The Reasons of Using the Original Stone for Repair and Conservation of Ancient Egyptian Buildings in The light of Discovery of Some Ancient Quarries which are inferred to be used as Stone Sourcing and The Reason of Using Other Alternatives

Abdou El-Derby♦

Abstract

The reason of using the original stone for stone repair and conservation of ancient Egyptian buildings with review of some reference examples of case study on which the researcher applied , it is the study which **the first theme** dealt with , consequently **the second theme** dealt the researcher′s discovery of 12 ancient limestone quarries locate in surroundings of Abydos to both the south west (in El-Ghabat village) and the north west of Abydos , to be affixed to documented two ancient limestone quarries in the same district and to be affixed to documented Eighty six ancient limestone quarries in the calcareous plateaus all over Egypt and to preserve them for own archaeological & technological values and for using their context as source of the original stone for repair and conservation , **the second theme** also enumerates the general and special evidences of using these quarries as a sourcing stone for ancient Egyptian buildings in Abydos , then it is requisite explain **in the third theme** the reason and criteria of using the stone alternatives whether the correspondent or the appropriate stone , artificial stone or the plastic repair for stone repair and conservation of ancient Egyptian buildings with review of some reference examples of case study on which the researcher applied.

♦Lecturer in Archaeology Conservation Department , Faculty of Archaeology , South Valley University, Supervisor on The Institute of Archaeology Conservation at Luxor.

1. Introduction

The stone - which has been abundant , readily available – in the cliffs and plateaus along the Nile Valley and the flanking deserts , workable and durable - has historically being the most widely used natural material for constructing buildings in ancient Egypt - so it was the most important raw material used mainly for funereal and sacral purposes such as pyramids, temples and various tomb constructions - which had been lasting about three thousands in building for eternity and consequently were constructed and decorated from primary stone materials much more resistant to the challenge of weathering and time (there have been a large number of types of stones which had been used but the most popular stone types in ancient Egypt are nearly eleven) - during the different periods from Pharaonic Egypt until Graeco-Roman and Arab times , in most cases - the dominant stone is of local origin where mainly selected near the construction sites themselves , but other stone types may have been needed for different elements of the construction such as the proper material for decoration , casing or elements which had been suitable for constructional and structural purposes which had had the strength required for load bearing elements such as lintels , columns , architraves , ceilings , or the need for large block sizes for certain design requirements may also had demanded different varieties, also some choices may have been purely aesthetic was not available locally , so the ancient Egyptian had fetched the required stone material over long distances to the construction sites .

Although stone is something of a metaphor for permanence and durability, this is not always the reality case , where the composition varies, even within a single source, and a building stone may prove unstable, brittle or soft, for example many limestones, are particularly subjected to decay, also to say nothing of deterioration and damage causes and factors such as ancient & modern disasters , man-made destruction , natural and environmental , urban , architectural , structural and biodeterioration ones , thereupon there are innumerable ancient Egyptian buildings have been left in bad state of preservation so the salvation of these buildings is a must and it is often necessary to replace some of its stone and regeneration, repair and maintenance for the sustainability of these buildings ([1]).

Despite the breadth and importance of stone repair and restoration works in ancient Egyptian buildings since ancient times chiefly since the eighties of the 20th century up till now ,but it did not take their share of studies in the literature compared with the latter works of deterioration causes , factors , mechanisms and symptoms , cleaning , consolidation .

For using the stone which has been used in the past for building repair , replacement and conservation in the future there are - in this paper - some view points , reasons and needs of aesthetic and functional necessities for ancient Egyptian buildings , which in turn have being destroyed wholly or partially in consequence of different deterioration and damage causes particularly with weak attention and consideration for sourcing and selection of original or appropriate stone although stone sourcing forms part of the design and specification stage of conservation and repair of the buildings , stone sourcing for ancient Egyptian buildings repair must take several factors into account and consideration .

Although of plenitude and redundancy of archaeological , Art , architectural studies of Ancient Egyptian buildings and monuments , there are - up till now - infrequency in studies of their sources ; ancient quarries from which we can obtain and debrief plenty of

([1])see : English Heritage , Identifying and Sourcing Stone for Historic Building Repair An approach to determining and obtaining compatible replacement stone , Technical advice note , English Heritage , London ,2006 . ; Klemm , D . and Klemm, R . , The building stones of ancient Egypt - a gift of its geology , African Earth Sciences 33, 2001, p. 631 .so ancient Egypt was regarded as the (state out of stone) according to Evers , see : Evers, H.G.,. In: Staat aus dem Stein Bruckmann, vol 2.,Bruckmann Verlag , Munchen ,1929.

archaeological and technological information , data and datum , to say nothing of for stone repair , compensation in preservation and conservation of these ancient buildings .

Non the worse neglecting the studying but also neglecting protection (by the Egyptian government either supreme council of antiquities or the organization which is responsible of quarries and mines) , therefore have been destroyed completely or partially particularly in the environs of the Nile valley wherein have been used as sources for modern building, construction and quarrying , it is a must to preserve , develop scientific and practical methodologies for documentation, exploit their surrounding geological formation , sourcing stone for archaeological conservation , preserve these ancient quarries landscapes and raising the awareness of its cultural significance and vulnerability and contribute to legal protection measures and sustainable management (include recognition , investigation and assessment of significance, to understanding the risks, developing sound conservation and monitoring concepts, and suggesting mechanisms for sustainable management) and exhibition & presentation in situ as ancient quarries around the archaeological site (Abydos).

So this paper deals - partially - with the researcher‘s discovery of 12 ancient limestone quarries , evidences of using them as a sourcing of stone for ancient Egyptian buildings and using them for sourcing stone for repair , replacement and conservation .

The First Theme

2. The Reason of Using the Original Stone for Stone Repair and Conservation (the Rule Like-for-like) or (in kind)

The use of a piece or a unit of the original stone (the same exact archaeological stone) , the similar stone and the artificial stone (molded material) aiming to compensate (match , anchor and fit the void of the loss of the deteriorated archaeological stone of the building which has not fulfilled any more its structural function called **replacement**, while the use of **mortars** is subtitled under the title (**plastic repair**) which means using mortars , putties (which are not confined the fine mortar of lime but adopted to include any fine mixture) ([2]) .

The reason of the replacement or plastic repair has to be lucid overlooking the compensation of functional (structural) role , visual role (integration with the adjacent context) plus prevention further damage , also overlooking the archaeological , architectural , artistic of the deteriorated or lost archaeological stone .

2.1 The reasons , criteria and foresight of using the original stone for archaeological Buildings repair and Conservation :

a. has the same nature where the most suitable stone will be the exact original material from a closely defined location - a particular horizon (bed) in the same quarry and appearance (where the temperament of conservation of ancient Egyptian buildings trends to match between the appearance of archaeological stones and replaced exact original stones regarding that the ancient Egyptian stones have distinctiveness relative importance in respect of surface texture, color, bed thickness and other dimensions, weathered appearance etc. ([3]) .

b. doesn't damage the original stone physically , mechanically or chemically .

c. Building and building stone importance to a concept with the archaeological , architectural , artistic , functional and

([2]) so the term (plastic) does not mean here the engineering or physical meaning (retaining deformation caused by an applied pressure on the plastic material , while the opposite expression the (elastic) material resumes its shape after removing applied pressure , see : Anderson , T. , Preservation of Rock Carvings and Rune-stones , In : Case Studies in the Conservation of Stone and Wall Paintings , ed.N.S. Brommelle and P.Smith , London :IIC., 1986 ,pp. 133-137 ; Griswold , J. and Uricheck , S. , Loss Compensation Methods for Stone , in : Journal of The American Institute for Conservation (JAIC), Spring 1998, Vol. 37, pp. 91, 92, 103-104.

([3]) Hughes , T., Sourcing Stone for Building Conservation , The Building Conservation Directory, 2006 ; Thompson , A .et al, Symonds Group Ltd, Planning for the Supply of Natural Building and Roofing Stone in England and Wales, Office of the Deputy Prime Minister, London, 2004 ; The English Heritage Technical Advice Note Identifying and Sourcing Stone for Historic Building Repair . .

symbolical significances thereupon it would be to use an authentic stone for replacement .

d. Technical importance in terms of its propriety particularly in the physical properties, compatibility with the context and environ which advances nowadays among conservators in Egypt .

e. Cultural importance in terms of scarcity its type , its use , the great architectural , archaeological ,artistic or religious values of the buildings in which had been used , would be a strong motive for repairing these buildings with the original stone regarding they reflect abstract concepts such as a sense of Archaeology , historical references to persons or ancient technological or cultural values .

f. The intrinsic value of a stone is determined by its technical suitability and its cultural and heritage importance.

g. Sometimes the archaeological stone type necessitates using mortar (plastic repair) such as granites and marbles seeing the difficulty of producing the appearance of them ([4]) .

h. Despite the fresh applied replacement with natural exact original stone - which had been newly quarried , carved and dressed - has fresh new dressed distinct surface from the adjacent archaeological stone - it is desired for distinction between archaeological and new- become after weathering soiling more integrated ([5]) .

([4]) Sorlis , T. , Restoration of the John J. Glessner House , In : Masonry : Materials , design , construction and maintenance , ed. H. Harris , Philadelphia , American Society for Testing and Materials, 1988 ,pp. 231-250 ; Griswold , J. and Uricheck , S. , Loss Compensation Methods for Stone , in : Journal of The American Institute for Conservation (JAIC), Spring 1998, Vol. 37, p. 92 .

([5]) Papanikolaou , A., the restoration of the Erechtheion , In: Aaopolis restoration, Athens :AcademyEditions ,1994, pp. 136-149 ; Griswold , J. and Uricheck , S. , 1998, Vol. 37, p. 92 .

2.2 Using the original Stone for Archaeological Buildings Repair and Conservation

The perfect selecting stone for repair of archaeological buildings using the exact original stone is not only from the same geological formation but also from the same quarry and even from the same bed from which the monumental stone blocks had been provided , but this is mostly to be achieved difficult due to either the difficulty of find the original quarry , the difficulty of find the same bed , even the bed is known its physical and mechanical properties of the exposed layer would be different from its semblances in the archaeological building .

Also the good quality craftsmanship is required to avoid the disfigure and the further damage .

The repairs achieve the structural or integrity (functional) unity , esthetical (visual) and prophylactic considerations .

2.2 .1 Examples of Case Studies of Partial Reconstruction of the Original Stone :

In our some case study of we Know the original quarry source of the archaeological buildings stone where the stone fortunately has been correctly identified and its source properly positioned ([6]) - then we have to position the place of surroundings of the quarry from which will be obtain limited quantities (snatch) from the same sacrificial bed line away from the ancient quarry and the most compatible source of available stone would be used , for preserving and protection it - regarding to poverty of skilled craftsmen in traditional hand working of stone quarrying , stone dressing , stone masons in addition to transportation , lifting and lowering of the new stone blocks , the researcher get a group of them from Eisawya Sharq south east of Akhmim (where it is well-known with Eisawya distinctive geological formation rocks which have been

([6]) Fortunately also the original stone quarries are local and close to the archaeological site of buildings which facilitate the transportation of the quarried stone blocks which were used to replace and compensate (the researcher) .

used in modern construction activities) which is well-known of - skilled craftsmen in traditional hand working of stone quarrying , stone dressing and stone masons - with using donkeys ([7]) in transportation quarried stone blocks from one of the original local open quarry El-Ghabat (**figs.36-41)** to the foot of the plateau , and using camels in transportation quarried stone blocks from the foot of the plateau to the site of temples conservation (about four kilometers) .

Wooden handbarrows were used for carrying the stone blocks in situ , the rollers were used for moving and towards their destination in the wall and levers were used for pushing and matching blocks into its position with pouring liquid gypsum mortar as lubricants on the and in between the vertical joints lower bed for smoothing , liquoring and facilitating the positioning of the block ([8]) , the stretching cord was used for leveling and alignment on the front line of the compensated blocks , in case of the compensated wall corner torus such as example (a) **(fig. 2)** the cutting and dressing will be more complicated and requires a proficient craftsmen because the compensated corner blocks would be dressed in form of salient extra stock for torus after the fashion of the archaeological western and southern walls of the temple Ramesses II at Abydos , the same complications for cornices compensated blocks such as the terrace of first portico of temple of Seti I at Abydos **(fig. 5)** .

Less complicated in dressing vertical water spout compensated blocks of the southern walls of the temple Ramesses II at Abydos **(fig. 3)** .

([7]) according to ancient Egyptian convention where donkeys had been used to carry building materials , and in our example a donkey carried about 90-100 kilograms over four kilometers . ancient Egyptian builders did not use camels and horses for carrying and used cattle for pulling only , see : Arnold, D., (1991), Building in Egypt,Pharaonic Stone Masonry , Oxford Univ. press p. 58 ; Cerny, J., Alan Gardiner, and Eric, T., Peet, The Inscriptions of Sinai I, 11, London and Oxford, 1952, 1955, nos. 110, 114, 284 and 500 donkeys! (the researcher) .

([8]) also according to ancient Egyptian convention, see : Arnold, D., 1991, op. cit .pp. 116-118 ; Reisner, G. A, Mycerinus the Temples of the Third Pyramid at Giza Cambridge, Mass., 1931, pp. 84-86, figs. 15,16 (the researcher) .

After completing laying one compensated course we have to level and dress to receive the following course and so on , the scaffolds were used for lifting the blocks by manual lifter .

The masons dressed exactly and neatly the corresponding planes on the five sides -except the inside one - and then adjust the blocks .

Skilled craftsmen , hand tools and stone masons used tools which have been used from ancient Egyptian periods up till now , where some ancient Egyptian tombs at Saqqara and Thebes display in its wall paintings hand tools similar to its semblances used nowadays ([9]) such as axes , picks , hammers , pitchers , punches , mallets , claw-tools , chisels(round bar – flat mortise – mortise –wide) – sawing tools ([10]) .

We used the original stone for repair because it has the same appearance and nature , and doesn't damage the original stone physically , mechanically or chemically , the stones blocks which used for be replacing were dressed to the original profile and the new replacement must be right, designed to match the original .

([9]) Petrie ,W.M.F , Ancient Egypt , 1930,pp.33-39, pt. 2.

([10]) for more about ancient tools See, in general, CEAEM, pp.35 ; Stocks, D., Popular Archaeology July 1986, pp. 25-28; Davies. N. D. G, The Tomb of Rekh-Mi-Re at Thebes Publications of The Metropolitan Museum of Art Egyptian Expedition 11, New York, 1943, p. 58, Pls. 60 ,62, ; Reisner, G, A., Mycerinus 88; Arnold, D., Amenemhet III I, 79 n. 81183-185, fig. 49; Petrie, W, M, F., Meydum and Memphis, 17; Petrie, W, M, F., Gerald A, Wainwright, and Ernest Mackay. The Labyrinthe, Gerzeh and Mazghuneh. British School of Archaeology in Egypt and Egyptian Research Account, no. 21. London, 1912, 54; Arnold, D., Amenemhet III I, 79c ; Holscher, U., MDAIK 12 1943, pp. 146-149, figs. 4-8. ; Uphill, E. P., the Temples of Per Remesses Warminster, 1984, pp. 19-20 ; Engelbach, R., ASAE 28 1928, pp. 144-152; Walter Wreszinsky, Von Kairo bis Wadi Halfa Halled, 1927, pl. 19; Borchardt, L., Allerhand Kleinigkeiten Leipziog, 1933, pl. 11, pp. 2-3 .

And see in general for metal tools : Anthes, R., MDAIK 10. 1941, pp. 79-121; Barta, W., in LA IV, pp. 19-20, For Minoal Crete, see Shaw, J. W., Minoan Architecture, pp. 44-61, figs. 35-48.

Also see : Michael, R., Cowell, in Davies W. V., Tools and Weapons, Vol. I, Axes catalogue of the Egyptian Antiquities in the British Museum London, 1987, pp. 96-101, With more references on recent surveys and analyses of Egyptian metalwork; Petrie, W.M.F., Tools and Weapons, pls. 21, 22.

2.2 .1.1 Examples of Case Studies

a. An example of a partial reconstruction of the third staircase leading from the second court to the third terraced portico of temple of Seti I at Abydos with the original stones from the same geological formation of surroundings of the original local open quarry El-Ghabat where were quarried , transported , dressed and built with traditional tools and methods , with keeping and preserving the original remains of archaeological steps , and reconstructed the rest of the staircase according to its architectural , artistic stylist and geometrically (length , width, height and inclinations) with the help of the comparative analysis of the other proverbial and semblances from the same temple and the similar temples which are coincident temporally and stylistically **(fig. 1) .**

This example of a partial reconstruction achieve -from my view point - the conservation of structural integrity, aesthetical , in addition to functional role of the element where it has domestic use to lead foot visitors from the second court to the third terraced portico of temple ([11]) .

b. An example of a partial reconstruction of the northern , western and southern walls of the temple Ramesses II at Abydos with the same original stones with the same traditional style and method **(fig.2-3)**.

This example of a partial reconstruction achieve also the conservation of structural integrity, aesthetical , in addition to the principle of preventive conservation for the remains of the valuable outer walls which were inscribed on the outer faces with very important events registers (Qadish battle) from further damage and destruction particularly with encircled urban activities , and this one of the important principles of the partial reconstruction .

([11]) The researcher applied the same style and method with same original stone in other architectural elements in the temple such as : the first staircase , parts of : walls of the first hypostyle hall , the second hypostyle hall , walls of the seven chapels .

2.2 .2 Examples of Case Studies of Compensation of the Original Stone :

the majority of compensations works which were carried out on ancient Egyptian buildings had mostly three failings ; a. had required removal of original archaeological environ . b. had not fulfilled aesthetic needs . c. had been complicated. (the researcher) , successful compensations of archaeological and historical stonework demands a thorough understanding of the properties of both existing stone and potential substitute materials. this document recommends criteria and processes for sourcing replacement stone: evaluation of existing stonework , sampling and identification , examination and analysis , criteria for selecting replacement stone , sources of stone , obtaining stone for repair

The strongest motive and reason of using the original stone - which has one or more values , such as archaeological , historical , architectural , artistic and / or symbolic values - should be replaced is the failure in compromising the **structural integrity** of the building and absence of **structural, functional and esthetical** role in addition to loss of inscriptions , drawings and paintings (documentary and esthetical function) . because of different . deterioration and decay factors such as environmental (weathering , disintegration or salt damage), **constructional** (location such as sandstone placed below limestone or wrong-bedded) , **structural** (when the stone has failed structurally due to movement in the building, causing undue, and undesigned for pressure on it) , **esthetical** (such as the environs of the stone may also need to be modified or corrected so that the new stone does not suffer the same fate) , bad maintenance or poor repairs in the past (with hard, impervious Portland cement pointing) or special or unique circumstances favored a principle of replacing stone .

So the first reason is loss and absence of performance the structural and functional original role (**figs.4-5)** .

In addition to preventive conservation from further damage , such as damaged stone blocks of elements proof or repellent of running water inside the archaeological buildings such as spouts on the ancient Egyptian temples ceilings or down the face the archaeological buildings such as cornices and molded torie and string courses which designed etc…

In some cases the decayed stone lost its structural and functional role but it still retains its archaeological and documentary values such as the base of colossal statue of Merit Amun in Akhamim where it lost its structural and functional role and it did not ordain any more to bear the dead load (weight) of the hefty statue , so the base was replaced with a stronger alternative with keeping the archaeological base in the site beside the statue because it still has a connection with the past (**figs .6-9) .**

2.2 .2.1 Examples of Case Studies :

a. An example of loss and absence of archaeological stone building structural, functional and esthetical role in addition to loss of inscriptions , drawings and paintings (documentary and esthetical function) in the funeral passage Osireion at Abydos because of raising of ground water tables and continuous salt crystallizing , so we have to stop deterioration and damage causes and sources before replacement with original local limestone (**fig.4**) .

b. Another example of loss and absence of archaeological stone building structural, functional and esthetical role in addition to loss of inscriptions , drawings and paintings (documentary and esthetical function) in the lower parts and foundations of the terrace of first portico of temple of Seti I at Abydos , and it is had to be replaced with the exact original limestone from its source which became known after this publishing this paper , while upper thick arrows indicate successful partial reconstruction with original limestone from its source (El-

Ghabat local quarry) , but we had to remove deterioration and damage causes and sources before replacement (**fig.5**) .

c. An example of emergency for partial reconstruction with the original stone from the local quarry for preventive conservation (from weathering and the majority of environmental deterioration causes and factors where the seven chapels of the temple of Seti I at Abydos had lost their ceilings and big parts of their upper walls , so the partial reconstruction **restored esthetical** role and provided a preventive conservation from weathering particularly inscriptions and pigments (**figs .10-11)**

2.2 .3 Piece in within existing with The Original stone :

this method is mostly unsuitable to losses of surfaces of building stones since its is too small to be compensated with original stone and since these losses are often irregular , unequal (in these cases the using the appropriate mortars (plastic repair) will be more suitable .) , and in case of large losses we can compensate them with replacement with the original stone with possibility of using stainless steel or titanium bars or rods , or polymeric composites to fit the new stone into place or to dowel pieces together .

The Second Theme

3. Discovery of Some Ancient Limestone Quarries and the evidences of using them as a sourcing stone for ancient Egyptian buildings .

This paper deal - partially - with the researcher's discovery of 12 ancient limestone quarries locate in surroundings of Abydos to both the south west (in El-Ghabat village) and the north west of Abydos (in Wadi naqb El-Salmani , El-Salmani village) ([12]) , these newly discovered quarries in this paper which are not yet registered are affixed to documented two ancient limestone quarries locate in the

([12]) A famous and principal ancient archaeological site situated in south of Egypt (Upper Egypt) on the western side of the Nile (about 15 km) , about 525 km. to south of Cairo and about 160 km. to the north of Luxor , locates on the edge and terraces of desert (calcareous Lower Eocene plateau) , in the ancient upper Egyptian 8th thinite nome and in west to the young alluvial plains of the Nile , sand dunes accumulations and old alluvial plains of the Nile.

same terrain and latitude of eleven of these quarries in the north west of Abydos (Harrell et.al. 1996 , p.23) ([13]) the first is published by James A. Harrell under serial number (61) from north to south from north to south among documented and published ancient limestone quarries ([14]) and was ascertained and verified by the researcher (it is open quarry) (**figs.12-13**) , now it is girdled with Man-made agricultural activities and growth , thereupon it is subject to ravage , and the second is published under serial number (62) , was ascertained and verified by the researcher and it is manifested that is false and the published position (26 ° 11.75 ′ N , 31 ° 51 .95 ′ E) or (26 ° 12.15 ′ N , 31 ° 52 .35 ′ E) is unsuitable to quarrying (**fig.14**) .

The researcher discovered these twelve ancient limestone quarries through his field tour and round in the geological context in the calcareous lower eocene plateau which nurture and hover the archaeological distinct Abydos , regarding to his own recognition of monumental stone sourcing (the researcher considers these sources as identical monuments and sources of archaeological and technological information , data and datum , also he considers the discovery and the study of ancient technology are competence of Archaeology conservator) and using the original stone for building repair and conservation (replacement) achieves some physical ,

([13]) the first of these two documented quarries locates in (26 ° 12.25 ′ N , 31 ° 52 .55 ′ E) and the second locates in (26 ° 11.75 ′ N , 31 ° 51 .95 ′ E), see : Harrell, J .A., Brown, V. M. and Masoud, S. M., Survey of Ancient Egyptian Quarries, Centennial of The Egyptian Geological Survey 1896-1996, paper no. 72, Cairo, 1996, pp.18-25; AEMT, 2000, figs. 2.1 a-b, 2.3, table 2.1, pp. 40-42.

([14]) for more information see :Harrell, J .A., Newsletter of The ARCE, 1989, pp. 3-5; Arnold, D., Building in Egypt, Oxford Univ. press, 1991, p. 29; Harrell, J .A., Ancient Egyptian Limestone Quarries - a petrological survey: Archaeometry, v. 34, no 2, 1992, pp. 195-212; Klemm, R. and Klemm, D. D., Stiene und Stienbruche im alten Agypten: Spring – Verlag, Berlin; Harrell, J .A., and Brown, V. M., Chephern ‘s Quarry in The Nubian Desert of Egypt: Nubica, v.3, 1994, pt. 1 p. 43-57; Harrell, J .A., Brown, V. M. and Masoud, S. M., Suevey of Ancient Egyptian Quarries , Centennial of The Egyptian Geological Survey 1896-1996 , paper no. , 72 , Cairo , 1996 , pp.18-25 ; AEMT, 2000 , figs. 2.1 a-b ,2.3 , table 2.1 , pp. 40-42 .

functional and aesthetic necessities in archaeological building as it was explained above .

Also the researcher thinks that there a likelihood of discovery of further more ancient limestone quarries in many various places between Cairo and Esna (Elwet Eddban about 20 kms. To the south of Esna) regarding to the widespread of ancient Egyptian buildings in that distance especially dating from the 3rd till the New Kingdom either on the east bank or on the west bank .

These newly discovered twelve ancient limestone quarries (six of them are covered and the other six are open) were recognized and identified with ancient tool (chisel) marks (stone picks) , stone pecks and ancient separation trenches remains , then their positions were appointed and assigned with Geographic Positioning System (GPS) instrument , then its rocks and stones features (of its geological formation) were compared with features of the largest survived limestone blocks of ancient building in Abydos ; Seti 1 and Ramesses 11 temples , then its mineral compound and chemical elements were also compared with those of two temples , in addition to other evidences , proofs and showings as following , and there are some general notes on these discovered quarries :

a. All these quarries locates on the west side of the Nile river far away more than 10 km. from the river west bank inside the calcareous Lower Eocene plateau .

b. Most of these quarries had been quarried within Drunka Geological formation ([15]) of the Thebes Group (Lower Eocene , Y Presian stage)

([15]) The Drunka formation was introduced by El-Naggar 1970 , see : El-Naggar , Z.R. , 1970 , (on a proposed lithostratigraphic subdivision for the late cretaceous-lower early paleogene succession In the Nile valley , Egypt (U.A.R.) , 7th Arab Petrol Congr.,Kuwait, paper No. 64 (B.3) , pp.1-50 , for the carbonate succession of Gebel Drunka near Assiut , where the type locality of the formation is taken according to El-Naggar , Z.R. , (1970) , the Drunka formation conformably overlies the Thebes formation , and is composed mainly of white , light grey and yellow white Limestone alternating with marly Limestone and marl with occasional flint bands and nodules,see:Ahmed,S.M.,(1980)"Geological Studies on The Area West and=

Where Limestone is fine grained mudstones , wackestones ,packstones and grrainstones with mainly echinoids and nonskeltal carbonate grains and lesser amounts of pelecypods ,(0-5% dolomite) (Harrell et.al. 1996 , pp.18-25) .

c. Some of them had been quarried within Drunka Geological formation in the upper part and the lower part had been quarried within transition zone between Drunka Geological formation and Thebes geological formation (which characterized with laminated limestone with chert bands interbedded with bioturbated hard clastic limestone beds

d. There is a plenitude in ancient limestone in the geological context in the calcareous plateau which besiege Abydos distinct , so there are additional numerous of quarries which the researcher ignored since it is too small to be source of a building stone blocks (may be had been used for quarrying a block for statute , stele or sarcophagus ..etc.) , is incomplete (may be had been experienced and was abandoned due to its bum and unsuitable material) , and this redundancy is running and frequent as a general in ancient limestone quarries between Cairo and Esna (where calcareous plateaus exist around the Nile Valley) . this wide distribution shortened the transport distances to less than sixty km (Arnold , 1991, p. 27) .

e. Eleven of these quarries locate to the north west of Abydos (in Wadi Naqb El-Salmani and El-Salmani village) and the twelfth one locates to south west (in El-Ghabat village) .

=Southwest of Sohag ” , Master Degree thesis , Department of Geology , Faculty of Science , Sohag , Assiut University .

f. Six of the twelve quarries are open ([16]) and the other six are covered ([17]).

3.1 and these quarries are :

in Wadi naqb El-Salmani and El-Salmani village :

I. (26 ° 11.58 ′ . 40 N , 31 ° 52 .08 ′ . 58 E) (Height : 289 m.)(covered quarry) the position of its entrance (**figs. 15-17**) , its approximate dimensions are 84.5 × 23.35 ×3.5 meters , also the interior of the quarry display ancient separation trenches remains and marks (**figs. 18-20**) and ancient marks of stone picks which are long lines that alternate in direction of work after each layer of

([16]) covered quarrying had been used when ancient Egyptian did not find the good and suitable rock in the top surface layers accomplished through the removal from the top or front of the cliff the covering of rubble , sand and bad rock. Then the top surface of rock was marked with a chisel by a succession of indentations of red ochre in double line indicates the separation trench between the blocks which were of different widths and depths from a quarry to another but enough for a stonecutter to stand or knee and descend 30-40 cm..below the cleavagesurface along which the blocks had to be split , but before the removal of the blocks the trenches must have exceeded one meter in depth because they had to be dragged out from the front , cutting straight front lines in vertical steps , and the open quarrying used normally to extract limestone and sandstone , see : Vyse, H., Pyramids III, pp. 93-98; Shaw, J. W., Minoan Architecture, Materials and Techniques, Annuario della Scuola Archeologica di Atene, Vol, 49, n.s. 33, 1971, Rome, 1973, pp. 32-35, figa. 263-28, toolmarks suggest that bronze picks were used, in Anatolia. Naumann, R., Architektur Kleinasiens von ihren Anfangen dis zum Ende der Hethitischen Zeit. Tubingen, 1955, pp. 38-39, figs. 18-19, Bogazkoy, and on the Easter Islands Mulloy, Easter Islands, p. 6, pl. 2 ; Arnold, D., (1991), Building in Egypt, Oxford Univ. press pp. 30-32 .

([17]) open quarrying was accomplished through the removal from the top or front of the cliff the covering of rubble , sand and bad rock. Then the top surface of rock was marked with a chisel by a succession of indentations of red ochre in double line indicates the separation trench between the blocks which were of different widths and depths from a quarry to another but enough for a stonecutter to stand or knee and descend 30-40 cm.. below the cleavage surface along which the blocks had to be split , but before the removal of the blocks the trenches must have exceeded one meter in depth because they had to be dragged out from the front , cutting straight front lines in vertical steps , see : Vyse, H., Pyramids III, pp. 93-98; Shaw, J. W., Minoan Architecture, Materials and Techniques, Annuario della Scuola Archeologica di Atene, Vol, 49, n.s. 33, 1971, Rome, 1973, pp. 32-35, figa. 263-28, toolmarks suggest that bronze picks were used, in Anatolia. Naumann, R., Architektur Kleinasiens von ihren Anfangen dis zum Ende der Hethitischen Zeit. Tubingen, 1955, pp. 38-39, figs. 18-19, Bogazkoy, and on the Easter Islands Mulloy, Easter Islands, p. 6, pl. 2 ; Arnold, D., (1991), Building in Egypt, Oxford Univ. press pp. 30-32 .

blows (so called herringbone pattern) characterize the early New Kingdom , and this concurs with a numerous of archaeological buildings in Abydos the adjacent district (**fig.21**). the interior of the quarry displays also very regular, closely set longish lines , all hewn from the same direction which characterize the Ramesside period until the end of Pharaonic times (**fig. 22**) and this also concurs with a numerous of archaeological buildings in Abydos , and this indicates this had been used during more than one period .

II.(26 ° 12.04 ′ . 57 N , 31 ° 52 .17 ′ .96 E) (Height : 277 m.) (covered) its width is about 20 meters (**figs. 23-24**) .

III.(26 ° 11.32 ′. 32 N , 31 ° 52 .17 ′.00 E) (Height : 141 m.) (covered quarry) (**figs. 25-26**) .

IV. (26 ° 11.56 ′ N , 31 ° 51 .99 ′ E) **(**covered**) (figs. 27-28).**

V.26 ° 11.64 ′ N , 31 ° 52 .00 ′ E) **(**covered**) (fig. 29) .**

VI.(26 ° 11. 65 ′ N , 31 ° 51 .99 ′ E) **(**covered**) (fig. 30).**

VII. (26 ° 12.01 ′ 69 N , 31 ° 52 .04 ′ , 26 E) **(Height : 292 m.)** (the first open quarry) (**figs. 31-32**).

VIII.(26 ° 11.63 ′ N , 31 ° 52 .02 ′ E) (open) **(fig. 33).**

IX.(26 ° 11.63 ′ N , 31 ° 51 .96 ′ E) (open) **(fig.34).**

X. (26 ° 11.65 ′ N , 31 ° 51 .98 ′ E) **(**open**) (fig. 35).**

XI. (26 ° 11. 66 ′ N , 31 ° 51 .99 ′ E) **(**open**).**

in El-Ghabat village :

XII. (26 ° 10. 16 ′, 00 N , 31 ° 30 .01 ′ , 00 E) (open) **(figs.36 - 41).**

This quarry display ancient tool (chisel) marks (stone picks which were mentioned before are very regular, closely set longish lines , all hewn from the same direction characterize the Ramesside period until the end of Pharaonic times) stone pecks and ancient quarrying pits , and this quarry was used by the researcher in partial reconstructions in some case study (temples of Seti I , Ramesses II at Abydos) .

3.2 Evidences of using These Quarries for Stone Sourcing for Building Ancient Egyptian Buildings (e.g. temples of Seti I and Ramesses II at Abydos as case study) .

3.2.1 General Evidence

Although there is an inscribed text on the southern outer wall of one of case study (temple of Ramesses II at Abydos) which mentions that the (fine) or (white) limestone of the temple had been brought from El-Masara **(fig. 42)** (it has been well-famed with the preferential limestone in ancient Egypt and locates at : 29 ° 54.09 ′ N , 31 ° 19 .02 ′ E , on Gebel Hof near El-Masara) and although of currency of bringing limestone for temples at Abydos from El-Masara in archaeological studies , but this research paper exposed that Abydos in common with another archeological sites - such as Saqqara , Dahshur, Pyramids , Lisht and Meet Rahena in Giza Plateau – the ancient buildings were with limestone blocks had been locally quarried from adjacent calcareous plateaus , and this thinking had been common in ancient Egypt ([18])

3.2.2 Special Evidences

3.2.2 .1 from the macro pictures of the limestone surfaces were examined visually and by means of visible-light photographs.

3.2.2 .1.1 The researcher discovery of what mentioned above about (numerous) twelve ancient limestone quarries - from Field survey and observations were done at the archaeological buildings and quarries at Abydos - quadrate and correspond in volume , locations , geological nature with limestone building blocks in archaeological buildings at Abydos (e.g. temples of Seti I and Ramesses II at Abydos) .

([18]) Stone samples from each surveyed structure have been characterized in order to identify the original stone types, and are matched to stone from the surroundings of explored ancient quarries to ensure that appropriate stone is used for the repairs. temples stone buildings directly reflect the local geology .

3.2.2 .1 .2 ancient marks of stone picks in these quarries also quadrate and correspond - as mentioned before - which are long lines that alternate in direction of work after each layer of blows (so called herringbone pattern) characterize the early New Kingdom , and this concurs with a numerous of archaeological buildings in Abydos the adjacent district (**fig.21**). the interior of the quarry displays also very regular, closely set longish lines , all hewn from the same direction which characterize the Ramesside period until the end of Pharaonic times (**fig.22**) and this also concurs with a numerous of archaeological buildings in Abydos (the Limestone parts of both temple of Seti I and temple of Ramesses II) .

3.2.2 .1.3 The similarity of optical symptoms , structure and texture etc. of the Drunka formation in limestone in both quarries , adjacent calcareous plateau and archaeological buildings in Abydos (e.g. temples of Seti I and Ramesses II at Abydos) .

where Limestone in both is fine grained mudstones , wackestones , packstones and grrainstones with mainly echinoids and nonskeltal carbonate grains and lesser amounts of pelecypods ,(0-5% dolomite) and transitional Drunka formation and Thebes geological formation (which characterized with laminated limestone with chert bands interbedded with bioturbated hard clastic limestone beds , and other features such as Oolitic Texture (**figs. 43 - 54**)

3.2.2 .2 for the laboratory investigation , analysis and tests ; the similarity of components and weathering (were investigated with polarizing microscope) (**figs. 55- 58**) (such as micro and macro algae in Algal Limestone , arrangement , development and dissolution and decay of calcite crystals and its remained specter , fine grain calcite , cleavage planes in the same direction, detrital Micrite , Massive Micrite and its alteration to Sprite and micro Sprite , dedolomization , so Mineralogical and petrographical analyses support that the Limestone parts of both temple of Seti I and temple of Ramesses II at Abydos had been quarried from the local twelve ancient limestone quarries which locate – as mentioned before - in surroundings of Abydos to both the south west (in El-Ghabat village) and the north west of Abydos (in Wadi naqb El-Salmani , El-Salmani village) , the similarity of compositions (were analyzed with XRD and were found composed mainly of Calcite $CaCo_3$ as a major and Dolomite Ca $Mg(Co_3)_2$. as a minor) (**figs. 59- 62**) and the similarity of physico-mechanical properties of the limestones of both temple of Seti I and temple of Ramesses II at Abydos and two selected quarries (I , XII) which were tested and were found similar in terms of their ultrasonic velocity values , effective porosity and bulk density.

Table 1. comparative Physico-mechanical Properties of limestones of ancient Egyptian buildings and quarries

Samples of :	**Ultrasonic Velocity (USV) (m/s)**	**Porosity (%)**	**Bulk Density (g/cm3)**
temple of Seti I at Abydos	2856	0.02	2.40 ± 0.02
temple of Ramesses II at Abydos	2875	0.02	2.63 ± 0.03
The quarry no. (I)	3066	0.01	2.68 ± 0.00
The quarry no. (XII)	3022	0.01	2.68 ± 0.01

We have to cite here that the authorities in charge of these quarries (such Supreme Council of Antiquities and The Egyptian Geological Survey) have to preserve them for own cultural, expedient and functional values and for using their context as source of the original stone for repair and conservation **.**

The Third Theme

4.The Reason of Using the Alternatives of the Original Stone for Repair and Conservation

In addition to difficulty of finding the original stone sometimes there are some warrants to affect alternatives for stone repair and conservation : delectability, reversibility and stability , and we have to considerate some technical estimations in the alternative where ;
a. it does not damage the archaeological environs .
b. it does not require environ (original) removal **c.** it must be reversible . **d.** it must be stable to light , variations of air temperatures and relative humidity . **e.** it must be equal or less than the mechanical properties of the archaeological stone . e. it must be easy to work . **f.** it fulfills aesthetic requirement .**g.** should not be a source of deterioration causes such as salts , excessive alkalinity or acidity . **h.** equality of the physical properties ([19]) of the archaeological stone

4. 1 The Reason and Criteria of Using the Correspondent or the Appropriate Stone for Stone Repair and Conservation (the Rule of Like-with-like) (near kind) ([20])

1- Practically we have faced problems trying to find the appropriate stone for repairs , since we can not find the same geological formation, or even the same quarry, or even the same bed from which the stone had been quarried , even if the bed is known, the working face may have retreated so far that the exposed stone

([19]) Sometimes the substrate stone should be for example more permeable and weaker to be victimized to deterioration causes instead of the archaeological stone , for further see : Peroni , 1981 , ; Weber and Zins, 1988 ; Carbonell , de Masy M. , 1992 ,Nouveaux materiaux pour la restauration des pierres alteres , In Proceedings of the 7th International Congress on Deterioration and Conservation of Stone , vol. 3 , Lsbon :Laboratorio Nacional de Engenharia Civil , pp. 1127 1135 ; Griswold , J. and Uricheck , S. , Loss Compensation Methods for Stone , in : Journal of The American Institute for Conservation (JAIC), Spring 1998, Vol. 37, p. 91.
([20]) Where there is distinguish between the new stone and the original .

differs significantly from the stone in the building ([21]) , thereupon Like-with-like rule will be appropriate ([22]) .

2- in case of hypothetical reconstructions it is not preferable to use the original stone to avoid confusion ([٢٣]) , also it is a must to cite the importance of the environment and the context in the choice of the correspondent or the appropriate stone (and method) ([٢٤]).

3- To accomplish using the correspondent or the appropriate stone for stone repair and conservation (applying Like-with-like Rule) we have to understand the properties of both existing stone and potential substitute stone ([25]) .

([21]) Honeyborne , D. B. , The selection of stone for repairs , in : Conservation of Building and Decorative Stone , edited by John Ashurst and Francis G Dimes, Vol 2, Butterworth-Heinemann, Elsevier Ltd, 1998 , p. 71.

([22]) In case of using the correspondent or the appropriate stone , we have to select - in the case of sedimentary rocks- the replacement and the original stone should be of a similar age, and from a similar sedimentary environment, and in the case of Metamorphic rocks in the building stones should be of a grade corresponding to the original, and igneous rocks should be from the same kind , see :.

([23]) Stubbs, J . H., Protection and Presentation of Excavated Structures , In : Price ,N.P. S., Conservation on Archaeological Excavation , ICCROM ,Rome , 1995 , pp. 77-78 .

([24]) for further see : Griswold , J. and Uricheck , S. , Loss Compensation Methods for Stone , in : Journal of The American Institute for Conservation (JAIC), Spring 1998, Vol. 37, p. 90 ; Marks , S., 1994 ,East and West : Approaches to Loss compensation : Technical and Philosophical Issues , Objects Specialty Group Postprints, Vol. 2, Washington .D.C :AIC , pp. 41-43 ; Loowinger , R. and Williams , D. , 1994 , Loss compensation in Contemporary Sculptures , in : Loss compensation : Technical and Philosophical Issues , Objects Specialty Group Postprints, Vol. 2, Washington .D.C :AIC , pp.103-114; Bongrino, B. , 1977 , The Preservation of the San Francisco mint :Cleaning structure repair and stone replacement techniques , Technology and Conservation 2(3): pp.22-25 .

([25]) should be used - stone that closely replicates the original in its appearance, chemical, physical and mineralogical properties, strength and durability, the aim should be to retain the maximum amount of original stone, wherever this does not compromise the integrity of the building , maximum retention is often the preferred option , It is therefore acceptable to replace stone selectively to ensure structural stability, or when it has decayed beyond repair, also replacement may be appropriate when the purity of the building design is considered equally valuable, or more valuable, than the original construction material , see :Identifying and Sourcing Stone for Historic Building Repair , An approach to determining and obtaining compatible replacement stone , Technical advice note , 2006 .

to provide a good match, a cut surface of the new stone must be similar in texture and color to the cut surfaces of its prospective neighbors, both wet and dry. Its appearance must also=

In this case we have to find a harmonizer compatible stone to match with the original as close as possible (achieve compatibility with the archaeological stone) and over the long term ([26]) . particularly in the type , the overall size , character (cutting and dressing techniques) the physical , textural , chemical , mechanical, durability , workability properties and characteristics (in addition to visual appearance and color in addition to grain size) to be tuned with the original stone , also it has to have physical and mechanical characteristics and minimum content of salt for better durability and with the repair purpose with the help of expecting its future behavior , thereupon we secure the health of the monumental stone and the success the repair and conservation .

4- The replacement stones have to be investigated , tested and evaluated ([27]) .
5- The replacement stone should not be selected and replaced oddly but in the sequence and the course of the monumental construction as a whole where there is relationship to the archaeological environ stonework .
6- In the same time the use of the incompatible stone will deform the monumental building and deteriorates and damage the archaeological stone ([28])
7- Also the replacement stone has to protect the archeological remaining stone in a sacrificial and selective way such as replacing the structural stone parts and elements (such as foundation , lintels , architraves corners and ceilings) .

An example of case study

=merge well with the weathered surfaces of its neighbors after long exposure, the best way to make a choice is to look for a good match in other buildings of similar age which are constructed of stone from discovered quarries , see : Honeyborne , D. B. , op. cit. , 1998 , p. 71.

([26]) including the structural repair in archaeological stone constructions , see : Peter Hill , Conservation and the Stonemason, Journal of Architectural Conservation I , 1995 , pp. 7-20.

([27]) Ashurst , J. and Burns , C., Philosophy , Technology and Craft , in : Conservation of Ruins , edited by John Ashurst , Elsevier Limited , First edition 2007 , pp. 121-126.

([28]) for example if the replacement stone is less porous than the archaeological one , this resulting in increasing of retention of moisture in the latter .

also the weak walls which are subjected to mechanical pressure and moistured & polluted soil , rubbish and garbage of the outraged urban context) such as our example of case study in the north wall of the Seti I temple at Abydos with an alternate stone of low permeability and high hardness from Eisawya distinctive geological formation rocks which have been used in modern construction activities regarding its stability of water and its distinctive mechanical properties) beside Eisawya Sharq village which located to the south east of Akhmim (**fig.63**)..

8- also replacing the artistic , carves and ornamental stone parts and elements (such as such as the cavetto cornices, torie, frieze of urauie, edges and protruding ornaments of columns capitals , edges of columns bases , edges of staircases , balustrades and so forth) with an alternate stone of low hardness .

9- So the replacement stone would overcome the infirmity and defect of the original stone and its inadequate position for example ([29]) , also would compensate the several varieties of the lost stones .

10-We have to cite that the correspondent stone should be intentionally distinguishable from the original and desirable due to protecting the original remaining stone for obtaining definite properties .

([29]) the same for selective deterioration of sandstone which in contact with limestone , see : Hyslop , E. , Sourcing and Selection of Stone for Repair , in : Stone Conservation , Principles and Practice , Donhead Publishing Ltd.UK , 2006 , p. 90 ; Ashurst , J. and Ashurst, N. , Practical Building Conservation , Viol. 1 :Stone Masonry , Gower Technical Press , Aldershot , 1988 ; Ashurst, N. and Kelly , J. , The analytical approach to stone , its cleaning , repair and treatment , Appendix 4 , in : Ashurst, J and Dimes, F J , 1990 , Conservation of Building and Decorative Stones ,London: Butterworth Heinemann .

11-So the replacement alternate appropriate stone has to achieve delectability, reversibility and stability - as mentioned above- plus parry the impropriety of the previous replacements .

12-the replacement alternate appropriate stone sometimes gets by failure of plastic repairs either esthetically or mechanically - particularly mortar repair material colored with pigments, or feather-edged to ragged areas of decay or finished with steel trowels, is often visually unacceptable in addition to that the over-strong mortars, mortars relying on bonding agents instead of mechanical keying , or large surface areas in exposed positions, will be mechanical failures ([30]) .

13-We can conclude the selection of the correspondent or the appropriate stone for stone repair and conservation in the following criteria : identifying the cultural significance (archaeological , architectural , artistic , functional , symbolic and etc.) , the need for intervention and the probable impact of this intervention .

14-The reason of this intervention (such as deterioration , damage , structural failure ([31]) , loss of visual integration and possibility of further damage) .

15-Defining the types of stone used , by visual examination *in situ* and the investigations (petrographical) ([32]), analysis (XRD, XRF,

([30]) Ashurst, J. , Methods of repairing and consolidating stone buildings , In : Ashurst, J and Dimes, F J , 1990 , op.cit.p.22 .

([31]) Probably because of the nature of the replacement. Is it due to the environment? Weather erosion, salt damage, or location and so on .

([32]) for petrography: the constituent grains should be of the same type, size, angularity and proportions as in the original stone, the binding material must also be similar, the ratio of binding material to constituent fragments or mineral grains and the porosity must also be alike, in case of similarity of the mineralogy of the replacement stone to the original, then the chemistry of the stone will effectively be the same, see : Identifying and Sourcing Stone for Historic Building Repair
An approach to determining and obtaining compatible replacement stone , Technical advice note , 2006 ; Ashurst, J and Dimes, F J , 1990 Conservation of Building and Decorative Stones ,London:=

Atomic absorption) ([33]) , tests (physical ([34])([35]) and mechanical properties) ([36]) , and etc. , where the reasons for these examinations are to : identify the type and source of stone so as to obtain an acceptable replacement , understand the manner in which a stone is weathering or decaying, to establish measures to slow the rate of deterioration , determine the nature and distribution of

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=Butterworth Heinemann ; Brereton, C 1995 The Repair of Historic Buildings: Advice on Principles and Methods, 2 ed. London: English Heritage .

([33]) for the chemistry of the replacement stone must be similar to that of the original, particularly the concentrations of silica, magnesium and iron. the iron content and the form in which iron occurs are particularly important, as this will largely determine the final color of the exterior surface, especially after weathering , see :

([34]) for appearance of the stone viewed in block form must be close to the original, if the petrography and chemistry are similar, then the small-scale appearance should also be the same, but large-scale features such as bedding and veining must also be considered. he bed-depth within the quarry must permit the extraction of suitably sized blocks for the intended purpose, see : Identifying and Sourcing Stone for Historic Building Repair An approach to determining and obtaining compatible replacement stone , Technical advice note , 2006 ; Ashurst, J and Dimes, F J , 1990 , Conservation of Building and Decorative Stones ,London: Butterworth Heinemann ; Brereton, C 1995 The Repair of Historic Buildings: Advice on Principles and Methods, 2 ed. London: English Heritage .

([35]) for porosity ; both the overall value of the porosity and the pore-size distribution should be as close as possible to those of the original stone. If a stone with the same porosity and permeability cannot be found, use one with a higher rather than lower porosity, any subsequent degradation is then more likely to occur in the new stone rather than in the original stone , see : English Heritage Identifying and Sourcing Stone for Historic Building Repair An approach to determining and obtaining compatible replacement stone , Technical advice note , English Heritage , London ,2006 ; Ashurst, J and Dimes, F J , 1990 Conservation of Building and Decorative Stones ,London: Butterworth Heinemann ; Brereton, C 1995 The Repair of Historic Buildings: Advice on Principles and Methods, 2 ed. London: English Heritage .

([36]) for compressive strength where it is not possible to match the compressive strength of the replacement with the original stone, the replacement stone should be weaker rather than stronger, so that it is the more likely to fail, satisfying all these criteria would ideally require the replacement stone to be from the original quarry, or at least a source in very close proximity to the original quarry, failing this , the new stone should meet as many of the above criteria as possible, with the first three being the most critical , see :English Heritage , Identifying and Sourcing Stone for Historic Building Repair An approach to determining and obtaining compatible replacement stone , Technical advice note , English Heritage , London , 2006 ; Ashurst, J and Dimes, F J , 1990 Conservation of Building and Decorative Stones ,London: Butterworth Heinemann ; Brereton, C 1995 The Repair of Historic Buildings: Advice on Principles and Methods, 2 ed. London: English Heritage .

contaminants within the pores of the stone, and their possible effect on the stone and on the surrounding context of the building Information required by the analyst , the aim of the petrographic analysis, and how the information will be used , the history, age and condition of the building, the nature and extent of visible decay , mechanisms , the context and location of specific stones or areas of the ancient building ([37]).

16- The process of sourcing and securing replacement stone from alternate quarries (this process require a team of skilled and experienced of specialists of geologist , stone consultant , petrographer , conservator in addition to who can both identify the stone and find either the most compatible petrographic match from new sources, or the most closely related alternatives in addition to proceeding mineral planning through stone sourcing , also the stonemason should be involved in this process to ensure that a usable stone is chosen - and not one which suffers from bed problems, poor quality, or inferior workability- durability and weathering are also important and lasting of the stone and compatibility with the archaeological stone ([38]) , and generally the stone sourcing for archaeological buildings repair and conservation must take the following consideration : the

([37]) Identifying and Sourcing Stone for Historic Building Repair

An approach to determining and obtaining compatible replacement stone , Technical advice note , 2006.

([38]) we have to proceed some tests for replacement stone such as the performance in the context of modern building practices, for example, the breaking, load of a fixing used in stone cladding , salt crystallization, saturation coefficient, porosity, and freeze/thaw cycles to define and indicate to durability, comparing the behavior of the potential replacement with that of the original stone, or with that of a stone whose properties in a similar environment are well understood , since these tests do not take the environment within and around the building, or the effect of the mortar between the blocks into account , so we need further procedures of large-scale environmental testing

Where major repairs are required, and the replacement stone chosen is not petrographically identical to the original, large-scale environmental testing can be useful, also we use a test chamber for simulation weathering conditions based upon real meteoro -logical data, including wetting and drying , see : Coulson ,M. ,Stone Replacement , To do? Or what to do? That is the question, The Building Conservation Directory, 2007 .

matching stone should be similar in color, texture and physical properties to the original , any intervention must not deteriorate the original stone , especially the juxtaposition of two incompatible stones (the insertion of a different type of stone) can lead to adverse chemical reactions ([39]).

4. 2 Replacement with cast stone (not natural but imitation or artificial)

It is (any product manufactured from aggregate and cement and intended to resemble in appearance and be used in a similar way to natural stone.) ([40]) , the cast is almost of silicone rubber .

this type has not been used before for stone repair and conservation of ancient Egyptian buildings as a substitute of natural stone although of its proportion for the following purposes :

1- the replacement with cast stone may be preferable to natural stone in sculptures , ornamental and architectural elements where the environment is particularly demanding and aggressive because of its durability , but its appearance is liable to become less
2- as a substitute for some forms of stone slate .
3- *in situ* replacements for sculpture .
4- as a building element may either be homogeneous or may consist of a facing material and a backing reinforcement .
5- desirable for architectural completeness or as landscape features ([41]) .

4. 3 Reason and Criteria of Using the mortars (Plastic Repair) for Stone Repair and Conservation

([39]) Identifying and Sourcing Stone for Historic Building Repair
An approach to determining and obtaining compatible replacement stone , Technical advice note , 2006.
([40]) The British standard (BS 12 17:1975) specification .
([41]) for further more see : Ashurst, J. , op. cit , 1990 , op. cit.pp.25-26 ; Warland, E.G., Modern Practical Musonty, reprinted by the Stone Federation, London. 1984 ; Clifton-Taylor, A., The Pattern of English Building, 2nd edition, Faber, London, 1977 .

The plastic repair is a moldable pliable material fill applied directly to the loss and set or hardened into place to the original and compensate the loss void by its own adhesion and includes mortars and putties and the paper deals with the term (plastic repair) and the term (mortar) as equals whichever mortars of lime-based (or any binder or cementation with or without organic and with or without internal reinforcements such as stainless steel , titanium , polymeric composites) include binder (matrix) (either inorganic binders such as natural &modern cements or organic binders such as different thermoplastic , reaction-cured , and solvent-cured organic), filler (aggregate) (inactive materials matrix or aggregate - ranges from powder to large aggregate such as crushed stone , crushed burnt-brick , microballons , and so on , the filler meets several needs such as acting to bulk up the binder , effect temper the qualities and improves the properties ([42]) , also the filler controls and changes the density , color , porosity, translucency ,gloss, autoxidation , coefficient of thermal expansion , the strength of the adhesion (such as pigments) and special additives ([43]).

These reasons are :

1- The difficulty of obtaining the original stone or the appropriate stone we have to use mortars (the researcher has noticed- throughout more than 25 years experience - that the stone repair and conservation works with the original or the appropriate stone have been few and exceptional particularly in stone integration).

([42]) The examples of fillers which change the properties of the binder such as colloidal fumed silica , also it has to be compatibility between filler and binder to avoid differential reactions resulting in internal stresses and lack of adhesion , also it has to be correspondence in ratio , type and so on , , see : Gansicke , S. and Hirx , J. , 1997 , A translucent wax –resin fill material for the compensation of losses in objects , Journal of the American Institute for Conservation , 36, pp. 17-29 ; Griswold , J. and Uricheck , S. , op.cit., 1998, , p. 94.

([43]) Barov , Z. and F. Lambert , 1984 ,Mechanical Properties of some fill materials for ceramic conservation , In : International Council of Museums Committee for Conservation , preprints, 7th Triennial meeting , Copenhagen , Paris , ICOM, pp. 1-4 ; Griswold , J. and Uricheck , S. , op.cit., 1998, , p. 94.

2- Use the original stone or the appropriate stone demands cost and long time for implementation .

3- Use the original stone or the appropriate stone demands skilled and best - trained stonemasons or craftsmen (sculptors) of a highly skilled profession and should only be undertaken by suitably qualified or experienced people who have the same skills of the Egyptians ancient and who are being very rare nowadays in Egypt and also the scarcity of stonecutters, which are hand-cut stone from the local and non local plateaus , as needed, as is now exploded rather than quarrying manual , so the researcher recommends the revival of ancient crafts of ancient Egyptian (Pharaonic, Ptolemaic, Romanian and Islamic including quarrying , storing , dressing, lifting , matching setting and so on) in view of the urgent need in the conservation and repair works .

4- Technically the use of plastic repair with mortars to avert disturbing critically fragile areas , to avert the removal of structural elements , to perform satisfactorily in the intended context , is more suitable for small areas , to avert unacceptability of matching stone a large replacement of stone , is more appropriate esthetically than new stone in the context of heavily weathered, softened outlines ([44]) .

([44]) Ashurst, J. , Methods of repairing and consolidating stone buildings , In : Ashurst, J and Dimes, F J , 1990 , op. cit.pp.22,24 ; Caroe, A.D.R. and Caroe, M.B., Stonework : Maintenance and Surface Repair, Council for the Care of Churches,London, 1984 ; BRE Digest 269, The Selection of Natural Building Stone, Building Research Establishment, 1983; Honeyborne, D.B ,The Building Limestones of France, Building Research Establishment Report, HMSO, London, 1982 ; Warland, E.G., Modern Practical Musonty, reprinted by the Stone Federation, London. 1984 ; Schaffer, R.J., The Weathering of Natural Building Stones, Department of Scientific and Industrial Research Special R e p o r1t 8 , HMSO, London, 1932 (available from Building Research Establishment, Watford WD2 7JR, England ; Powys, A.R., Repair of Ancient Buildings, reissued by the Society for the Protection of Ancient Buildings, London, 1981 ; Clifton-Taylor, A., The Pattern of English Building, 2nd edition, Faber, London, 1977 ; Derbyshire County Council, Traditional Stone Roofing .Design and Conservation Section, County Planning Department, Derbyshire County Council .

5- Plastic repair is considered sometimes as an alternative to cutting out and piecing in with new stone ([45]) .
6- The difficulty of the formation and reconstruction of many of the sculpture , ornamental and architectural elements (such as the cavetto cornices, torie, frieze of urauie, edges and protruding ornaments of columns capitals , edges of columns bases , edges of staircases , balustrades and so forth) with the original stone or the appropriate stone , even the reconstructions which had been executed with stones are less accurate and homogeneous , while the works which have been executed with mortars on and in these ornamental sculpture ornamental and architectural elements are more accurate and took less time, and consumed less financial cost, and required less effort .

An example of case study

the cavetto cornices , torie of the terrace of the second court and edges of staircases and balustrades of the staircases leading from the first to the second court of the temple of Seti I and Ramesses II at Abydos where there is a difficulty of the formation and reconstruction of many of the ornamental and architectural elements with accuracy and homogeneity in addition to that the use of the plastic repair (mortars) here opened up addition of chemical additives to mortars to increase resistance of tread , trample and friction of the infantry (visitors and tourists) of the staircases , also plastic repair (with mortars) avert disturbing fragile areas (**figs. 64- 65**).

But we have to cite that the replacement with stone (such as the corner torus of Ramesses II temple (**fig. 66**) sometimes affords more accurate and homogeneous compensations

([45]) Ashurst, J. , Methods of repairing and consolidating stone buildings , In : Ashurst, J and Dimes, F J , 1990 , op. cit. , p.22 ; Caroe, A.D.R. and Caroe, M.B., 1984 , op. cit. ; BRE Digest 269, op. cit. , 1983;. Honeyborne, D.B , 1982 , op. cit. ; Warland, E.G., 1984 , op. cit.; Schaffer, R.J., 1932 op. cit.; Powys, A.R., 1981, op. cit. ; Clifton-Taylor, A., 1977, op. cit.; Derbyshire County Council, Traditional Stone Roofing .Design and Conservation Section, County Planning Department, Derbyshire County Council .

than that of mortar (such as the corner torus of Elvantine temple (**fig. 67**) .

7- also the nature of the loss (for example the salient or obtrusive loss should be filled with replacement not with plastic repair , while the symmetrical or repeated elements and units should be compensated with plastic cast multiplies with difficulty of quarrying , transport , carving , dressing and forming of stone) , its size , its context and environment , .

8- The difficulty of achieving that in the natural stones and rocks such as limestone, sandstone and granite, as well as they require a lot of time, effort and money in the cutting and transport, handling and dressing, as well as the difficulty of finding .

9- Sometimes the interventions (particularly the replacement and partial reconstruction) have to avert and overcome the deficiencies , defects , satisfy the varieties of the lost archaeological stone (such as : the inability of weathering stability of stones of surface of outer or external walls , the inability of durability of stones for overloading e.g. foundation ,the bases of columns , columns , lintels , architraves , the inability of friction resistance such as corners , Cornices , edges & corners of steps of staircases , balustrades , Torie, Frieze of Urauie, edges and protruding ornaments of columns capitals and etc.), and overcome its inadequate position such as incompatibility of some adjacent types of stone deterioration of sandstone which in contact with limestone and limestone which in contact with magnesian limestone ([46]).

10- Some conservators nowadays consider and suppose the re-construction with original or appropriate materials in full conformity resulting confusion over time particularly in the case of the broadcast of the areas and volumes of substitutes ,

([46]) Hyslop , E., op.cit. , 2006 , p. 91; Stone Federation Great Britain , Stone Specifiers Guide , Excel Publishing ltd, Manchester , 2006 ; Ashurst , J. and Ashurst, N. , op.cit., 1988 ; Ashurst, N. and Kelly , J. , op.cit., 1990 .

and so there is a tendency of the substitutes , compensation and the reconstruction with variant materials to be so easy to distinguish between them and the original stones , also these repairs are also more consistent with Articles 12.13 of the Charter of Venice (47) , also when stones are replaced unnecessarily this will have a de-valuing effect on the monumental wall or element (48) , in the past it had been current to fit the loss void with replacement , but nowadays and regarding the plastic repair preserves all remaining stone and does not require preparation and planning of the archaeological surfaces and regarding to the addition of a new stone is considered an excessive intrusion intervention (49) and in general the implementation of the two methods or styles (mortars and stone) provides an objective comparison between them all the flaws and features.

11-Recently there are a general agreement on the allusion and imitation to the original stone are simplicity , crude reminiscent form and create conspicuous , distracting and dishonest particularly for non-specialists (٥٠) .

12- Generally the mortars (plastic repair) characters and odds fast and simple application particularly to deteriorated and missed archaeological surfaces specially belonging the adhesion between the archaeological stone and the new chosen matched material (٥١).

(47) The International Congress of Architects and Technicians of Historic Monuments (Venice Charter) , Venice . Document 1 , 1964

(48) Ashurst, J. , Methods of repairing and consolidating stone buildings , In : Ashurst, J and Dimes, F J , 1990 , op. cit.p.1 .

(49) Griswold , J. and Uricheck , S. , Loss Compensation Methods for Stone , in : Journal of The American Institute for Conservation (JAIC), Spring 1998, Vol. 37, pp. 91-92 .

(50) with alleviation the exaggerated homogeneity , see : Mertens , D. , Planning and Executing Anastylosis of Stone Buildings , In : Price ,N.P. S., Conservation on Archaeological Excavation , ICCROM ,Rome , 1995 , pp. 120 -121 .

(51) loc.cit. .

13-Sometimes we use the mortars (plastic repair) to alleviate the exaggerated replacement of more stone than is necessary.

14- Generally the mortars (plastic repair) achieve - through compensating for loss and repair - the structural necessity , alleviate more deterioration and damage and aesthetical integration (according to size ,context) where .

15- Generally it has to be taken several technical considerations in account such as avoidance deterioration or damage of the original , avoidance removal any layers of the original, equality or weakness the mortar to the original , stability , easiness to work , flexibility of transference to all purposes and economy & saving the time & money

16-Selection of the method of application rely on scale of the loss , environment or context and resources .

17- Types of compensation or replacement is either in-kind , in near-kind or in pre-cast .

18-Repair with mortars is either constitutional or superficial, and is either fill or patch , is applied either as a one layer (all-in-one) including colorant , texture and volume or as multilayer (the bulk then the suave surface) .

19-The main components of mortars are : the binder (such as lime , resins and etc.) , the filler (stone smithereens , chips , and powder , minerals , fumed silica frits and etc.) and the colorants (such as pigments) .

20- The steps of repair with mortars are : preparing to matching samples of mortars – on a piece of stone or tile, not in a wooden mould -to the various conditions of weathering on monumental stones of the building which exhibit a subtle variety of color in the light the unnatural uniformity of the plastic repair , removal the deteriorated parts and surfaces , Saturation the repaired surfaces sterilized primal to prevent dewatering of the repair mortar , placing the mortar in thin layers in each one application ,then allow each layer to dry out before placing the next layer, reinforcing the mortar in case of exceeding it over 5cm. in depth and in extent with appropriate material and technique , finishing the repairs to the required profile using the appropriate tools , material and technique , avoiding the cracks during drying resultant the fine shrinkage , if the monumental stone is limestone the plastic repair mortars have to be based on a lime binder, but with sandstones we have not use lime as a binder because it deteriorates the sandstone ([52]) .

Generally the mortars (plastic repair) - in addition to chemical treatment - are of shorter life than the stone either the original or the appropriate stone , where are not more than tens of years .

The preferable mortars are of lime-based regarding its either natural or semi- chemical (with additives).

The Mortars (Partial Reconstruction)

The reasons and criteria of using the mortars for Partial Reconstruction :

1- weakness and infirmity of the physical , mechanical durability , workability , properties of the original stone (such as softness of stone and its sensitivity to moisture content) .

Also mortars should be intentionally distinguishable from the original the appropriate stone and desirable due to obtaining definite properties or purposes .

5. Conclusion

This paper add the researcher's exploration of 12 ancient limestone quarries locate in surroundings of Abydos to both the south west (in El-Ghabat village) and the north west of Abydos to

([52]) Ashurst, J. , Methods of repairing and consolidating stone buildings , In : Ashurst, J and Dimes, F J , 1990 , op. cit. , p.24 ; Caroe, A.D.R. and Caroe, M.B., 1984 , op. cit. ; BRE Digest 269, op. cit. , 1983;. Honeyborne, D.B , 1982 , op. cit. ; Warland, E.G., 1984 , op. cit.; Schaffer, R.J., 1932 op. cit.; Powys, A.R., 1981, op. cit. ; Clifton-Taylor, A., 1977, op. cit.; Derbyshire County Council, Traditional Stone Roofing .Design and Conservation Section, County Planning Department, Derbyshire County Council .

be affixed to documented Eighty eight ancient limestone quarries in Egypt , to preserve them for own cultural, expedient and functional values and for using their context as source of the original stone for repair and conservation , the researcher enumerates the general and special evidences of using these quarries as a sourcing stone for ancient Egyptian buildings in Abydos .

The paper recommends preservation of these quarries for own cultural, expedient and functional values and for using their context as source of the original stone for repair and conservation **.**

And in the light of discovery of these quarries the research - consequently - dealt the reason of using the original stone with review of some examples of case study, then it is requisite explain the reason and criteria of using the stone alternatives also with review of some reference examples of case study .

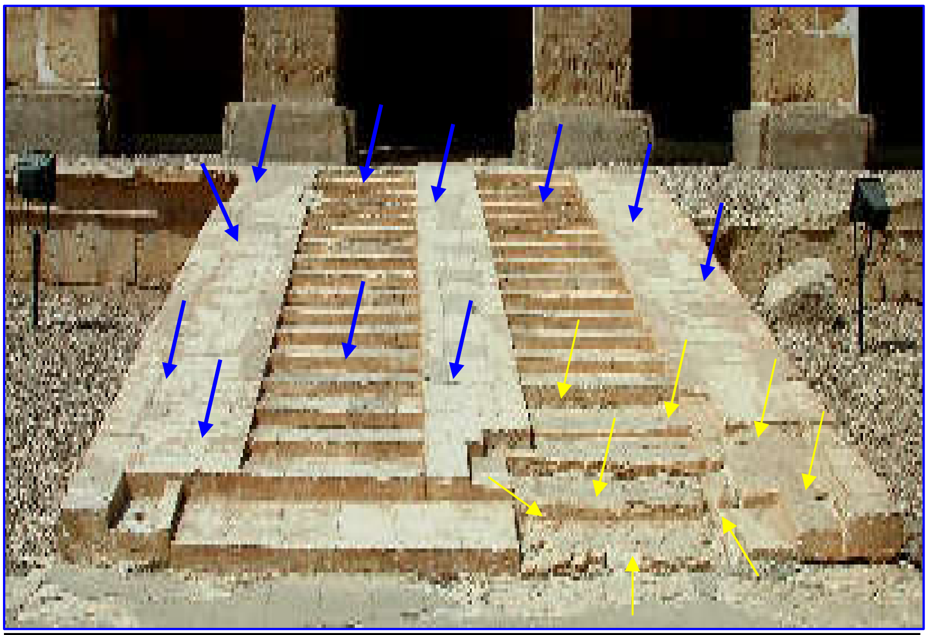
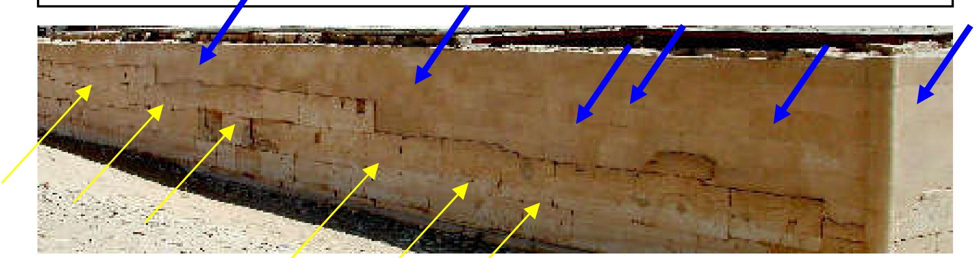


Fig. 1 Display An example of a partial reconstruction of the third staircase of temple of Seti I at Abydos with the exact original stones from local open quarry El-Ghabat , we preserved and kept the original remains of archaeological steps (thin yellow arrows) , and reconstructed the rest of the staircase (thick blue arrows) according to its architectural and artistic stylist with the help of the comparative analysis of the other proverbial and semblances from the same temple and the similar temples which are coincident temporally



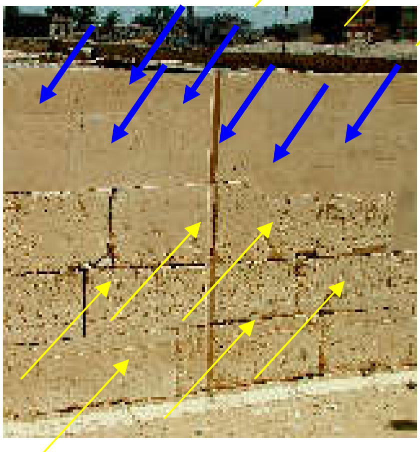


Fig. 2 , 3 Display Another example of a partial reconstruction of the northern , western and southern walls of the temple Ramesses II at Abydos with the same original stones with the same traditional style and method (thick blue arrows) which achieved preventive conservation for the remains of the valuable outer walls (thin yellow arrows) from further damage and destruction.

Fig.4 Display an example of loss and absence of archaeological stone building structural, functional and esthetical role in addition to loss of inscriptions , drawings and paintings (documentary and esthetical function) in the funeral passage Osireion at Abydos because of raising of ground water tables and continuous salt crystallizing , so we have to remove deterioration and damage causes and sources before replacement with original local limestone

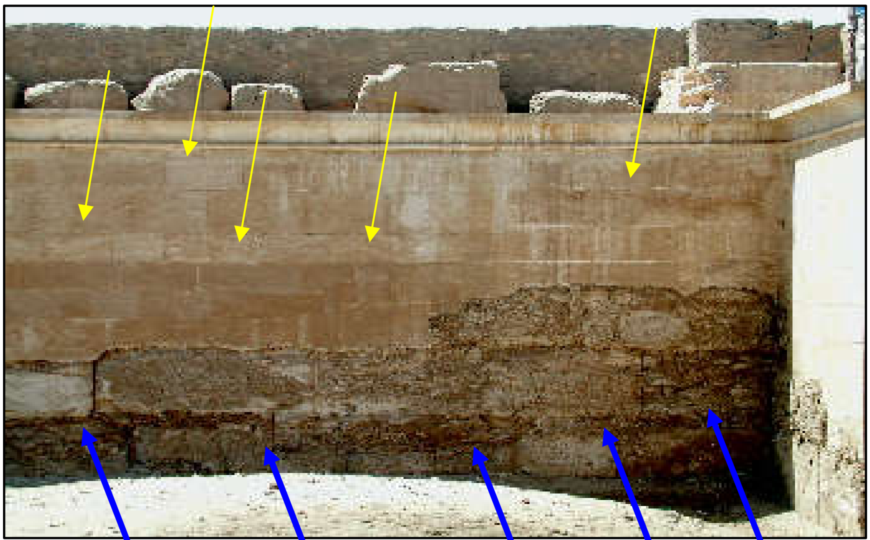
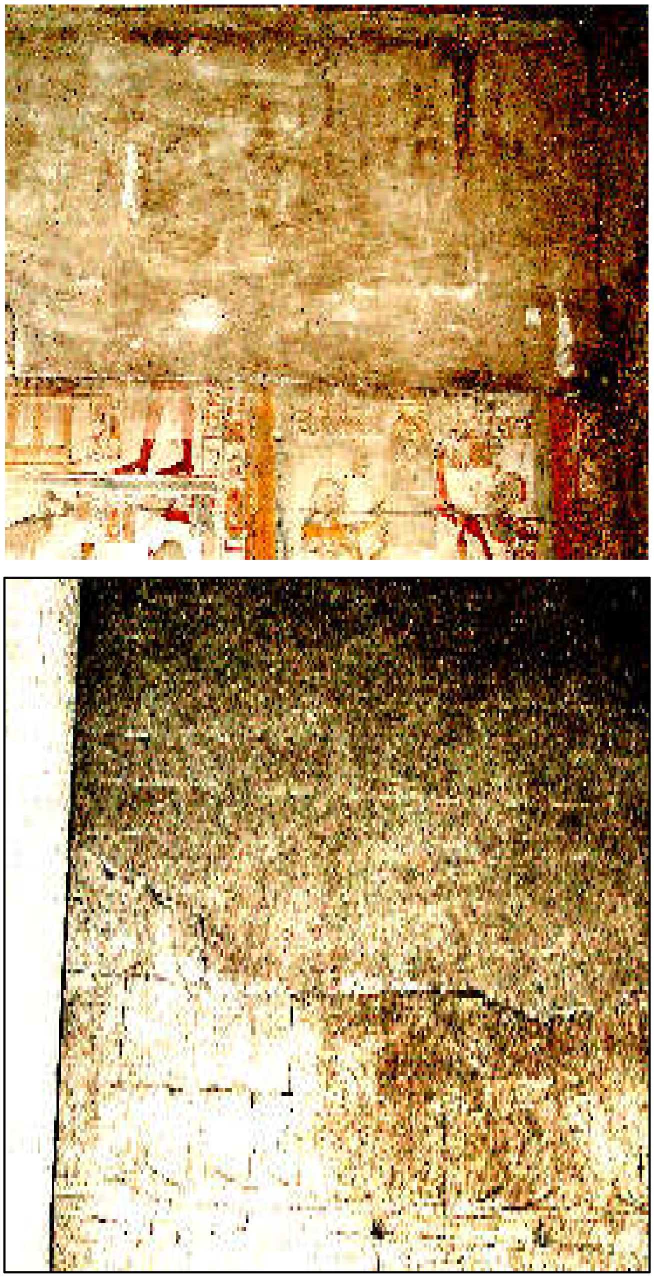


Fig. 5 Display another example of loss and absence of archaeological stone building structural, functional and esthetical role in addition to loss of inscriptions , drawings and paintings (documentary and esthetical function) in the lower parts and foundations of the terrace of first portico of temple of Seti I at Abydos (lower thin arrows) , and it is had to be replaced with original limestone from its source which became known after this publishing this paper , while upper thick arrows indicate successful partial reconstruction with original limestone from its source (El-Ghabat local quarry) , but we had to remove Deterioration and damage causes and sources before replacement

Figs .6-9 display the base of colossal statue of Merit Amun in Akhamim as an example of the decayed stone which lost its structural and functional role but it still retains its archaeological and documentary values , so the base was replaced with a stronger alternative with keeping the archaeological base in the site beside the statue because it still has a connection with the past .



Figs .10-11
Display examples of emergency for partial reconstruction with the original stone from the local quarry for preventive conservation where the seven chapels of the temple of Seti I at Abydos had lost their ceilings and big parts of their upper walls , so the partial reconstruction restored esthetical role and provided a preventive conservation from weathering particularly inscriptions and pigments .

Fig12 displays an aerial view photo (by Google Earth) of surroundings of the first quarry which was published by James A. Harrell under serial number (61) from north to south among documented and published ancient limestone quarries and was ascertained and verified by the researcher , the yellow position mark and the red arrow indicate the quarry , which is girdled with Man-made agricultural activities and growth , thereupon it is subject to ravage

Fig.13 displays an detailed zoom in aerial view photo (by Google Earth) of the upper figure , the yellow position mark and the red arrow indicate the quarry

Fig. 14 displays an aerial view photo (by Google Earth) of surroundings of the hypothetical position of the second quarry which was published by James A. Harrell under serial number (62) , and was ascertained and verified by the researcher , and it is manifested that is false and the published position the published position (26 ° 11.75 ′ N , 31 ° 51 .95 ′ E) or (26 ° 12.15 ′ N , 31 ° 52 .35 ′ E) is unsuitable to quarrying as the yellow position mark and the red arrow indicate to that location .

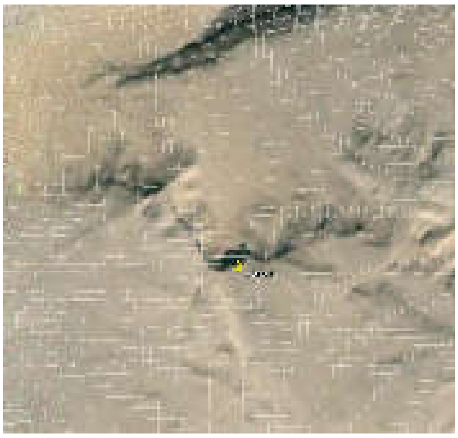


Fig. 15 displays an aerial view photo (by Google Earth) display the first discovered quarry (I) (covered quarry) (26 ° 11.58 ′. 40 N , 31 ° 52 .08 ′ . 58 E) (Height : 289 m.) the position of its entrance (arrow) , its approximate dimensions are 84.5 × 23.35 ×3.5 meters

Fig. 16 displays an aerial view photo (by Google Earth) with (position mark) and lattice of latitude and longitude lines display the same quarry (I)

Fig. 17 Display the entrance the first discovered quarry (I) (covered quarry) , its position of its entrance locates at (26 ° 11.58 ′. 40 N , 31 ° 52 .08 ′ . 58 E) (Height : 289 m.) .

Fig. 18 display the interior of the quarry (I) where we note the ancient separation trenches remains and marks

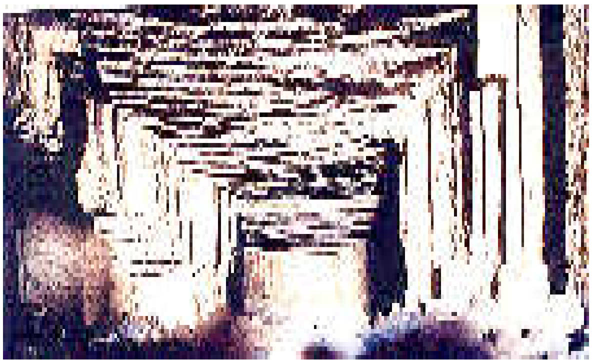


Fig. 19 display the interior of the quarry where ancient separation trenches remains and marks are noted more obviously .

Fig. 20 Display the inside of the first discovered quarry (I) (covered quarry) where ancient separation trenches remains and marks are noted

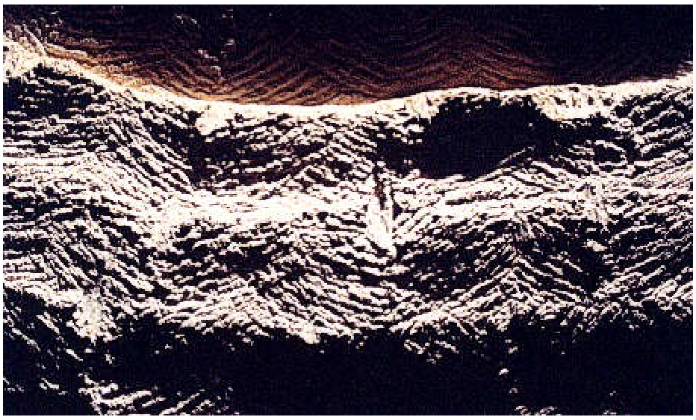


Fig. 21 Display the interior of the first discovered quarry (I) (covered quarry) of where ancient marks of stone picks are noted which are long lines that alternate in direction of work after each layer of blows (so called herringbone pattern) characterize the early New Kingdom , and this concurs with a numerous of archaeological buildings in Abydos the adjacent district

Fig. 22 Display the interior of the first discovered quarry (I)where very regular, closely set longish lines , all hewn from the same direction characterize the Ramesside period until the end of Pharaonic times , are noted and this concurs also with a numerous of archaeological buildings in Abydos the adjacent district , and this indicates this had been used during more than one period

Fig. 23 Display An aerial view photo (by Google Earth) of the second discovered quarry (II) (covered quarry) , its position of its entrance locates at : (26 ° 12.04 ′ . 57 N , 31 ° 52 .17 ′ .96 E (Height : 277 m.), the yellow position mark indicate the quarry entrance

Fig. 24 Display the entrance the second discovered quarry (II) (covered quarry) , its position of its entrance locates at : (26 ° 12.04 ′ . 57 N , 31 ° 52 .17 ′ .96 E (Height : 277 m.) its width is about 20 meters .

Fig. 25 Display An aerial view photo (by Google Earth) of the third discovered quarry (III) (covered quarry) , the red arrow indicate the quarry entrance which its position locates at :(26 ° 11.32 ′. 32 N ,31 ° 52 .17 ′.00 E) (Height : 141 m.) .

Fig. 26 Display the entrance the third discovered quarry (III) (covered quarry) , its position of its entrance locates at : (26 ° 11.32 ′. 32 N ,31 ° 52 .17 ′.00 E) (Height : 141 m.) .

Fig. 27 Display zoom out panoramic view of the fourth discovered quarry (IV) (covered quarry) the red arrow indicate the quarry, its position of its entrance locates at : (26 ° 11.56 ′ N , 31 ° 51 .99 ′ E) .

Fig.28 Display the entrance the fourth discovered quarry (IV) (covered quarry) , its position of its entrance locates at : (26 ° 11.56 ′ N , 31 ° 51 .99 ′ E) .

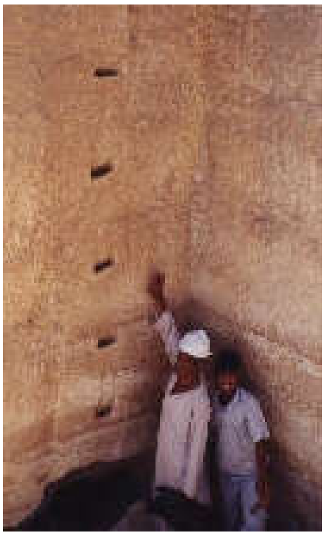
Fig. 29 Display the entrance the fifth discovered covered quarry (V) , its position of its entrance locates at : 26 ° 11.64 ′ N , 31 ° 52 .00 ′ E) .

Fig.30 Display the entrance the sixth discovered covered quarry (VI) , its position of its entrance locates at : (26 ° 11. 65 ′ N , 31 ° 51 .99 ′ E) .

Fig.. 31 Display An aerial view photo (by Google Earth) of the seventh (VII) the first open quarry (small) , the red arrow indicate the quarry which locates at : (26 ° 12.01 ′ 69 N , 31 ° 52 .04 ′ , 26 E) (Height : 292 m.).

Fig.. 32 Display An aerial view photo (by Google Earth) of the seventh (VII) the first open quarry (small) , the red arrow indicate the quarry which locates at : (26 ° 12.01 ′ 69 N , 31 ° 52 .04 ′ , 26 E) (Height : 292 m.).

Figs.33, 34 , 35 from left to right and from up to down display of , the eighth (VIII) , the ninth (IX) and the tenth (X) open quarries ,



Figs.36 , 37 , 38 , 39 , 40 , 41 . from left to right and from up to down display of , the twelfth (XII) open quarry (El-Ghabat quarry) which locates to the west of El-Ghabat village which locates at : (26 ° 10. 16 ′, 00 N , 31 ° 30 .01 ′ , 00 E) **,** also display ancient tool (chisel) marks (stone picks which were mentioned before are very regular, closely set longish lines , all hewn from the same direction characterize the Ramesside period until the end of Pharaonic times) stone pecks and ancient quarrying pits , and this quarry was used by the researcher in partial reconstructions in some case study (temples of Seti I , Ramesses II at Abydos)

Fig. 42 displays Oolitic structure in remains of the north tower of the first pylon of Seti I temple at Abydos similar to in the adjacent calcareous lower Eocene plateau

Fig. 43 displays Oolitic structure in remains of the north tower of the first pylon of Seti I temple at Abydos similar to in the adjacent calcareous lower Eocene plateau

Fig.44 displays Oolitic structure in the calcareous lower Eocene plateau similar to in remains of the north tower of the first pylon of Seti I temple at Abydos .

Fig. 45 displays Oolitic texture in the inside southern wall at the temple Ramesses II at Abydos similar to in the adjacent calcareous lower Eocene plateau

Fig. 46 displays the laminated or bedding limestone (Thebes and transitional Drunka formations) in the adjacent calcareous lower Eocene plateau similar to in Seti I and Ramesses II temples at Abydos

Fig. 47 displays the laminated or bedding limestone (Thebes and transitional Drunka formations) in western wall of Ramesses II temple at Abydos **similar to in** the adjacent calcareous lower Eocene plateau .

Fig. 48 displays the laminated or bedding limestone (Thebes and transitional Drunka formations) in northern wall of **Seti I** temple at Abydos **similar to in** the adjacent calcareous lower Eocene plateau .

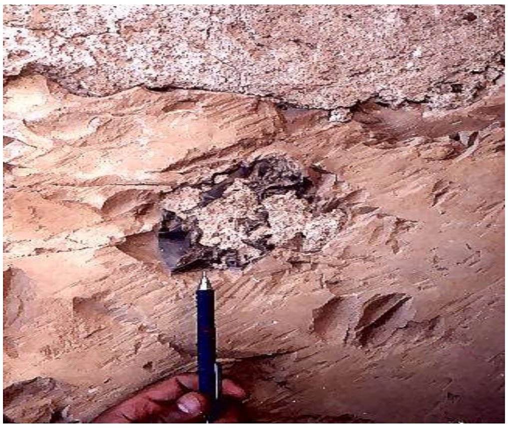


Fig. 49 displays the same.

Fig. 50 displays the **Flint Concretion** (Thebes and transitional Drunka formations) in the walls blocks of Ramesses II temple at Abydos **similar to in** the adjacent calcareous lower Eocene plateau .

Fig. 51 displays the **Flint Concretion** (Thebes and transitional Drunka formations) to the south of the first staircase of **Seti I** temple at Abydos **similar to in** the adjacent calcareous lower Eocene plateau .

Fig.52 displays the same.

Fig. 53 displays the **Marley lamelliform limestone** (Drunka formations) in the lateral terrace blocks of **Seti I** temple at Abydos **similar to in** the adjacent calcareous lower Eocene plateau .

Fig. 54 Display the Nummulitic facies (Thebes formation) in the walls blocks of **Seti I** temple at Abydos **similar to in** the adjacent calcareous lower Eocene plateau .

***Fig. 55** display thin section of limestone from archaeological buildings in Abydos cross sections (normal) (x 4) which contains Nummulitiic (Thebes formation) , echinoids (Drunka transitional formation) sand some fossils void , And this indicates to the locality of the limestone which quarried from local quarries in the calcareous lower Eocene plateau*

Fig.45 display thin section of limestone from archaeological buildings in Abydos (cross Nikol) (C.N) (x 4) (microscope which exhibits Nummulitiic limestone (Thebes formation) which contains algae and a few fossils voids , and the main component Micrite , indicating to similarity in structure , , composition and features to the limestone from local quarries in the calcareous lower Eocene plateau

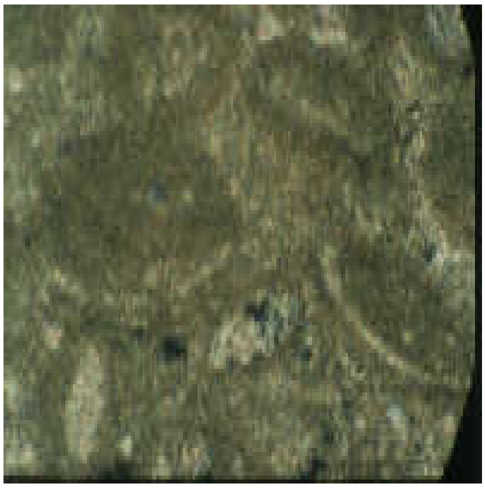
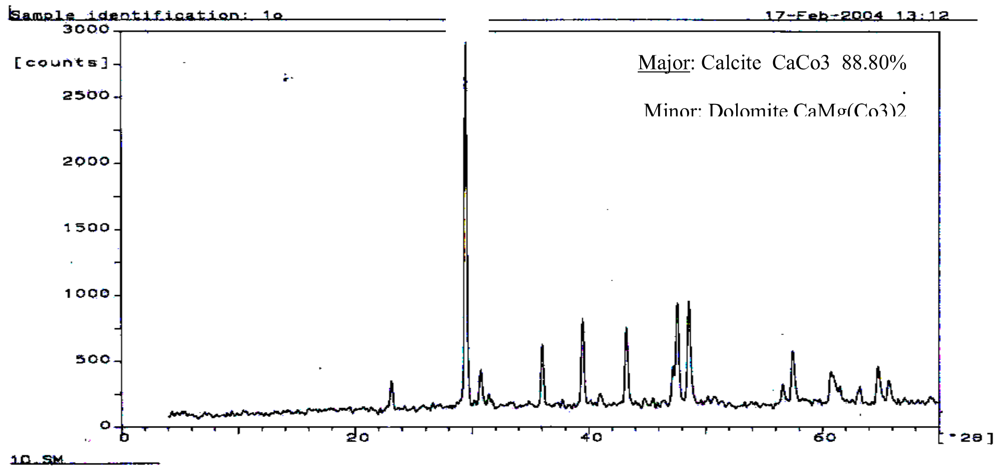
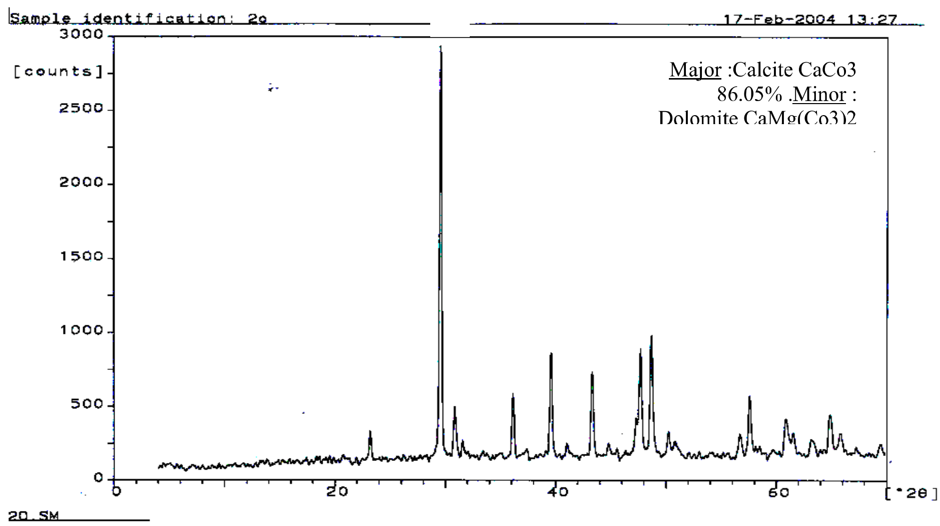


Fig.46 display thin section of limestone from local quarries in the calcareous lower Eocene plateau (cross Nikol) (**C.N**) (x 4) (microscope which exhibits Nummulities and some fossils voids

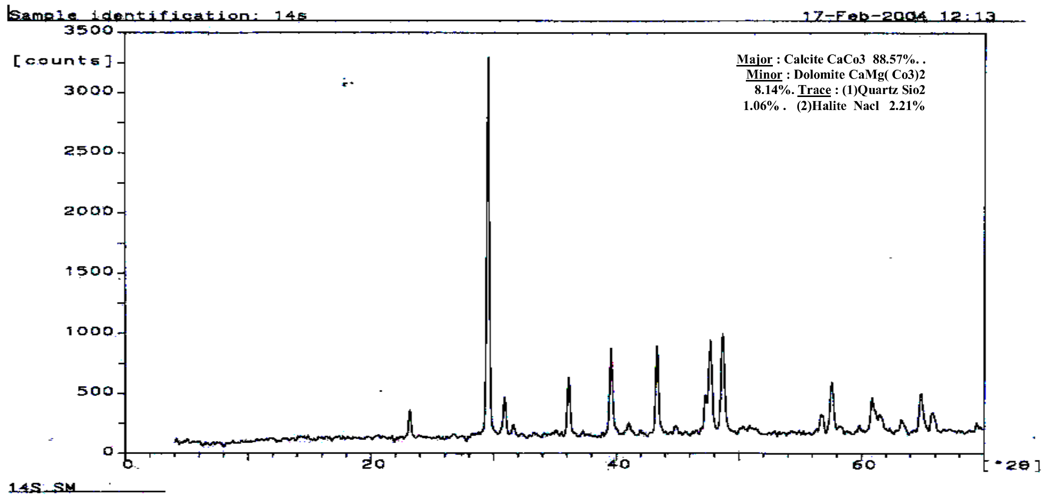
Fig . 47. display thin section of limestone from another local quarries in the calcareous lower Eocene plateau (cross Nikol)(**C.N**) (x 4) which exhibits the same



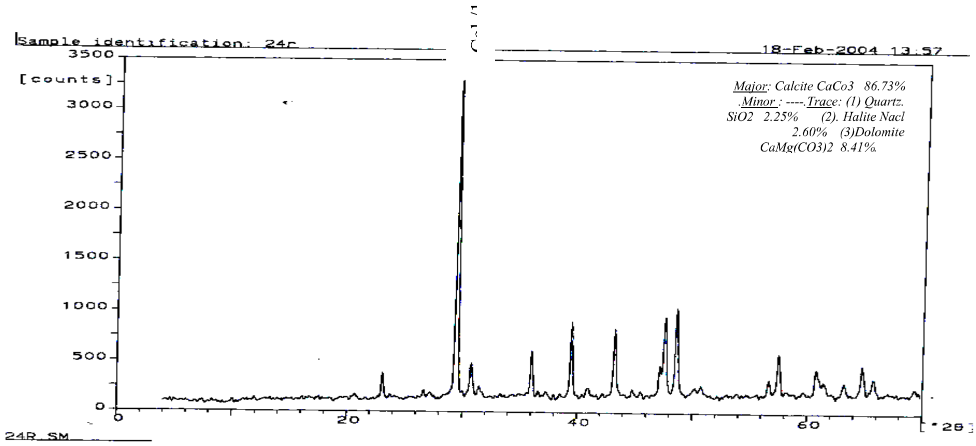
Figs.48 Quarry I Major: Calcite CaCo3 88.80% .Minor: Dolomite CaMg(Co3)2 7.72% .Trace: (1).Silicon Oxide SiO2 0.97% . (2) Quartz SiO2 1.86% . (3) Halite NaCl 0.62% .



Figs.59-60 SEM X-ray diffraction patterns display similliar compounds of limestone of both Quarry (XI) and Quarry (I) as follow : Major :Calcite CaCo3 86.05% .Minor : Dolomite CaMg(Co3)2 10.06% .Trace : Halite NaCl 3.87% .



Figs.61 SEM X-ray diffraction pattern displays compounds of limestone of Seti I temple_at Abydos_as follow : Major : Calcite CaCo3 88.57%. . Minor : Dolomite CaMg(Co3)2 8.14%. Trace : (1)Quartz Sio2 1.06% . (2)Halite Nacl 2.21%



Figs.62 SEM X-ray diffraction pattern displays compounds of limestone of Ramesses II at Abydos_as follow : Major: Calcite CaCo3 86.73% .Minor : ----.Trace: (1) Quartz. SiO2 2.25% (2). Halite Nacl 2.60% (3)Dolomite CaMg(CO3)2 8.41%.

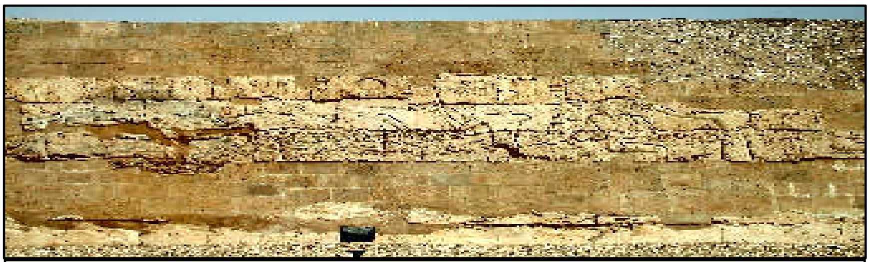
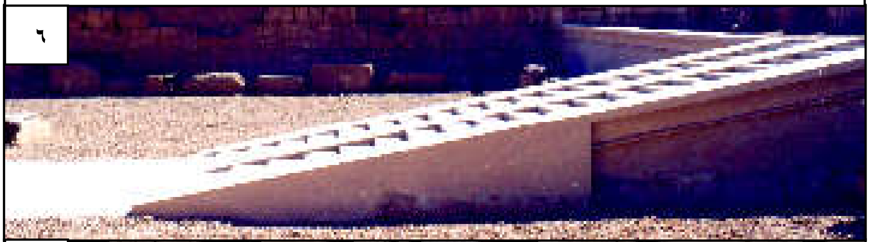


Fig.63) displays the weak and partial lost north wall of the Seti I temple at Abydos which are subjected to mechanical pressure and moistured & polluted soil , rubbish and garbage of the outraged urban context ,so it was compensated with an alternate stone of low permeability and high hardness from Eisawy limestone..



Figs.64 - 65) display the compensation with plastic repair (mortars) for the cavetto cornices , torie of the terrace of the second court and edges of staircases and balustrades of the staircases leading from the first to the second court of the temple of Seti I (64) and Ramesses II (65) at where the plastic repair is more suitable for formation and reconstruction of many of the ornamental and architectural elements with accuracy and homogeneity plus the possibility of addition of chemical additives to mortars to increase resistance of friction of the infantry, also prevents from disturbing fragile areas .

Figs.66) displays the replacement with stone in the corner torus of Ramesses II temple which affords more accurate and homogeneous compensations than that of mortar (such as the corner torus of Elvantine temple (fig. 67) .