Two Examples of Egyptian Alabaster Weathering, Deterioration and Damage from Ancient Egyptian Buildings and Islamic Buildings in Egypt and Some Recommendations of Preservation.

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Abstract:

Weathering and deterioration of the Egyptian alabaster were not studied enough as much as the other rocks (such as sandstone , limestone , granite and marble) , and the negative influences ring may occur hastily because of its chemical composition so the selected two examples of the Egyptian alabaster the most important examples of using it in building in Egypt and at same time is the most insecure , were studied through several visits to sites , description and Characterization of the Egyptian alabaster (Travertine) either in original sources (quarries) or in archaeological sites where samples were collected and taken to laboratory analyses and investigation ,to identify Deterioration ,Weathering and Damage such as : Constructional Defects (Cracks and Frailty and debility structure of some ornamental architectural) , Structural Defects(the colloform structure ,Vugs and cavities and granulation), Climatic (physical) weathering and Deterioration (Discoloration /deposit such as Bleaching , Gypsum formation , The soiling , Black or Dark Crust and Efflorescence and Sub florescence of Halite salt) , Loss of stone material such as Roughening , Pitting and Back weathering due to loss of scales) , Detachment such as granular disintegration , Crumbling , flaking to contour scaling , flaking to contour scaling and Fissures independent of stone structure) and Man-made faults (erroneous restoration) .

In addition to Some Recommendations of preservation , and I satisfied to put the results discussion and conclusion in comparative table form .

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1. Introduction

Egyptian alabaster (Travertine) ([1]) is well-known and one of the most desired rock types in ancient Egypt from Predynastic until the end of Muhammad Ali Dynasty rule in Egypt(throughout the recent history), either as a building stone, as an ornamental stone , for sculptures or for objects manufacture . for fine arts may be due to the easiness of its quarrying and being a very soft material of indentation hardness and is easily worked, and possibility of carving with a fingernail, and it is easily taken on a good polish

([1]) Note that throughout this paper I'll consider the term (Egyptian alabaster) and the term (Travertine) express the same rock , so Egyptian alabaster is actually Travertine, so the travertine used in ancient Egypt is frequently described as Egyptian Alabaster , and some researchers consider this terminology is incorrect because the true Alabaster according to geologists recognition is composed of the mineral gypsum hydrated calcium sulphate , $CaSO_4.2H_2O$, so some try to compromise for this inappropriate term travertine either with the term calcite, but this term expresses mineral name and does not consort a rock , or with the term calcite-alabaster , also this term is bastard and unknown , Aston , B.G. , Harrell . J. and Shaw , I. , Stone in :Ancient Egyptian Materials and Technology , Edited By Paul T. Nicholson and Ian Shaw ,Cambridge University Press , 2000, pp. 21 , 59 . the early Greek Philosophers in the Fourth Century B.C., and Romans, in the first century A.D. who suggested the term alabasterite- transferring the name lapidum alabastrites to this rock confusing it with the similarly appearing, but softer gypsum rock occurring in the vicinity of Volterra, Tuscany - where The most prominent deposits of this rock type in Egypt occur in the former Ptolemaic province Alabastrites in Middle Egypt- for stones that came from local quarries to the north of Thebes and Alabstron (tnub) regions of Egypt (Lucas, A.and Harris, J.R., 1962. Ancient Egyptian material and industries (4th. Ed.). Edward Arnold, London, 523 p. , and Mitchell, 1985). This definition of Alabasterite was misinterpreted and forgotten when in the 18th century, the modern definition was confined to a variety of gypsum that superficially resembles “Egyptian alabasterite” Harrell, J.A., 1990: Misuse of the term“alabaster” in Egyptology Newsletter of the Amer. Research Center in Egypt,No. 119, 3M, 37-42.it was also called Aragonite by Fourtau , 1904 , and Carter andP. Newberry , 1904 , legrain replaced the term alabaster instead of Aragonite distinguishing it from true alabaster or gypsiferous alabaster , El-Hinnawi, E. E., and Loukina, S.M.,(1971 and 1972) In order to avoid confusion between both types of alabaster due to this fundamental difference in composition, they use frequently the word "marble" to describe Egyptian Alabaster; "marble" being a technical term used for any carbonate rock which can be polished and used for ornamental purposes. , and Gray et.al.eds.1977 define Egyptian alabaster as a massive or compact variety of Glossary of Geology .

easily [2] , its translucent character and its characteristic piebald textures [3] the rock travertine also exhibits a high rock hardness, which allows it to be finely detailed when carved , also it was used as a subsidiary building material, chiefly for the lining [4], but it was used almost in ancient Egypt and Islamic Egypt in small objects particularly for small vessels, vases beside statuettes, delicate statues bowls, dishes, offering tables etc., may be because of difficulty of quarrying of large blocks because of joints between thin beds in its Geological formations , so the Egyptians had not mined more than about some hundred thousand tons of it , But recently a new occurrence, 10 km west of Qurna has been opened, delivering the raw material for tourist attractions such as small figurines and vases, sometimes artificially altered to give them the impression of antiquities [5].

The fewer examples of less common purposes of buildings and construction are wall- lining or wall- veneering either as internal decorative stones or as wall-casings) , pavements (temple pavements) , Alone in the funeral chambers beneath Djoser's pyramid,

in Sakkara, occasionally large or colossal statues , sarcophagi, altars and naoi beside small shrines ,

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[2] Soliman , N. F. , Investigation of an Egyptian Alabaster Ore by Measuring its Natural Radioactivity and by NAA Using K0 Standardization and Comparator Method , Journal of Nuclear and Radiation Physics, Vol. 1, No. 1, 2006, p. 31 .

[3] Sidraba I, Normandin KC, Cultrone G, Scheffler MJ , Climatological and regional weathering of Roman travertine. In: Prikryl R, Siegel P (eds) Architectural and sculptural stone in cultural landscape. Carolinum Press, Prague, 2004,pp 211–228 ; Sidraba I , Weatherability of Roman travertine. Ph.D. thesis Faculty of Material Science and Applied Chemistry, Institute of Silicate Materials, Riga Technical University, Latvia 2006 ,(unpublished) ; To¨ro¨k A , Black crusts on travertine: factors controlling development and stability. Env Geol, 2008 , 56:583–584.

[4] the normally very low temperature of precipitation and extremely porous nature of travertine leads to a totally different appearance, it is not translucent and was never used in ancient Egypt , see: Klemm , D . and Klemm , R . , The building stones of ancient Egypt - a gift of its geology , African Earth Sciences 33 , 2001,p. 641.

[5] Klemm , D . and Klemm , R . , op. cit. , 2001,p. 641.

The most well-known examples of either construction or buildings (wall- lining) are : chapels of Amenhotep I ,Thutmosis I , Thutmosis III at Karnak ([6]), sanctuary of Ramsses II at Abydos and Muhammad Ali Mosque in Saladin's Citadel in Cairo .

The two examples of Egyptian alabaster which were selected to be subjects of study due to be the most important examples of using it in building in Egypt and at same time is the most insecure .

For the first example of Egyptian alabaster of chapel of Thutmosis IV at Karnak quarried from Wadi El-Assiuty quarry ([7]) (27º18.75́ N, 31º20.7́ E) dating 18th Dynasty ,New Kingdom ([8]),(and 27º18.50´ N, 31º20.48´ E according to El Naggar ([9]) it is of two types. and in details it is divided into two main types according to the degree of translucency , color and grain size of calcite (the main mineral or component) the first one is solid massive , translucent , coarse to medium grained , it has color graduation from pale tan to yellowish white with an orange tint , it consists of elongated fibrous calcite crystals and - normally - show faint to marked layering . the second one is is a hard solid banded gently , compose of continual running alternation of successive bands of crusts of translucent (the 1st type) and thin parallel bands of white (the 2nd type) with a few mms. wide , the alternation regularity resulting in delicate band or crusts rock assimilates onyx , agate , chalcedony and chrysocolla , the bands range and differ in thickness in different

([6]) Pylon No. III consists of reused bocks of the chapels of Senwosert I and of Amenhotpe I , Hatshepsut and Thutmose IV .

([7]) Lucas , A. Ancient Egyptian Materials and industries , Revised by J.R. Harris . Edward Arnold, London , 1962, p.407.

([8]) Aston, B.G. ,Harrell , J. A and Shaw , I. , Stone , in :. Ancient Egyptian Materials and technology , Nicholson, P. T. and Shaw , I. ,Cambridge University Press , 2000, p.14.

([9]) We can reach the area of Wadi El-Assiuty Egyptian alabaster (Travertine) quarry and deposits exist after crossing the bridge capping Assiut Barrage , travel following the main road south to Sahel Selim, either via traveling till Bisra's village , then we begin from nearby it the track called (Darb El Rukham) which after 25 km. heads us northeast in the main Wadi El-Assiuty leading up to its deposits , or via traveling till Arab Moteir's village –about 1 km. to the south of Sahel Selim - we track about 18 km. trending direct east leading to the track of (Darb El Rukham) , see :El Naggar, M.H. , Petrological Studies on The Egyptian Alabaster , M.Sc. Thesis Degree , Dept. of Geology , Assiut University , 1962 , pp.10-11.

rocks even in the same rock from fractions of 1 mm.to fractions of 5 cm. and these bands are almost paralleled , also the alternate white bands are of different thickness , in most cases the opaque milky white bands exhibits a marked colloform structure ([10]) .

And For the second example of Egyptian alabaster of Muhammad Ali Mosque quarried from Umm Argoub near wadis Muwathil and Sannur quarry([11]) (28º39.0́ N, 31º15.6́ E) ([12]) dating 18th Dynasty ,New Kingdom ([13]) (fig.), a type is banded calc-sinter is interlayering of the translucent calc-sinter ,coarser- grained , fibrous , colored of honey coloring shades with layers and opaque , white calc-sinter , fine-grained , its crystals less than 1mm , without layering or with little layers ([14]).

([10]) El Naggar, M.H. , , 1962 , pp.36-38.

([11]) Lucas , A. op.cit, 1962, p.407; Embabi , N.S., The Geomorphology of Egypt , Landforms and evolution, The Nile valley and the western desert , Department of Geography , Faculty of arts , Ain Shams University , vol. 1 , 2004, p.313.

([12]) besides wadi el-Assiuty quarry and Umm Argoub near wadis Muwathil and Sannur quarry , the quarries from which two examples of study were quarried , there are more seven Archaeological quarries of travertine in Egypt as following :

1- in Wadi Gerrawi near Helwan city which dates to the 4th dynasty - the Old Kingdom ,lies on 29º 48.5´ N, 31º27.4´ E . 2- between Wadi Araba and Wadi Aseikhar dates to the Roman period ,lies on 29º 4.75´ N, 32º3.1´ E . .3- numerous quarries in El-Qawatir area opposite El-Minia city dates to the Old Kingdom and from the Middle Kingdom to the New Kingdom ,lies on 28º 6.2´ N, 30º49.4´ E . 4- in Wadi Bershawi near Amarna ruins , dates to from the Middle Kingdom to the New Kingdom , lies on 27º 42.0´ N, 30º56.3´ E .5- near Wadi El-Zebeida and Amarna ruins , dates to the 19th dynasty - the New Kingdom ,lies on 27º 40.8´ N, 30º55.8´ E . 6- in Wadi El-Zebeida near Amarna ruins , dates dates to from the Middle Kingdom to the New Kingdom , lies on 27º 41.4´ N, 30º54.15´ E . 7- at Hatnub near Amarna ruins , dates dates to the 4th – 6th dynasty- the Old Kingdom, 1st intermediate period , the 12th dynasty - the Middle Kingdom, the 18th dynasty - the New Kingdom , lies on 27º 33.3´ N, 31º1.3´ E. , see: Aston, B.G. ,Harrell , J. A and Shaw , I. ,op. cit. , 2000, p.14 ; Shaw , I.1986. A survey at Hatnub , In Amarna Reports III(ed. B.J. kemp).London : EES, PP.189-212; The 1986. Survey of Hatnub In Amarna Reports IV(ed. B.J. kemp) London : EES , PP.160-7; Harrell, J.A.1990. Misuse of the term alabaster in Egyptology. GM, 119:37-42; De Putter , T. and Karlshausen , C . 1992. Les Pierres Utilisees dans la sculpture l'architecture de l' Egypte pharaonique : guide pratigye illustre . Brussels : Connaissance de l'Eegypte Ancienne;Klemm , D . and Klemm , R . Steine und Steinbruch im Alten Agypten . Berlin: Springer Verlag , 1993 ; Aston , BG 1994, Ancient Egyptian Stone Vessels : Materials and Forms .Studien zur Achaologie und Geschichte Altagyptens Heidelberg : Heidelberger Orientverlag ; AEMT, 2000 , p. 59-60 .

([13]) Aston, B.G. ,Harrell , J. A and Shaw , I. , op,cit., 2000, p.60.

([14]) loc.cit..

2. Materials and methods

2.1 Description of the Egyptian alabaster(Travertine) in Egypt

It is a natural chemical sedimentary precipitate rock(Quaternary or Plio-Quaternary in age) formed mostly of carbonate minerals deposited from and around the water of mineral seepages ,springs and along streams and rivers saturated with dissolved calcium bicarbonate ([15]) , so It consists of calcite or aragonite, of low to moderate inter-crystalline porosity and often high mouldic porosity ([16]), during Precipitating carbon dioxide transfers via a groundwater source to calcium carbonate (CaCO3) , they are formed by the deposition of rising carbonate solutions through fissures, the stone is characterized in general by pitted holes in its surface, and the variety of its types of travertine due to variation in depositional environment and components, so Travertine is generally more porous than most carbonate building stones (e.g., limestone, marble), but has higher strength and durability than many porous dimension stones. Even though it is porous, polished slabs of travertine are often used as exterior wall cladding or pavements ([17])), weathering may be quite destructive for travertine in a short time span due to soluble carbonate composition and porous structure.

Egyptian alabaster (Travertine) exhibits a variety of structures such as botryoidal structure, banding, cockade structure, vugs and cavities Banding consists of alternating translucent and white bands of different sizes, the mineralogical composition of the translucent bands has been determined as magnesian calcite and that of the milky-white bands as normal calcite , differences in the Ca/Mg and Sr/Ca ratios between both types of bands have been noticed and are

([15]) Gauri K, Bandyopadhyay JK. Carbonate stone chemical behavior durability and conservation. New York: J. Wiley & Sons; 1999.

([16]) Pentecost A Travertine. Springer, Berlin, 2005, pp 1-4.

([17]) To¨ro¨k A , Black crusts on travertine: factors controlling development and stability, Environ Geol,2008 , 56:584.

attributed to differences in the solubilities of Ca-, Mg-, and Sr-carbonates ([18]) .

2.1.1 Egyptian alabaster (Travertine) in Egypt :

Egyptian alabaster (Travertine) in Egypt occurs as a small deposits spasmodically in Eocene limestone of the Nile valley and adjacent desert - particularly the east side – plateaus between Esna and Cairo , there are nine ancient quarries , such as the quarry of Wadi El Assiuty , the quarry of Wadi Sannur , the famous quarries located southeast of Amarna (Hatnub or Manson of gold) which were exploited since the reign of khufu till the Roman period , the quarry of Wadi Gerrawi which was exploited since the Old kingdom period ([19]).

2.1.1.1 Description and Characterization

It is considered as a dense –non-porous- rock consisting entirely of calcite (calcareous or calc sinter) and it is formed in subsurface caverns and fissures in the Eocene limestone bedrock and consists of the same material which cave stalagmites , stalactites and other flowstones spelothems are made , the springs participated in the formation of these deposits in three forms ; 1- opaque , white calc-sinter , fine-grained , its crystals less than 1mm , without layering or with little layers

2- translucent calc-sinter ,coarser- grained , fibrous , colored of honey coloring shades 3- banded calc-sinter of an interlayering , the latter two types which used commonly in ancient Egypt of the two forms with layers and re-crystallized calcium carbonate occurs along fault planes over east of Helwan ([20]) the same consideration for the Egyptian alabaster of both wadi Sannur and wadi El-Assiuty as re-crystallized calcium carbonate - Eocene limestone - in situ ([21])

([18]) El-Hinnawi, E. E., and Loukina, S.M., A Contribution to the Geochemistry of"Egyptian Alabaster" , TMPM Tsehermaks Min. Petr. Mitt. 1972, 17, p.215.

([19]) Aston, B.G. ,Harrell , J. A and Shaw , I. , op,cit., 2000, p.59; Murray , 1945 , p. 6 ; Dreyer and Jaritz , 1983

([20]) Ismail and Farag , 1957.

([21]) Said , 1962 ; El-Hinnawi, E., and Loukina, S.M.,: A contribution to the geochemistry of Egyptian alabaster. TMPM. Tscherm. Miner. Petrol. Mitt., V. 17, 1972 , 215-221.

and re-crystallization occurred when the pressure of carbon dioxide become lower , which was anticipated with underground carbonated waters which caused dissolution of limestone ([22]) , it is assumed that the Egyptian alabaster (Travertine) was formed from calcium carbonate –bearing solutions - which filled the caves of the Eocene limestone – and which were attributed to some rainy period (may be during the Pleistocene) when extensive areas of Eocene limestone were washed by large amount of meteoric water , the deposition extended a long time and was affected in the form of continuous incrustations and coatings on the surfaces ([23]) , Zaki propose the opinion that ([24]) ; the Egyptian alabaster (Travertine) was almost formed by fissure filling of available faults , joints and fractures of the Middle Eocene limestone to form the ore veins and lenses , by infiltration - diffusion replacement of the limestone beds , particularly along the contacts of ore flats and pitches , the precipitation of deposits of the Egyptian alabaster (Travertine) was accomplished under the affect of rising thermal igneous waters plays a strong role in the stability of the system where lifts temperature , increases carbon dioxide pressure and activates metals cation , and explained some factors and field evidences which support his proposal .

It was considered as of stalactitic- salagmitic origin ([25]) , also was considered as re-crystallized calcium carbonate along fault planes over the areas east of Helwan , Wadi Sannur and Wadi El-Assiuty ([26]) .

([22]) Zaki , R. M. , Petrological and Geochemical studies of some Alabaster Rocks in Egypt , Master Degree Thesis , Faculty of Science , Minia University , 1988 p. 60.
([23]) Akaad, M.K.and Naggar,M.H.,. Petrography of the Egyptian alabaster of Wadi Al Assyuti . Bulletin of the Faculty of Science , Alexandria University, 1964a 6:157-73 ; Zaki , R. M. , 1988 p. 60.
([24]) Zaki , R. M. , 1988 pp. 60-61.
([25]) Newbold , 1848 ; Dana , 1932 ; Gharieb , S.E.M., Geological and Geomorphological Studies on The Limestones , East of The Nile , Beni-Suef and Minia Governorates , M.Sc. degree Thesis , faculty of Science , Cairo University , 1990 , pp.113-114 .
([26]) Ismail and Farag , 1957 ; Said , 1962 ; Gharieb , S.E.M., op. cit. , 1990 , pp.113-114 .

The deposits of Egyptian alabaster (Travertine) Wadi Sannur and Wadi El-Assiuty east of Assiut city are of chemical and colloidal origin , and the cavities in which Egyptian alabaster formed in the Eocene limestone were essentially closed .

This calcitic rock type was formed as a result of the intrusions of olivine-basaltic magmas during the lower Miocene, contemporary with the formation of the Red Sea graben and the river Nile fault structures. The calcite alabaster occurs exclusively in Eocene limestones in veins and elongated karst systems, always perpendicular to these dilation directions , CO2-rich magmatic degassing products mixed with the pore space waters of the limestones, dissolved them partly and reprecipitated the calcite within the temperature range of 100-170 - C in the open veins and karst systems at higher levels ([27]).

For the texture is banded , colloform , intraformational alabaster enclaves , limestone xenoliths , cavities and vugs or cavernous alabaster , the caves were filled with calcium carbonate and bicarbonate which bears solutions during the Pleistocene rainy period , faults and fissures initiate cracks and fissures across the rock , water run carrying iron oxide and sand throughout cracks and fissures resulting in precipitation of ochreous sandy calcareous sediments in the unfilled cavities and vugs , the solutions which bears Iron which in turn were unfiltered from sand and clay and penetrate deeper into the Egyptian alabaster and limestone xenoliths , and prolonged corrosion of the Eocene limestone eventually exposed the Egyptian alabaster-filled caves which had being buried in these limestone ([28]) .

([27]) Klemm, D., Klemm, R., Calcit-Alabaster oder Travertin? G€ottiniger Miszellen 122, 1991., pp.7–70..

([28])Akaad, M. & Naggar, H., 1964. Petrography of the Egyptian alabaster of Wadi Sannur, Bull. Fac. Sci. Alexandria Univ., V. 6, pp 157-167; Akaad, M., and Naggar, M, 1965, Geology of Wadi sannur alabaster and general geological history of the Egyptian alabaster deposit ;; Gharieb , S.E.M., op. cit. , 1990 , p.114 .

2.2 Egyptian alabaster (Travertine) at Karnak :

As it mentioned above briefly the Egyptian alabaster at Karnak which quarried from Wadi El-Assiuty quarry in details it is divided into four types according to the degree of translucency , color and grain size of calcite (the main mineral or component) : the first type of Egyptian alabaster (Travertine) quarried from wadi El-Assiuty quarry is the most important because it was used as an ornamental stone inasmuch as the hardness of this type and possibility of quarrying it into regular blocks and masses , this type is solid massive , translucent , coarse to medium grained , it has color graduation from pale tan to yellowish white with an orange tint , it consists of elongated fibrous calcite crystals and - normally - show faint to marked layering , posses a greater tendency to splitter and chip parallel to the direction of elongation of the fibrous calcite and normal to the layering , and this direction can be therefore considered the grain of the rock with the rock fiber in it, this type is free pores or cavities because of the interlock tightness of calcite crystals .

The second type of Egyptian alabaster (Travertine) quarried from wadi El-Assiuty is opaque , ranges from coarse to medium to fine grained reaching a diameter of up to 2.5 mm., is saccharoidal milky white and contains affluent tiny vugs or cavities (cavernous) which are stained pale pink and spread throughout it , they are empty hollow lined with colloform structure of the rock: these vugs and open spaces characterize the travertine of wadi El-Assiuty , and differ in size , nature and form (explain will be forth coming) and this type is common and it occurs in bands (20-30 cm.) commonly alternates with solid translucent bands forming the main bulk of the travertine mass . this type almost was not used as an ornamental stone nor for any other purposes since it is friable and can not endure processing , because of non-cemented , non-tight interlocking of calcite crystals and because of presence of the intergranular minute cavities

The third type of Egyptian alabaster (Travertine) quarried from wadi El-Assiuty is very important also for this paper because it is commonly used as an ornamental stone due to its hardness and its beautiful appearance , it is a hard solid banded gently , compose of continual running alternation of successive bands of crusts of translucent (the 1st type) and thin parallel bands of white (the 2nd type) with a few mms. wide , the alternation regularity resulting in delicate band or crusts rock assimilates onyx , agate , chalcedony and chrysocolla , the bands range and differ in thickness in different rocks even in the same rock from fractions of 1 mm.to fractions of 5 cm. and these bands are almost paralleled , also the alternate white bands are of different thickness , in most cases the opaque milky white bands exhibits a marked colloform structure .

The fourth type of Egyptian alabaster (Travertine) quarried from wadi El-Assiuty was not used as an ornamental stone although of its hardness and possibility of quarrying it as masses and regular blocks because of lack of the beautiful appearance of the usual travertine , this type is divided into two subtypes , the first one is of lively colloform structure along the layering , the second one is of a marked to faint layering and lacks any marked colloform structure , this type is hard , less cavernous and exhibits faint layering .

This type is also a proper banded type where the bands ending abruptly against other bands perpendicular to them , is hard , opaque , milky white color and consists of calcite which is medium to fine grained ([29]).

For vugs and cavities in the travertine of Wadi El-Assiuty , they are divided into three types , the first type of vugs and open spaces is a minute cavities stained with red iron-oxide of distribution throughout the rock , these type exists in the Egyptian alabaster occurs as a thick bands alternating with bands of solid Egyptian alabaster. The second type of vugs and open spaces is confined to

([29]) El Naggar, M.H. , , 1962 , pp.36-38.

parts which appear to the outer surface of the alabaster deposit, which occurs in the eastern , northeastern and northern peripheries of the deposit as well as on its upper surface , the vugs occur elongated between thin bands – as which the alabaster occurs of thickness 1-2 cm., and is of the milky white type - and almost constantly horizontal to sub- horizontal , the surfaces of the alabaster in between these vugs are devoid of colloform structure - details are forthcoming – and are sometimes lined with elongated calcite crystals in comb structure and stained with wan red hydrated iron oxides , the thin bands alternating with these elongated horizontal and sub- horizontal vugs , usually taper down and converge on one side assuming a form recalling some type of current bedding , The third type of vugs and open spaces is large , 30-80 cm. long into which protrude almost spherical surface are thinly encrusted with elongated calcite crystals arranged with their longest axes normal to the surface , so producing well developed comb structure , the crystals of calcite are almost stained with dull red hydrated iron oxide , the surrounding alabaster is massive , and some of the large vugs are lined with clusters of coarse long calcite crystals of special character , these crystals ranges in color from colorless to pale brown to very deep brown either in one or in the same specimen, there is evidence that this type of vugs due to the crystallization in open spaces and the crystallization cessation anticipate the complete filling of the whole volume ([30])), these vugs and cavities were covered with thin film of red Iron oxide .

The colloform structure in the Egyptian alabaster (Travertine) Includes reniform , botryoidal , spherical and mamillary forms or structures occurring in some minerals as chalcedony , chrysocolla , the Egyptian alabaster (Travertine) of Wadi El-Assiuty characterized of presence of botryoidal or colloform structure which are lining some of the vugs which are in the travertine mass , the part of the travertine which shows this colloform structure is the

([30]) El Naggar, M.H. , , 1962 , pp.34-35.

fine grained milky white travertine , also the spheroidal surfaces in it exhibits a variety of forms and shapes and are reniform , botryoidal or mamillary .

there three types of colloform structures , the 1st one likes kidney shape is wholly of the milky white travertine and terminates with the spheroidal surface exhibiting colloform structure .

The 2nd type of the colloform structure exists in huge blocks of a translucent creamish or yellowish color and are capped with thin layer , about 5 mm. thick of the milky white travertine which shows colloform structure of kidney shape and may form regular hemispheres , with existence of another rock was found in the field includes cavities into which hemispherical protuberances conform .

The 3rd type of the colloform structure forms the lining of the cavities of the milky white cavernous travertine , the outer surface of the convex

of this type is covered with a thin layer of red iron oxide . the deposits which exhibits the colloform structure – as well as fine grain – of colloidal origin and existence of the spheroidal surfaces - which due to surface tension phenomena - exhibiting colloform structure ,deposited in open spaces , includes form varieties such as reniform , botryoidal or mamillated, nodular etc. and may be to be partial of colloidal origin ([31]).

The cockade structure ([32]) of conformable layering or banding around inclusions occur in the travertine of Wadi El-Assiuty as following :

([31]) El Naggar, M.H. , , 1962 , pp.28-30.

([32]) The cockade or ring structure is the crustification of mineral matter is successive layers around rock fragments of older components , are supposed to have been torn off the walls of a cavity or fissure and which dropped in it or brought to the cavity by another means , if the older fragments are not lined by definite layers , but the interspaces between the fragments are merely filled with out marked lining or layering , the texture then represents a breccia texture not a cockade structure see :

Kutina, J., and Sedlackova, J.,. The role of replacement in the origin of some cockade textures. Econ. Geol., V.56, 1961, pp. 149-175 . the cockade structure may indicate that the travertine deposit is younger than the surrounding country rock limestone with its characteristic flint nodules , is also younger than the limestone breccia found in the region , and there are exotic=

Around individual concretions of flint of whole or angular parts , around rubble or fragments torn off the country rock limestone , some of these xenoliths were found to be in contact with sharply angular limestone breccia , individual xenoliths or aggregates of them are bounded by saccharoidal calcite , around torn fragments of pink crystalline limestone or small thin streaks of limestone breccia associated with pink crystalline limestone , encrusted and surrounded with travertine in typical cockade structure of roughly oval shape ([33]).

2.3 Egyptian alabaster (Travertine) of Muhammad Ali Mosque quarried from Umm Argoub near wadis Muwathil and Sannur quarry :

Akaad and Naggar([34])believe that Egyptian alabaster (Travertine)

at Sannur was formed by re-crystallization of limestone in situ. The dissolution of the limestone was mainly affected by underground carbonated waters. When the pressure of CO2 became low, calcium carbonate started to crystallize. The variation of the degree of crystallization of the Travertine bands was mainly due to differences in the concentration of the solution controlled mainly by the partial pressure of C02 and the Ph ([35]).

The fine to colloidal milky-white bands were formed mainly from supersaturated solutions from which rapid precipitation of calcium carbonate took place, while the translucent alabaster was formed by slow crystallization ([36]).

A periodical change in the concentration of the solutions was

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=pieces of travertine which occur within the mass and are surrounded by successive bands of younger travertine following the outlines
of exotic pieces such as cockade structure , El Naggar, M.H., 1962 , pp.32-33.

([33]) loc.cit..

([34]) Akaad, 2kl. K., and M. H. Naggar,: Geology of the Wadi Sannur alabaster. Bull. Inst. Desert. Cairo 13 1963,, pp. 35-50; Petrography of the Egyptian alabaster of Wadi Sannur, Bull. Fac.Sci. Alexandria Univ., V. 6, 1964. pp 157-167.

([35]) El-Hinnawi, E. E., and Loukina, S.M., op.cit. 1972, 17, p.215-217.

([36]) loc.cit.

responsible for the formation of banding in the alabaster. The dome-like
appearance of the alabaster in the quarries of Sannur points to the fact that dissolution of the limestone was affected from below. The upper parts of the solution crystallized rapidly -through the rapid loss of C02-
giving the milky-white marble in the form of convex layers, while the inner parts crystallized slowly to yield most of the translucent alabaster. It should be noted that the solutions were in a state of moderate agitation. This is illustrated by the absence of any bedding in the alabaster and by the presence of botryoidal and cockade structures ([37]).

The formation of Travertine by re-crystallization of limestone in situ has been also recorded in other localities in Egypt, although on a small scale. Small bands of alabaster are present along fissures in Eocene limestones of Mokattam, near Helwan, and occur also in more recent limestones along the Mediterranean coast ([38]).

Wadi Sannur is low-lying hills East of Beni Suef consist mainly of Upper Eocene limestones intercalated with shales. In 53 km South east of Beni Suef, the hills consist of Middle Eocene nummulitie limestone.

The two, roughly circular, quarries of marble in Wadi Sannur are located in the Middle Eocene limestone hills; they were mapped and geologically described ([39]). The alabaster of these quarries exhibits a number of structures, the most common of which are: botryoidal structure, banding, cockade structure, vugs and cavities.

Banding is a characteristic feature of Egyptian Alabaster and consists of alternating bands of pale-orange translucent and milky-white marble has no definite arrangement and varies greatly in size. Banding may run across a large wall in the quarry, or may be

([37]) loc.cit.
([38]) loc.cit.
([39]) Akaad, 2kl. K., and M. H. Naggar,: Geology of the Wadi Sannur alabaster. Bull. Inst. Desert. Cairo 13, 1963 , 35-50.

observed only on a small scale. In hand-specimens, the different bands vary greatly in thickness; a thin band (or even a mieroband) of milkywhite marble may be followed by a thick or a thin band of the translucent one which may be followed in turn by a rather thick white band ([40]) .

3. Methods

3.1 Stone walls of chapel of Thutmosis IV at Karnak in Luxor and the other adjacent chapels built of the Egyptian alabaster and Egyptian alabaster veneers Muhammad Ali Mosque in Saladin's Citadel in Cairo were studied in situ and samples were collected and taken to laboratory analyses and investigation , also fresh or unweathered samples were collected from both Wadi El-Assiuty quarry - the source of Egyptian alabaster at Karnak- and wadis Muwathil and Sannur quarry - the source of Egyptian alabaster Muhammad Ali Mosque - and taken to laboratory analyses and investigation with polarizing mineralogy (petrography) and scanning electron microscopy to investigate and study the morphology and the mineralogical characterization , in addition to weathering and deterioration symptoms and forms .

And with X-ray diffraction (XRD), X-ray fluorescence (XRF), to analyze and study the composition of the stone and its weathering and deterioration symptoms and forms .

3.2 Petrographic study of the Egyptian alabaster of Wadi El-Assiuty quarry (the source of Egyptian alabaster at Karnak) :

Quarry samples belong to both the first type and the third type which had been quarried for archaeological purposes were investigated for characterization :

In thin sections of the first type they consist of drusy mosaic of calcite , the texture is an harmonic mixture of fibrous and equant mosaics resulting in the fine layering of the alabaster (which in turn consists of parallel layers appear undulate with short amplitude ,

([40]) El-Hinnawi, E. E., and Loukina, S.M., op.cit. 1972, 17, p.215-217.

each layer consists of fibrous crystals of calcite with sharp boundaries and with occasional of rhombohedral cleavage) , the fibers are normal to the margin of the layers which each one of them exhibits a comb structure , and the sides of the crystals interlock tightly- although of they are jaggement and irregularity - resulting in the non-porous texture , also the alabaster consists of rows of fibrous crystals of calcite , and regarding to the shortage of any orientation continuity the successive rows of oriented fibrous crystals of calcite appear distinct under crossed nicols , it is noted that : the longest grain axes of fibrous mosaic tends to orient perpendicular to layers of the rock , clearness of the intergranular boundaries of fibrous mosaic , fibrous crystals of calcite exhibit curved nature of groups or bundles via marked wavy extinction , the larger fibrous crystals of calcite are divided into elongated sub-grains , the layers end suddenly against dark sharp lines of discontinuity consist of amorphous carbonate .

In thin sections of the third type , it includes a variety of bands of variety of translucency degrees especially delicately banded which due to alternation of bands of translucent creamish type with the opaque milky white type , a yellowish translucent band consists of elongated fibrous crystals , the texture is a fibrous mosaic alternating with an equant mosaic

A white band with a pale yellowish tint is less translucent than the yellowish , the band contains abundant dendritic and bifurcating veinlets of opaque fine amorphous carbonates , there is a turbidity in the crystals of calcite due to of rhombohedral cleavage inclusions , the layering of the translucent bands is always parallel to the banding of the alabaster , the texture of is a combination of fibrous and equant mosaics , together with bands of rich amorphous carbonate appear as dark lines marking the colloform structures and they are the milky white bands , cavities are common and some of them are of 7 mm. and lined with clear calcite crystals with rhombohedral cleavage, the milky white band is succeeded with band of equant granular mosaic of coarse calcite crystal , the coarse and fibrous calcite crystals are elongated in direction normal to the direction of the white bands which in turn are not always in straight lines but deformed and contorted , they sometimes buckle on themselves particularly when run through coarse calcite crystals , or the may crumple particularly in the fibrous mosaic ([41])

And there is an important note : there no almost micro cracks or fissures with presence of some gypsum crystals comparing with the weathered samples were taken from Karnak according to explain forth coming (figs.).

3.2.1 **Mineral composition**

X-ray diffraction and fluorescence analysis patterns of a an alabaster sample of Wadi El Assiuty the source of alabaster at Karnak displays presence the calcite CaCO3 as the principle mineral component , the secondary materials are composed mainly of calcite, in addition to presence of some gypsum crystals and also is found contains - chemically -calcium as a principle element in addition to minute traces of elements of magnesium , strontium (figs 1-7.).

3.3 Petrographic study of the Egyptian alabaster of wadis Muwathil and Sannur quarry : (the source of Egyptian alabaster Muhammad Ali Mosque) :

Thin sections microphotograph of a translucent alabaster sample which were collected from Wadi Sannur the source of alabaster at Muhammad Ali Mosque displays In thin sections, a mosaic of interlocked calcite crystals of different size and shape. They vary from flat platy to fibrous and bent, exhibiting undulatory extinction between crossed polarizers. The crystals have generally different optical orientations, zoning is also well-marked, representing the successive growth of different layers with the same optical orientation. In sections cut perpendicular to the elongation

([41]) El Naggar, M.H. , , 1962 , pp.45-76.

of the translucent crystals a mosaic of fibrous and fine patches of crystals appears, giving a characteristic wavy extinction between crossed polarizers. Parallel orientation may be noted or just a random distribution of the feather-like crystals may be observed.

In thin sections microphotograph of a the milky-white bands alabaster sample of Wadi Sannur - Suturing may be distinct between groups of calcite bundles Contrary to the translucent bands- consist of an aphanic to finely grained (crystalline) mosaic of calcite.

X-ray diffraction analysis of both the translucent and milky-white alabaster showed no aragonite lines. no gradation of growth has been observed between the milky-white and the translucent bands. In many cases the white bands appear to be fine and dense, giving a dark (opaque) appearance under the microscope. colloform texture is very common in these bands indicating their deposition from a colloidal medium.

In many eases, especially in the saccharoidal alabaster, small bands of reddish iron oxides are very common. these oxides occupy mainly the open spaces between the alabaster bands and sometimes penetrate the interstices between calcite crystals. Parallelism between the iron oxide bands and the calcite bands is common. This indicates that the reddish iron oxides were introduced in a later stage by solutions percolating along the cracks and open spaces in the alabaster ([42]) (figs.8- 23).

([42]) El-Hinnawi, E., and Loukina, S.M.,op.cit., 1972 , 216-217..

Deterioration ,Weathering ([43]) and Damage of the Egyptian alabaster(Travertine)

The Egyptian alabaster (Travertine) weathering and deterioration were not studied enough as much as the other rocks (such as sandstone , limestone , granite and marble) , and the negative influences ring may occur hastily because of its chemical composition (calcium carbonate) and its high porous texture , but in addition to weathering and deterioration due to external factors there are Constructional Defects and Structural Defects lead to , maximize and arise weathering and deterioration symptoms as follow :

4. Constructional Defects :

4.1 Cracks

There are two types of the numerous cracks which spread on the alabaster veneers of Muhammad Ali Mosque , the first type - which are usually short and isolated involving small deformation of masonry , and they are distributed randomly and irregularly over the whole building - is related to both the physical and chemical properties of materials and constructional methods , and isn't related to the stresses of the mechanical loads which the Mosque structure carries , these cracks were caused by the expansion - consequent on the rusting and corrosion of hundreds thousands of short iron bars which were used to tie blocks of alabaster veneers to the wall core

([43])Weathering is mostly the effect of air, water, and biological factors- at or near the earth's surface- by time on the rock which in turn tries to adapt from its former environment to its new environment after exposing on the earth surface , where the rock and minerals are breakdown, resulting in variations in chemical and physico-mechanical properties – forming products that are more in equilibrium with the conditions found in this environment - and the degree of weathering depends to some extent on rock mass and rock material properties as in addition to what mentioned above of environmental conditions and factors . Chemical weathering involves the alteration of the mineral constituents of the rock. Physical weathering is the breakdown of minerals by entirely mechanical methods that lead to the rupture of the rock, and from which can result different processes ,the most common chemical weathering processes are hydrolysis, oxidation, reduction, hydration, carbonation, and solution , see : -------, Building, Monumental, and Statuary Materials, -----, ---- ?????

(these bars were fixed in walls with lead) - which produced forces which in turn created tension (figs. 24- 31) resulting in this type of crack which is less dangerous and have a local effect ([44]) , but sometimes they located by accident in locations under excess load and are affected overstressing , in this case that type become dangerous ([45]), also there is an important note that the alabaster veneers are thick to normal thickness of veneers and to be hanging on (its thicknesses range from twelve to twenty centimeters (the standard thickness about five centimeters) , the alabaster veneer slabs were felled sometimes by their own dead overweight , where its thickness range from 12-20 cm , so the weight of one square meter may reach to 500 kg.

Also there are micro cracks can be observed in SEM and petrography microphotographs and filled with dense nodules as a secondary material.

The second type of cracks occurred at positions of heavy load concentration which causes stress intensity which in turn transfer from part to part and from an element to other causing ceases in performance of duty particularly in elements which may never had been designed to carry or to resist these loads , so the effect of this type of cracks is not confined to its vicinity but its effect extends not only to other parts of the building but to the general equilibrium of it , such as the cracks at the springings of the four arches of the mosque may be because of the design of the metal tie-bars anchorage of makes it too weak to resist the stress imposed on them , or the volume of masonry engaged in transferring the thrust from the bars to the arches springings were too small to allow the stress being properly distributed , thereupon the stonework adjacent to the

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([44]) so they required local compensation by replacement the stone parts which were pushed outward with new parts , during these measures and repairs the rusted iron ties were noted and were removed as far as possible , see : Leliavsky , S., Reconstruction of Mosque of Mohamed Aly Pasha , Royal Egyptian institution of Engineers , No.123 , IMPR.MISR, S.A.E., Cairo, 1935, pp. 13-14.

([45]) Leliavsky , S., op.cit., 1935, 14-18 .

bars was torn away from the rest of the masonry , the ties in turn lost their effectiveness , thus is considered the main cause of deformation of mosque ([46]) .

The importance here scoped on the fist type of cracks because of its influence on the veneers of alabaster , and we can observe - for example-

That all lintels above openings in the mosque have cracks in their springings at positions of heavy load (figs. 32- 42) .

4.2 Frailty and debility structure of some ornamental architectural elements in addition to being hanged partially on space , have exposed them to fracture and loss or to erosion of some ornamental architectural elements of Egyptian alabaster chapels at Karnak and Muhammad Ali Mosque , for chapels such as Egyptian George Or Cavetto Cornice , Torus and corners (figs 43-54.) .

5. Structural Defects :

5.1 The colloform structure

The Egyptian alabaster (Travertine) chapels of Karnak of Wadi El-Assiuty characterized of presence of botryoidal or colloform structure which Includes reniform , botryoidal , spherical and mamillary forms or structures and the planes of the colloform structure are weakness planes because of the tendency to break along these planes, also we note covering the convex and the outer surface of stone with a thin layer of red iron oxide and that indicts it belongs to the 3rd type of the colloform structure forms which is of colloidal origin and existence of the spheroidal surfaces - which due to surface tension phenomena as I mentioned before (figs. 55-60) .

The Egyptian alabaster (Travertine) surfaces of Muhammad Ali Mosque of Wadi Sannur characterized also of presence of botryoidal or colloform structure also but the planes of the colloform structure are not weakness planes such as chapels of Karnak of Wadi El-Assiuty, even in external veneers , and that

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([46]) Leliavsky , S., op.cit., 1935, 17-18 .

indicates to that weakness due to structural and geological reasons not to external deterioration factors (figs.61- 64) .

5.2 Vugs and cavities

For vugs and cavities in the travertine of Wadi El-Assiuty , as I mentioned above there are three types , the first type of vugs and open spaces is a minute cavities stained with red iron-oxide of distribution throughout the rock , the second type confined to parts which appear to the outer surface of the alabaster deposit , the vugs occur elongated is of the milky white type (it looks like weathering out of stone components (which mean relief due to selective weathering of sensitive stone components - clay lenticels, nodes of limonite etc.- or due to break out of compact stone components - pebbles, fossil fragments etc., Hole-shaped forms.- or clearing out of stone components (which mean relief in the form of protruding compact stone components (pebbles, fossil fragments, concretions) due to selective weathering.**)** (fig .65-66), The third type of vugs and open spaces is large 30-80 cm. long into which protrude almost spherical surface, I note the presence of the three types on the surfaces of the chapels at Karnak , and s were filled with dense nodules as a secondary material, and I think that they appeared as a result of erosion of the archaeological smoothed surface because of presence of Mechanical influences , erosion and friction more than physical influences (figs.67- 68).

The second type of vugs which is confined to parts which appear to the outer surfaces of the travertine of chapels at Karnak of Wadi El-Assiuty, of the alabaster deposit , the vugs occur elongated is of the milky white type (figs.69- 72).

and they are not noticed on the surfaces of the Egyptian alabaster Muhammad Ali Mosque may be because of absence of Mechanical influences , erosion and friction less than physical influences .

Sometimes the ancient Egyptian undertaken repairs for the vugs in the surfaces of the travertine of chapels at Karnak of Wadi El-Assiuty (fig.73)

5.3 Granulation

Also the surfaces of the travertine of chapels at Karnak show superficial coarsening and granulation smoothed by corrosion polishing as external deterioration factors ,this symptom is not noticed on the surfaces of the Egyptian alabaster Muhammad Ali Mosque may be because of absence of Mechanical influences , erosion and friction (figs.74-75) .

6. Climatic (physical) weathering and Deterioration

The travertine of chapels at Karnak and the travertine of exterior wall-casings of Muhammad Ali Mosque are exposed and subjected (because of its being –as edifices -in open air areas) to direct solar radiation , variation and changes in air temperatures and relative humidity daily , seasonally and annually, where air temperature reaches up to 45°c during days time of summer months (May-June –July -August) and hauls down to about 20°c during nights time during the same months and varies from less than 5°c during nights time during the winter months (December-January-February) and reaches up to 30°c during days time of the same months, and relative humidity varies from about 90 % during nights time during the winter months (December-January-February) and hauls down to less than 20 % during days time of the same months and varies from about 55 % during nights time during the summer months (December-January-February) and hauls down to less than 15 % during days time of the same months , in Luxor district(figs.76- 77).

And where air temperature reaches up to 40°c during days time of summer months (May-June –July -August) and hauls down to about 20°c during nights time during the same months and varies from about 5°c during nights time during the winter months (December-January-February) and reaches up to 25°c during days time of the same months, and relative humidity varies from about 90 % during nights time during the winter months (December-January-February) and hauls down to less than 20 % during days time of the same months and varies from about 55 % during nights time during the summer months (December-January-February) and hauls down to less than 15 % during days time of the same months , in Cairo district (figs.78-79).

The spring season (March to May) over Cairo and Luxor is characterized by strong winds, moderately high temperature, low relative humidity, and decreasing , for the summer season (June to August) is characterized by high temperature, low relative humidity, and low wind speeds over Cairo and Luxor, for the autumn season (September to November) differs from spring with higher values in temperature and relative humidity, and wind events leading to dust storms. As a result of this climatic situation, the values of aerosol optical characteristics still have higher values than spring until the end of this season , the lowest values of aerosol optical characteristics over Luxor are recorded in November, as opposed to the winter season , for the spring season (March to May) over Cairo and Luxor is characterized by strong winds, moderately high temperature, low relative humidity, in the spring dust and sand particles are carried from the desert area to Cairo and Luxor ([47])

- In addition to direct solar radiation in Luxor and Cairo - resulting in cycles of expansion and shrinkage in turn producing stresses , strains , physical& Mechanical influences on the travertine minerals (calcite crystals expansion and contraction along the C-axis) , also exterior wall-casings of Muhammad Ali Mosque are exposed to wind pressure (figs. 80-81) and air pollution (particularly with sulphur dioxide), resulting in several symptoms and weathering forms according to ([48]) as follow ;

([47]) Zakeya, A.S. Abdelwahab, M.M.and Makar , P.A. Atmospheric turbidity over Egypt , Atmospheric Environment 38, 2004,pp.1579–1591

([48]) The damage diagnosis is required for characterization, interpretation, rating and prediction of weathering damage on stone monuments and is vital for sustainable monument preservation. Damage diagnosis is required for comprehensive characterization, interpretation and rating and prediction of weathering damage on stone monuments and is vital for sustainable , as well as an important basis for deduction of appropriate and economic monument preservation measures , From scientific point of view evaluation by means of weathering forms, damage categories and damage indices provides important information on:
weathering damage in dependence on lithotypes, environmental influences and=

=monument exposure characteristics, development of weathering damage, weathering rates , weathering progression, factors and processes of stone weathering, stone durability , site investigation of monuments makes an important contribution to damage diagnosis on stone monuments, is required as a registration, documentation, quantitative evaluation and rating of stone damages , it is very suitable for certification and control of preservation measures and for long-term survey and maintenance of stone monuments and is useful in planning and decision making of monument preservation policies and strategies as well as to architects, engineers, restorers, conservators, consultants, project managers or construction companies involved in damage diagnosis and monument preservation activities , see : Fitzner, B., Heinrichs, K. & Kownatzki, R., Weathering forms - classification and mapping, Denkmalpflege und Naturwissenschaft, Natursteinkonservierung I, Verlag Ernst & Sohn, Berlin, 1995, pp. 41-88 , also see : Fitzner, B., Heinrichs, K. & Kownatzki, R., Weathering forms at natural stone monuments – classification, mapping and evaluation, International Journal for Restoration of Buildings and Monuments, Vol. 3, No. 2, pp. 105-124,Aedificatio Verlag / Fraunhofer IRB Verlag, Stuttgart, (1997) ; ; Fitzner, B., Heinrichs, K. & Volker, M., Monument mapping - a contribution to monument preservation, in Zezza, F. (Ed.): Proceedings of the E.C. Research Workshop „Origin, mechanisms and effects of salts on degradation of monuments in marine and continental environment“, Bari (Italy), 25-27 March1996, pp. 347-355, C.U.M. – University School of Monument Conservation,
Bari, (1997) ; Fitzner, B. & Kownatzki, R., Erfahrungen mit der Kartierung von Verwitterungsformen an Natursteinbauwerken, in Leschnik, W.& Venzmer, H. (Ed.): Bauwerksdiagnostik und Qualitätsbewertung, WTA-Schriftenreihe, Heft 13, pp. 157-172, Fraunhofer IRB Verlag, Stuttgart, (1997); Kownatzki, R., Verwitterungszustandserfassung von Natursteinbauwerken unter besonderer Berücksichtigung phänomenologischer Verfahren, Dissertation RWTH Aachen, Aachener Geowissenschaftliche Beiträge, Band 22, Verlag der Augustinus Buchhandlung, Aachen, (1997); Fitzner, B. & Heinrichs, K., Damage diagnosis at natural stone monuments - mapping and measurements, Proceedings of the 4th International Congress on Restoration of Buildings and Architectural Heritage, La Habana-Cuba, 13.- 17.07. 1998, pp. 170-172, CICOP – Centro Internacional para la Conservación del Patrimonio, Spain, (1998) ; Kownatzki, R. & Fitzner, B., Verwitterungszustandserfassung an Natursteinbauwerken, Zeitschrift der Deutschen Geologischen Gesellschaft, 150/3, pp. 543-564, E. Schweizerbart´sche Verlagsbuchhandlung, Stuttgart,(1999); Heinrichs, K. & Fitzner, B., Comprehensive characterization and rating of weathering state at monuments carved from bedrocks in Petra/Jordan - weathering forms, damage categories and damage index, Annual of the Department of Antiquities of Jordan, XLIII, pp. 321-351, Amman, (1999); 14. Fitzner, B., Heinrichs, K. & La Bouchardiere, D., Damage index for stone monuments, Proceedings of the 5th International Symposium on the Conservation of Monuments in the Mediterranean Basin, Seville, 5-8 April, 2000, ; Fitzner, B. & Heinrichs, K., Evaluation of weathering damages on monuments carved from bedrocks in Petra/Jordan – a research project 1996-1999, Annual of the Department of Antiquities of= =Jordan, XLII, pp. 341-360, Amman, (1998b) ; Fitzner, B. & Heinrichs, K., Damage diagnosis and preservation of Petra monuments, Mediterranean Magazin: Science, Training and Technology, No. 1, Special issue „New materials and methods for the preservation, conservation and restoration of the Mediterranean cultural heritage and the development of an innovative environmental friendly form of tourism“ (Expert seminar in Naples, 24-25 April 1998), pp. 13-16, Italian National Research Council - Office for Scientific and Technological Cooperation with Mediterranean=

6.1 Discoloration /deposit

6.1.1 Bleaching :

Although of the definition of Bleaching meaning is chromatic alteration resp. decolorization due to chemical weathering of minerals or extraction (e.g. reduction of iron and manganese compounds) or extraction of coloring matter (leaching, washing out) ([49]) , the Bleaching in both the Exterior veneers of Muhammad Ali Mosque and the Exterior surfaces of chapel of Thutmosis IV at Karnak to has a particular meaning As follow : belonging to the distribution of magnesium in Egyptian alabaster there is a difference and a variation in the magnesium content between the translucent type (which is more enriched in magnesium) and the milky-white type, due to differences in the rate of crystallization of both types. The milky-white bands are fine grained because of rapid crystallization) while the translucent bands are coarse-grained because of slow crystallization. Now, if we take the magnesium content as a factor of the solubility where the high- magnesian calcite is more soluble and the low-magnesian calcite which is less soluble into consideration , the differences in magnesium content between the translucent and milky-white marble bands resulting in the latter bands which separate first from solution contain the least soluble component, i.e., the low-magnesian calcite, while the translucent bands which crystallize later contain the more soluble component, i.e. the high-magnesium calcite. The high content of magnesium in the translucent bands had a significant effect on their rate of crystallization ([50]).

It is found - experimentally –that magnesium precludes the formation of calcium carbonate nuclei and is the predominant factor

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=Countries, Naples, (1999) ; 17. Heinrichs, K. & Fitzner, B., Deterioration of rock monuments in Petra / Jordan, Proceedings of the 9th International Congress on the Deterioration andConservation of Stone, Venice – Italy, 19-24 June 2000, Vol. 2, pp. 53-61,Elsevier, Amsterdam, (2000).

([49]) Fitzner, B., et.al., loc.cit., 1995, pp. 41-88.)

([50]) El-Hinnawi, E. E., and Loukina, S.M., , 1972, p.218.

in determining the time of nucleation at high carbonate concentrations , so the enrichment of magnesium in the translucent bands slowed down the rate of crystallization which led to the formation of coarse-grained crystals in these bands ([51]) .

The increase in magnesium content in the translucent bands is accompanied by an increase in the strontium content , this variation in the Sr/Ca ratio is due to differences in the solubility of $CaCO3$ and $SrCO3$. where the latter is more soluble than $CaCO3$ especially at higher temperatures , this indicates that strontium remained largely in solution and accompanied the translucent bands which crystallized later and much slower than the milky-white bands ([52]).

As a result of the exposure of the Egyptian alabaster of wall-casings of the two examples of case study in the Exterior veneers of Muhammad Ali Mosque and the Exterior surfaces of the chapel of Thutmosis IV at Karnak to sunlight for long times , the alabaster translucent of coloring of honey , pale-orange , pale yellow , brown or pale tan to yellowish white with an orange tint calcite is bleached or faded to nearly white.

Ultraviolet and gamma irradiation experiments were undertaken to investigate the source of these colors and the process by which it fades ([53]) . It was found that the coloration results from the activation of color centers by natural radioactivity within the alabaster, and that these color centers are deactivated by the ultraviolet component of sunlight.

The results also demonstrate that the original color of sun-bleached, alabaster objects can be restored by artificial gamma irradiation ([54])

([51]) Pytkowicz, R. M., 1965: Rates of inorganic Calcium carbonate nucleation. J. Geol. 73, 196-199 ;El-Hinnawi, E. E., and Loukina, S.M., , 1972, p.218.
([52]) see : El-Hinnawi, E. E., and Loukina, S.M., , 1972,table 1, p.219.
([53]) Harrell , J. A. , Broekmans, M. A. T. M. and Godfrey-Smith , D. I. , The Origin, Destruction And Restoration of Colour in Egyptian Travertine , Archaeometry , vol.49 , issues 3 ,published online 2 July , 2007, pp.421-436 .
([54]) loc.cit.

up till now this method has not experimented on t the exterior surfaces of the alabaster of building which exposed permanently to the sunrays .

The difference between color of the wall-casings of Egyptian alabaster inside (interior veneers) Muhammad Ali Mosque and outside it (exterior veneers)is not only noticed but also very obvious and the Bleaching of the latter is visible (figs.82- 90) , where the coloring of honey , pale-orange , pale yellow , brown or pale tan to yellowish white with an orange tint are bleached or to white color due to exposure to the sunrays .

And for the Exterior surfaces of the chapel of Thutmosis IV at Karnak and other adjacent alabasterite chapels this phenomena or weathering form is present but is less attractive in view of :

a. The weakness of difference between color of the exterior surfaces of the chapel and interior ones because of the former exposure of bothsunlight due to ancient human-made destruction (the blocks of the chapel were reused in core of Pylon No. III at Karnak where it was found consisted of reused bocks of the chapels of Senwosert I , of Amenhotpe I , Hatshepsut in addition to of Thutmosis IV) .

b. due to he weakness of difference between the quantity of sunrays (ultraviolet rays) which falls on the exterior surfaces and which reach the interior surfaces and reflected on them due to the design of the chapel

c. the exposure of both to sunlight for longer times (figs.91-95).

Lastly I have to cite that what is mentioned above converse what was epidemic before that iron oxides are responsible the coloration of Egyptian alabaster , and prove that it is existed as impurities (figs.96-97).

6.1.2 Gypsum formation

The sulphur dioxide one of the most common and dangerous pollutants which affect the Egyptian alabaster surfaces in buildings in Egypt and in our two examples of this study in wall-casings of Muhammad Ali Mosque , forming gypsum (hydrated calcium sulphate) due to development of sulphate layer via chemical attack on carbonate with the aid of a various catalysts and impurities (which are present either as impurities or) such as air dust (clay minerals) climatic conditions (continental) , wet (high relative humidity) , high values of atmospheric particulate matter porosity and iron oxides .

The presence of gypsum is not restricted to the surface but penetrates deeply down unequally into the alabaster , thereupon deeper penetration and absorption pf sulphur dioxide occurs ([55]), and of course there is a linear direct relationship between the age of archaeological building and the amounts of gypsum formed , although of inverse of results in our two examples , and this may due to shortage of exposure time of alabaster at Karnak regarding to preservation unintentionally as core inside the pylon no. 3 at Karnak , so the presence of some gypsum crystals may be due to Geological formation (according to the presence of some gypsum crystals in the Egyptian alabaster of Wadi El-Assiuty quarry ,the source of Egyptian alabaster at Karnak) , not to alteration (or degradation) of calcium carbonate to calcium sulphate or gypsum formation .

The presence of gypsum formation in the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque and its absence on the Egyptian alabaster of chapel of Thutmosis IV at Karnak indicates to the effectiveness of air pollution in the surroundings of Muhammad Ali Mosque , and is not clear in the surface of the chapel of Karnak because of its weakness of it in Karnak surroundings .

X-ray fluorescence patterns of part of an Egyptian alabaster of exterior wall-casings of Muhammad Ali Mosque , exhibits affluent

([55]) This phenomena not only was observed in limestone because of their porous structure but also in compact structure such as proper Marble , Caner , E., Gukturk , E.H., Turkmenoglu , A. G.and Eseller , G., Effects of Air Pollution on The monuments in Ankra-Case study : Temple if Augustus .Durability of Building Material, Vol.5, 1988 , pp. 463-473 : Boke , H., Caner , E.,Gukturk , H. , Gypsum Formation on Travertines in Polluted Atmosphere , p.243 .

presence of element sulphur (S) which indicates to the presence and gypsum formation (fig.98).

X-ray fluorescence patterns of part of an Egyptian alabaster of Karnak chapel , exhibits limited presence of element sulphur (S) which indicates to the presence of gypsum formation but less than in Muhammad Ali Mosque , also displays presence of Iron as an impurity (fig.99).

SEM micrograph of the sample of exterior wall-casings of Muhammad Ali Mosque , exhibits the formation of gypsum (G), in addition to efflorescence and sub florescence of Halite (H) (fig.100), Egyptian alabaster of Karnak chapel , exhibits limited presence of gypsum formation but is less than in Muhammad Ali Mosque , and presence of some crystals of it may be due to Geological formation not to alteration (or degradation) of calcium carbonate to calcium sulphate or gypsum formation, may be because the air pollution is not influential such in Muhammad Ali Mosque surroundings (fig.101) .

6.1.3 The soiling

For our two examples of this study , the soiling is not very clear in Karnak but it is clear on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque (figs.102-112) **,** (where the latter is in the air polluted capital Cairo where the air pollution Mobile (automotive) emissions are one of the major sources for poor air quality in the Cairo area, and the aerosols formed through primary emissions and secondary reactions are thus potential causes for the observed turbidity values during this season, In addition, strong vertical temperature gradients in the Cairo area in late summer lead to enhanced vertical convection, carrying aerosols aloft and enhancing turbidity .

It was found that in the transitional seasons (spring and autumn), the aerosol optical characteristics recorded significant high values, due to the effects of sand and dust particles emitted from the desert, and also from road-dust sand emitted from the road inside the towns itself. these effects were accentuated in autumn by higher relative humilities and temperatures. Cairo city is also surrounded by Mokattam Hill which provides Cairo with fine sand during strong spring and autumn winds. In the summer season photochemical processes became the main origin of the aerosol and this leads to slight increases in the values of aerosol optical characteristics, despite lower wind speeds (hence less wind-blown dust) relative to other seasons, and In the winter season, the lowest aerosol optical characteristics were measured over Cairo , this was due to the washout by rain and high relative humidity (the latter responsible for increases in aerosol size and deposition especially in the morning hours and late night , A comparison of the seasonal cycle of aerosol optical characteristics at both sites showed: aerosol of photochemical origin in the summer, a significant impact of temperature, relative humidity and dust storms in the autumn; low values of aerosol optical characteristics in the winter (due to precipitative removal as well as relative humidity-impacted deposition); and high values in the spring resulting from seasonal dust storms ([56]) .

So the Soiling on the surface of it is a allochthonous dirt deposits on the stone surface either of pollutants of the atmosphere and are of poor adhesion mainly of grey to black deposits of dust (the composition of settling dust is very rich in quartz and contains gypsum and calcite , The calcium, sulphur, silica and aluminum content of the crusts and dust are also very different. In particular, the silica and aluminum accumulates in the dust compared to the crusts ([57])), fly ash etc. or of particles from surface and bottom water and are of poor adhesion mainly of grey to brown deposits of dust, soil or mud particles, on the stone surface ([58]) of carbonate

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([56]) Zakeya, A.S. Abdelwahab, M.M.and Makar , P.A. Atmospheric turbidity over Egypt , Atmospheric Environment 38, 2004,pp.1579–1591

([57]) To¨ro¨k A , op.cit., 2008 , 56:p.586..

([58]) Fitzner B, Heinrichs K, Kownatzki R , Weathering formsclassification and mapping. In: Snethlage R (eds) Denkmalpfelge und Naturwissenschaft, Natursteinkonservierung I. Ernst &Sohn, Berlin,1995,p 60.

rocks and the formation of weathering crusts in urban areas has been long recognized ([59]), causing blackening of the stone surface (due to the deposition on the stone surface of particulate matter rich in carbonaceous particles,) , and the formation of gypsum , so all degrees of soiling , gypsum was revealed to be the major constituent of dirt layers or crusts , and these layers can vary from tiny prisms to large tabular crystals , SEM show that the dark areas are formed by small-scaled crusts sitting on top of the calcite crystals, due to local dissolution along the crystal boundaries, micro-erosion , another type of discoloration, frequent in well protected places, is characterized by uniform, thin layers of grey to black color, such layers are revealed to be compact though many times very thin, tend to be well-adhered to the surface which, however, frequently shows evidences of dissolution at low rates , It thus seems likely that water accumulating in small amounts with in or beneath such thin crusts has a limited capacity to dissolve the stone material without, however, completely dissolving the gypsum in the overlying layer thick black crusts of irregular shape are just an extreme case of the above , Since such crusts are brittle and tend to detach from the alabaster ([60]) .

The presence of soiling on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque and its absence on the Egyptian alabaster of chapel of Thutmosis IV at Karnak indicates also to the effectiveness of air pollution in the surroundings of Muhammad Ali Mosque , and is not clear in the surface of the chapel of Karnak because of its weakness of it in Karnak surroundings .

X-ray fluorescence patterns a part of an Egyptian alabaster of exterior wall-casings of Muhammad Ali Mosque , exhibits the

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([59]) Kieslinger A Die steine von Sankt Stephan. Verlag Herold,Wien , 1949 ; To¨ro¨k A , op.cit., 2008 , 56:p.588..

([60]) Weber , J. , Beseler , S., Sterflinger K.,Thin-section microscopy of decayed crystalline marble from thegarden sculptures of Schoenbrunn Palace in Vienna , Materials Characterization 58 , 2007, pp. 1042–1051.

presence of element sulphur (S) which is more abundant in surface than the back , in addition to calcium as a principle element , beside Aluminum , silicon , potassium (indicate of the presence of dust (clay minerals) , high values of atmospheric particulate matter and the presence of element of iron indicates to the presence of iron oxides , also the presence of element of lead indicates to the presence of air pollution (fig.113).

SEM photomicrograph of the soiling on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque show that the dark crusts are formed dissolving the gypsum in the overlying layer. thick black crusts of irregular shape are just an extreme case of the above , Since such crusts are brittle and tend to detach from the alabaster , also exhibits the abundant presence of gypsum , in addition to the presence of dust (clay minerals) , high values of atmospheric particulate matter (figs.114 -116).

6.1.4 Black or Dark Crust

The crust on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque is a firmly adhesive deposits on the stone, and the black or dark crust are the most frequent forms of soiling and is related to high concentration of atmospheric pollution a continental climate , air dust , wet, porous, sheltered and semi-sheltered surfaces ([61])

([61]) There are two morphological forms of black crust are the framboidal and laminar black crusts, the first morpho-type has also been described as ropey, dendritic , see : Fassina V, Favaro M, Naccari A , Principal decay patterns on Venetian monuments. In: Siegesmund S, Weiss TS, Vollbrecht A (eds) Natural stones, weathering phenomena, conservation strategies and case studies, special publications 205, Geological Society, London, 2002, pp 381–391; To¨ro¨k A , op.cit., 2008 , 56:p.586

The globular black crusts or black crust changing the surface , see : Antill SJ, Viles HA , Deciphering the impacts of traffic on stone decay in oxford: some preliminary observations from old limestone walls. In: Jones MS, Wakefield RD (eds) Aspects of stone weathering, decay and conservation. Imperial College Press, London , 1999, pp 28-42; Camuffo D (1995) Physical weathering of stone. Sci Total Environ 167:1-14 ; Fitzner B, Heinrichs K, Kownatzki R , Weathering formsclassification and mapping. In: Snethlage R (eds) Denkmalpfelge und Naturwissenschaft, atursteinkonservierung I. Ernst &Sohn, Berlin,1995,pp 41–88; Maravelaki-Kalaitzaki P, Biscontin G , Origin, characteristics and morphology of weathering crusts on Istria stone in Venice.Atmos Environ 331999,pp.1699–1709; To¨ro¨k A , op.cit., 2008 , 56:p.586 .=

And for Two examples of Egyptian alabaster of the study , there is no black or dark crust in the first example of Egyptian alabaster of chapel of Thutmosis IV at Karnak (fig.117) .

The presence of black or dark crust on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque and its absence on the Egyptian alabaster of chapel of Thutmosis IV at Karnak indicates also to the effectiveness of air pollution in the surroundings of Muhammad Ali Mosque , and is not clear in the surface of the chapel of Karnak because of its weakness of it in Karnak surroundings .

X-ray diffraction analysis patterns of dark (grey - to black colored) crust of compact deposits on the surface of a part of an Egyptian alabaster of Muhammad Ali Mosque , exhibits the presence of Gypsum $CaSO_4 .2H_2O$ and $Ca(SO_4) (H_2O)_2$, due to atmospheric pollution (SO_2 pollution) , the continental (arid) climate , air dust , wet, porous, sheltered and semi- sheltered surfaces (figs.118-119)

X-ray fluorescence patterns of Dark crust on both the surface and the back of the same part of an Egyptian alabaster of Muhammad Ali Mosque , exhibits the presence of element sulphur (S) which is- of course - more abundant in surface than the back of the same sample , in addition to calcium , chloride and sodium, that indicates to presence of salts of sodium chloride . This sodium is present - in the Egyptian alabaster of Muhammad Ali Mosque of Sannur- mainly as sodium chloride - by the presence of water-soluble chloride ion - and/or as sodium carbonate, it is to be noted that natron has been detected in minor amounts associated with

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=The framboidal black crust develops on sheltered parts of walls and cornices , the crust can also form isolated patches within the sheltered joints of exposed surfaces or on protected parts of ornaments. The framboidal black crusts are further divided according to their thickness into thin framboidal crusts have a thickness of 1–2 mm

Thick framboidal crusts are the crust surface displays idiomorphic rosette-like gypsum crystals with particulates, calcite and gypsum crystal aggregates , the crusts adhere to the travertine surface and rarely show mechanical decay forms that are typical features of porous limestone , see : To¨ro¨k A , op.cit., 2008 , 56:p.586

travertine – or limestone re-crystallized by the action of subsurface carbonated waters- in the neighborhood of Sannur ([62]) (figs.120-121) .

Thin sections under the petrography of part of Dark crust on the surface of a part of an Egyptian alabaster of Muhammad Ali Mosque cross sections (normal) (left column) (cross Nichol) (right column) x 4) display the presence of gypsum crystals (of white color in left column and of black color in right column) which distributed not only to the surface layer but also distributed inwards and also in pores , the size of gypsum crystals gradually increases outward form the substrate within this layer exterior part of the crust, where the crystals are free to grow, also display minute vugs(of black color in left column) , also display micro cracks (turquoise arrows) ,and a developing micro cracks (bright green arrows) , The underlying substrate is cemented with carbonate and forms a thin weathering rim on the alabaster which is encrusted by gypsum-rich outer layer (figs.122 -127).

6.1.5 Efflorescence and Sub florescence of Halite salt

Where Efflorescence is a Poorly adhesive deposits of salt aggregates on the stone surface and sub-fluorescence is a poorly adhesive deposits of salt aggregates below the stone surface, e.g. in the zone of detachment of scales ([63]) , and for alabaster at Karnak and because of some parts of them which were sunk of more one meter deep annually and watermarks are evident up till now, and because of the rising water of the river Nile had unfiltered - for hundreds of years - before flowed , and infiltration is more harmful than flowing because the rising water through the soil bears salts and pollutants which deteriorated and damaged the stones so photos shows symptoms of Efflorescence Sub florescence of Halite salt , we can observe the form light -colored crust of salt tracing the surface where compact deposit, light - colored, changing the morphology of alabaster surface , due to mainly precipitation

([62]) see : El-Hinnawi, E. E., and Loukina, S.M., , 1972, p.217.
([63]) Fitzner, B., et.al., loc.cit., 1995, pp. 41-88.

process (fig.128-131), also investigation with X-ray fluorescence and analysis with X-ray diffraction display the presence of Halite (figs.132-133) .

X-ray fluorescence patterns of part of an Egyptian alabaster of the chapel of Thutmosis IV at Karnak displays presence of elements sodium (Na) which indicates to the presence of sodium chloride (Halite) (due to efflorescence and sub florescence of Halite salts) in addition to calcium as a principle element , beside Magnesium , silicon , indicate of the presence of dust (clay minerals) due to exposure of inundation matters beside a high values of atmospheric particulate matter (fig.132).

X-ray diffraction patterns of part of an Egyptian alabaster of the chapel of Thutmosis IV at Karnak displays presence of sodium chloride (Halite) (due to efflorescence and sub florescence of Halite salts) in addition to calcium as a principle element (fig.133).

And for alabaster of Muhammad Ali Mosque of Sannur- mainly as sodium chloride – as mentioned before as a result of the action of subsurface carbonated waters- in the neighborhood of Sannur ([64]) , so photos shows symptoms of Efflorescence Sub florescence of Halite salt (fig.134 -140), also investigation with X-ray fluorescence and analysis with X-ray diffraction display the presence of Halite (figs.141-142)

X-ray fluorescence patterns of part of an Egyptian alabaster of Muhammad Ali Mosque displays presence of element of calcium as a principle element ,abundant presence of both sodium (Na) and chloride (Cl)which indicate to the abundant presence of sodium chloride (Halite) (due to efflorescence and sub florescence of Halite salts (of the action of subsurface carbonated waters- in the neighborhood of Sannur) in addition to Magnesium .

So the presence of sodium chloride in Egyptian alabaster of Muhammad Ali Mosque although of rarity of its external sources due to its original geological formation and the presence of sodium

([64]) see : El-Hinnawi, E. E., and Loukina, S.M., , 1972, p.217.

chloride in Egyptian alabaster of chapels of Karnak due to external sources .

6.2 Loss of stone material

6.2.1 Roughening

Finest relief resp. alteration of gloss due to the loss smallest stone particles or corrosion of stone surface smoothed by sawing , grinding or polishing ([65]) , it is observed on the surfaces of the travertine of chapels at Karnak , this symptom is not observed in Egyptian alabaster surfaces of Muhammad Ali Mosque , may be because of absence of Mechanical influences , erosion and friction ,and present in the alabaster of Karnak because of presence of Mechanical influences , erosion and friction more than physical influences (fig.143) .

6.2.2 Pitting

it is a type of loss of stone material as an individual weathering forms is a relief in the form of small pits are caused by biogenically induced corrosion processes, particularly in carbonate rocks ([66]), or are caused may be either by the reaction calcium carbonate with pollutants such as either sulphur (dioxide or sulphate) or chlorides (this cause is outweigh because of presence of evidence of air pollution of ambience of Muhammad Ali Mosque) producing calcium sulphate or calcium chloride which were removed leaving pits or pitting or because of remove of calcite mega crystals and silica ([67]), or caused by taking-down of tenacity of grains of stone with solution due to surface and sub- surface water (we note the influence of surface and sub- surface water on Egyptian alabaster surfaces of Muhammad Ali Mosque via Efflorescence and Sub florescence of Halite salt) resulting in grains separation dissolution near and on the surface producing the pitting symptom on Egyptian alabaster surfaces .

([65]) Fitzner, B., et.al., loc.cit., 1995, pp. 41-88.
([66]) loc.cit.
([67]) Ismail , B., High Light on The Characterization and Conservation of Monumental Travertine (Egyptian Alabaster) , The 2nd International Conference for Development and Environment in The Arab World , 23-25 March , Assiut , 2004, p.11.

this pitting symptom is noticed only on the Egyptian alabaster surfaces of Muhammad Ali Mosque , and were filled with dense nodules as a secondary material , and it is not noticed on the surfaces of chapels at Karnak may be due to the weak presence of air pollution of ambience of Karnak ,or may be due to the structure of the Egyptian alabaster of Muhammad Ali (figs.144-147) .

6.2.3 Back weathering due to loss of scales

It is an Uniform loss of stone material parallel to the original stone surface due to contour and falling down of scales ([68]), this symptom is observed in Egyptian alabaster surfaces of both Muhammad Ali Mosque and chapels at Karnak (figs.148-149).

6.3 Detachment ([69])

6.3.1 Granular disintegration

It is Detachment of individual grains or small grain aggregate into grus

Where there is detachment of larger grains as individual grains or small grain aggregates (stone grus) where shows transitional forms both to flaking and to crumbling ([70]), in Egyptian alabaster of both chapels at Karnak and Muhammad Ali Mosque , and they are observed at the lower parts of walls (figs. 150 -153).

6.3.2 Crumbling

is Detachment of larger , compact stone elements in the form of crumbs, in Egyptian alabaster of Muhammad Ali Mosque and not observed in chapels at Karnak may be due to exposure to less Climatic (physical) influences than Muhammad Ali Mosque (figs. 154 - 155).

6.3.3 flaking to contour scaling

it is observed in Egyptian alabaster of Muhammad Ali Mosque and not observed in chapels at Karnak (fig. 156).

([68])Fitzner, B., et.al., loc.cit., 1995, pp. 41-88.

([69]) Detachment is a group of weathering forms includes all weathering forms describing the actual detachment , see : Fitzner Bet.al .,1995,p 49.

([70]) loc.cit..

6.3.4 Fissures independent of stone structure

it is Fissures Individual fissures or systems of fissures due to natural or constructional causes independent of structural features such as bedding, foliation, banding etc... in Egyptian alabaster of both chapels at Karnak and Muhammad Ali Mosque(figs.157-158).

7. Man-made faults (erroneous restoration)

The chapels of Karnak – where the blocks of the chapels of Thutmosis IV Senwosert I , Amenhotpe I and Hatshepsut were reused in core of Pylon No. III at Karnak – were reconstructed and were compensated with unsuitable material (Portland and white cement) and in with out character style (figs. 159 -164).

Also Muhammad Ali Mosque alabaster veneers were fixed with rusting and insufficient iron bars - which in turn were fixed in walls core with lead- where they are not resistant of the alabaster veneers which are thick to normal thickness of veneers and to be hanging on (its thickness reach to fifteen centimeter , the alabaster veneer slabs were felled by their own dead overweight , thereupon some of these veneers slabs felled down and more could be fall (figs.24-27) .

Also Muhammad Ali Mosque alabaster veneers were compensated with unsuitable material (Portland and white cement) and in with out character style (figs. 165-167).

8. Some Recommendations of preservation

8. 1 . for Muhammad Ali Mosque alabaster veneers :

8.1.1 Dismantling of Mosque alabaster veneers with rightful , feasible and suitable techniques and methods ; for the following reasons :

(i) existence of constructional problems since the design of the metal tie-bars anchorage of makes is too weak to resist the stress imposed on them there are or the volume of masonry engaged in transferring the thrust from the bars to the arches springings were too small to allow the stress being properly distributed , thereupon the stonework adjacent to the bars was torn away from the rest of the masonry , the ties in turn lost their effectiveness , thus is considered the main cause of deformation of mosque as mentioned before , thereupon it is a must to treat it , and for treat it we have to dismantle and remove the mosque alabaster veneers .

(ii) the over thickness and weight of the veneers slabs are thick to normal thickness of veneers and to be hanging on (its thicknesses range from twelve to twenty centimeters (the standard thickness about five centimeters), the alabaster veneer slabs were felled sometimes by their own dead overweight , where its thickness range from 12-20 cm , so the weight of one square meter may reach to 500 kg., as mentioned before , whence the dismantle of the veneers slabs is necessary to deal with the over weightiness of slabs .

(iii) insufficiency of rusted short iron bars which were used to tie blocks of alabaster veneers to the wall core and were fixed in walls with lead **,** therefore the dismantle of the veneers slabs is necessary **.**

(iv) Weathering , deterioration and damage of the veneers slabs **, so** the dismantle will make the preservation process under control and more effective .

where give attention to :

8.1.1.1 preparation a removal scheme ; in which is programmed :

(i) from any façade will be the beginning .

(ii) stage scaffolding against it .

(iii) marking each slab as is removed with appropriate method (according the façade , location of slab ,etc. with documentation and registration and record with suitable method) , and for simple cases a marked elevational photograph would suffice , but for whole facades slabs should numbered from right to left and from below to above on each elevation , and all openings lettered with each of the slabs forming the dressed surround numbered in association with the key letter , the drawings being used as an index.

As it is expected it will be a lot fractures and rubbles of stones regarding the weathering , deterioration and damage of external veneer slabs so we have to employ a code , and a reference grid of smallish squares can be marked out in a removable paint on the face of the façade , we must record the character of each façade by both black and white and colored photographs and a sample of the old work should be left to guide those concerned with reconstruction .

the removing of slabs begins from above to below and from right to left .

(iv) wrapping the slab with appropriate techniques and materials .

(v) lowering the slab .

(vi) since the slabs are weathered , deteriorated , damaged , with low strength and some of them badly fractured , so it had better to be strengthened the weak slabs with inserting thin stainless steel or titanium cemented with mortar and epoxy resin .

(vii) use a small crane and special yokes for lowering the wrapped weak slabs in definite positions , then lifting and transport them from their lowering positions to the storage site with low small light loaders where they have to be trimmed according to its markings and in conservative way and placed on sands bed .

8.1.1.2 preservation works in storage site

8.1.1.2.1 inspection of all slabs carefully to prepare a scheme for preservation

And classify the slabs according its requirement and needs either, compensation , replacement, cleaning and consolidation , isolation and so on .

8.1.1.2.2 And for compensation (completion) of missed parts of veneers slabs , we have to choose and control the Egyptian alabaster of wadis Muwathil and Sannur quarry the original source of Egyptian alabaster Muhammad Ali Mosque (from which we have to select carefully the most appropriate type of alabaster from the quarry ([71]) because is definitive for fidelity of compensation

([71]) so we have to - at the beginning preserve the historical quarry of Sannur (which sometimes nominated Muhammad Ali quarry) and re-open it temporarily to extract and obtain a limited quantity of supply of original the Egyptian alabaster from locations free of any historical marks of stone picks or any archaeological or historical marks , records or inscriptions , so a specific alabaster type is required for the compensation of historical veneers slabs Muhammad Ali quarry) then re-closed or reinstated (the writer of this paper participated in reconstruction and compensation of columns of the hypostyle hall of Amenhotep III at Luxor temple where a=

(completion) process and to indemnify the future health of alabaster - the majority of conservators and restorers in Egypt do not give enough consideration and care and there are not generally sufficient effort to characterize the properties and nature of the archaeological and monumental stone and to identify a replacement and compensation stone with compatible properties , then the use of inappropriate stone or mortar may not only disfigure the appearance of the buildings and monuments but also cause physical damage to the remaining original materials .

In case of

8.1.1.2.2.1 The compensation , partial replacement or replacement of the Egyptian alabaster veneers

For the decision of the compensation , partial replacement or replacement of the Egyptian alabaster veneers of Muhammad Ali Mosque particularly external wall-casings (which are weathered , decayed , deteriorated and damaged of Climatic (physical) and air pollution influences and factors) I conceive that the compensation , partial replacement or replacement with the appropriate type of the Egyptian alabaster of Sannur quarry the original source not only for esthetic and physical future health of stone ([72]) - as mentioned above - but also for two more reasons :

(i) poverty of appropriate restitution mortar .

(ii) the vacancy of the wall-casings slabs of inscriptions .

=quantity of the original Nubian sandstone were quarried - in traditional methods - and transported from Gebel El-Silsila to the site and were used in compensation (completion) of missed parts of columns, and I presume this context to cite of neglect of study and preservation of the archaeological and historical quarries in Egypt as either an extreme source of archaeological and historical data and information or as a basic source for long-term preservation of many archaeological and historical buildings and monuments particularly with the importance of maintenance and conservation of the character and distinctiveness of the archaeological and historical buildings and monuments in Egypt) .

([72]) to saying nothing of having the same properties such as ; thermal expansion , water absorption and strength see : Griswold , J. and Uricheck , S. , Loss Compensation Methods for Stone , Journal of American Institute for Conservation (JAIC) , Spring 1998 , vol. 37, pp. 89-110 .

(iii) the relative recentness of the building , thereupon we can intervene (via partial replacement or replacement) with less sensitivity .
(iv) the compensation , partial replacement or replacement lead to preventive conservation of Frailty and debility structure of the remaining original damaged slabs and to prevent further damage . Then we select compensation for loss to achieve structural necessity , visual integration , taking technical considerations in account ([73]) ,
And of course with putting the value and function in account .

8.1.1.2.2.2 For compensating for small and smaller limited loss in the alabaster veneers

For small limited loss appropriate mortars or plastic repair with internal reinforcement such as wire mesh , stainless steel , titanium pins , dowels or epoxy splints have been to used to preserve all original material - can be made from a completely inorganic and nonpolymer material - where we use a moldable fill including quarried crushed Egyptian alabaster and powder applied directly to the loss of alabaster slabs and set into place by its own adhesion , and includes - beside crushed alabaster and powder - mortar and putty of a fine slaked lime plus fine grain sand -based plus organic binder with consistency of a dough , to be of binder (matrix) , filler (aggregate , here the crushed alabaster and powder) , color components and special additives .

For smaller limited loss appropriate mortars or plastic repair without internal reinforcement .

8.1.1.2.3 Cleaning and removal of weathering and deterioration products on veneers

This process has to be delayed either to pro reconstruction of veneers or after reconstruction to avoid re-staining during wrapping , transportation , lifting and re-fixing .

([73]) such as ; to be reversible, does not damage the original , does not require original removal , equal or less than the strength of the original material , stable , non toxic , transferable to all cases and satisfies aesthetic requirement , select replacement (in-kind) and subjugate replacement (near -kind) and (in pre-cast) forms of compensation

8.1.1.2.3.1 Removal of soiling

With non-ionic detergents and gels and packs with a PH range of 7.5-8.5 , and we have to collect the bulk of the cleaning materials before rinsing which requires extensive protective and water collection procedures .

8.1.1.2.3.1 Removal of Efflorescence and Sub florescence of Halite salt

(i) brushing with soft natural bristle brushes and removing the brushed deposits to avoid entering again .

(ii) avoiding watering to avoid reabsorbing , instead we can use damp sponge and is frequently rinsed in clean water .

(iii) we can use the weak acid ethylene diaminotetra-acetic acid via Mora poultice (EDTA) which used successfully on the Egyptian alabaster because of its ability of dissolution of calcium salts , it contains 60 g. ammonium bicarbonate , 60 g. sodium bicarbonate , 25 g. (EDTA) , 10 g. surfactant disinfectant and 60 g. carboxymethylcellulose in 1000 ml of water where ammonium and sodium bicarbonate give a slightly basic mixture of PH 7.5 is able to dissolution of some salts , where the poultice is applied in the form of jelly on a pre-wetted surface to a thickness of 3-4 mm and is covered wit a thin polyethylene film to avoid drying out particularly with the difficulty of removing the dried cellulose body , then it is left for 24 hours and is lifted then is reapplied , then the surface is washed with clean water , and this poultice is safe chemically and does not remove surface material from friable surfaces of veneer slabs ([74])

Also we can use clay poultices , with removing the poultice as soon as dried to avoid re-depositing efflorescence .

8.1.1.2.4 Fracture repair

For vertical ones are repaired from the bottom to the top and bonding both sides , stainless steel or titanium wire reinforcement

([74]) Ashurst , J., conservation of Building and Decorative stone , vol. 2 , Butterworth-Heinemann Ltd. , 1990, p.134.

can be inserted and a precast mortar bonding beam can be cut and faced within the thickness .

8.1.1.2.5 Consolidation

For several Weathering and Deterioration forms and symptoms such as Granular disintegration , Fissures independent of stone structure , etc.

Wacker OH 100, MTMOS and Paraloid B 72 were experienced where Wacker OH 100 improved Muhammad Ali Mosque veneers weathered samples of Bulk density from (2.75) in untreated sample to (2.80) with Paraloid B 72 , to (2.84) with Wacker OH 100 and to (2.92) with MTMOS (fig.168).

And for water absorption improved (reduced) from (0.8 %) in untreated sample to (0.25 %) with Paraloid B 72 , and to (0.3 %) with MTMOS , and does not improve with Wacker OH 100 (fig.169).

And for compressive of strength (dry) from (375.5) in untreated sample to (512.1) with Paraloid B 72 , to (524.7) with MTMOS and to (524.7) with Wacker OH 100 (fig.170).

And for compressive of strength (wet) from (266.5) in untreated sample to (450.3) with Paraloid B 72 , to (524.7) with MTMOS and to (527.5) with Wacker OH 100 (fig.171).

So all tried consolidates improved the weathered samples of Muhammad Ali Mosque veneers (except Wacker OH 100 in water absorption) , but there is an important note that Paraloid B 72 changed -insignificantly - the surface color Wacker OH 100 exhibited a good penetration .

Thereupon I conceive that Wacker OH 100 is very appropriate for surface consolidation .

But another important note that the study recommendation include

Dismantling of veneers slabs , so there a golden opportunity to consolidate the slabs via their backs - after of course – another interventions steps like thickness reduction etc. , so I conceive

Paraloid B 72 will be the most appropriate consolidate here for its many advantages (like its good spread inside the stone structure , its suitability to the climate and physical influences for which the masque is subjected and its ambient.) .

8.1.1.2.6 Strengthening and compensation of frailty and debility structure of some ornamental architectural elements .

Also with appropriate mortars or plastic repair without internal reinforcement .

8.1.1.2.7 Cracks repair

For inactive short and isolated Cracks , it is nonsense because it will be disappeared with Dismantling of veneer slabs which will be preserved in storage site and will be reconstructed in their positions.

For active Cracks , it is symptom due to the design of the metal tie-bars anchorage of makes it too weak to resist the stress imposed on them , and we have to begin with deal with the cause and source Constructional defects, where we have to correct and rectify the defects .

8.2 Constructional (structural) preservation :

Because of existence of constructional problems in the mosque (since the design of the metal tie-bars anchorage of makes is too weak to resist the stress imposed on them or the volume of masonry engaged in transferring the thrust from the bars to the arches springings were too small to allow the stress being properly distributed , thereupon the stonework adjacent to the bars was torn away from the rest of the masonry , the ties in turn lost their effectiveness , thus is considered the main cause of deformation of mosque as mentioned before , thereupon it is a must to exchange the metal tie-bars anchorage of makes is strong enough to stress imposed on them or the volume of masonry engaged in transferring the thrust from the bars to the arches springings have to be big enough to allow the stress being properly distributed.

Constructional (structural) preservation needs along detail , and this context does not admit it .

8.3 Reconstruction of veneers slabs

After the ending of the constructional (structural) preservation of the mosque , after the ending of preservation works for slabs in storage site (the compensation , partial replacement or replacement , Fracture repair , Consolidation , with delaying the cleaning and removal of weathering and deterioration products completely or partially (it is possible to remove and clean the complex products in storage site , and delayed the others after reconstruction operations).

Then reconstruction operations are carried out with sufficient and appropriate fixers of strong stainless metal .

Accomplishment of cleaning process , and it is possible to repeat some Consolidating process if it is necessary .

8.4 for chapels of Karnak

8.4.1 for compensation (completion) of missed parts **, partial replacement or replacement and for compensating for small and smaller limited loss**

I recommend the same material and technique which is recommended in veneers slabs of Muhammad Ali Mosque .

8.4.2 Cleaning and removal of weathering and deterioration products

8.4.3 for the Removal of Efflorescence and Sub florescence of Halite salt

I recommend the same material and technique which is recommended in veneers slabs of Muhammad Ali Mosque .

8.4.4 Fracture repair

I recommend the same .

8.4.5 Consolidation

Wacker OH 100, MTMOS and Paraloid B 72 were experienced where Wacker OH 100 improved of Karnak chapels weathered samples of Bulk density from (2.45) in untreated sample to (2.84) with Paraloid B 72 , to (2.96) with Wacker OH 100 and to (2.95) with MTMOS (fig.172).

And for water absorption improved (reduced) from (1.1 %) in untreated sample to (0.7 %) with Paraloid B 72 , and to (0.45 %) with MTMOS , and to (0.6 %) with Wacker OH 100 .

And for compressive of strength (dry) from (296.5) in untreated sample to (451.11) with Paraloid B 72 , to (463.7) with MTMOS and to (475.9) with Wacker OH 100 (fig.173).

And for compressive of strength (wet) from (260.5) in untreated sample to (444.3) with Paraloid B 72 , to (518.7) with MTMOS and to (521.5) with Wacker OH 100 (fig.174).

So all tried consolidates improved the weathered samples of Karnak chapels, thereupon I conceive that Wacker OH 100 is very appropriate for surface consolidation particularly it exhibits a good penetration (fig.175).

8.4.6 Strengthening and compensation of frailty and debility structure of some ornamental architectural elements .

Also with appropriate mortars or plastic repair without internal reinforcement .

8.4.7 Perfection of some man-made faults (erroneous restoration)

As possible as we can to remove unsuitable material of reconstruction and compensation (Portland and white cement etc. from the chapels of Thutmosis IV Senwosert I , Amenhotpe I and Hatshepsut at Karnak

and re-compensated or replaced in character style (it is preferable that the re-compensation or replacement are accomplished with the appropriate type of the Egyptian alabaster of El-assiuty quarry the original source not only for esthetic and physical future health of stone .

and the same for veneers slabs of Muhammad Ali Mosque .

9. results discussion and conclusion

Table 1 Comparing in weathering , deterioration , damage and Some Recommendations of preservation between Egyptian alabaster of chapel of Thutmosis IV at Karnak and Egyptian alabaster of Muhammad Ali Mosque

Serial No.	Weathering , Deterioration and Damage form or symptom	chapel of Karnak	Muhammad Ali Mosq ue	N.B.
1	**Constructional Defects**			
1.1	**Cracks**			
1.1.1	Inactive short and isolated Cracks	absent	present	It is absent in Karnak because of absence Constructional defects (Constructional methods plus physical and chemical properties of materials) .
1.1.2	Active Cracks	absent	present	It is absent in Karnak because of absence Constructional defects (because of the design of the metal tie-bars anchorage of makes it too weak to resist the stress imposed on them , or the volume of masonry engaged in transferring the thrust from the bars to the arches springings were too small to allow the stress being properly distributed , thereupon the stonework adjacent to the bars was torn away from the rest of the masonry , the ties in turn lost their effectiveness , thus is considered the main cause of deformation of mosque.
1.2	Frailty and debility structure of some ornamental architectural elements	present	present	
2	Structural Defects			
2.1	The colloform structure	present	present	
2.2	Vugs and cavities	present	absent	The absence in Muhammad Ali Mosque because of absence of Mechanical influences , erosion and friction less than physical influences .
2.3	Granulation	present	absent	absent in Muhammad Ali

Serial No.	Weathering , Deterioration and Damage form or symptom	chapel of Karnak	Muhammad Ali Mosque	N.B.
				Mosque because of absence of Mechanical influences , erosion and friction .
3	Climatic (physical) weathering and Deterioration			
3.1	Discoloration /deposit			
3.1.1	Bleaching	present	present	This symptom in Karnak is less clear than Muhammad Ali Mosque for several reasons
3.1.2	Gypsum formation	absent	present	The absence of gypsum formation in Karnak , may due to shortage of exposure time of alabaster at Karnak regarding to preservation unintentionally as core inside the pylon no. 3 at Karnak , so the presence of some gypsum crystals may be due to Geological formation not to alteration (or degradation) of calcium carbonate to calcium sulphate or gypsum formation, may be because the air pollution is not influential such in Muhammad Ali Mosque surroundings
3.1.3	Soiling	Not clear	present	The soiling is clear in Muhammad Ali Mosque because of effectiveness of air pollution in its surroundings , and is not clear because of its weakness of it in Karnak surroundings .
3.1.4	Black or Dark Crust	absent	present	For the former reasons mentioned above .
3.1.5	Efflorescence and Sub florescence of Halite salt	present	present	Efflorescence and Sub florescence of Halite on the alabaster of Karnak due to the rising water of the river Nile had unfiltered - for hundreds of years , so it is of external sources, but Efflorescence and Sub florescence of Halite on the alabaster of Muhammad Ali Mosque of Sannur- mainly as sodium chloride as a result of the action of subsurface carbonated waters- in the neighborhood of Sannur in its original geological formation

Serial No.	Weathering , Deterioration and Damage form or symptom	chapel of Karnak	Muhammad Ali Mosq ue	N.B.
4	Loss of stone material			
4.1	Roughening	present	absent	absent in Muhammad Ali Mosque because of absence of Mechanical influences , erosion and friction ,and present in the alabaster of Karnak because of presence of Mechanical influences , erosion and friction more than physical influences .
4.2	**Pitting**	**absent**	**present**	**it is absent on the surfaces of chapels at Karnak may be due to the weak presence of air pollution of ambience of Karnak ,or may be due to the structure of the Egyptian alabaster of Muhammad Ali .**
4.3	**Back weathering due to loss of scales**	**present**	**present**	
5	**Detachment**			
5.1	**Granular disintegration**	**present**	**present**	
5.2	**Crumbling**	**absent**	**present**	**It is absent at Karnak may be due to exposure to less Climatic (physical) influences than Muhammad Ali Mosque**
5.3	**flaking to contour scaling**	**absent**	**present**	**It is absent at Karnak may be due to exposure to less Climatic (physical) influences than Muhammad Ali Mosque**
5.4	**Fissures independent of stone structure**	**present**	**present**	
5	**Some Recommendations of preservation**			
5.1	**Dismantling of the alabaster veneers with rightful , feasible and suitable techniques and methods**			
		absent	**present**	**for the special reasons of Muhammad Ali Mosque**
5.2	**preservation works in storage site**			
		absent	**present**	
5.2.1	**inspection of all slabs carefully to prepare a scheme for preservation**			
5.3	**The compensation , partial replacement or replacement of the Egyptian alabaster**			
		present	**present**	It is preferable that the appropriate type of the

Serial No.	Weathering , Deterioration and Damage form or symptom	chapel of Karnak	Muhammad Ali Mosq ue	N.B.
				Egyptian alabaster of the quarry the original source not only for esthetic and physical future health of stone
5.3.1	**compensating for small and smaller limited loss**			
		present	present	It is preferable that with the appropriate mortars or plastic repair with internal reinforcement
5.3.2	**For smaller limited loss**			
				It is preferable that with the appropriate mortars or plastic repair without internal reinforcement .
5.4	**Cleaning and removal of weathering and deterioration products on veneers**			
5.4.1	**Removal of soiling**			
		absent	present	With non-ionic detergents and gels and packs with a PH range of 7.5-8.5 , and we have to collect the bulk of the cleaning materials before rinsing which requires extensive protective and water collection procedures .
5.4.2	**Removal of Efflorescence and Sub florescence of Halite salt**			
		present	present	we can use the weak acid ethylene diaminotetra-acetic acid via Mora poultice (EDTA) which used successfully on the Egyptian alabaster
5.5	**Fracture repair**			
		present	present	For vertical ones are repaired from the bottom to the top and bonding both sides , stainless steel or titanium wire reinforcement can be inserted and a precast mortar bonding beam can be cut and faced within the thickness .
5.6	**Consolidation**			
		present	present	Paraloid B 72 will be the most appropriate consolidate here for Muhammad Ali Mosque veneers slabs via its back after dismantale for its many advantages (like its good spread inside the stone

Serial No.	Weathering , Deterioration and Damage form or symptom	chapel of Karnak	Muhammad Ali Mosq ue	N.B.
				structure , its suitability to the climate and physical influences for which the masque is subjected and its ambient. And for Karnak chapels, Wacker OH 100 is very appropriate for surface consolidation particularly it exhibits a good penetration
	Strengthening and compensation of frailty and debility structure of some ornamental architectural elements .			
5.7		**present**	**present**	with appropriate mortars or plastic repair without internal reinforcement .
5.8	**Perfection of some man-made faults (erroneous restoration**			

Figs. 1-5 Thin sections microphotograph of a an alabaster sample of Wadi El Assiuty the source of alabaster at Karnak displays drusy mosaic of calcite (disoriented small calcite crystals), the texture is an harmonic mixture of fibrous and equant mosaics resulting in the fine layering of the alabaster a variety of bands of variety of translucency degrees especially delicately banded which due to alternation of bands of translucent creamish type with the opaque milky white type , a yellowish translucent band consists of elongated fibrous crystals , the texture is a fibrous mosaic alternating with an equant mosaic , abundant amorphous carbonate either as patches or as bifurcating vein lets , and there is an important note : there no almost micro cracks or fissures with presence of some gypsum crystals comparing with the weathered samples were taken from Karnak according to explain forth coming .

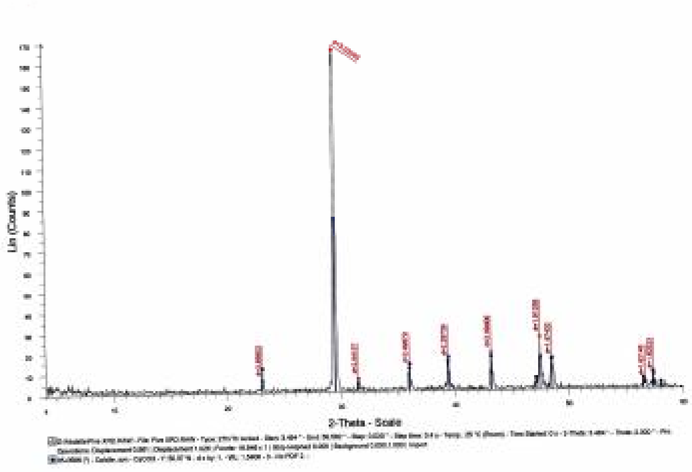


Fig. 6 X-ray diffraction analysis patterns of a an alabaster sample of Wadi El Assiuty the source of alabaster at Karnak displays presence the calcite CaCO3 as a main component .

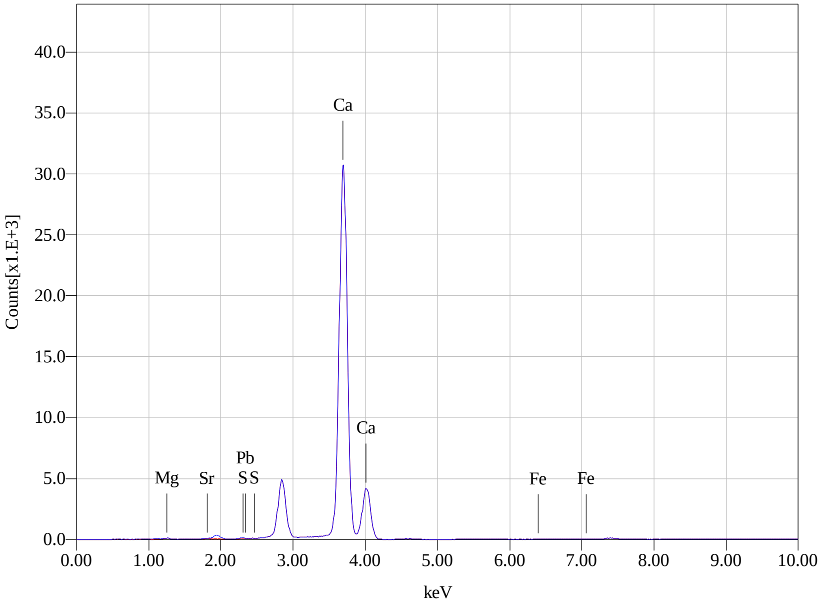
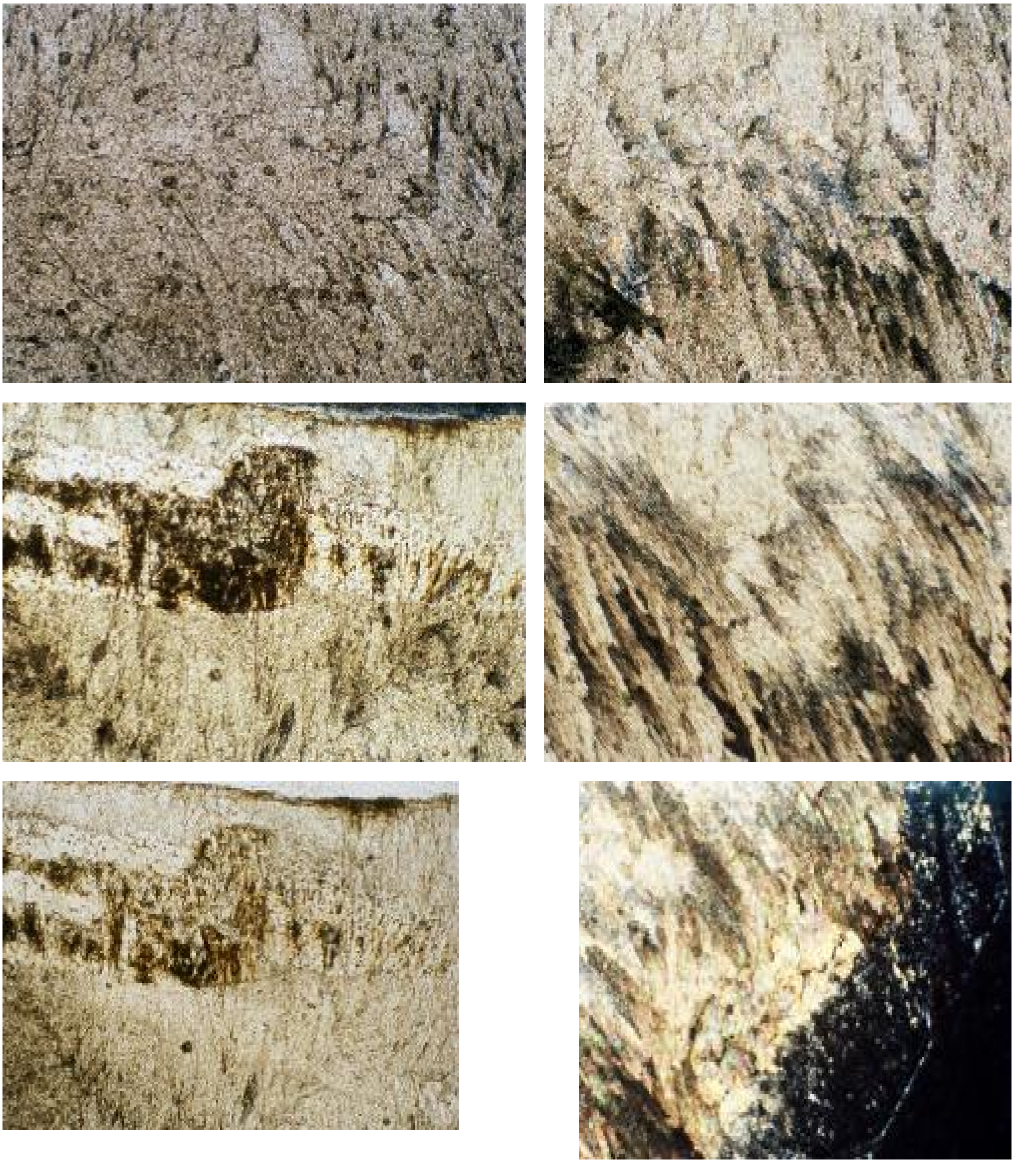


Fig. 7 X-ray fluorescence patterns of part of a an alabaster sample of Wadi El Assiuty the source of alabaster at Karnak displays presence of calcium as a principle element in addition to magnesium , strontium

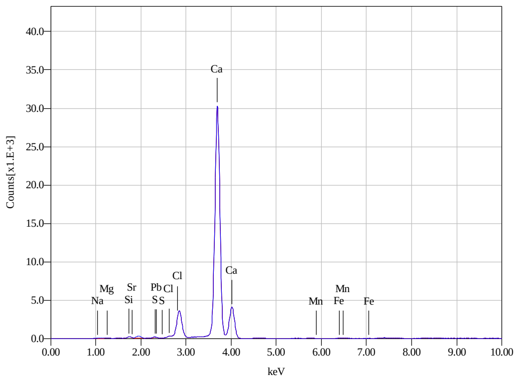
Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Mg	K	1.25	2.3711	3.8573	0.0058472	1034	4.2256
S	K	2.31	0.0452	0.0557	0.0004477	561	0.0790
Ca	K	3.69	97.1988	95.9148	0.5602907	455902	0.3258
Fe	K	6.40	nd				
Sr	K	14.14	0.3787	0.1709	0.0042925	4382	0.2458
Pb	L	10.54	0.0062	0.0012	0.0000803	37	0.5293

Figs. 8-13 Thin sections microphotograph of a translucent alabaster sample of Wadi Sannur the source of alabaster at Muhammad Ali Mosque (Normal – left column) (C.N - displays a mosaic of interlocked calcite crystals of different size and shape.)right column They vary from flat platy to fibrous and bent, exhibiting undulatory extinction between crossed polarizers(right column) where he crystals have generally different optical orientations, zoning is also well-marked, representing the successive growth of different layers with the same optical orientation. In sections cut perpendicular to the elongation of the translucent crystals a mosaic of fibrous and fine patches of crystals appears, giving a characteristic wavy extinction between crossed polarizers (right column). Parallel orientation may be noted or just a random distribution of the feather-like crystals may be observed.

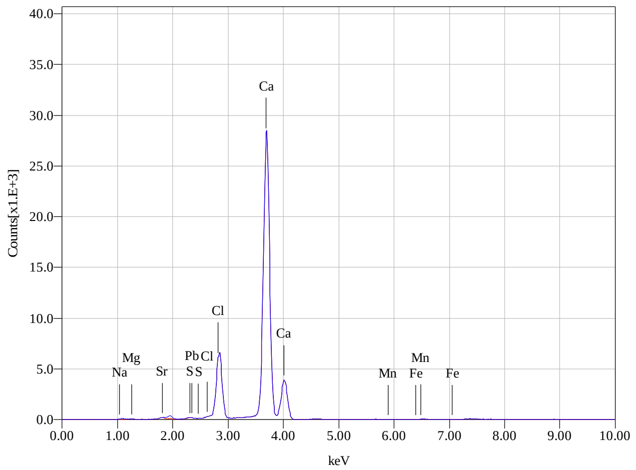


Figs. 14-19 thin sections microphotograph of a the milky-white bands alabaster sample of Wadi Sannur(Normal – left column) (C.N - right column) - Suturing may be distinct between groups of calcite bundles Contrary to the translucent bands- consist of an aphanic to finely grained (crystalline) mosaic of calcite. X-ray diffraction analysis of both the translucent and milky-white alabaster showed no aragonite lines. no gradation of growth has been observed between the milky-white and the translucent bands. In many cases the white bands appear to be fine and dense, giving a dark (opaque) appearance under the microscope. colloform texture is very common in these bands indicating their deposition from a colloidal medium.

Figs . 20 -21 **X-ray fluorescence patterns of part of a an alabaster sample of Wadi El Assiuty the source of alabaster at Sannur the source of alabaster at Muhammad Ali Mosque displays presence of calcium as a principle element in addition to magnesium and silicon .**



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Na	K	1.04	0.4408	0.7595	0.0007417	41	30.9663
Mg	K	1.25	0.9318	1.5182	0.0025761	399	3.1321
Si	K	1.74	0.6667	0.9403	0.0039977	2470	0.3385
S	K	2.31	0.1364	0.1685	0.0015364	1686	0.0577
Cl	K	2.62	0.5327	0.5952	0.0059914	5067	0.1325
Ca	K	3.69	97.0308	95.8999	0.6260502	445733	0.2415
Mn	K	5.89	nd				
Fe	K	6.40	0.0433	0.0307	0.0001602	206	0.2156
Sr	K	14.14	0.1771	0.0801	0.0022681	2026	0.1805
Pb	L	10.54	0.0405	0.0077	0.0005934	237	0.3895



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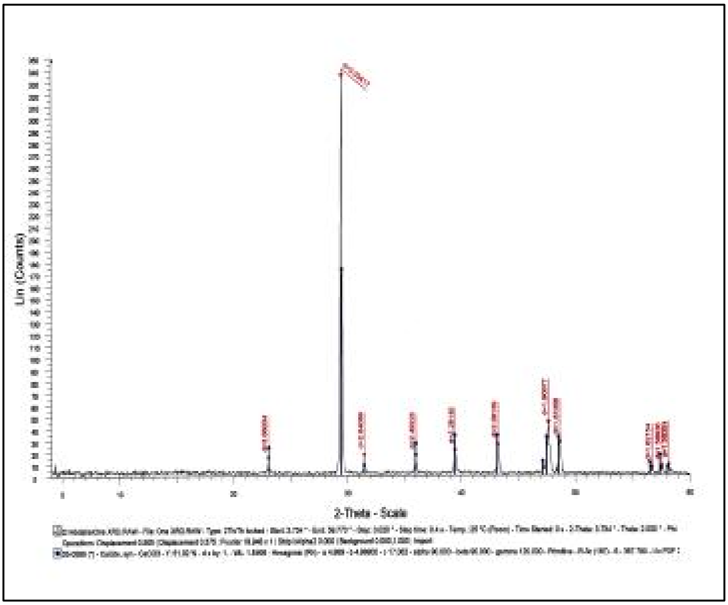
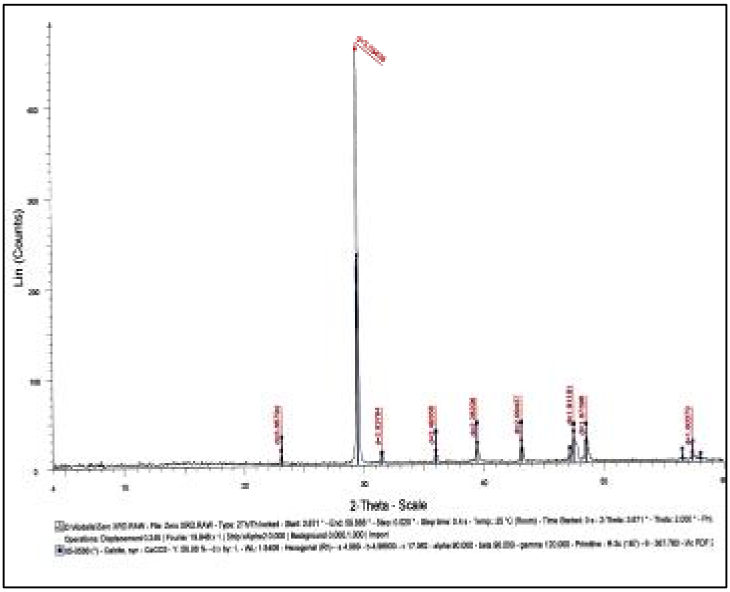
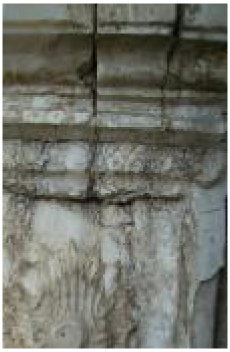




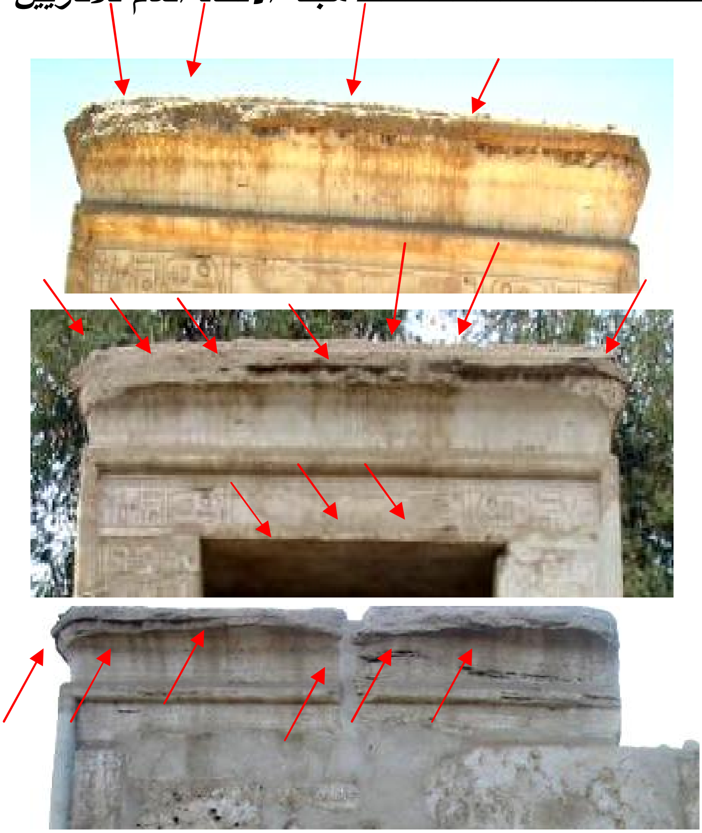
Figs. 22-23 X-ray diffraction analysis patterns of a an alabaster sample of Wadi Sannur the source of alabaster at Muhammad Ali Mosque displays presence the calcite $CaCO_3$ as a main component .

Figs. 24- 27 The short iron bars which were used to tie blocks of alabaster veneers to the wall core and were fixed in walls with lead , the rusting and corrosion of hundreds thousands of caused expansion consequently produced forces which in turn created tension resulting in the 1st type cracks , also I have to cite that the alabaster veneer were felled by their own dead overweight .



Figs. 28-31 the first type of cracks which are usually short and isolated involving small deformation of masonry , and they are distributed randomly and irregularly over the whole building **-** is related to both the physical and chemical properties of materials and constructional methods

Figs. 32 - 42 Display cracks of 2nd type in the springings of all lintels above openings in the mosque at positions of heavy load, the lower left photo. From Supreme Council of Antiquities archives (1935) .



Figs. 43- 47 Display frailty and debility structure of some ornamental architectural elements of Egyptian alabaster chapels at Karnak such as the Cavetto Cornices and torie which are along the horizontal upper edge and along the corners of the façade of them , in addition to being hanged partially on space , have exposed them to fracture and loss or to erosion (arrows) .

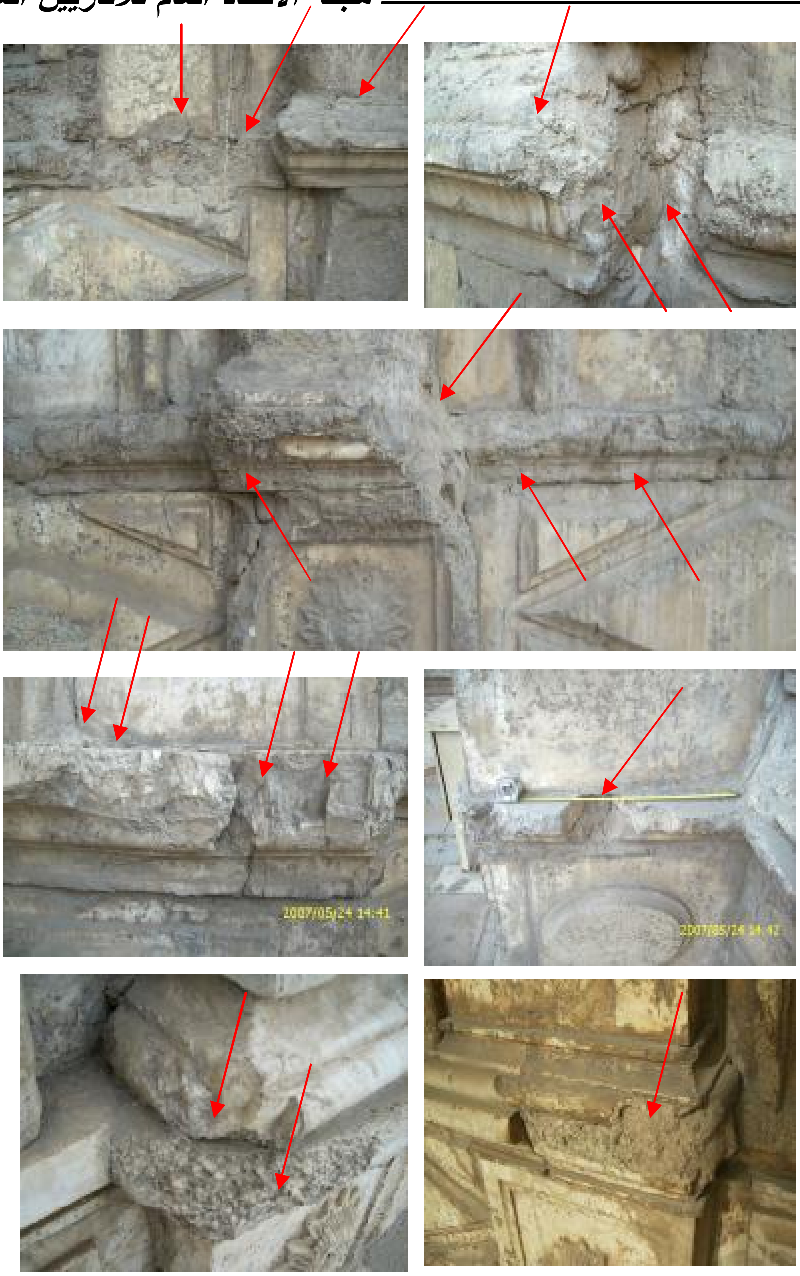
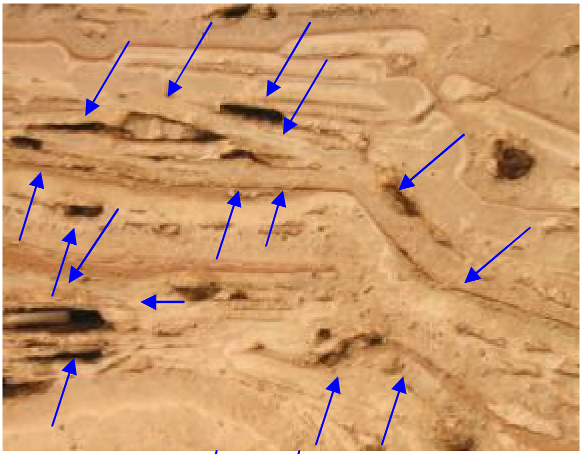
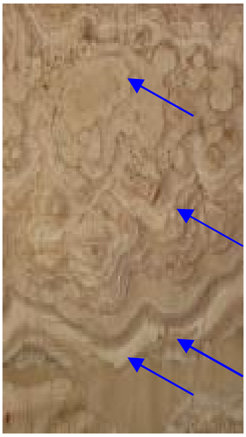
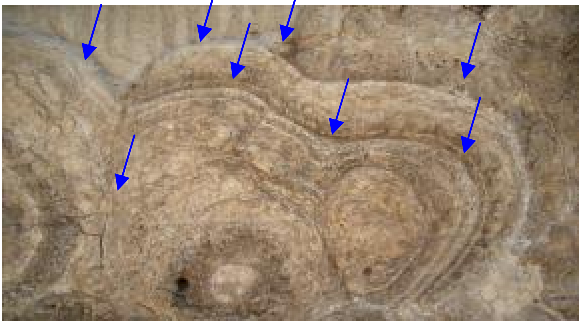
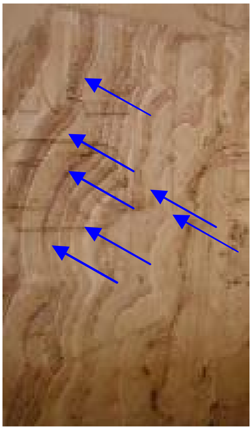


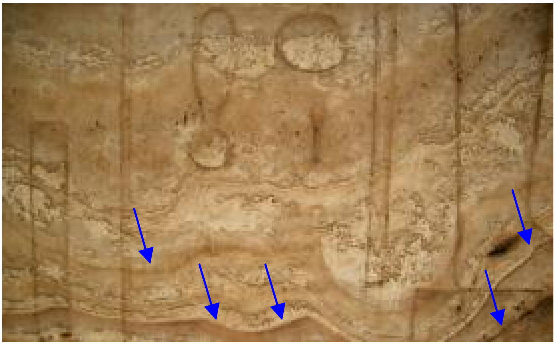
Fig.48-54 Frailty and debility structure of some ornamental architectural elements of Egyptian alabaster of Muhammad Ali Mosque such as the Cavetto Cornices , in addition to being hanged partially on space , have exposed them to fracture and loss or to erosion (arrows) , also disintegration and soiling can be noted .











Figs. 55- 60 Display the Egyptian alabaster (Travertine) surfaces of chapels of Karnak of Wadi El-Assiuty characterized of presence of botryoidal or colloform structure and the planes of the colloform structure are weakness planes because of the tendency to break along these planes (arrows) , also display covering the convex and the outer surface of stone with a thin layer of red iron oxide and that indicts it belongs to The 3rd type of the colloform structure forms which is of colloidal origin and existence of the spheroidal surfaces - which due to surface tension phenomena

Figs. 61-64 Display the Egyptian alabaster (Travertine) surfaces of Muhammad Ali Mosque of Wadi Sannur characterized also of presence of botryoidal or colloform structure but the planes of the colloform structure are not weakness planes such as chapels of Karnak of Wadi El-Assiuty, even in external veneers , and that indicates to that weakness due to structural and geological reasons

Figs 65-66 display the first type of vugs and open spaces is a minute cavities of distribution throughout the surfaces of the travertine of chapels at Karnak of Wadi El-Assiuty, and they were stained with red iron-ox**ide**

Figs 67-68 display the third type of vugs and open spaces is large 30-80 cm. long into which protrude almost spherical surface of the travertine of chapels at Karnak of Wadi El-Assiuty

Figs 69 – 71 display the second type of vugs which is confined to parts which appear to the outer surfaces of the travertine of chapels at Karnak of Wadi El-Assiuty, of the alabaster deposit , the vugs occur elongated is of the milky white type

Fig. 72 display the vugs occur elongated is of the milky white type surfaces of the travertine of chapels at Karnak of Wadi El-Assiuty (it looks like weathering out of stone components clearing out of stone components

Fig.73 display the vugs repair in the surfaces of the travertine of chapels at Karnak of Wadi El-Assiuty

Figs. 74-75 Display superficial coarsening and granulation on the surfaces of the travertine of chapels at Karnak smoothed by corrosion polishing as external deterioration factors.

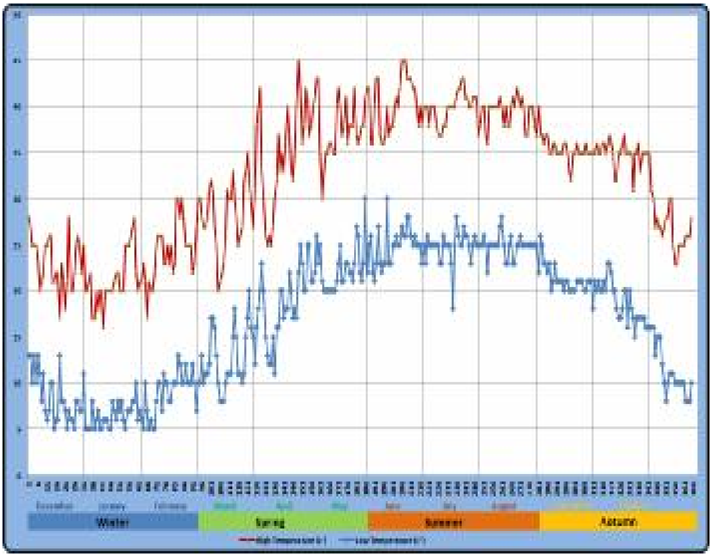


Fig. 76 display daily variation of air temperature in Luxor (maximum temperature and minimum temperature) during 2007 .

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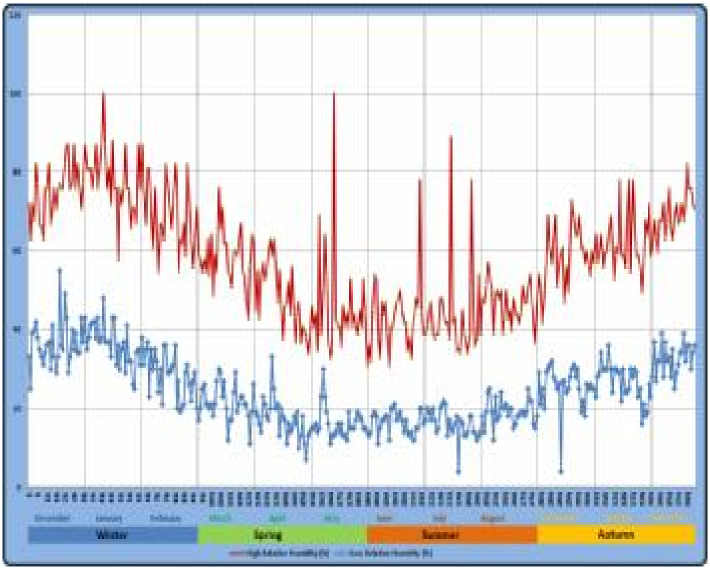


Fig. 77 display daily variation of relative humidity in Luxor (maximum temperature and minimum temperature) during 2007 .

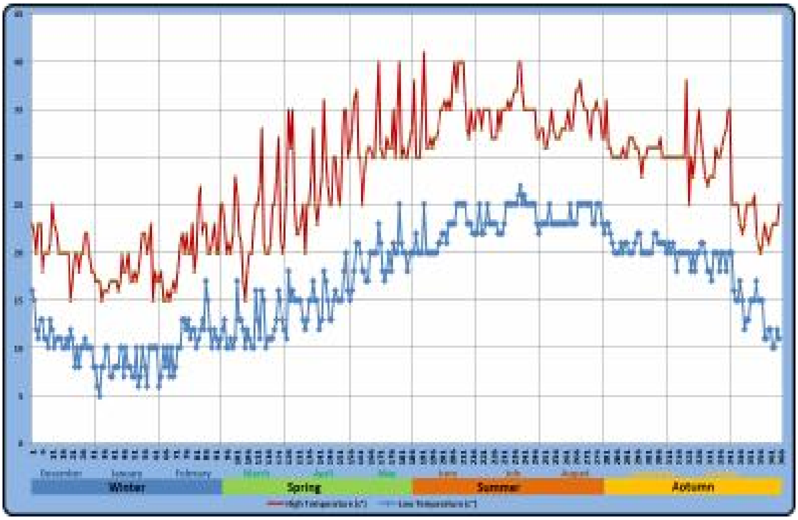


Fig. 78 display daily variation of air temperature in Cairo (maximum temperature and minimum temperature) during 2007 .

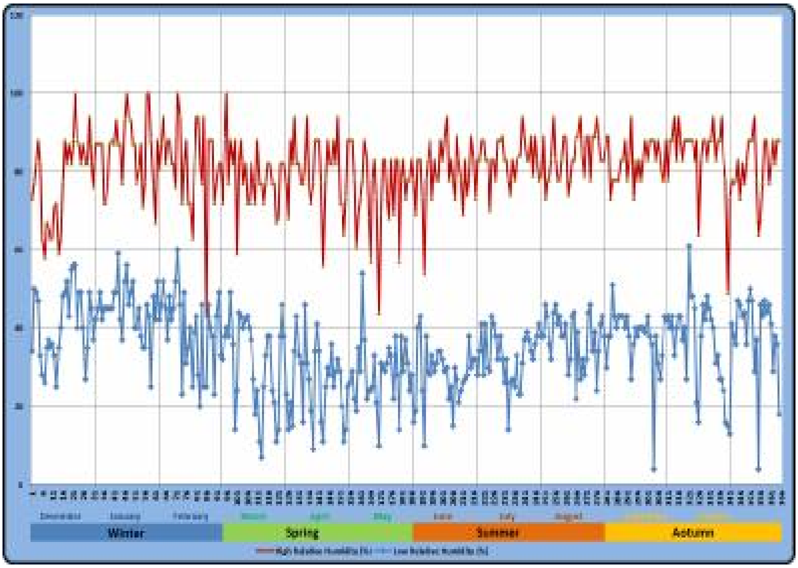


Fig. 79 display daily variation of relative humidity in Cairo (maximum temperature and minimum temperature) during 2007 .

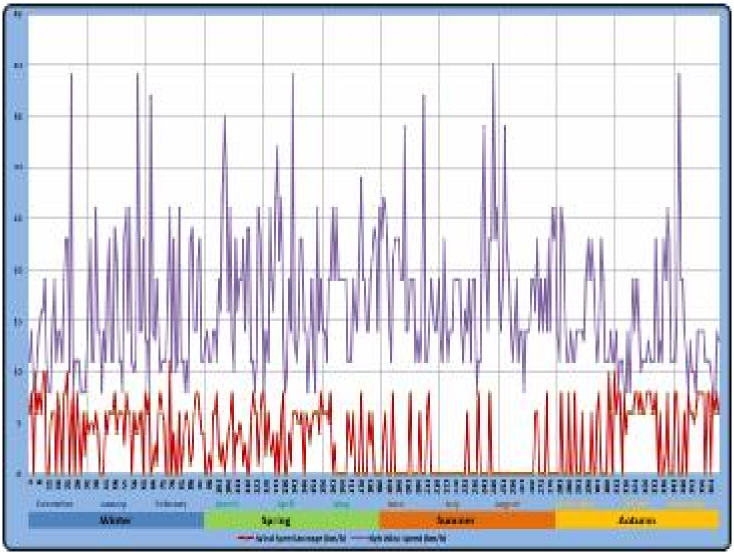


Fig. 80 display daily variation of wind speed in Luxor during 2007 .

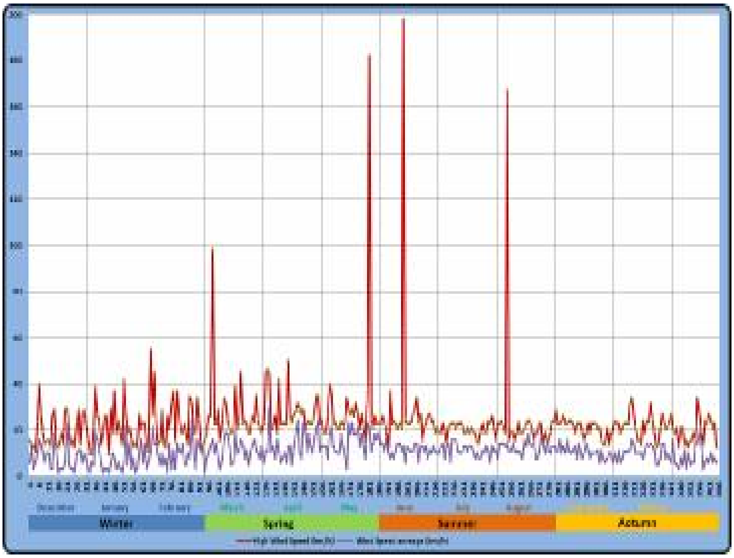
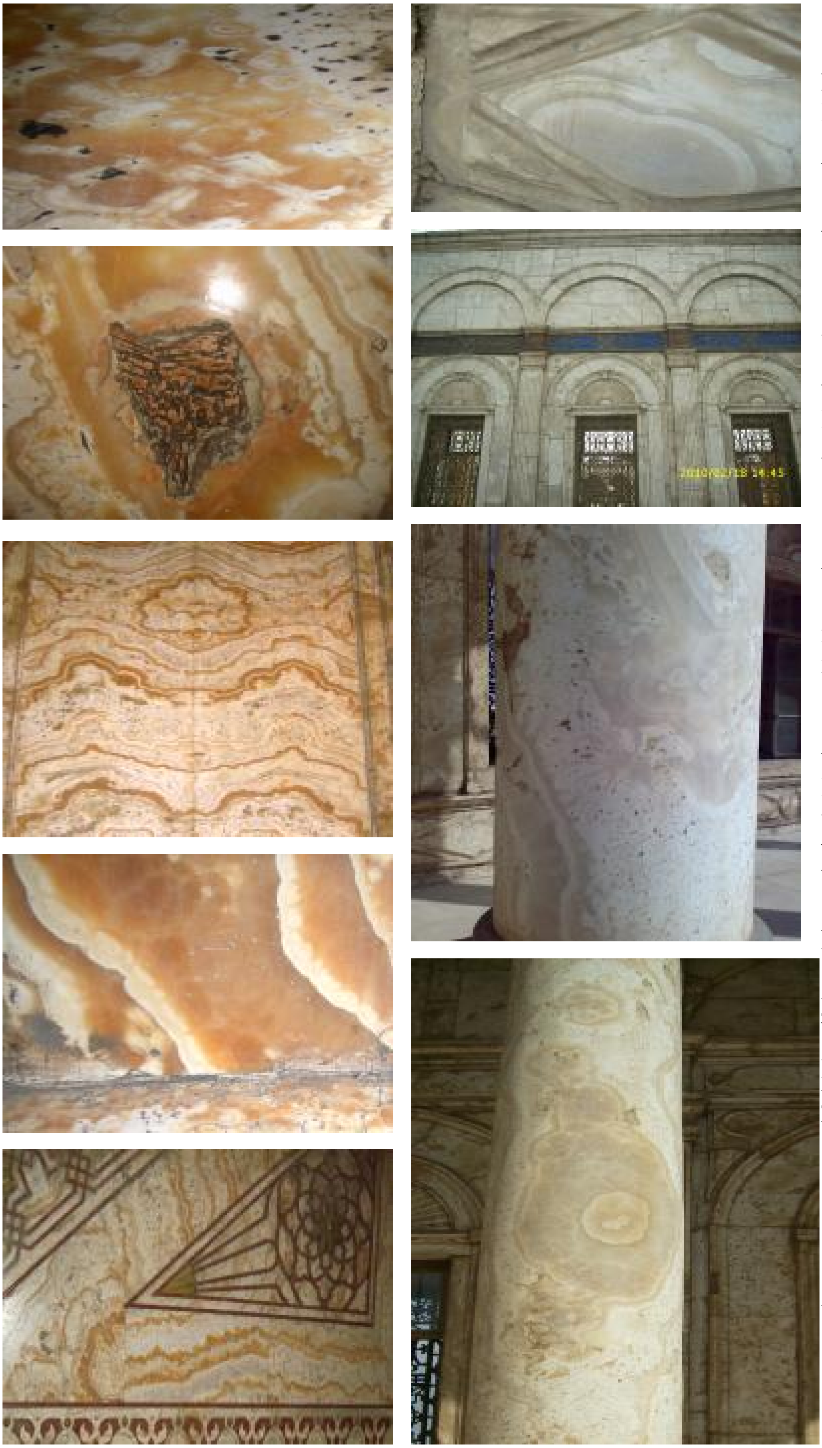
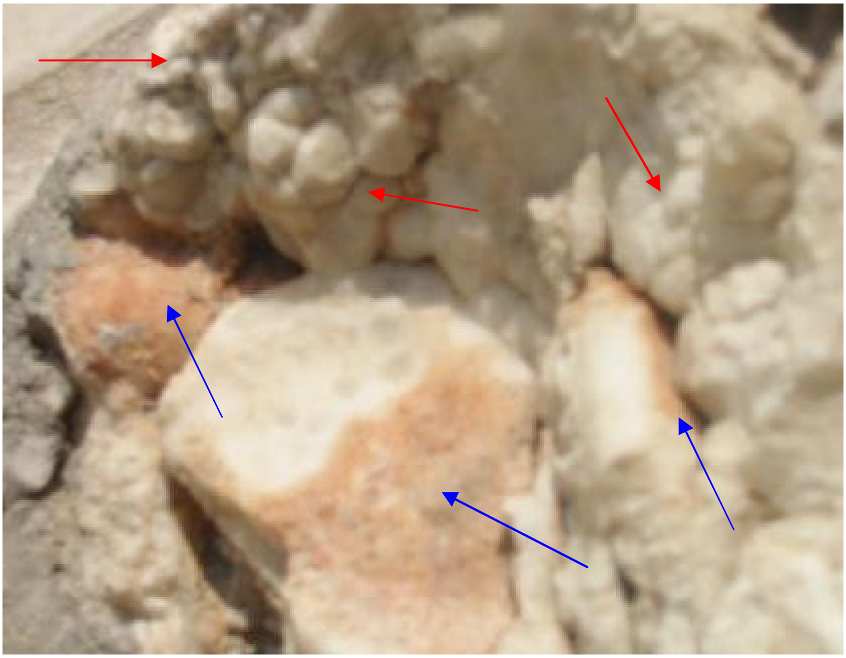


Fig. 81 display daily variation of wind speed in Cairo during 2007 .

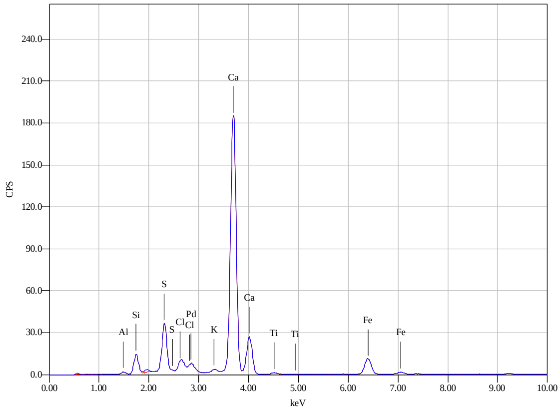


Figs.82-90 Display the difference between color of the wall-casings of Egyptian alabaster inside (interior veneers) Muhammad Ali Mosque (left column) and outside it (exterior veneers) (left column) is not only noticed but also very obvious and the Bleaching of the latter is visible , Where the coloring of honey , pale-orange , pale yellow , brown or pale tan to yellowish white with an orange tint are bleached or to white color due to exposure to the sun .

Figs. 91- 95 Display the Bleaching of the exterior surfaces of the chapel of Thutmosis IV at Karnak and other adjacent alabasterite chapels Where the coloring of honey , pale-orange , pale yellow , brown or pale tan to yellowish white with an orange tint are bleached or faded to white color due to exposure to the sun .

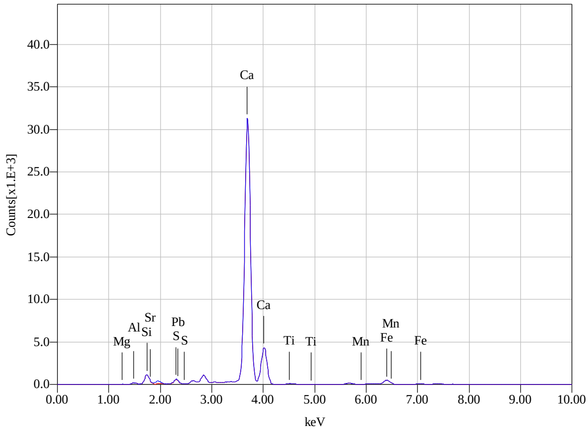


Figs.96-97 Display the iron oxides inside the Egyptian alabaster in both Karnak (left) and Muhammad Ali Mosque veneers(right) (blue arrows) which existed as impurities and which are not responsible the coloration of the Egyptian alabaster, also the granular disintegration into grus can be observed in lower photo (red arrows).



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Al	K	1.49	1.4455	2.1094	0.0029731	2179	0.0755
Si	K	1.74	4.9981	7.0071	0.0136756	18709	0.0690
S	K	2.31	5.1246	6.2930	0.0232031	56374	0.0132
Cl	K	2.62	1.6480	1.8303	0.0066508	12455	

Fig .98 **X-ray fluorescence patterns of part of an Egyptian alabaster of exterior wall-casings of Muhammad Ali Mosque , exhibits affluent presence of element sulphur (S) which indicates to the presence and gypsum formation**



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Mg	K	1.25	0.6895	1.1149	0.0014830	328	1.0144
Al	K	1.49	1.1843	1.7255	0.0039289	1858	0.1284
Si	K	1.74	3.1644	4.4294	0.0142774	12602	0.1138
S	K	2.31	0.5796	0.7107	0.0046569	7300	0.0202
Ca	K	3.69	92.2081	90.4448	0.4559663	463768	0.0789
Ti	K	4.51	0.5451	0.4473	0.0009966	1326	0.1234
Mn	K	5.89	nd				
Fe	K	6.40	1.5784	1.1111	0.0046414	8509	0.0679
Sr	K	14.14	0.0259	0.0116	0.0002588	330	0.0578
Pb	L	10.54	0.0249	0.0047	0.0002844	162	0.1250

Fig . 99 **X-ray fluorescence patterns of part of an Egyptian alabaster of Karnak chapel , exhibits limited presence of element sulphur (S) which indicates to the presence and gypsum formation but less than in Muhammad Ali Mosque , so the presence of some gypsum crystals may be due to Geological formation not to alteration (or degradation) of calcium carbonate to calcium sulphate ., also displays presence of Iron as an impurity .**

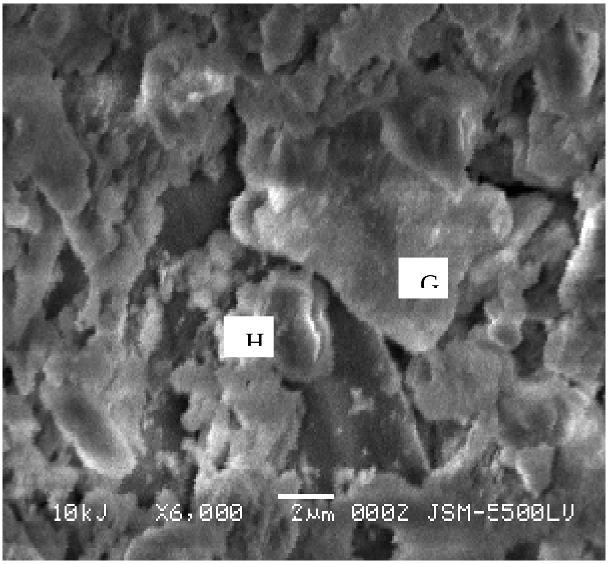


Fig. 100 SEM micrograph of the sample of exterior wall-casings of Muhammad Ali Mosque , exhibits the formation of gypsum (G), in addition to

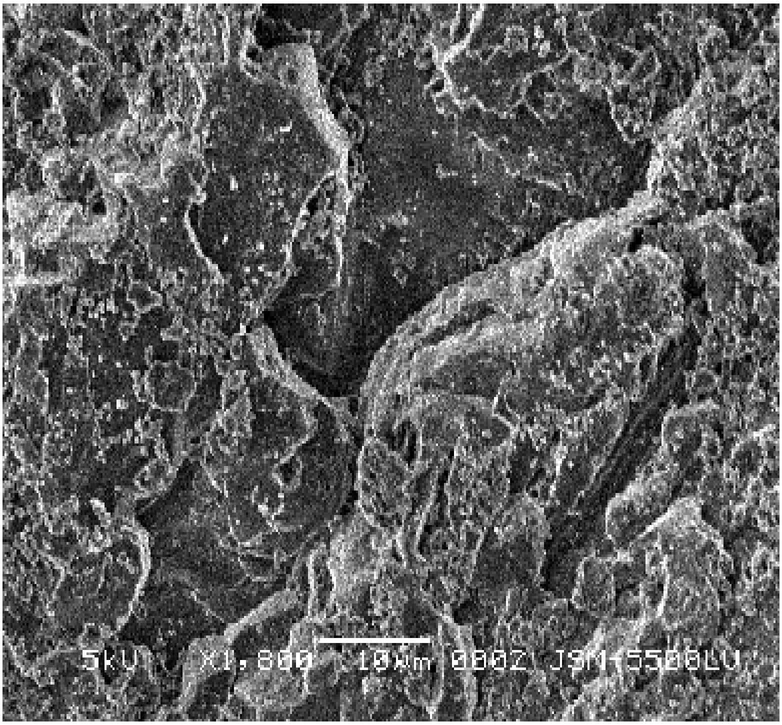
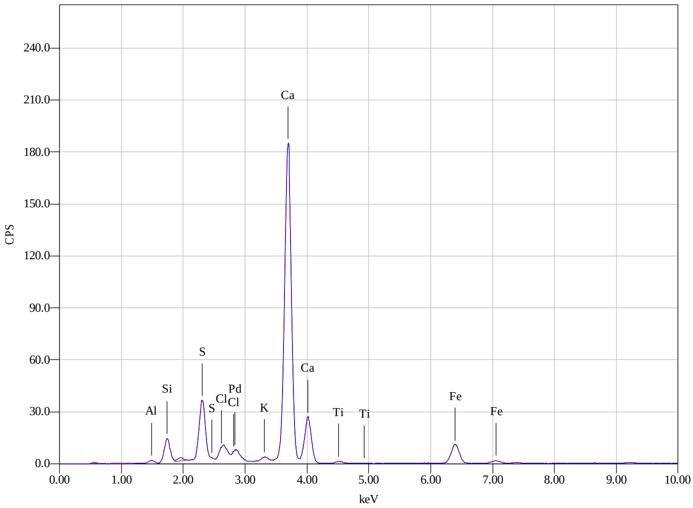


Fig. 101 SEM micrograph of the sample of an Egyptian alabaster of Karnak chapel , exhibits beginning of the formation of gypsum , in addition to efflorescence and sub florescence of Halite (H)

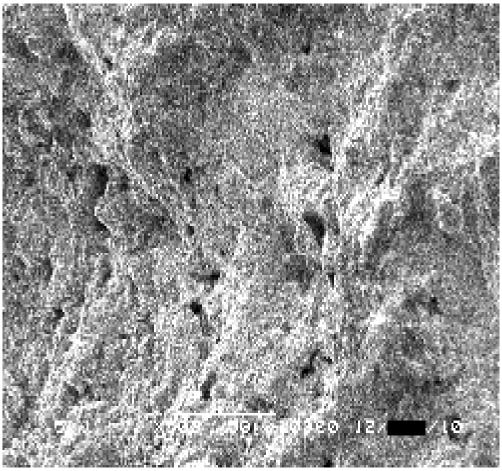
Figs. 102-107 Muhammad Ali Mosque show that the soiling areas easily removed and another type of soiling is not easily removed , also here there is a thick black crusts of irregular shape or discoloration (soiling) to crust are just an extreme case of the lower right photo , Since such crusts are brittle and tend to detach from the alabaster (red arrows) .

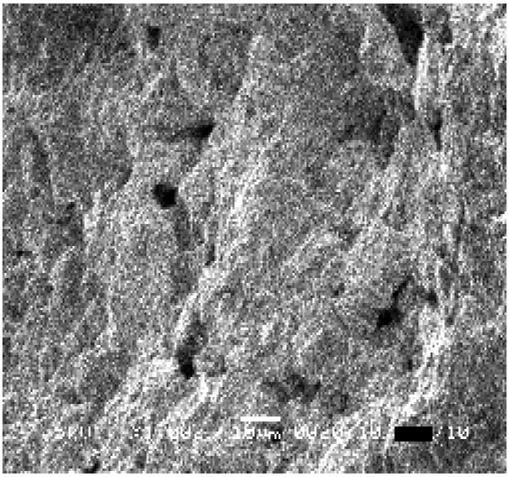
Figs. 108 -112 photographs of the soiling on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque show that the dark areas of a allochthonous dirt deposits on the stone surface either of pollutants of the atmosphere and are of poor adhesion mainly of grey to brown black deposits of dust , soil or mud particles, fly ash etc. or of particles from surface , on the stone surface and easily removed (blue arrows) . another type of discoloration, is characterized by uniform, thin layers of grey to black color, such layers are revealed to be compact though many times very thin they tend to be well-adhered to the surface , they have a limited capacity to dissolve the stone material without completely dissolving the gypsum in the overlying layer (red arrows). thick black crusts of irregular shape are just an extreme case of the lower photos , Since such crusts are brittle and tend to detach from the alabaster .

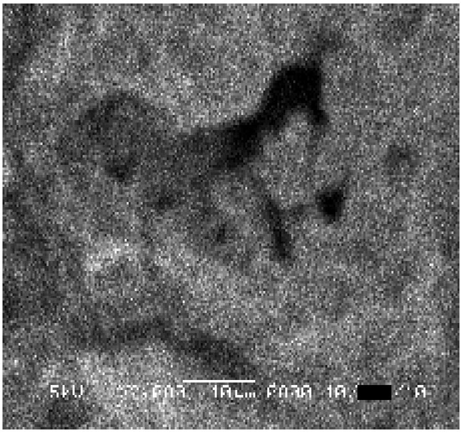


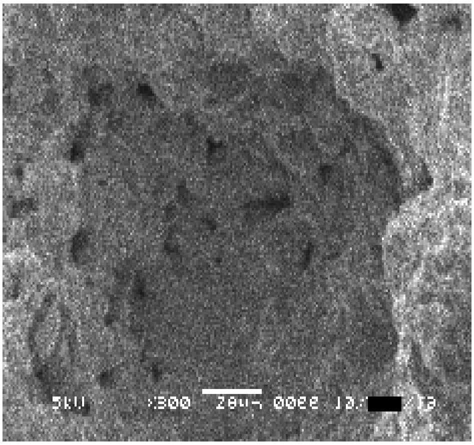
Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Al	K	1.49	1.4455	2.1094	0.0029731	2179	0.0755
Si	K	1.74	4.9981	7.0071	0.0136756	18709	0.0690
S	K	2.31	5.1246	6.2930	0.0232031	56374	0.0132
Cl	K	2.62	1.6480	1.8303	0.0066508	12455	0.0340
K	K	3.31	0.9934	1.0004	0.0034210	4524	0.0514
Ca	K	3.69	78.6884	77.3038	0.2106683	332123	0.0536
Ti	K	4.51	0.8406	0.6910	0.0010371	2139	0.0672
Fe	K	6.40	4.3224	3.0475	0.0084417	23988	0.0376
Pd	L	2.84	1.9389	0.7175	0.0111766	4138	0.1386

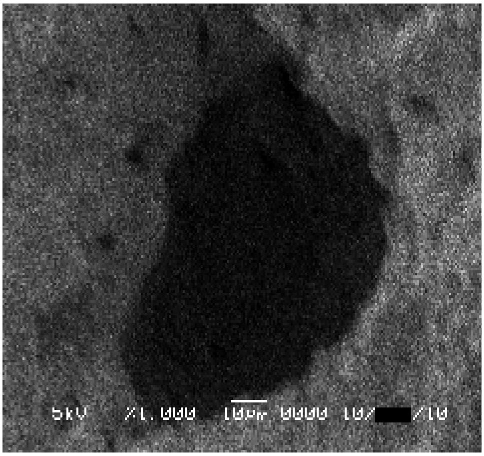
Fig . 113 **X-ray fluorescence patterns of part of an Egyptian alabaster of exterior wall-casings of Muhammad Ali Mosque , exhibits soiling via the abundant presence of element sulphur (S) which indicates to the presence of gypsum in addition to calcium as a principle element , beside Aluminum , silicon , potassium (indicate of the presence of dust (clay minerals) , high values of atmospheric particulate matter and the presence of element of iron indicates to the presence of iron oxides , also the presence of element of lead indicates to the presence of air pollution .**











Figs.114- 116 **SEM photomicrograph of the soiling on the surface of Egyptian alabaster of wall-casings of Muhammad Ali Mosque show that the dark crusts are formed by dissolving the gypsum in the overlying layer. thick black crusts of irregular shape are just an extreme case of the above , Since such crusts are brittle and tend to detach from the alabaster , also exhibits the abundant presence of gypsum , in addition to the presence of dust (clay minerals) , high values of atmospheric particulate matter .**

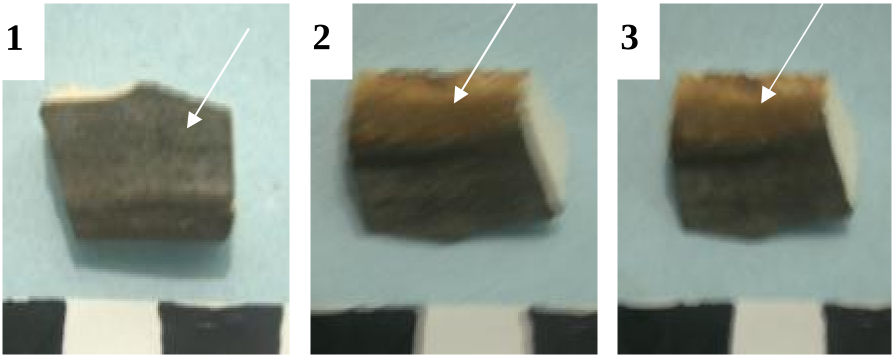
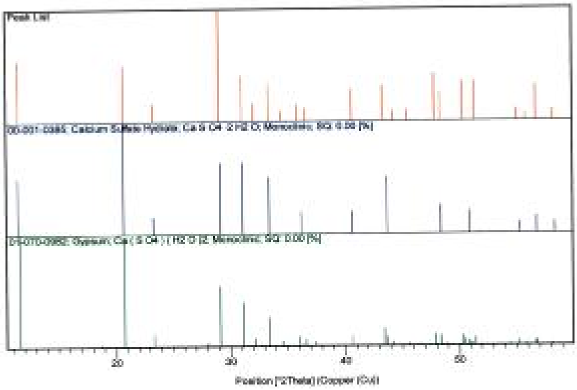
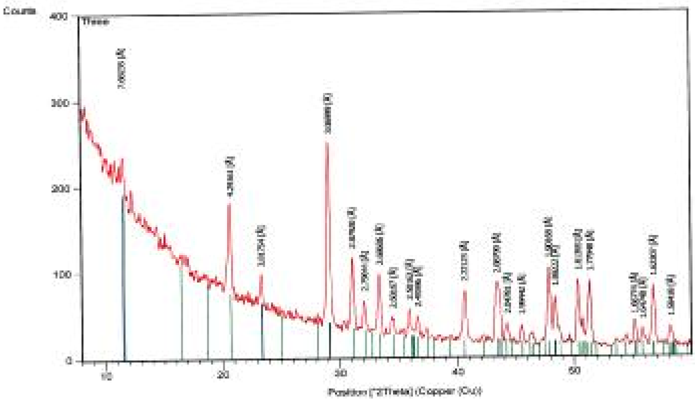
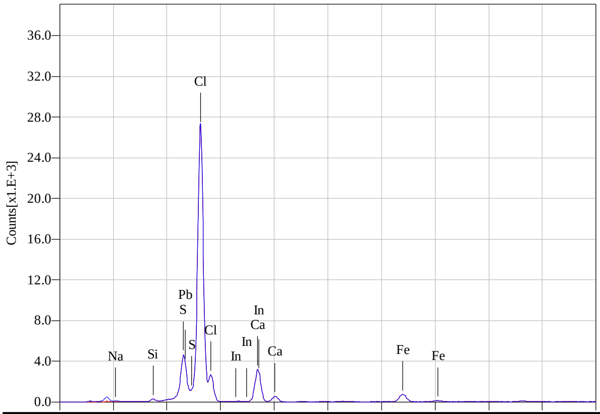


Fig. 117 Dark (grey - to black colored crust of compact deposits on the surface of a part of an Egyptian alabaster of Muhammad Ali Mosque changing the surface in (1) (arrow) , partially changing the surface and partially tracing the surface in (2) (arrow) and tracing the surface in (3) (arrow) , so it is of compact deposit of pollutants of the atmosphere mainly of gypsum crust including dirt .

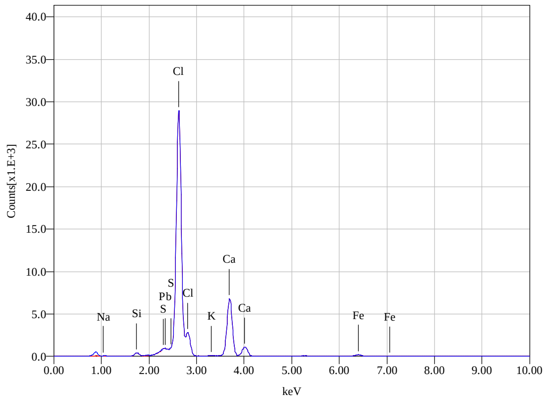




Figs . 118-119 X-ray diffraction pattern of Dark (grey - to black colored) crust of compact deposits on the surface of a part of an Egyptian alabaster of Muhammad Ali Mosque , exhibits the presence of Gypsum $CaSO_4 .2H_2O$ and $Ca(SO_4) (H_2O)_2$, due to atmospheric pollution , the continental climate , air dust , wet, porous, sheltered and semi-sheltered surfaces

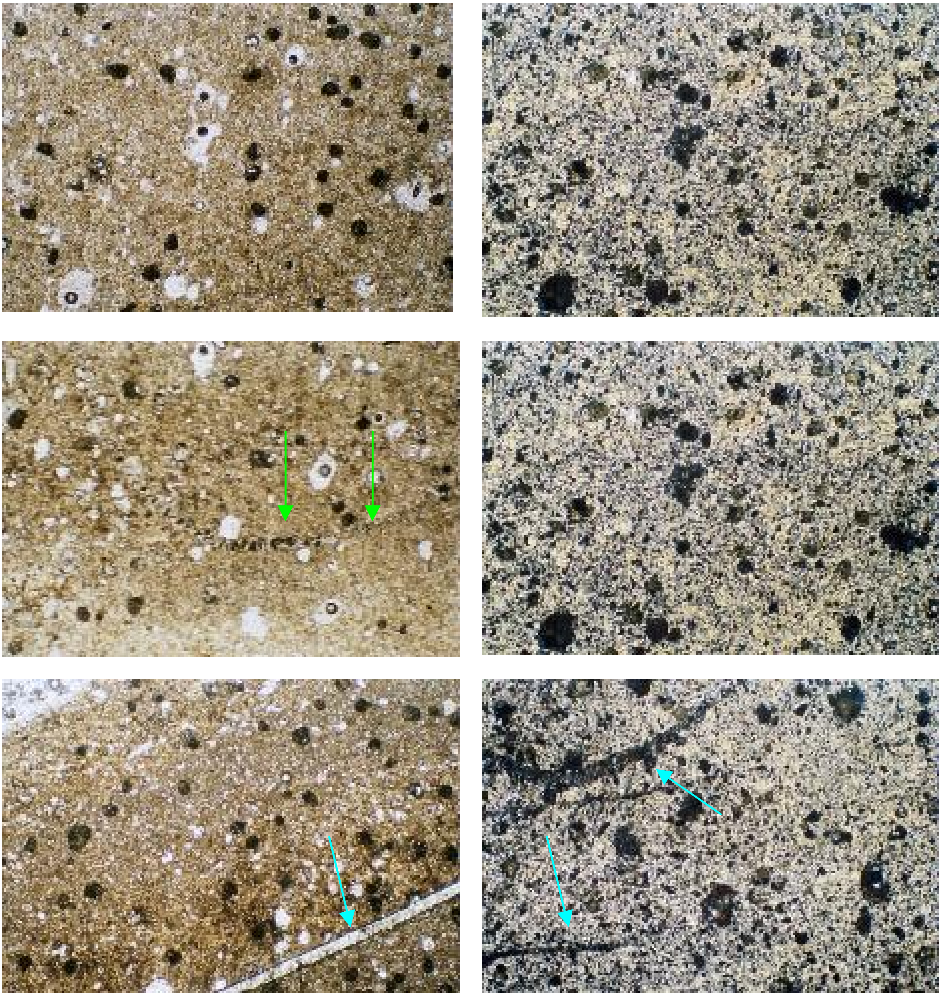


Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Na	K	1.04	1.4240	2.2969	0.0037025	174	9.8258
Si	K	1.74	0.6172	0.8149	0.0050137	2655	0.1227
S	K	2.31	4.1477	4.7970	0.0555623	52256	0.0238
Cl	K	2.62	68.5094	71.6590	0.5043995	365655	0.0995
Ca	K	3.69	19.3022	17.8588	0.0782198	47735	0.1891
Fe	K	6.40	1.9177	1.2734	0.0120310	13234	0.0624
In	L	3.29	3.9545	1.2772	0.0248750	4809	0.5860
Pb	L	10.54	0.1273	0.0228	0.0030646	1049	0.1164



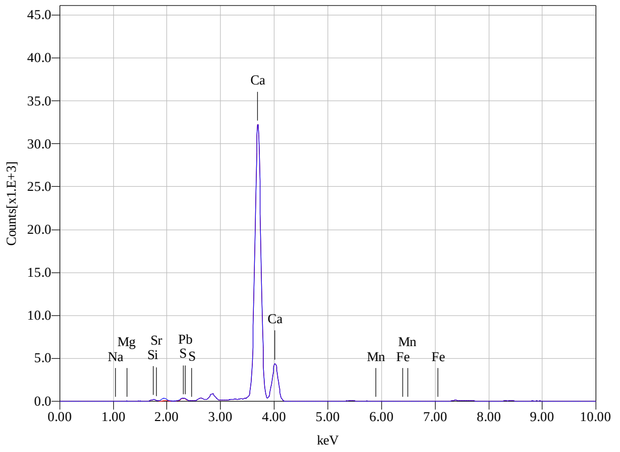
Element	Line Type	Energy	ms%	mol%	K	Net	Error%a K
1.04	nd						
Si	K	1.74	0.9719	1.2813	0.0086430	4577	0.1133
S	K	2.31	0.2821	0.3258	0.0042752	4021	0.0213
Cl	K	2.62	60.2997	62.9777	0.5337948	386965	0.0836
K	K	3.31	0.7467	0.7071	0.0031472	1611	0.2263
Ca	K	3.69	37.2612	34.4235	0.1664736	101593	0.1731
Fe	K	6.40	0.4259	0.2824	0.0025614	2818	0.0658
Pb	L	10.54	0.0124	0.0022	0.0002965	101	0.1187

Figs .120-121
X-ray fluorescence patterns of part of Dark crust on both the surface (above) and the back (below)of the same part of an Egyptian alabaster of Muhammad Ali Mosque , exhibits the presence of element sulphur (S) which is more abundant in surface than the back , in addition to calcium , chloride and sodium, that indicates to presence of salts of sodium chloride



Figs.122 - 127 Thin sections of part of Dark crust on the surface of a part of an Egyptian alabaster of Muhammad Ali Mosque cross sections (normal) (left column) (cross Nikol) (right column) x 4) display the presence of gypsum crystals (of white color in left column and of black color in right column) which distributed not only to the surface layer but also distributed inwards and also in pores , the size of gypsum crystals gradually increases outward form the substrate within this layer exterior part of the crust, where the crystals are free to grow, also display minute vugs(of black color in left column) , also display micro cracks (turquoise arrows) ,and a developing micro cracks (bright green arrows) , The underlying substrate is cemented with carbonate and forms a thin weathering rim on the alabaster which is encrusted by gypsum-rich outer layer .

Figs.128 -131 display the travertine of chapels at Karnak of Wadi El-Assiuty, where show symptoms of Efflorescence Sub florescence of Halite salt, we can observe in the lower left photo. The form light -colored crust of salt tracing the surface where compact deposit, light -colored, changing the morphology of alabaster surface , due to mainly precipitation process .



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Na	K	1.04	0.8034	1.3799	0.0012592	79	8.9983
Mg	K	1.25	0.9558	1.5523	0.0024474	433	0.9154
Si	K	1.74	0.6135	0.8626	0.0034103	2408	0.0988
S	K	2.31	0.3492	0.4301	0.0036691	4601	0.0167
Ca	K	3.69	97.1413	95.6992	0.5887194	479034	0.0696
Mn	K	5.89	nd				
Fe	K	6.40	0.0682	0.0482	0.0002348	344	0.0627
Sr	K	14.14	0.0565	0.0255	0.0006757	690	0.0523
Pb	L	10.54	0.0120	0.0023	0.0001641	75	0.1132

Fig .132 X-ray fluorescence patterns of part of an Egyptian alabaster of the chapel of Thutmosis IV at Karnak displays presence of elements sodium (Na) which indicates to the presence of sodium chloride (Halite) (due to efflorescence and sub florescence of Halite salts) in addition to calcium as a principle element , beside Magnesium , silicon , indicate of the presence of dust (clay minerals) due to exposure of inundation matters beside a high values of atmospheric particulate matter .

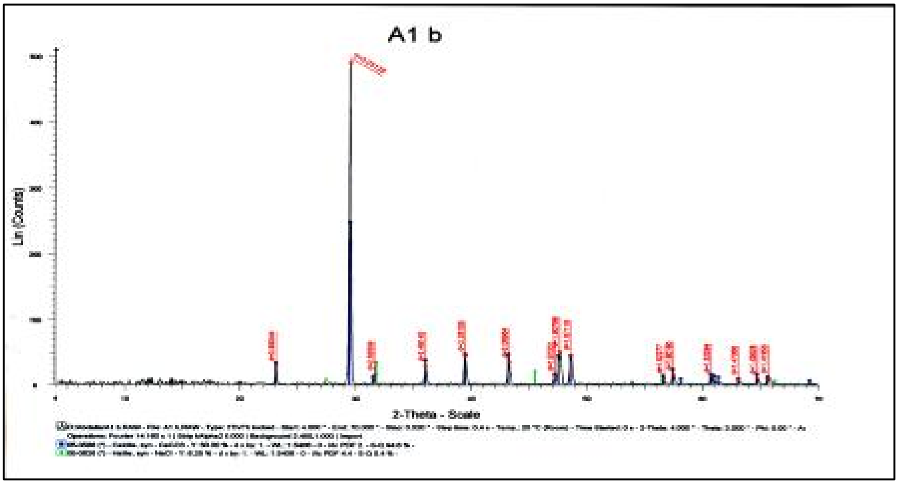


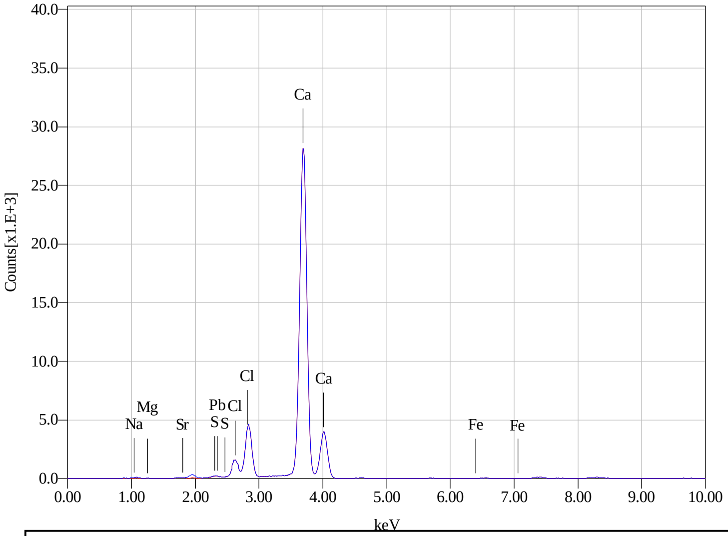
Fig .133 **X-ray diffraction patterns of part of an Egyptian alabaster of the chapel of Thutmosis IV at Karnak displays presence of sodium chloride (Halite) (due to efflorescence and sub florescence of Halite salts) in addition to calcium as a principle element .**


Figs.134-135 display Egyptian alabaster of the southern east façade of Muhammad Ali Mosque displays, where display



Figs.136-138 display Egyptian alabaster of the northern east façade of Muhammad Ali Mosque displays, where display symptoms of Efflorescence Sub florescence of Halite salt


Figs.139-140 display Egyptian alabaster of the façade of Muhammad Ali Mosque displays, where display symptoms of Efflorescence Sub florescence of Halite salt



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Na	K	1.04	3.2843	5.5542	0.0049185	308	39.9371
Mg	K	1.25	0.6194	0.9905	0.0014536	257	4.2354
S	K	2.31	0.1357	0.1645	0.0013240	1660	0.0764
Cl	K	2.62	2.3592	2.5872	0.0225539	21800	0.1790
Ca	K	3.69	93.4174	90.6175	0.5152254	419233	0.3242
Fe	K	6.40	0.0176	0.0122	0.0000579	85	0.2774
Sr	K	14.14	0.1664	0.0739	0.0019063	1946	0.2316
Pb	L	10.54	nd				

Fig .141 **X-ray fluorescence patterns of part of an Egyptian alabaster of Muhammad Ali Mosque displays presence of element of calcium as a principle element ,abundant presence of both sodium (Na) and chloride (Cl)which indicate to the abundant presence of sodium chloride (Halite) (due to efflorescence and sub florescence of Halite (of the action of subsurface carbonated waters- in the neighborhood of Sannur) salts) in addition to Magnesium**

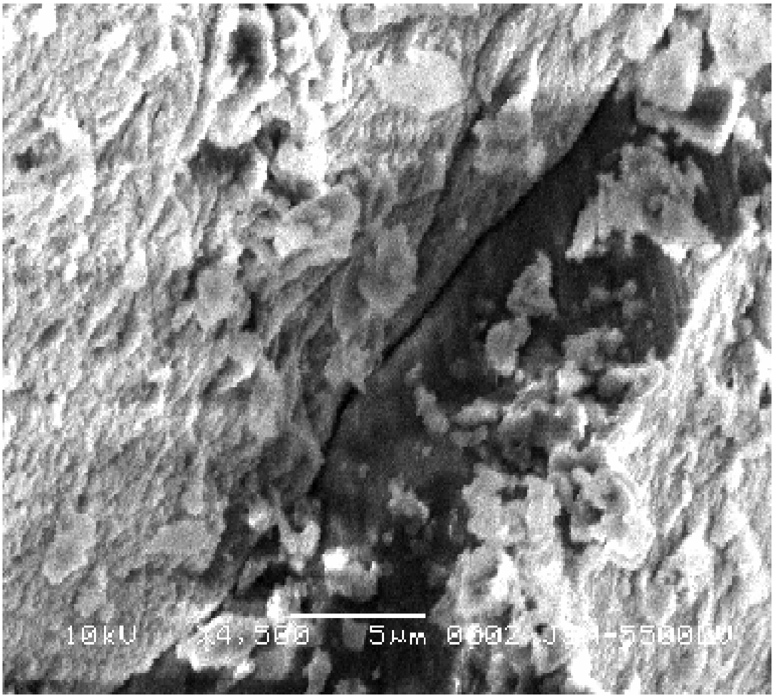


Fig.142 SEM micrograph of the sample of an Egyptian alabaster of Muhammad Ali Mosque displays efflorescence and sub florescence of Halite, in addition to beginning of the formation of gypsum.

Fig. 143 lay the roughening in the travertine of chapels at Karnak as a finest relief resp. alteration of gloss due to the loss smallest stone particles or corrosion of stone surface smoothed by sawing , grinding or polishing , it is observed on the surfaces of the travertine of chapels at Karnak .

Figs.144-147 Display the form of small pits - are caused by biogenically induced corrosion processes, particularly in carbonate rocks , it is noticed only on the Egyptian alabaster surfaces of Muhammad Ali Mosque , it is not noticed on the surfaces of chapels at Karnak

Figs. 148-149 Display Back weathering due to loss of scales where is observed in Egyptian alabaster surfaces of both chapels at Karnak (above) Muhammad

Figs.150 -153 Display the granular disintegration which is Detachment of individual grains or small grain aggregate into grus where there is detachment of larger grains as individual grains or small grain aggregates (stone grus), in Egyptian alabaster of both

Figs. 154- 155 Display the crumbling which is Detachment of larger , compact stone elements in the form of crumbs, in Egyptian alabaster of Muhammad Ali Mosque and not observed in chapels at Karnak.

Fig.156 Display flaking to contour scaling, in Egyptian alabaster of Muhammad Ali Mosque and not observed in chapels at Karnak.

Fig.157-158 Display fissures independent of stone structure in Egyptian alabaster of both chapels at Karnak (left) and Muhammad Ali Mosque (right).

Figs.159-164 Display some Man-made faults (erroneous restoration) In the chapels of Karnak – where the blocks of the chapels of Thutmosis IV Senwosert I , Amenhotpe I and Hatshepsut were reused in core of Pylon No. III at Karnak – were reconstructed and were compensated with unsuitable material (Portland and white cement) and in with out character style .

Figs.165- 167 display some Man-made faults (erroneous restoration) in Muhammad Ali Mosque alabaster veneers were compensated with unsuitable material (Portland and white cement) and in with out character style .

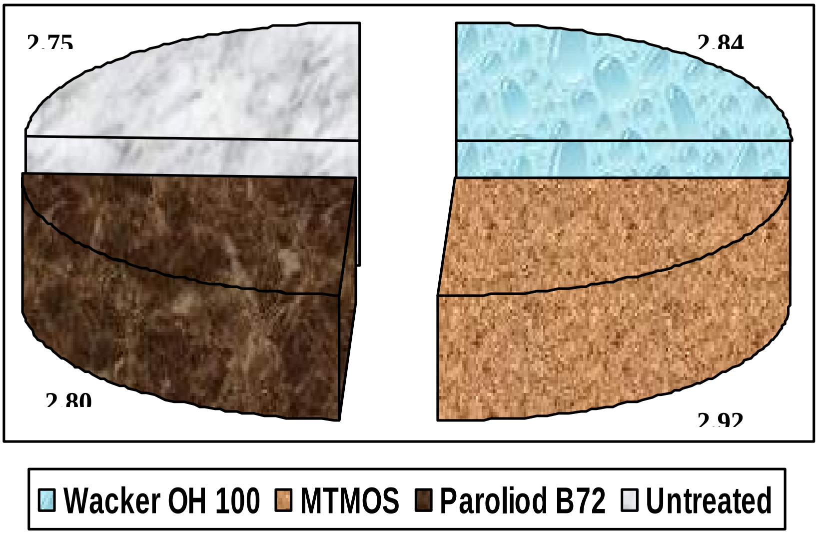


Fig. 168 display the Improvement of Egyptian alabaster weathered samples of Muhammad Ali Mosque veneers of Bulk density from (2.75) in untreated sample to (2.80) with Paraloid B 72 , to (2.84) with Wacker OH 100 and to (2.92) with MTMOS .

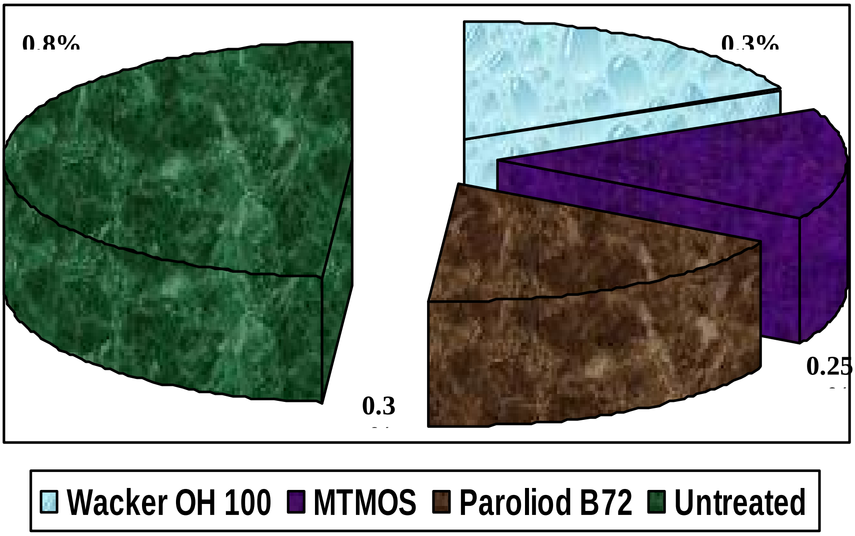


Fig.169 display the Improvement (reduction) of Egyptian alabaster weathered samples f Muhammad Ali Mosque veneers of Water absorption from (0.8 %) in untreated sample to (0.25 %) with Paraloid B 72 , and to (0.3 %) with MTMOS , and does not improve with Wacker OH 100..

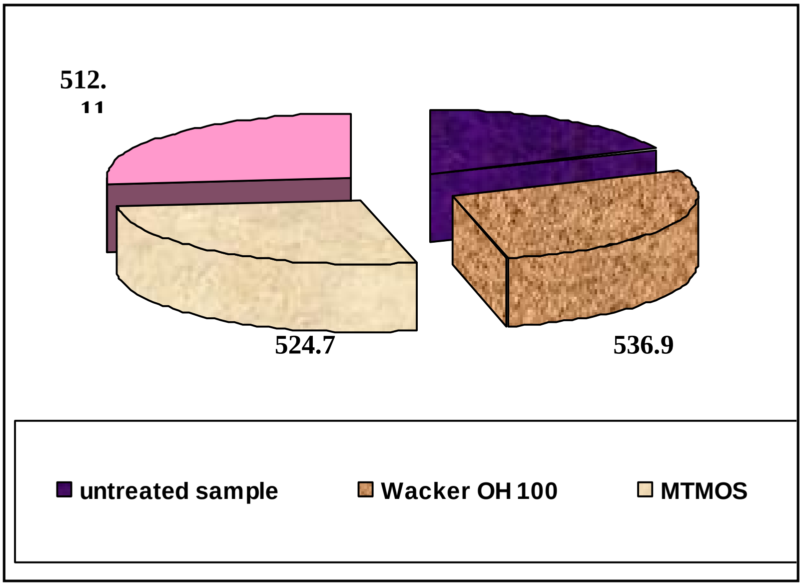


Fig.170 display the Improvement of Egyptian alabaster weathered samples of Muhammad Ali Mosque veneers of compressive of strength (dry) from (375.5) in untreated sample to (512.1) with Paraloid B 72 , to (524.7) with MTMOS and to (524.7) with Wacker OH 100.

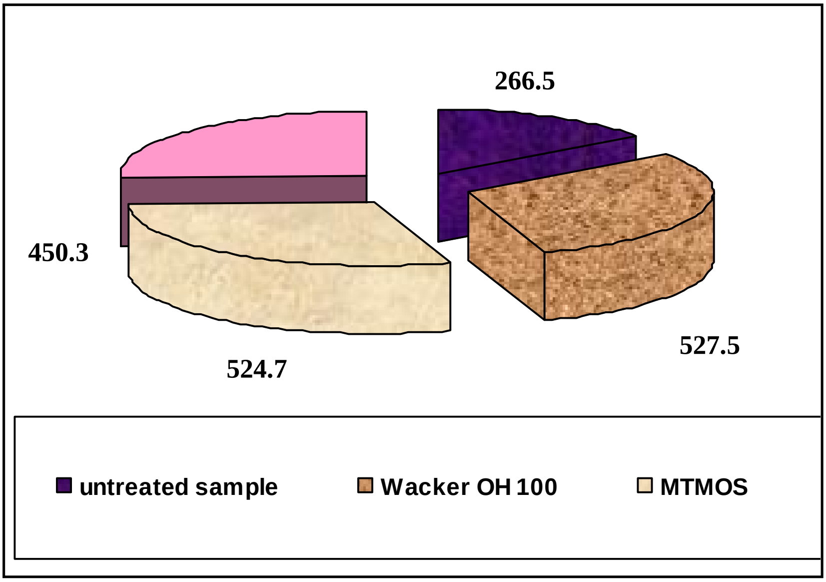


Fig.171 display the Improvement of Egyptian alabaster weathered samples of Muhammad Ali Mosque veneers of compressive of strength (wet) from (266.5) in untreated sample to (450.3) with Paraloid B 72 , to (524.7) with MTMOS and to (527.5) with Wacker OH 100.

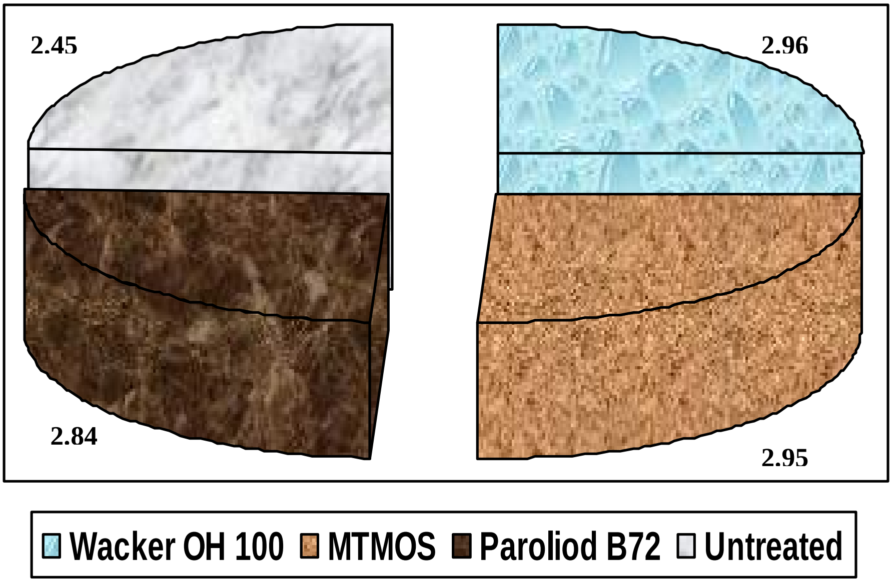


Fig. 172 display the Improvement of weathered samples of Egyptian alabaster of Karnak chapels of Bulk density from (2.45) in untreated sample to (2.84) with Paraloid B 72 , to (2.96) with Wacker OH 100 and to (2.95) with MTMOS .

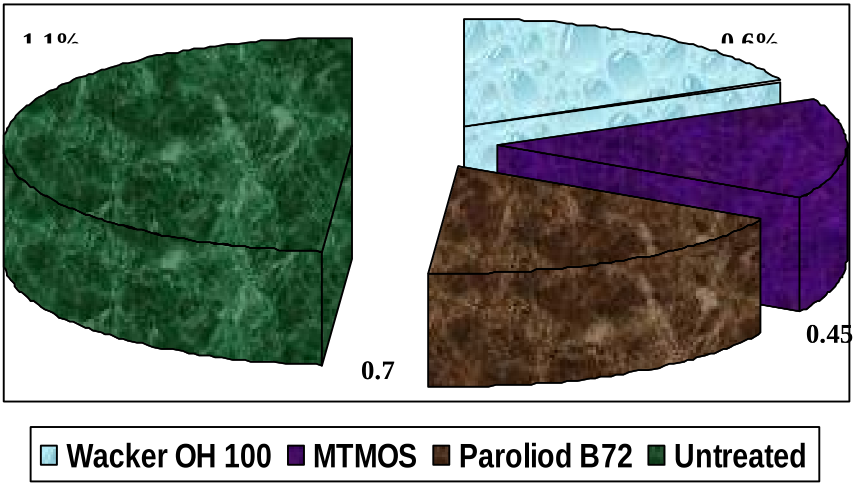


Fig.173 display the Improvement (reduction) of Egyptian alabaster weathered samples of Karnak chapels of Water absorption from (1.1 %) in untreated sample to (0.7 %) with Paraloid B 72 , and to (0.45 %) with MTMOS , and to (0.6 %) with Wacker OH 100..

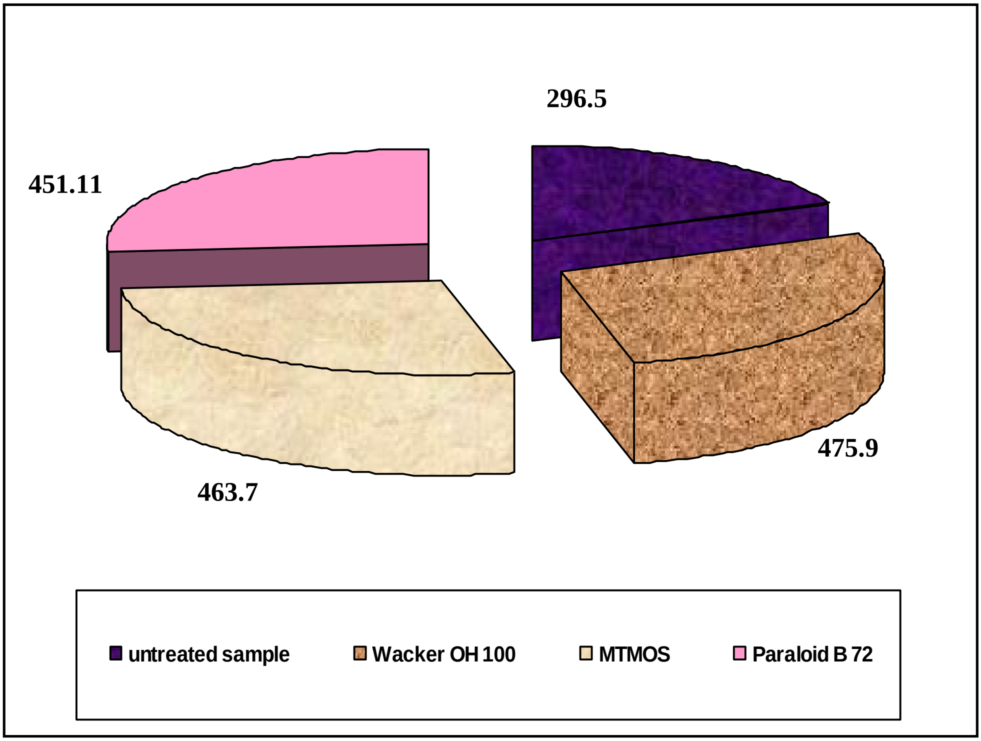


Fig. 174 display the Improvement of Egyptian alabaster weathered samples of Karnak chapels of compressive of strength (dry) from (296.5) in untreated sample to (451.11) with Paraloid B 72 , to (463.7) with MTMOS and to (475.9) with Wacker OH 100.

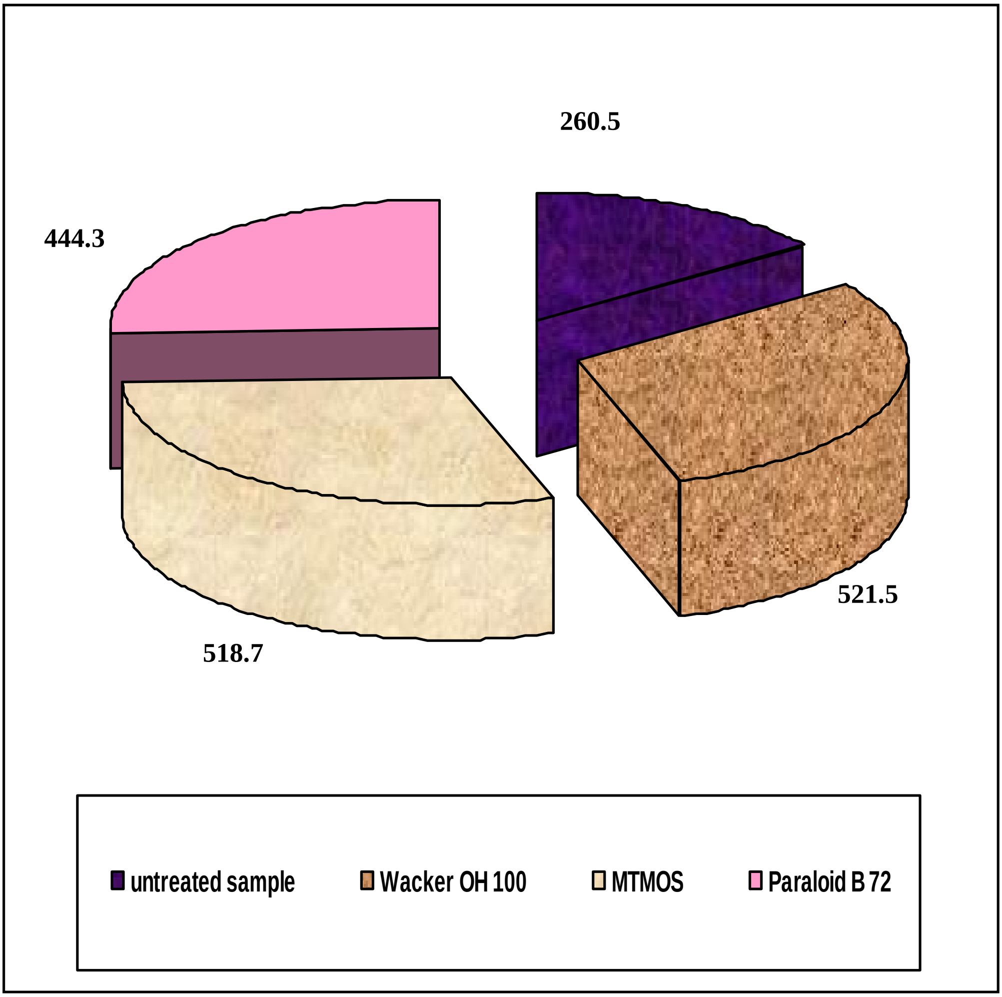


Fig.175 display the Improvement of Egyptian alabaster weathered Karnak chapels of samples of compressive of strength (wet) from (260.5) in untreated sample to (444.3) with Paraloid B 72 , to (518.7) with MTMOS and to (521.5) with Wacker OH 100.