biotite and zircon sphene, as the representation of alkali feldspar by microcline pyrite. Pyrite orthoclase distinguishes microcline pyrite as a type of vein, and the incomplete fine line is characterized by a dense cross-twisting **[FIGURE 3A]**, quartz crystals appear in [**FIGURE 3B**], orthoclase appears as a semi-surface crystal, and quartz appears in the form of single, rough and irregular crystals. The plagioclase also appears in the form of an oblong crystal with a semi- linear. The rock study showed that plagioclase and feldspar are followed by biotite, and these minerals are the primary minerals that are subject to damage and change. In the appearance of some dust and the foggy appearance of feldspar minerals along the levels of cleavage and the crystalline boundaries of its minerals, where the products of hornblende damage appeared such as the formation of hematite and iron oxides and hydrated iron, and they showed a red to brown color on the surface of the granite stones exposed to damage, as the petrological study showed that the hematite mineral gave a cover of granite surface. Orthoclase is largely divided into many remaining dominants through a network of transverse cracks that are semi-parallel and accompanied by some irregular longitudinal cracks, and the change occurred in plagioclase as a result of the presence of some iron-rich compounds. The inner borders of the mineral grains were also irregular, in addition to the deterioration products. It is irregular in its distribution, because it penetrated the remaining depth along the different cracks of the plagioclase, and during the study of minerals the presence of broken pieces of feldspar grains, which have the same direction of cleavage were observed, and these fractures were formed by the next transition of cutting feldspar and as a result of this the long mineral fracture cut quartz grains and it caused damage to the feldspar, as the grains appeared slightly stained with iron oxides, and the color spots were from red to black in the form of a thin layer or the shape of a crust.

Some changes occurred in the plagioclase granules, and this is evident through the crack networks that are close together, in addition to the presence of some fractures in the pores resulting from the presence of clay minerals. The plagioclase also showed a somewhat dull gray color, and the plagioclase changed to kaolin. The granite contained both hornblende and biotite, and this led to an easy fracture with the occurrence of isolation of components that are less able to absorb water, and the fracture had a specific shape because the biotite crystals were replaced by kaolinite. This replacement resulted in a large increase in size, and this caused some continuous fractures in the shape.

Additionally, the network of fractures gave pores that contribute to the accumulation of some residues that result from the damage that occurred to crystallize from the solutions that were absorbed, where the damage resulted from weathering. Some biotite flakes in smectite mineral, and replacement processes took place along the circumference of the flakes, as it extended irregularly to a point in the direction of the depth of the mineral, and biotite is exposed to damage as one of the main sources of clay minerals that are present in the gaps and cracks between minerals, It was also observed that there were some gypsum stains as one of the products of damage as a result of the changes that occurred, and the transformation of biotite mineral to kaolin and iron oxides was one of the most important products of damage **[FIGURE 3C]**. This led to an increase in pressures due to the swelling of clay minerals **[FIGURE 3D]**, which contributed to the distortion of all the materials resulting from biotite. The layers of red color formed by iron oxyhydroxides are also connected regularly to the internal parts of the minerals and are in the lenticular or planar form, where they are distributed irregularly around the pores and inside all the external pores, which are filled with iron products, are dark brown, and the thick layers consisting of kaolin are evenly distributed between the layers that are rich in iron,or by coating the grains with a thin layer, and this discoloration is due to the decomposition of minerals that contain iron oxides. Some of these fractures through the products of damage are seen in [**FIGURE 3E & F**].



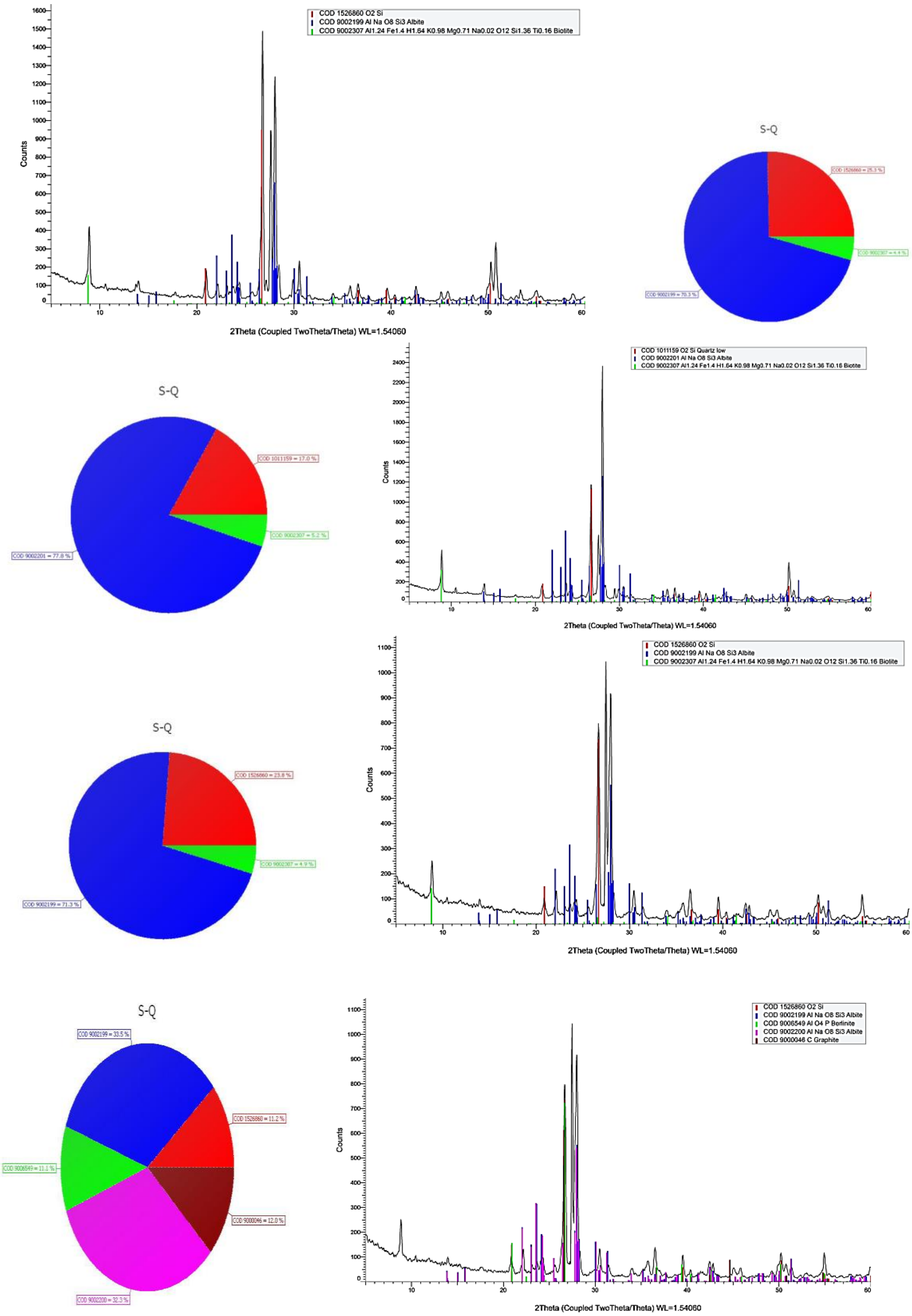
A B C



D E F

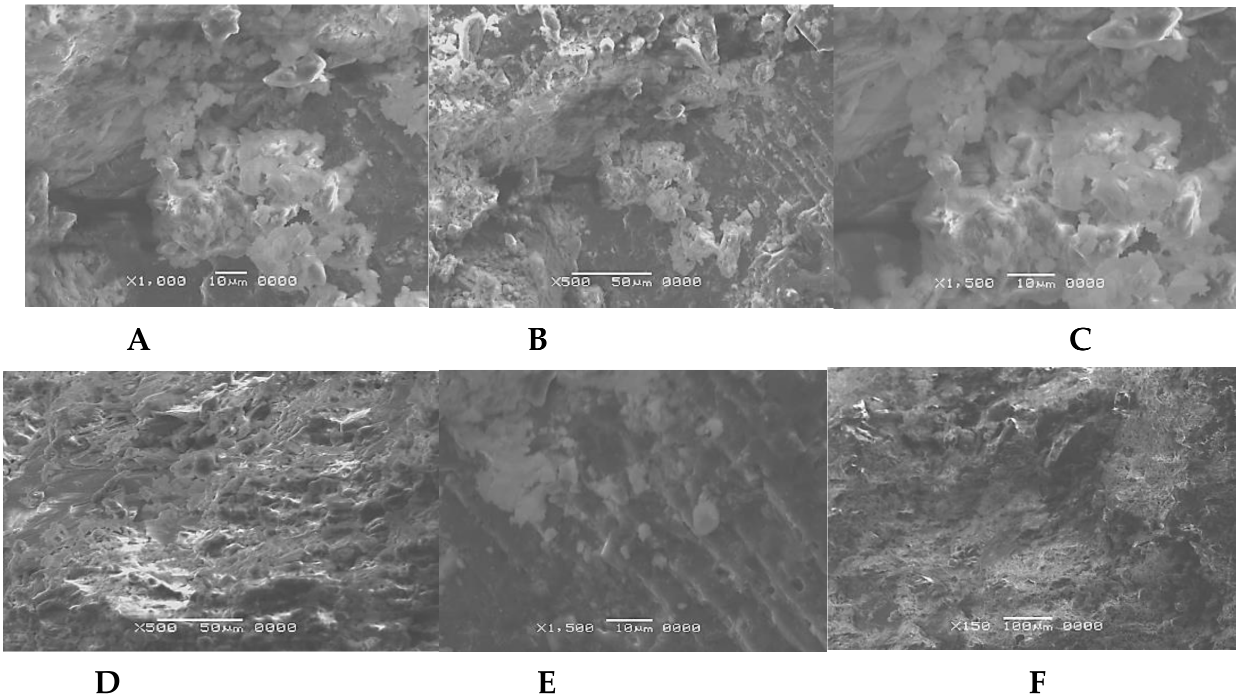
[FIGURE 3]: Petrographic study of granite sample by PLM, x. 40: A.)Granite samples appear pink, coarse-grained and large, quartz and feldspar are the main component of granite; B). quartz crystals appear;C). gypsum stains as one of the products of damage as a result of the changes that occurred, and the transformation of biotite mineral to kaolin;D). increase in pressures due to the swelling of clay minerals; E & F). Some of the fractures that are products of damage.

It is clear from the X-ray diffraction analyzes of the damaged granite samples that the main minerals include feldspar (microcline (52%), albite (17%), anorthite (1%), while quartz is up to (10%), mica (muscovite is about (5%), phlogobiteis about (4%) in addition to the presence of minor elements representing biotite (0.4%), and the d-spacing figure for (001) reflects the types of basic minerals that make up the granite samples, and it gives reliable information about the degree of crystallization of the granite samples, especially around default values along the c-axis, and these samples consist of quartz, pyrethite, microcline, plagioclase and micro-biotite **[FIGURE 4].**



[FIGURE 4]: X-ray diffraction analyzes of granite sample.

SEM: The remains of granite columns at the Merit Amun site in Akhmim were severely affected because of their exposure to various weathering factors, including the rise in ground water levels, which resulted in a high proportion of relative humidity, which led to the occurrence of many aspects of damage, and some changes resulted as a result of granite damage operations. This is through the appearance of some forms of damage and some crusts and fine cracks in the mineral grains that make up the granite **[FIGURE 5].**

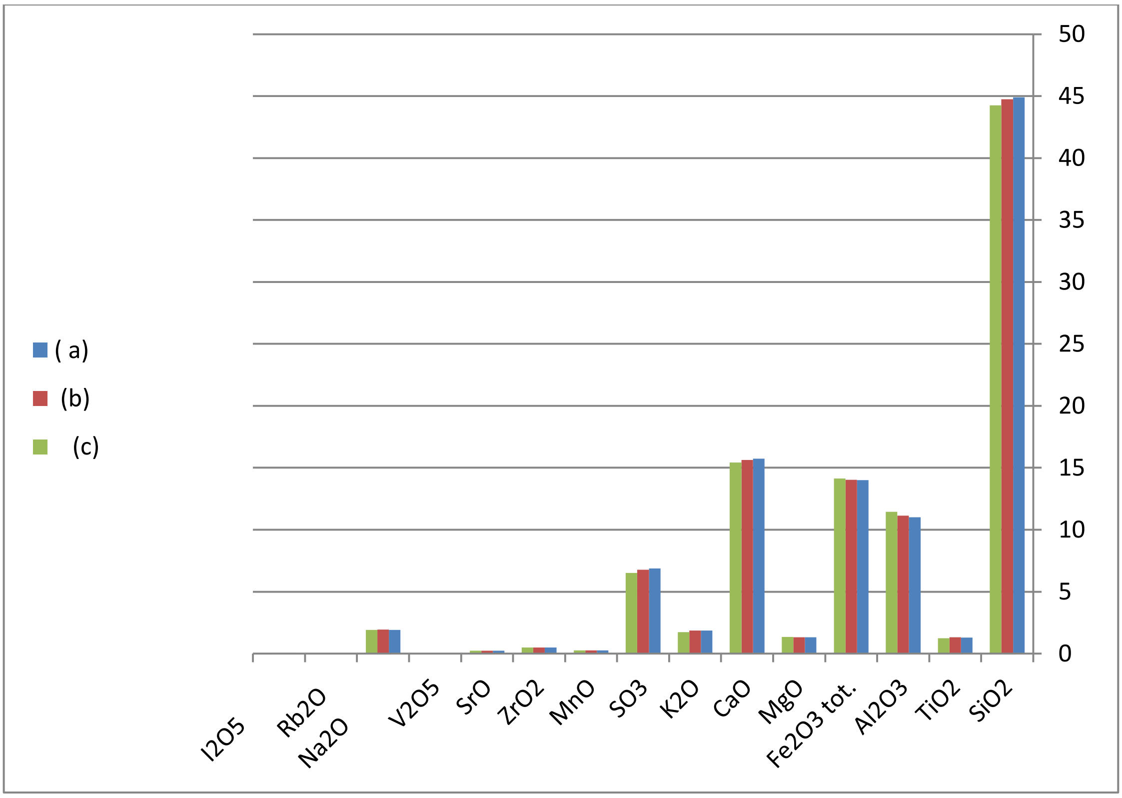


[FIGURE 5]: A, B, C, D, & F) SEM photomicrographs showing the crystals of granite and their damage features.

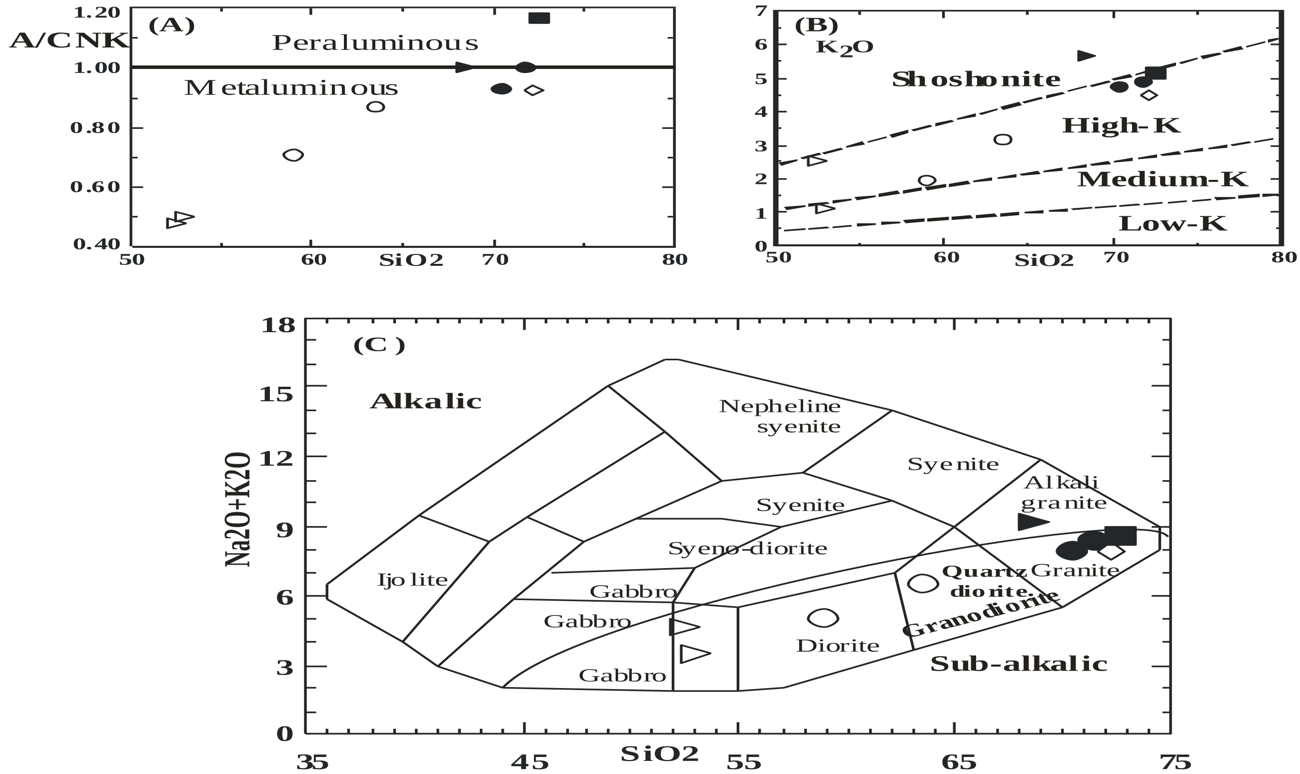
The study of the granite rocks in the study area showed that samples were collected from the Merit Amun area, and they are similar to the granite in Aswan **[TABLE 2 &FIGURE 6]**, where it was found that the granite samples that were analyzed are close to the granite in Aswan, and the samples that were analyzed contain a high percentage of potassium and are similar to the huge Aswan granite **[FIGURE 7]**.

Main Constituents Wt%	(A)	(B)	(C)
SiO_2	44.8868	44.7421	44.2506
TiO_2	1.2861	1.3245	1.2463
Al_2O_3	11.0043	11.1328	11.4561
Fe_2O_3 tot.	14.0084	14.0216	14.1257
MgO	1.3076	1.3261	1.3571
CaO	15.7468	15.6253	15.4362
K_2O	1.8629	1.8724	1.7359
SO_3	6.8778	6.7782	6.5232
MnO	0.2657	0.2564	0.2620
ZrO_2	0.4919	0.4923	0.4935
SrO	0.2480	0.2473	0.2461
V_2O_5	0.0216	0.0225	0.0218
Na_2O	1.9033	1.9447	1.9128
Rb_2O	0.0303	0.0335	0.0404
I_2O_5	0.0475	0.0432	0.0461

[TABLE 2]: XRF analysis of the three granite samples.



[FIGURE 6]: Main Constituents Wt%.



[FIGURE7]: A). A/CNK vs. SiO_2/B. K_2O vs. SiO_2 (Pecerillo and Taylor, 1976) & C). TAS Chart for Aswan Granites and Granite Pillar Remains in the Merit Amun Region[18].

The degree of difference in the electromagnetic radiation (EMR) generation processes of wet and dry rocks can be attributed to the difference in the time of electrical relaxation which is proportional to the electrical resistance[19], as the granite is characterized by the presence of low tensile strength between its grains, in addition to its large mineral particles, which produces electromagnetic radiation mainly as a result of tensile fracture. EMR Rocks contain two distinct forms of waves: continuous waves that have a small amplitude of low frequency and pulse waves that have a large amplitude of variable frequency. Significant effects on the electromagnetic radiation result in cracking mineral grains of granite[20], especially when granite rocks are exposed to infrared temperature, which is randomly distributed and is under the influence of external infrared convection, where energy accumulation occurs inside the granite, which eventually leads to its brittle collapse[21].

EMR can use this technique as a suitable method for monitoring the deformation that occurs in granite as a result of its damage. This requires conducting many experimental studies, in addition to developing knowledge bases through the use of some mathematical and simulation-based techniques.

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[18] WILSON 1989: 514; EL-BIALY et Al. 2015: 1-29.

[19] YOSHIDA et Al. 2004: 1-11.

[20] LIN et Al. 2021: 798-810.

[21] PENG et Al. 2021: 713.

In terms of studying some prototypes or applications that could be suitable for the simulation process, which leads to further progress in studies of controlling the deformation caused by damage through the use of electromagnetic emissions that result from deformations in granite, which can be considered a preliminary indication of what is happening in the deformation[22].

VI. DISCUSSION & SUGGESTED TREATMENT

The samples that were studied, examined and analyzed to assess the state of the bases of the granite columns in the archaeological area of Merit Amun, Akhmim, were found to be similar in their mineral components with the components of the granite minerals found in Aswan, and the geochemical tests of the granite samples of Merit Amun indicated that the granite formations agree with the rocky description of the Aswan granite, in A/CNK and K_2O versus SiO_2 clusters. The granite column base remnants of the structures found in the Akhmim archaeological area of Merit Amun contain aluminum (A/CNK <1) and as a high-type K very similar to the Aswan mega granite. Different techniques have been used to examine and analyze granite damage, such as polarizing microscopy, SEM, XRD, and X-ray fluorescence. Environmental factors affecting the granite stones in the region were also studied. They showed the disintegration of some of the grains and their splitting into plates and crusts that led to the damage of the granite. It also showed the loss of parts of the granite surface and its separation in the form of plates parallel to the outer surfaces, and hornblende and biotite minerals turned into iron oxides, in addition to the presence of some fine cracks within the different minerals, where the granite subject to damage, which resulted in the occurrence of some cracks related to fine networks, which led to an increase in the rates of damage in the granite, and the results of XRD indicated that there are various environmental damages, and this was confirmed by the study with scanning electron microscope of the granite samples that had been subjected to damage. The cracks resulted in an increase in the pores in the granite, as well as swelling and shrinkage of the clay minerals that resulted from the transformation of feldspar inside those fine cracks of the granite. The most appropriate methods of treating and maintaining the bases of the granite columns for the granite installations in the Merit Amun area were presented.

Detecting electromagnetic radiation is one of the modern methods that can be used to explore and study building materials, including granite, by studying the electromagnetic emissions that are produced when granite is exposed to external loads or damage. These laboratory studies or theoretical studies show that these emissions may be appropriate to monitor the beginning of the deformation of granite as a kind of initial warning of the occurrence of damage. Electromagnetic and radioactive emissions are also studied and explored through various chemical and mathematical equations to shed light on the main results and physical studies, so that the processes and applications of this technology can be beneficial in detecting the electromagnetic emission resulting from exposure. Granite is subjected to stresses and loads resulting from different types of damage.

In the proposed restoration work, dust was removed from granite surfaces by mechanical cleaning tools, such as a soft and coarse brush, or an air compressor.

[22] SHARMA et Al. 2021: 4500–4551.

Chemical cleaning was also used through the use of distilled water, which is an effective solvent and can be used in more than one form by spraying. A type of neutral soap is added and used on small areas to prevent leakage into the granite so as not to cause damage as a result of the formation of salts. Dust, dirt and soot are removed and washed with distilled water added to neutral soap and ammonia in different proportions, and then the traces of dirt and remaining stains were cleaned using a diluted solution of freshly prepared 2% chloramines in water, followed by cleaning with water. Oil and grease stains were removed from the granite surface using a mixture of ammonia, benzene and alcohol in equal proportions. Stains were removed by washing with water, and stains caused by them were also removed. Microorganisms were removed using formaldehyde with 5% wash water and ammonia, and wild bee nests were removed using the appropriate tools or brush, followed by cleaning the remains with water, alcohol or water and ammonia. To remove salts, such as sulfate or carbonate salts, where calcium carbonate had been formed from various weathering agents, the surfaces of granite blocks were cleaned with a solution diluted with 5% hydrochloric acid, then the surface was cleaned using a soft brush. During this procedure the surfaces were moistened with hydrochloric solution until the reaction occurred using the least amount of acid. Work began with a small area, then moved to another area. This was followed by removing the calcium carbonate after wetting manually using a blunt scalpel or other suitable tools, and after calcium carbonate removal, the treated areas were washed well with distilled water to get rid of the effects of hydrochloric acid. Salts were detected using a silver nitrate solution, and sulfate salts were removed using 10% ammonium carbonate with water and the treated parts were washed thoroughly with water[23].By studying the height of the ground water levels and the aerial photography maps of the Merit Amun region, it was noted that it is located at a very low ground level (-9 m) than the levels of the surrounding areas, including popular dwellings, so it is a drainage area for ground water that is drained from the surrounding areas, especially the archaeological hill area located on the western side of the area. This area is at risk and the increased drainage of ground water from that area towards the study area is represented by several factors, including the presence of the archaeological hill at a level much higher than the level of the study area. Moreover, the site lacks proper sanitation standards, and the drinking water supply networks need renovation, and these reasons present a major challenge to the granite stones and the people responsible for maintenance. Therefore, the ground water level must be reduced by making productive wells in areas with lower levels that allow the areas to be safe from drainage and far from the archaeological site. It is also preferable to separate the archaeological area from ground water sources through the work of a surrounding trench. Drainage of the surrounding ground water away from the archaeological site is a necessity, and work must be done to improve and develop the drinking water and sewage network, after which the processes of granite stone blocks are strengthened using ParaloidB82 solution at a ratio of 3: 7% in a mixture of organic solvents consisting of acetone, toluene, benzene and ethyl alcohol in equal proportions.

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[23] ÖZTÜRK 1992: 264.

VII. CONCLUSION

The mechanism of granite damage depends on the natural role of moisture and heat that causes physical and chemical phenomena, such as expansion, contraction and crystallization of dissolved salts in wet water. It is absorbed from the air by a type of salt or a mixture of salts known as the equilibrium moisture of this salt or mixture of salts, and the crystallization of halite on the surface of the granite may cause deformation and surface damage; which leads to cracking in the granite and perhaps some of its parts falling off. The deposition of oxidizing salts in the atmosphere and dissolution in rain water over the granite surfaces led to some types of damage and stress; causing chemical damage to the granite. These salts include sulfates and nitrates, in addition, some red blisters are produced, known as red weathering; which is caused by the washing of the alkali produced by the silica, and this phenomenon can be observed in some granite blocks that are constantly exposed to successive cycles of wetness and dehydration.

The effect of the mechanical properties of granite on the mechanism of electromagnetic radiation (EMR) in granite is one of the recent research topics in studying the mechanics of granite; and the mechanical properties of granite have obvious effects that are in the form of waves of electromagnetic radiation during granite damage. The current study provided a better understanding of the EMR mechanism of granite damage, the electrodynamics and radioactivity in the granite caused damage and accelerated the decay rates, which depend in the granite damage in the Merit Amun, Akhmim area on the ability of the ground water to rise, and the depth The study area, and the surface of the ground water level in the area, which affected the interconnection between the granite grains

From the above, we note the strength and hardness of granite that prompted the ancient Egyptians to use it in many aspects of life. However, the granite was subjected to complete collapse as it was found in the study area. The damage and human actions must also be taken into consideration when noticing any changes in the granite stone to stop the causes of damage to it; therefore, the preservation of the archaeological granite is necessary and important to preserve this cultural heritage.

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