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The Petra Great Temple: A Triumph of Conservation, Restoration and Preservation

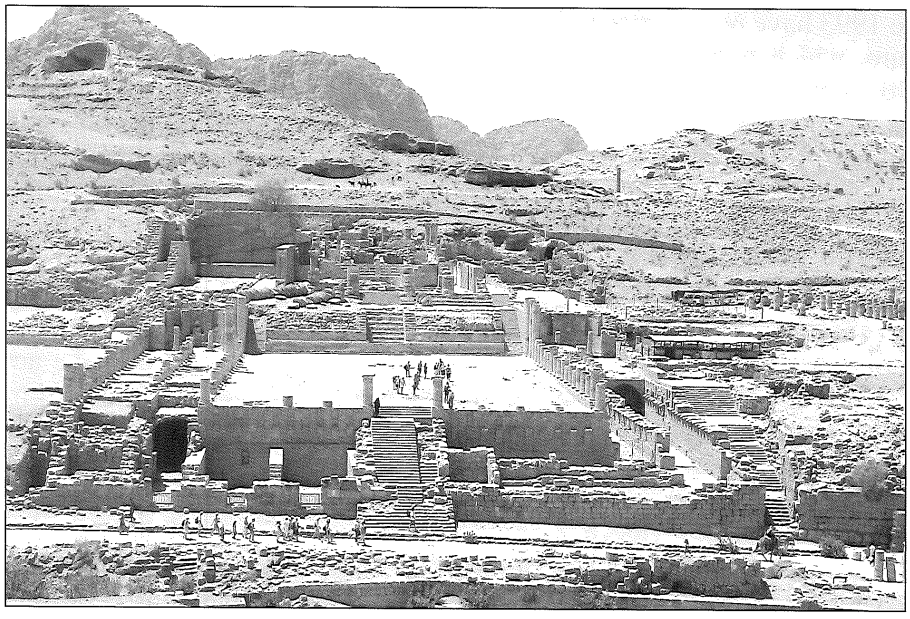
Often archaeologists leave behind a denuded wasteland, as excavation brings destruction to many sites while simultaneously destroying the vegetation. In our attempts to excavate the Petra Great Temple, we have tried to control the damage and minimize the effect of the excavations on the environment. The success and final result required planning and vision during the execution of the excavation. It was often dependent on attitudes, values and financial resources all working in concert. We have attempted to look beyond the immediate survival of the Great Temple precinct for its protection and its future use as an archaeological resource and, ultimately, to preserve and restore its precinct as a Jordanian and Petraean national monument. FIG. 1 is a view of the Petra Great Temple site in 1992 before excavation. FIG. 2 shows it as conserved, at the close of the 2009 excavations. FIG. 3 is a 2009 plan of the site.

Brown University excavations conducted at the remarkable Petra Great Temple since 1993 have revealed a colossal Nabataean structure, which is a principal component of the Petra city-centre. This highly visible precinct functioned as a commemorative, dynastic, religious and administrative quarter of the city. Occupied continuously from before the first century BC to the Byzantine period, the project to preserve the site, which extends over an area of 12,092m^2, began simultaneously with its excavation. In Petra we live with the environmental uncertainties of flash floods, earthquakes and erosive action. To us, conservation is essential for the care and protection of the Great Temple site, although we are sure that these natural disasters will continue to threaten the site and cause widespread damage. It is too soon for us to have any feeling of security about either our short-term or long-term Great Temple site-conservation efforts or for the future of Petra as a whole. The battle we have waged at every stage of our 18-year excavation process has pitted us against 'Mother Nature'.

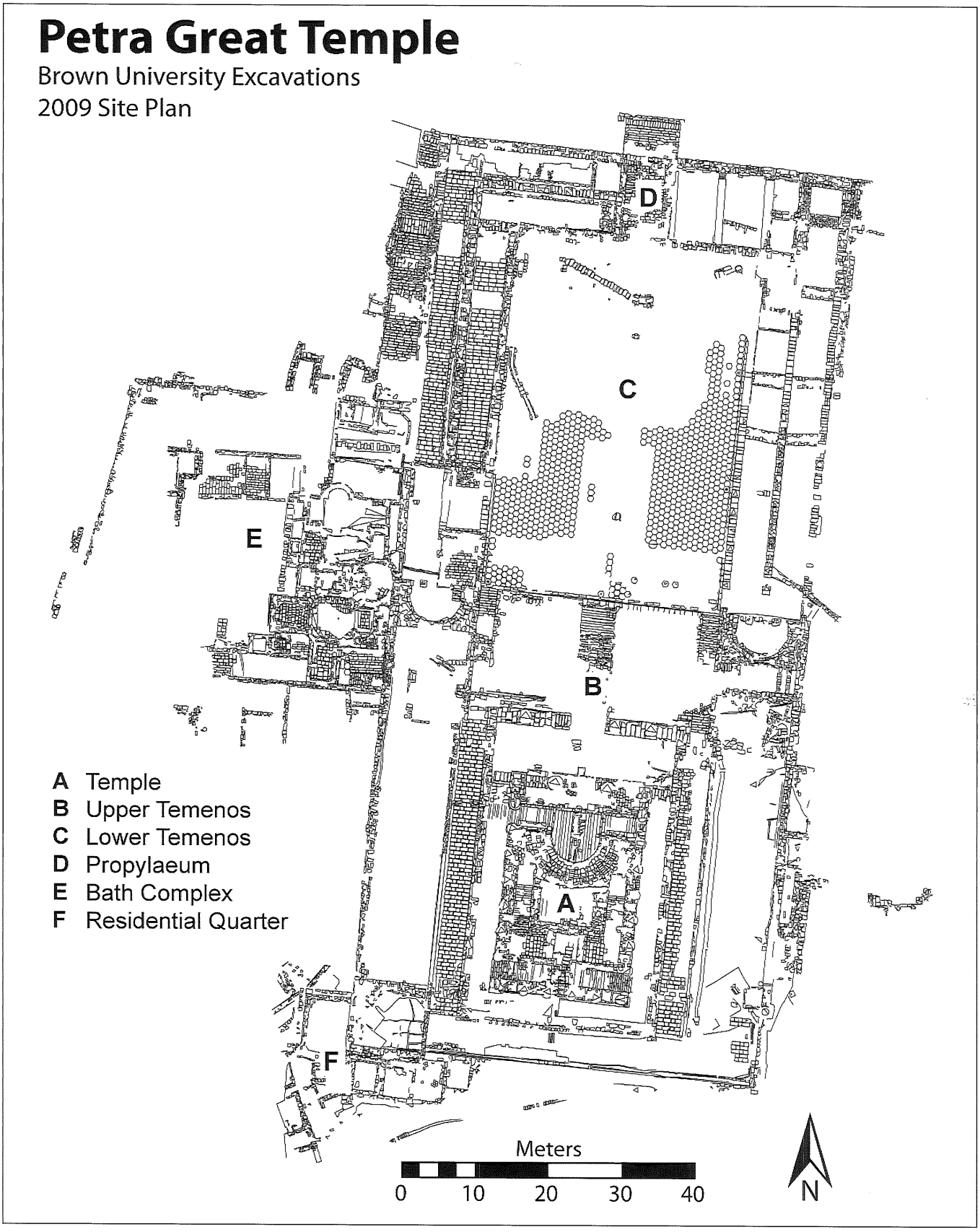
In 1993, although the precinct had largely been abandoned, we found the Great Temple site had been exploited by locals for building and farming-there was serious deterioration of many of the architectural elements while others were severely eroded. The Great Temple site had suffered from neglect, as is common in Petra. Individuals who had over many years used the area for farming had plundered the Lower Temenos. Elephant-headed capitals when found on the surface had been carried away as souvenirs – one still serves as a door – stop in a local *bedouin* house!

At the outset of the 1994 excavations, we organized a long-term view of our site preservation. These measures were often impacted by the short-term, year-by-year progress of excavation that served as immediate temporary expedients to strengthen elements that required specific stabilization. More than 100 archaeologists and conservators have been involved with the meticulous study of the Great Temple's significant architecture and artifact repertoire. With its elephant-headed capitals and theater, the Great Temple has come to be recognized architecturally as an important, well-preserved, freestanding structure of the Nabataean capital city. Inherently a destructive science, archaeological excavation raises the issue of on-site efforts of consolidation and restoration. In the act of rescuing architecture and material culture from a dense cover of debris and accumulation, the elements of a site are exposed anew to the threats of human contact and environmental decay. From the beginning of our work, the fundamental philosophy of the Petra Great Temple excavations has been to treat the site as a fragile and non-renewable

1. Great Temple precinct before excavation, 1992 aerial view.



2. View of the Great Temple to south, 2009.



3. Great Temple site plan.

resource requiring protection.

Constructed primarily from friable sandstone and degraded limestone, the temple complex is a prime target for material exfoliation as a result of wind- and water-erosion, and the deposition of insoluble salts. This assumption of the potential for structural deterioration makes efforts of consolidation and restoration an ongoing priority.

To combat these natural threats a number of measures were taken to reinforce the physical structure of the site, with vigorous support from Directors of the Department of Antiquities of the Hashemite Kingdom of Jordan and from the Director of the Petra National Park. Conservation management requires a high degree of international co-operation with the Jordanian Department of Antiquities and a willingness to agree to some forms of control. We formed a scientific advisory committee to help us rule on the appropriateness of any proposed consolidation and restoration. We knew that careful planning had to be undertaken if we were to modify the landscape naturally or artificially.

Attempting to undertake conservation efforts during excavation and on the completion of each season, annual consolidation plans with scale drawings were proposed to the Jordanian Department of Antiquities and American Center of Oriental Research (ACOR), where site-specific measures were discussed and problems addressed. In most cases, solutions were found. Our annual conservation and preservation measures have been deliberate and now can be appreciated. ACOR monitors the status of many aspects of our consolidation and conservation strategies. All of our proposals are carefully considered before a decision is made to conserve a particular wall, column or other feature.

In a continued effort to uphold the principles proposed by the International Council on Monuments and Sites, the International Committee on Archaeological Heritage Management, the World Heritage Convention of 1972, the 1966 Venice Charter, the Hague Convention and the tenets of the 1956, 1970 and 1985 UNESCO Conventions, we have adhered to field-treatments that prevent any harm to the site and are reversible. The conservation of the Petra Great Temple also includes the preservation of those *in situ* elements that were essentially undisturbed by excavation but required structural protection because of natural process of deterioration. We attempt to carry out restoration so that the structural integrity of the architecture is sustained.

To this end, it is important to note that architectural restoration at the Petra Great Temple has not been undertaken in a true sense. With elements frequently lacking a clear basis for their reconstruction based on archaeological context, the measures we took are geared solely toward the immediate – though impermanent – preservation of the structural integrity of the precinct. When intact, original stones were reconstituted into temple masonry. In almost all cases original building materials were used. When fragmentary or robbed out, original constructions were replaced by new stone fills recycled from our 'lapidary' (see below) or quarried from the Petra bedrock.

Conservation and restoration have multiple values that can be briefly summarized as the scientific interest and value of the remains, their aesthetic value for art historians and tourists, the unique archaeological features and information they provide, and the technological acumen of the Nabataeans. Our aim is to restore and consolidate a stable structure in as stable an environment as possible.

Financial Considerations

Although the importance of consolidation and conservation may seem obvious, most excavation budgets are so constrained that to be concerned with anything more than excavation is difficult. Since our annual budget was not guaranteed, we had to select our projects carefully; planning for site conservation was in doubt when excavation costs alone were a cause for concern. Such activities – excavation, conservation, consolidation, preservation and publication – are always planned along with our Brown University annual budgets, although when finances are tight there have been moments of conflict and financial readjustments between these areas. Each year we outlined and refined what we were realistically capable of conserving in the temple precinct.

Once the annual excavations ended, it was found that there was time to consolidate those individual areas that required repair. Each year we proposed a long-term plan and prioritized those projects which required immediate attention. Once the short-term annual goals were met, the longer-term goals of a working plan were resolved by deciding on what the priorities were for consolidation, mapping and photographing the areas, and what materials would be needed, such as scaffolding, mortar components,

stones that needed to be cut and dressed etc. Along the way there have been considerable challenges and opportunities, and extraordinary changes have taken place.

From the beginning, it was made clear that the Department of Antiquities would not be able to support the provision of conservation measures in financial terms. This meant that our project had to incorporate conservation plans concurrent with the excavation. Even at the time of writing, there are no governmental agencies that can financially care for Petra, which puts the World Heritage site at risk.

Yearly conservation efforts were made financially possible by two awards from The World Monuments Fund, a grant from the Samuel H. Kress Foundation through an American Express Award from World Monuments Watch (1996 and 1998 respectively), a program of the World Monuments Fund and the generous support of the Joukowsky Family Foundation. Since 2000, the Joukowsky Family Foundation has provided subventions for annual conservation expenses. These funds have been generously matched several times over by special subventions through donations to the Petra Excavation Fund constituted at Brown University.

A Concern about Water

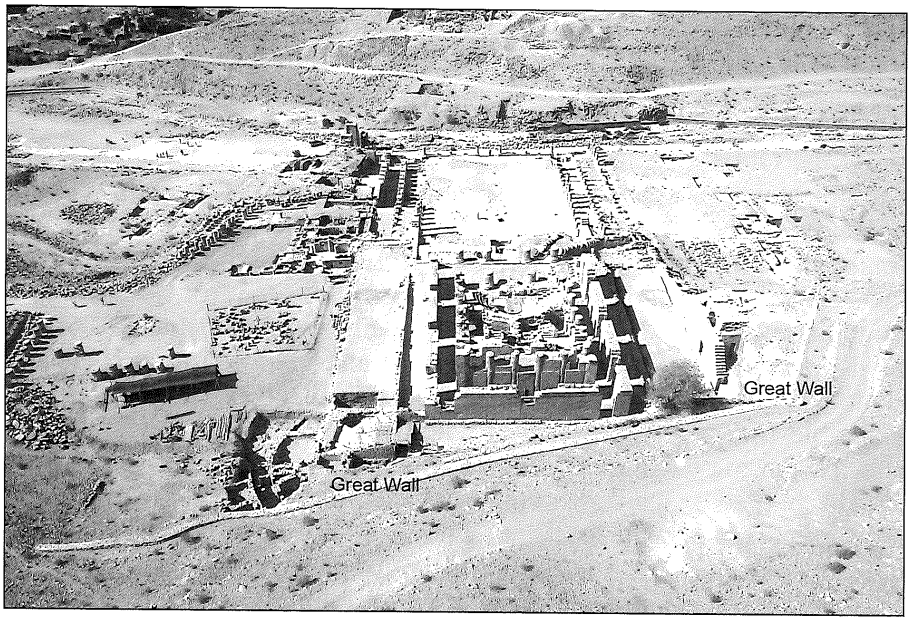
The Nabataeans developed their city plan with great skill, creating agricultural landscapes that reflected the skillful manipulation and management of water resources. Now Jordan witnesses unusually severe water shortages- there has been a serious lowering of the water table and the seasonality of water flow in Petra is acute. As expert water conservationists report, the sub-surface aquifers today have all but run dry, and water is a scarce exhaustible resource. The rates at which available reserves are being depleted exceed the rate at which new resources can be formed. There have been extreme changes in the Petraean landscape within the memory of a single generation. As there have been changes in the abundance of wildlife, the continued survival of wild nature is limited.

The Great Wall (FIG. 4)

Knowing that the site is finite, we knew that it must be protected in ways that provide for its stability and that we could help temporarily to reverse the process of its deterioration. But of course the hope was that whatever measures we took would have long-term benefits. Like most of Petra, the Great Temple is extremely vulnerable to flash floods.

The most effective way of ensuring the least impact from flash floods and rains was to build a terrace-wall along the south flank of the site to deflect the water and ensure that the soils of az Zanṭūr ridge would have a barrier to prevent their washing down on to the Great Temple. This wall has increased the protection of the site and ensured its architectural preservation.

The Great Wall is a freestanding structure safeguarding the Great Temple precinct. Following the bedrock south of the precinct, it is comprised of excavated stones bound together with mortar. In



4. Great Wall flanking the Great Temple south perimeter.

a direct line it measures 104m in length by 1.5m in width, and is constructed with offsets and insets to conform with the topography. The overall constructed length totals 110.63m. A retaining ashlar wall protects the cacti planted along its top as a shelter to hold the soil in place and to support the wall. The wall provides a guarantee of water flow away from the site, helping to place as little strain on the temple precinct as possible.

Excavation

We planned our archaeological investigations as a long-term commitment to the Great Temple, to Petra and to Jordan. With the continued excavation of the site, the research design, including the needs of its architectural elements, required expansion. It became essential to organize and direct conservation efforts over an increased area.

Excavation is invasive; it has made the site vulnerable and our challenge has been to respond to its preservation in the most effective ways possible. In 1993 we initiated excavation training and since then have trained more than 90 students from Brown University in excavation methodology, including surveying and conservation. Working painstakingly beside us are our local Jordanian workmen who willingly help us to reverse existing damage that is discovered during the excavation process. They have become skilled in moving architectural fragments with the attendant dangers of imminent collapse. They fill vulnerable cracks in the walls with broken bits and chunks of stone to prevent the wall-ashlars from collapsing.

Although excavation can reveal a site, it may not relate to the consequences that take place as the site is excavated. These consequences may have side-effects that were not anticipated, thereby disrupting the overall excavation research plan. At the Great Temple, a multitude of different examples were encountered. For example, when we discovered in 1996 that the temple arched passage entrance of the West Corridor was seriously buckled and was in a state of imminent collapse, we immediately restored it. The Upper Temenos Baroque Room, with its astonishing ceiling, and the Residential Quarter were uncovered in 2002 with considerable time-consuming, specialized restoration needs. During the same year the Great Cistern was discovered, which required additional, altogether different conservation measures. The Propylaeum Room 3 arch was unearthed in 2004 in a state of disintegration. Similarly, the Lower Temenos West Cryptoporticus walls were slumped out of position and required support. Our excavation plans had to be flexible and innovative to meet the challenges that excavation posed. In each instance we had to reorganize our excavation research and readjust our research design, so that their recovery and consolidation would be in keeping with the overall integrity of the site. To the non-archaeologist, these aspects of excavation may seem to be the exception to the rule, but it is striking that during every excavation season at the Great Temple, such 'exceptions' have become commonplace. Similar to the step-by-step process by which areas are selected for excavation, our prioritized preservation projects have to be both appropriate and meaningful. In spite of these considerations, we have had remarkable breakthroughs.

During excavation, each trench supervisor recorded all stones with a trench code and unique number reference, and marked the artifact. This number was carried both to the site database and to the 'lapidary' where the stones were stored. We use a minimum of mechanical equipment to remove debris from the site and to lift heavy objects. Rollers (metal pipes) are used dexterously to bring large stones into position for removal. If the object was sculpted, it might have been swaddled in a blanket or wrapped in foam before lifting. Steel-reinforced straps served to cradle the fragments to be carried to specifically prepared storage areas. This system proved invaluable for the protection of our pilaster blocks and finely sculpted capitals, and particularly for our spectacular elephant-headed capitals. Debris from the site was trucked to the place reserved by the Jordanian authorities for our spoil heap. Fragments associated with elephant-capitals and the complete massive elephant-head capitals, volutes and ballista balls have been drawn, photographed and cataloged in our artifact registry, and then stored. Many of these have been turned over to the Petra Museum for safe keeping. Every architectural element excavated has been numbered, measured and recorded in our site database. Included in this database are ashlars and thousands of wall-blocks that originally served as the defining building blocks of the precinct. There are also voussoirs and arch slabs used to embellish the walls, as well as door-jambs, threshold blocks and flagstones used for pavements. Other elements include many hundreds of column drums and asso-

ciated column decoration such as attic bases, capitals and capital elements.

During restoration, the workers used wooden scaffolding for platforms, along with a simple block and tackle to lift heavy architectural fragments such as column drums, capitals, vault slabs, ashlars and lintels.

The 'Lapidaries'-Storage for Architectural Elements

The function of our varied stone object storage areas -'lapidaries'- is to keep architectural elements in a favorable and separate micro-environment until they can be used for restoration. We realize as well that some of the most serious conservation problems are associated not with the way these elements have been excavated, but with the ways in which they are stored. We make every effort to protect our storage areas.

During our years of excavation, architectural fragments overwhelmed us. Therefore, from the first years of our work, we established 'lapidaries' for these elements divided by type. We have six main areas for architectural storage. Small decorative elements including pine-cones, hibiscus flowers, poppies, vines and the like have been stored underground at the site in a specially prepared trench – the result of previous excavation – thereby returning them to their micro-environment. In the West Cryptoporticus we have a mini site-museum protected by a locked gate, where volutes from capitals, bosses, nearly complete capitals and ballista balls are placed. In a fenced off area to the west of the temple is our so-called 'sculpture garden', which is reserved for larger elements such as pilaster blocks and large domestic implements such as grinders and millstones. Column drums are stored in the West Lapidary, while voussoirs and arch blocks, along with arch slabs, are stored on the West Roadway. Another area is reserved solely for ashlars that have promise of re-use. Finally, there is an area for broken and fragmented pieces that have little structural or decorative integrity, but may be used for snecking stone support between architectural elements. We have had limestone facsimiles made of the *betyls* found in the West Propylaeum and have re-installed them; the originals have been turned over to the Petra Museum. In the West Entry Stairs we commissioned the carving of a fine replica of the *nefesh*, which replaced the original recovered from the platform in the West Entry Stairway. The original has been deposited with the Petra Museum for display.

Recycling

One of our plans was to recycle and reprocess sandstone ashlars and column drums, as well as limestone elements used in the Great Temple. Sandstone blocks are often cracked by natural weathering and disintegrate, eventually reverting to sand. It is quite common to see them flaked or pitted, encrusted with salts or other erosive elements responsible for their disintegration. Although the grains of many blocks are dissolved from leaching and surfaces have become etched and friable, each is studied. If sufficient structural integrity remains, they are reclaimed, re-cut and dressed at a 45 degree angle in the Nabataean manner.

Mortar

During the conservation process, several studies were made of consolidates for the restoration of standing structures and decorative detailing, leading to the successful identification of appropriate responses to structural fragility and other material sensitivities. Effective measures therefore had to be undertaken to analyze Nabataean mortars. Samples were extracted between the ashlars in the South Corridor Wall for chemical testing at the Canadian Conservation Laboratory. As far as extant mortars between blocks are concerned, we remove only that increment or missing portion that needs to be replaced. As clean sand is an essential ingredient in the mixture, a search was made of the Petra area to find the purest sand. It was brought to the site from nearby Wādī Farasa.

Stone Masons

In the early years of our work, professional qualified master stonemasons needed to be found for the restoration of the Great Temple. Such masons were hired and brought from 'Ammān to help us duplicate the dressing of the stone. This not only involved knowledge of the techniques of Nabataean stonemasons, but also strategies for the conservation and consolidation of the stone. With time, these master masons had trained our local *bedouin* workmen to understand the techniques of the ancient Nabataeans. For the past 18 years it has been our local *bedouin* stonemasons under the direction of Dakhilallah Qublan who have restored the Great Temple.

Consolidation Efforts at the Petra Great Temple 1994-2010

Keeping in mind the strategy outlined above, the following record will present a summary of conservation efforts undertaken at the Petra Great Temple in annual field seasons from 1994 to 2010. Each element, including the subterranean canalization system, curbing, floors, walls, columns and capitals as well as the stucco decoration of the precinct will be presented separately, as a summary, so that the overall efforts might be better understood. We focus on the complexities encountered and emphasize how various factors were reconciled in dealing with the different areas of the site.

Subterranean Water System

The Nabataean rock-cut channels and supplementary built up subterranean water channels had to be consolidated so the water run-off would protect the site as it did in the Nabataean period. In 1995, exposed and crumbling sections of the canalization system underlying the east Forecourt were reinforced using mud and lime mortars, while a number of ceramic drainage pipes were covered with clean sand and backfilled.

In 1996, the canalization below the East staircase was accessed and consolidated and, north of the West Exedra, a drainage channel was covered with sand and backfilled.

Curbing, Pavements and Floors

Beginning in 1994, consolidation efforts in the Petra Great Temple Propylaeum focused on the *anastylosis* (reconstruction stone by stone) of the lower curbing of the Propylaeum Central Staircase. The north curbing of the Lower Temenos East-West Retaining Wall underwent preliminary consolidation in 1997.

Most of the Great Temple pavements and floors had been robbed out in antiquity.

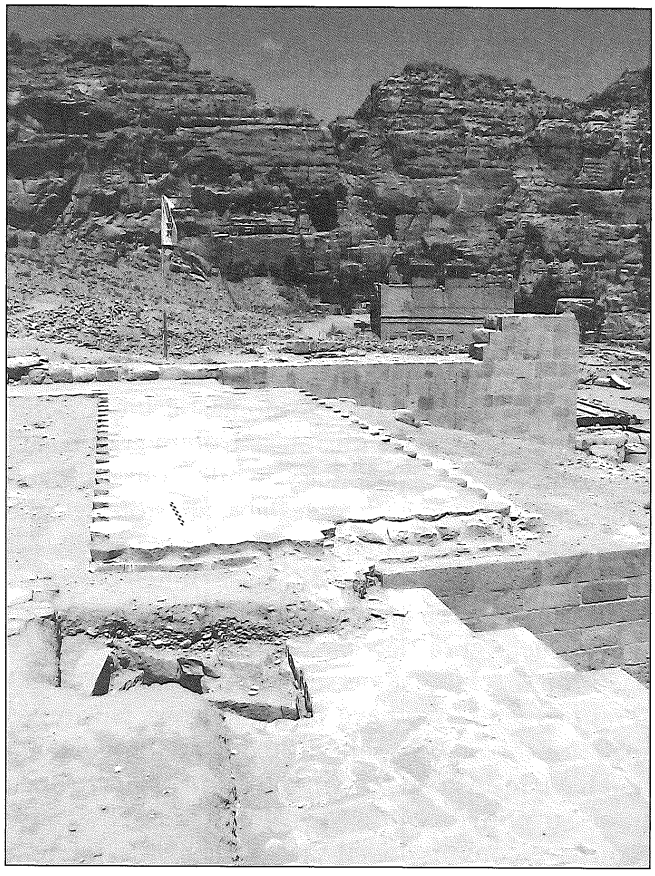
In 1996, efforts moved to the central plaza of the Lower Temenos, where a number of hexagonal paving tiles were removed to allow for the refilling and leveling of the fill between the subterranean canalization capstones and the pavement above. The insertion of new fill material was a delicate procedure calling for a primary investigation of the pavement substructure to determine the optimal type and weight of the new fill prior to installation. By 2005, Special Project 104 had been undertaken in the East Corridor of the West Cryptoporticus and a number of flagstones had been removed. This area was refilled and the original pavement restored.

The condition of the small hexagonal Temple forecourt pavers had been sorely compromised by falling porch columns. As part of the temple's expansion into a *tetrastyle in antis* structure, the temple Forecourt foundations were consolidated in 1994 using re-cut hexagonal pavers, mud mortar and small fieldstones. In 1999 and 2000, the damaged tiles were reconstructed using re-cut ancient blocks from the site. Additional portions of this Forecourt pavement were restored in 2002. In 2005-2006, a major portion of the pavement (see FIG. 5) was completed by mixing original hexagonal pavers with newly cut pavers, leaving the subterranean canalization system open to view.

Walls

At the Great Temple there are approximately 110 walls of varying lengths and heights. FIG. 6 illustrates the cleaning of wall-surfaces before restoration takes place.

With restoration we have set forth a few standards



5. Upper Temenos restored pavement in front of the Great Temple.

6. Cleaning of the Propylaeum wall by a *bedouin* workman.

for our work. Walls partially recover their original heights only when these heights are known. Not only are the ashlars in the wall pointed, but also the upper wall courses are reinforced with wood beams where we have known them to exist. The tops – or exterior uppermost course – of the walls are covered with a protective layer of waterproof cement.

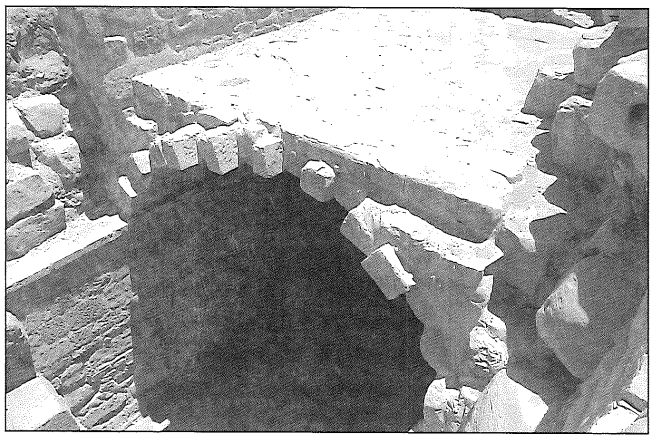
During the 1998 and 2001 seasons, reconstruction efforts moved to the Propylaea East and West, where a number of collapsed arch springers were consolidated and reset into the Cryptoporticus walls. During 2003-2005, restoration concentrated on the Propylaeum East. This involved the restoration of the interior partition walls between Rooms 1, 2 and 3 to a height of 3.2m. An overview of these walls can be seen in FIG. 7. Pointing between the out-of-position ashlars also consolidated the Portico Wall and doorways of these rooms. The 2004 excavation of the Chamber 3 vault posed a significant challenge for restoration, which was undertaken in autumn 2004 and winter 2005. When excavated, the large vaulted space was in danger of collapse and needed to be supported with wooden scaffolding. Details of the north end of the vault can be seen in FIG. 8, with its projecting voussoirs indicating that that the restoration of the vault, though stabilized, is incomplete-it appears unfinished. In antiquity this vault did continue, but we refrained from over-restoration.

In 1996, conservation efforts in the south-east Lower Temenos included repair of the East Exedra following structural damage incurred during the winter downpours of 1996. Stabilization of the East Exedra continued into the 1998 and 2001 seasons with the removal and replacement of deteriorating blocks which were weakening the integrity of the overall structure. In 2002, additional eroded blocks in the East Exedra walls were replaced and were rebuilt to the height of the West Exedra walls. In the south-west, comparable degradation was visible in the gaps along the eastern portion of the West Exedra walls. The dislodged weathered ashlars were filled with mud mortar and small stone wedges.

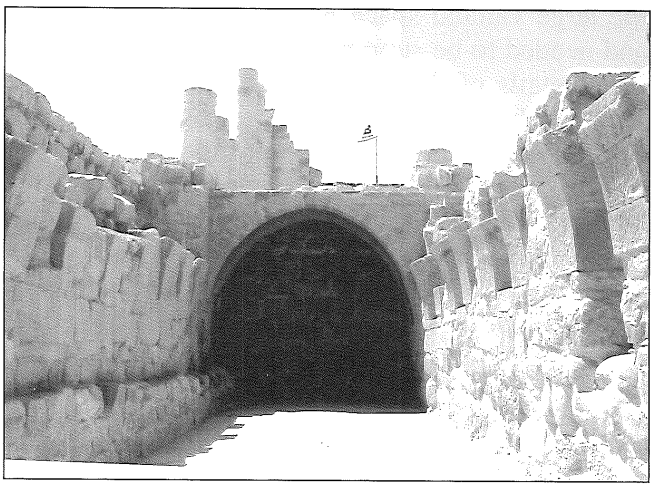
Over several years, the West Cryptoporticus had come to light. All walls of the structure required consolidation-the east and west walls of the twin galleries as well as the central buttress wall. Vaults were constructed between the central wall and east and west walls so that this originally subterranean structure could be better understood. In 2002, two of the dramatic vaults were rebuilt in the West Cryptoporticus. One of these restored twin vaults can be seen in FIG. 9. In 2006, large sculpted architectural fragments, such as capitals and volutes, were moved into this vault for their protection from the elements. This vault now protects the artifacts in an informal 'site-museum'.

The West Stairway east wall (West Cryptopor-

7. Propylaeum walls between Rooms 1 and 3 restored, 2005.



8. Propylaeum vault partially restored.



9. Lower Temenos, West Cryptoporticus vault.

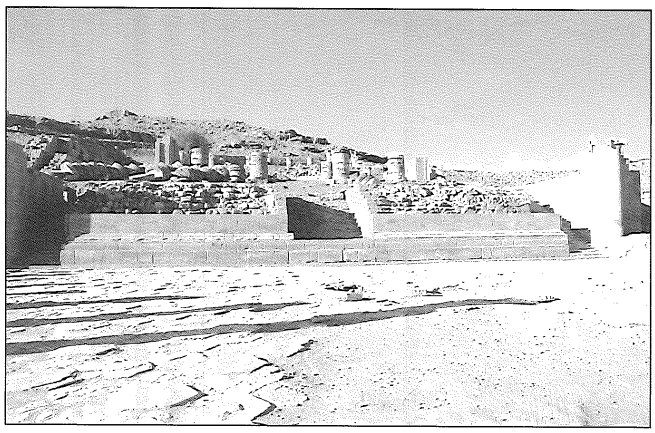
11. Upper Temenos, East 'Cistern' arches restored.

ticus west wall) was in danger of collapsing into the adjacent West Cryptoporticus. There were signs that this wall had partially eroded in antiquity and was perhaps one of the reasons behind the collapse of the West Cryptoporticus East Gallery. While excavating, we found that a portion of the east wall had fallen into the east gallery in antiquity; with excavation it was further compromised. In a ruined state, this section of wall needed to be completely dismantled, reconstructed and pointed.

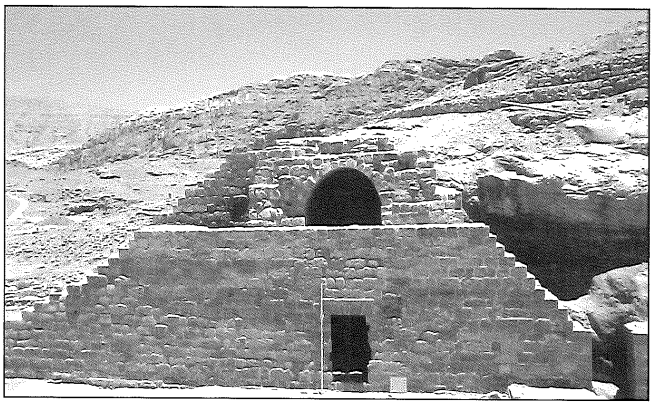
In 2004, the Lower Temenos Retaining Wall shown in FIG. 10 required additional consolidation owing to the fact that the fill behind the wall was in a state of collapse. Therefore, in 2004-2005 four courses of blocks were added atop the wall on both the east and west, leaving the earlier stair bedding exposed. The new blocks are smaller than the original wall ashlars, so it is evident to the visitor that this part of the wall is restored.

In the Upper Temenos, following the 1998 excavation season, the walls of the East 'Cistern' shown in FIG. 11 were reinforced and its arches were re-pointed after their initial consolidation in 1997. In 2001, the south extension of the East Perimeter Wall was pointed and the East Arch was dismantled, consolidated and returned to its original position as can be seen in FIG. 12. The walls and niches of East Perimeter Wall Room A were stabilized. The mouth of the 'Great Cistern' was fitted with a cover to prevent winter rains from collecting beneath the complex. During the 2002 season the south-east ashlars of the South Passageway were consolidated.

With the discovery of the Roman-Byzantine Baths in 2005, a major restoration and consolidation project had to be initiated. Initially the West Precinct Wall had to be stabilized and pointed. The north, south and east walls had to be reconstructed to the same heights as the north wall and door. The *frigidarium* entry had many decorative stones that had fallen out of position. Although many of the original *opus sectile* elements had been recovered



10. Lower Temenos, East-West Retaining Wall.



12. Upper Temenos, East Perimeter Wall vault and doorway restored.

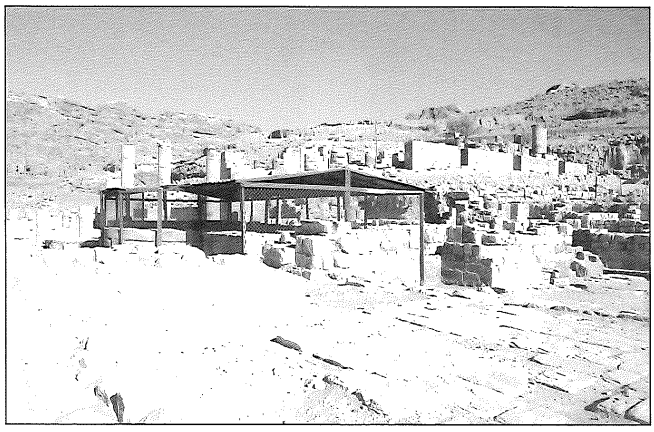
during the excavation, we were unsure where they belonged. As a result, white plaster was used to build the walls up to a single level for the stabilization of *in situ* elements. A pipe extending around the base of the lavatories had to be cleaned, fully exposed and supported with mortar, so its position would be evident to the public.

With the 2006 discovery of the apsed *caldarium* in Trench 126, we were dealing with extremely delicate remains that would be damaged through exposure to the elements. More recently, in 2009-2010, the *caldarium* of the Roman-Byzantine Baths has been restored and protected with a shelter (FIG. 13).

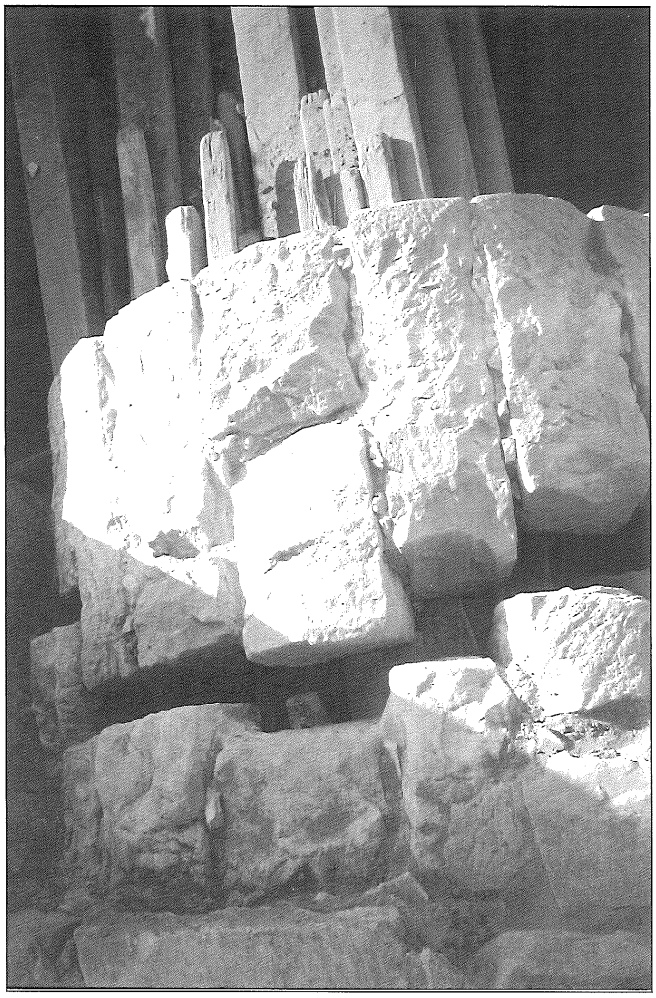
The West Cistern Reservoir also had to have its perimeter walls pointed. As excavated, these walls were a pastiche of blocks. After the walls were reconstructed in antiquity, they had suffered multiple episodes of fire-damage and many of the blocks had slumped out of position. This conservation was also undertaken in 2005-2006.

In the Great Temple interior, work focused on the conservation of the corridor and walkway walls. During 1996 and 1997, consolidation was undertaken in the temple West Corridor with the resetting of fallen ashlars within the masonry of the north-west wall. The north-west section of the West Corridor with its vault was then dismantled, reconstructed and pointed, both to reinforce the wall and to close large gaps between its ashlars. FIG. 14 dramatically portrays the result of the blocks pulling away from each other. Also in 1997, the central portion of the West Corridor's inter-columnar wall – which had sustained significant earthquake damage – was taken down and rebuilt. Later work in 1998 included the full restoration of the East and West Interior Staircases and the complete *anastylosis* of the West Corridor inter-columnar wall with its vault and window. It was completely restored, as illustrated in FIG. 15.

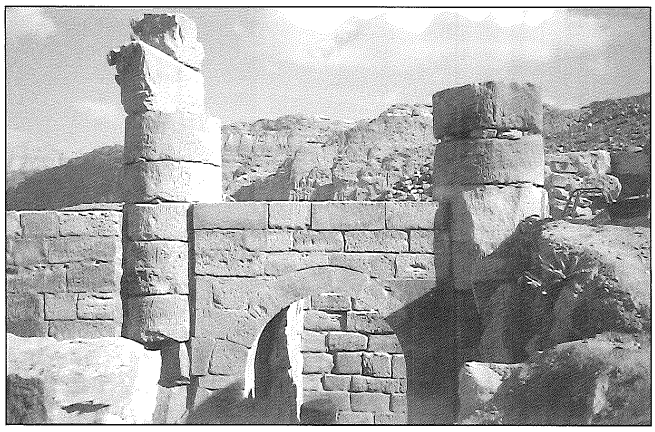
In the West Interior Chamber, gaps between the wall-stones were filled with mud mortar mixed



13. Roman-Byzantine Baths, *caldarium* shelter.



14. Temple, West Corridor wall vault.

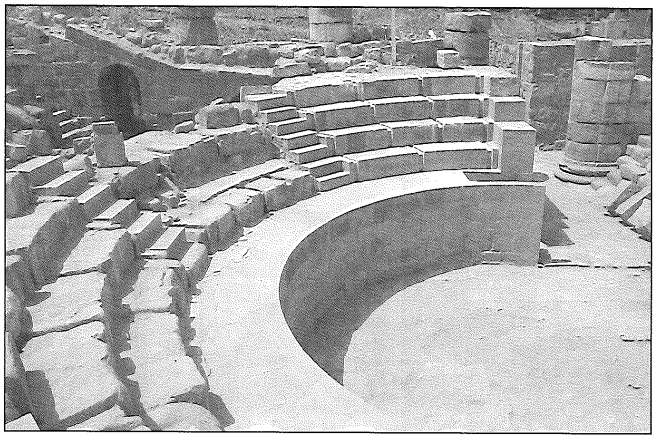


15. Temple, West Corridor wall inter-columnar wall and arch restored.

with small fieldstones. A niche discovered in the south wall was reinforced using flat fieldstones and mortar to shore up the surrounding wall. *Anastylosis* was undertaken on the east side of the room through the removal and replacement of vault stones bonded with local mud mortar. In 1999, the vault stones of the doorway into the East Interior Chamber were consolidated.

Additional conservation efforts in the West Corridor included the re-erection of the northernmost doorway. In the south, conservation efforts focused on consolidation of the South Corridor intercolumnar wall, which was partially dismantled in 1997 and reconstructed to allow for the adjacent re-erection of the south-east double engaged heart-shaped column. In 2000, the upper courses of the north face of the South Corridor Wall were consolidated. The ashlars were numbered, removed from the fill and returned to their original places in the wall. To divert potentially destructive water accumulation following this restoration, a protective drainage ditch was dug south of the column niche.

Turning to those architectural elements of the Temple contemporary with the construction of the central Theater, consolidation efforts in the north included the restoration of the upper wall of the *cavea* in 1999. Also at this time, the staircases, aisles and seats were assessed and rebuilt where necessary from original and recycled materials. FIG. 16 shows the restored west side of the theater. In 2006 we had excavated a sondage, removing the some of the Theater seating to do so. After a number of possible alternatives were proposed, we elected to construct a supporting metal frame under the seats which would bear the weight of the two rows. The seats were then replaced and mortared in place. The logic behind this endeavor was that any future researcher who wanted to view the stratigraphy would be able to remove the seats and climb down into the sondage.

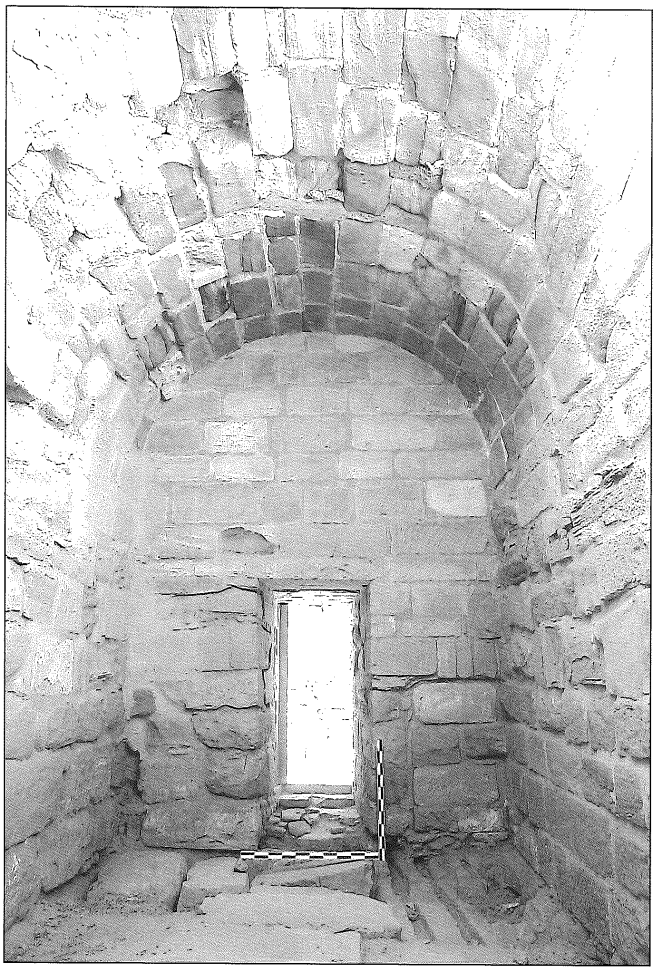


16. Temple, Theater (west) restored.

At the rear of the temple, preliminary consolidation began in 1995 with the investigation of the Central Arch, which led to reconstruction efforts in 1996 and 1997 to ensure stability for the forthcoming excavations. During the 1998 season, once excavation had begun, the Central Arch exhibited complex structural needs, requiring the erection of a 55-ashlar support wall to stabilize the arch. FIG. 17 depicts this Central Arch wall. Following the excavation of the adjacent South Corridor in 2001, the lintel above the doorway to the Central Arch was reinforced.

Stairways

There are 16 major staircases in the Great Temple precinct. In 2004-2005, the West Entry Stairway (FIG. 18) was exposed in the Propylaeum and Lower Temenos. In 2005, it was apparent that the east entry to the stairway had to be consolidated and re-



17. Temple, Central Arch restored.

18. Lower Temenos, West Entry Stairway restored.

stored, and three or four steps leading up from the Roman Street had to be placed in order to access the entry doorway, using its width as a guide. Additionally, the ashlar entry blocks had to be cleaned out and pointed, particularly those that were in danger of collapse. In 2006, the top of the West Entry Stairway and its platform were excavated. It was found that two or three steps were missing; using excavated ashlars these have been placed at the top of the West Entry Stairs. Now there is direct access from the Roman Street to the stairway.

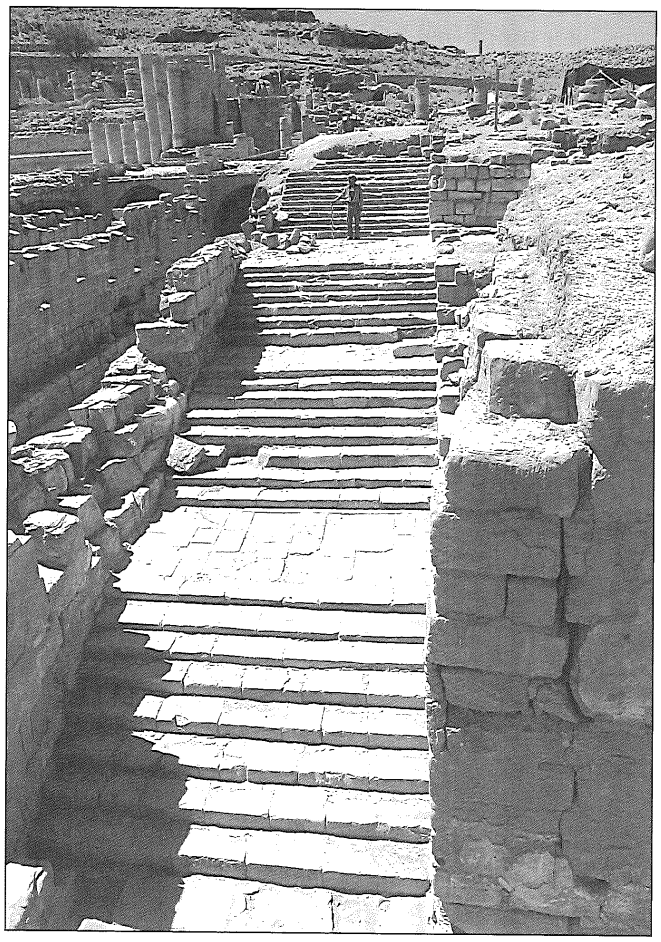
In 1996, at the extreme south of the Lower Temenos, collapsed elements of the East Staircase adjacent to the East Exedra were restored. The east and west walls of the West Staircase were pointed and missing ashlars were replaced with newly carved stone blocks. The foundations of the staircase were treated with fills of mud-mortar and small fieldstones prior to the restoration of the steps, using both original and newly cut ashlars.

It also was discovered that the foundations of the Central Stairs were blocked by the Lower Temenos East-West Retaining Wall; these were preliminarily consolidated using mud-mortar and large pebbles.

In 2004 and in 2006-2007, several of the limestone steps were replaced, leaving the remaining bedding open so that visitors can experience the originally excavated stairs and compare them with those repaired. In 1998, the steps leading to the West Walkway from the Upper Temenos Forecourt, many of which were broken, slumped out of position or robbed out, were stabilized.

In the Upper Temenos in 2005 we re-excavated the Residential Quarter Steps by removing them in order to find dateable material below. These steps had to be reinstalled in their original positions and pointed, a project undertaken in 2005.

In 2005, the Great Temple entrance steps were lengthened to the full width of the entry in order to facilitate modern access to the structure and to punctuate the original point of entry of the Site Phase IV 'grand design'. Above the Central Arch, the 1998 season also saw the replacement of some 18 or 19 steps at the top of the rear East (East-West) Staircases (FIG. 19), which had been robbed out in



19. Temple, East Interior Staircase restored.

antiquity. In 1999, the East and West Rear Staircases were rebuilt to their full extent to permit visitor access to the second storey of the building.

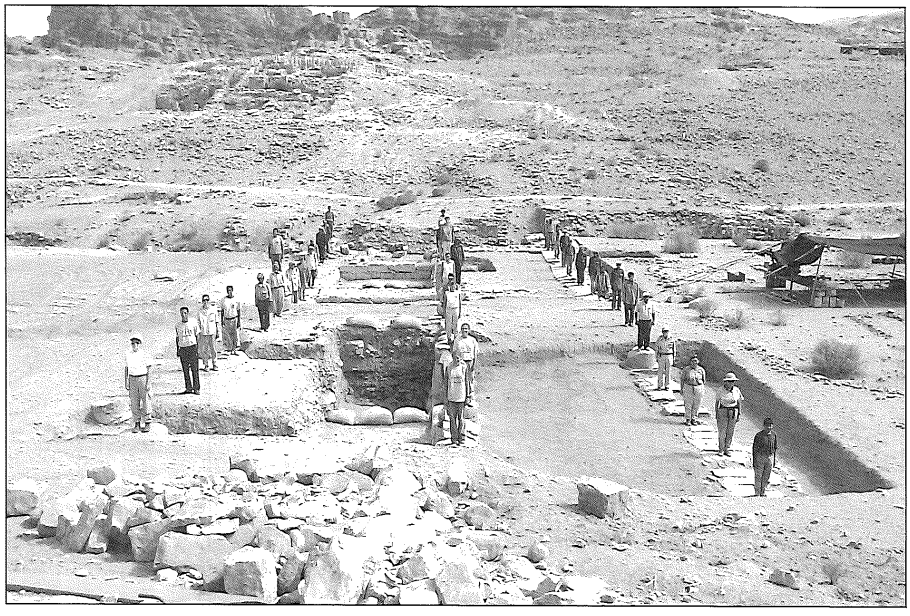
The West Interior Staircase was partially restored to undo erosion damage caused by winter rains. Full restoration of the staircase was completed in 2000 (FIG. 20).

Columns and Capitals

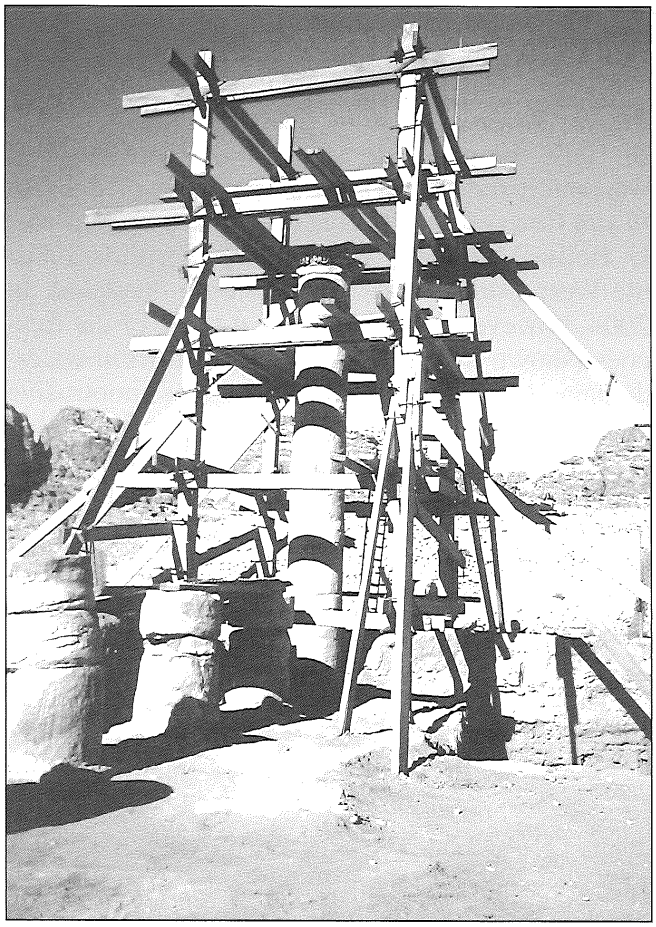
Approximately 178 columns adorn the Great Temple precinct: 28 in the Propylaeum and 124 in the Lower Temenos. Conservation efforts in the Petra Great Temple Lower Temenos east began in 1994 with the replacement of a number of weathered column drums in the East Triple Colonnade to a height of 6.8m. FIG. 21 shows the 1998 Brown team standing in place of the columns; FIG. 22 illustrates the same colonnade to the north during restoration activities in 2000. Additional columns were re-erected and a carved elephant-headed capital was placed atop the highest column to give visitors a better understanding of the position and appearance of these features (FIG. 23). This effect was later amplified during the 2001 season with the placement of an elephant-headed capital (FIG. 24) on a consolidated column of the West Colonnade north of the West Exedra. During 2002-2009, additional columns of the West Colonnade were re-erected as shown in FIG. 25.

After the 2003 excavation season we re-erected four columns in the Lower Temenos: two adjacent to the Propylaeum Central Stairs and another two at the end of the Propylaeum Retaining Wall. When elephant-capitals were recovered during the 2004

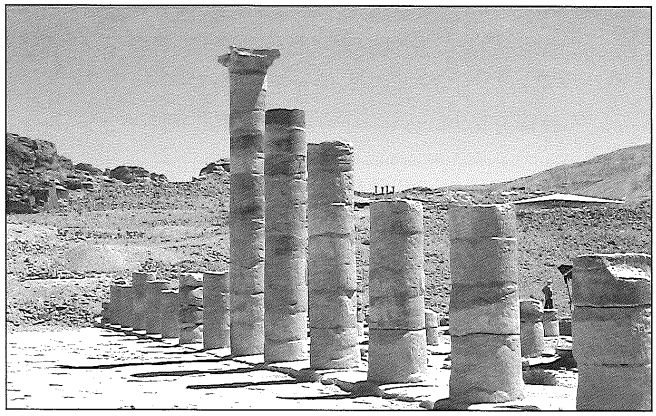
20. Temple, West Interior Staircase restored.



21. Lower Temenos, 1998 Brown team standing in place of columns.

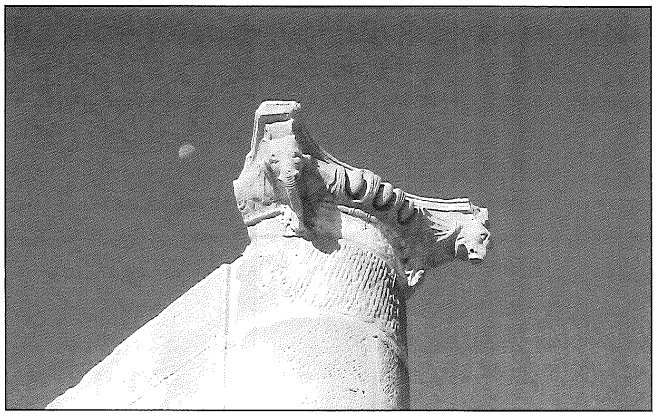


22. Lower Temenos, East Triple Colonnade during restoration, 2000.

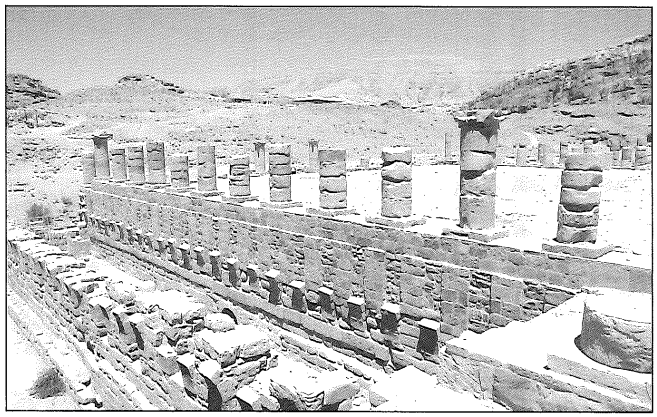


23. Lower Temenos, East Triple Colonnade restored.

excavation, they were mounted atop the four to five stacked column drums at a height of 2.4-2.5m of course, in antiquity these columns stood much higher, to a height of more than seven meters, but in this case we opted to indicate the placement of the columns and the idea of their positions and not to restore them to their original height.



24. Lower Temenos, elephant-headed capital restored to the West Exedra.



25. Lower Temenos, West Triple Colonnade restored to north.

The Temple alone has 26 columns with four part upper order capitals and two part lower order capitals, totaling 104 upper orders of exquisitely carved vines and flowers and 52 lower orders of acanthus leaves. Beginning with the original *distyle in antis* structure, conservation efforts in the Temple proper in 1997 and 2000 focused on the repair and rebuilding of a number of column bases and drums from the peripteral colonnades. In the south in 1999, 11 courses of the south-east heart-shaped double engaged column were re-erected. FIG. 26 shows the column restored with its original elements. The mirroring column in the south-west was also restored to a height of 7m, using original components excavated and recorded the previous year, in 1998. In the west of the Temple, fragments of white cable-fluted plaster were re-adhered to an exposed column shaft following their *in situ* discovery in 1999.

When discovered, the crumbling architectural fabric of heavily eroded, or absent, Porch column drums was removed. The central west column had been knocked off the stylobate in the Great Temple collapse and needed to be completely replaced. Be-

26. Temple, south-east heart-shaped double engaged column restored.

cause its Attic base was missing we replaced it and the columns with re-stacked porch drums without mortar. *In situ* plaster fragments found on the columns themselves or on the walls were treated with sealant to bond the decoration and forestall further deterioration. In a two cases, capital components were restored on the Corridor columns only, because no capital elements could be securely identified as belonging to the Porch columns.

Capitals, Betyls, Nefesh and Sculpted Pilasters

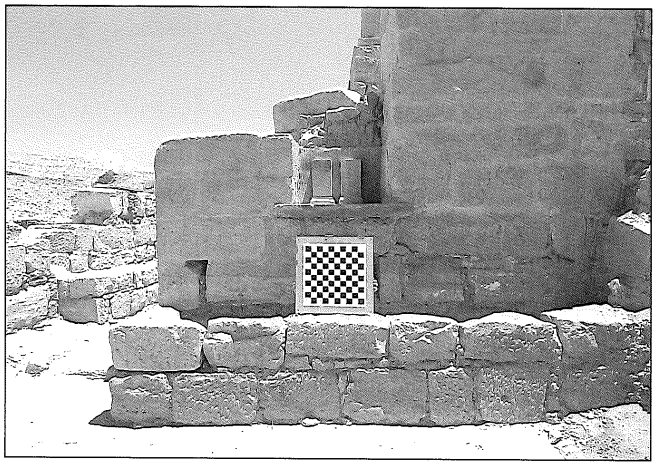
In 2000 and 2001, at the entrance of the Petra Museum we installed two complete elephant-headed capitals recovered in the Propylaeum West. Also in 2001, the double *betyls*, discovered in a niche in the Propylaeum West, were turned over to the Petra Museum for safekeeping and replacement stone copies were carved to indicate their *in situ* excavated position. FIG. 27 portrays the restored *betyls*, bench and wall. For their protection, five sculpted pilaster blocks were moved into the niches of the East Exedra in 2006, where they are now on view.

Plaster Revetments

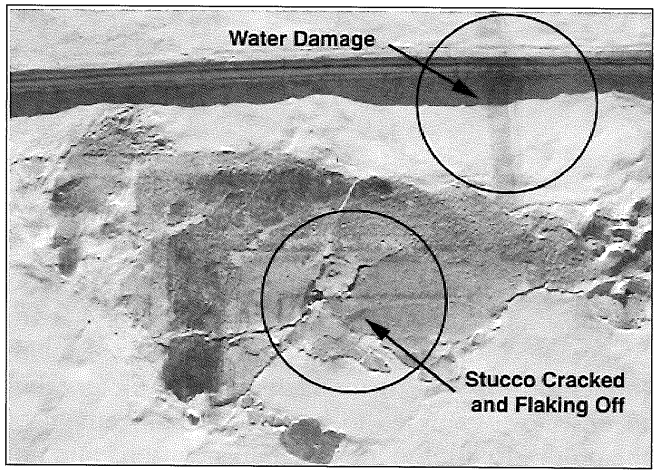
In 1999, the east face of the West Corridor Wall was stabilized following the exposure of delicate *in situ* fresco elements consolidated by conservator U. Bellwald in 1998. In 2000, the consolidation of the West Corridor Wall was all but completed. In 2004, however, it was found that some of the frescoes (shown in FIG. 28) had suffered from water-damage, so in 2005 we constructed an unobtrusive sloping roof on the top of the West Corridor West Walkway wall to deflect the winter rains.

In 2001, consolidation of the South Corridor Wall was completed and the *in situ* plaster discovered on the wall's north face flanking the central doorway was reinforced to preserve its structural integrity. These frescoes had to wait until 2005-2006 for further support and restoration.

The recovery of the Baroque Room's extraordi-



27. *Betyl* replicas installed in the Lower Temenos.



28. Fresco damage on the West Corridor wall.

nary decorated ceiling in 2002 demanded all of our efforts for its recovery, stabilization, restoration and the analysis of its original design (Joukowsky 2007: 157, 185-192, 244, 288, 296).

Artifacts

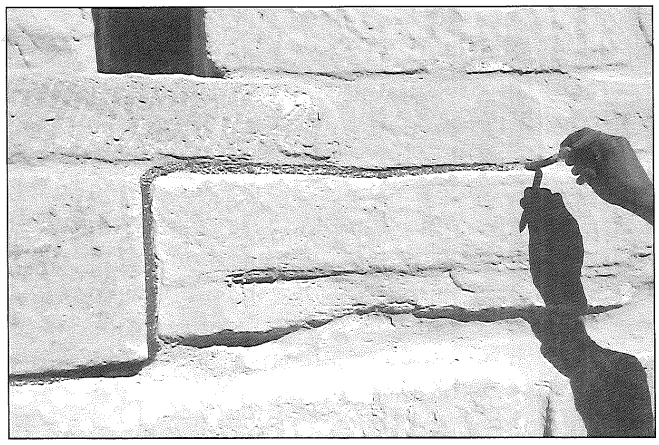
We have undertaken on-site repair of individual ceramics and have spent months looking for joins for the restoration of the inscriptions, specifically those of the Small Temple. We have worked on the stabilization of our metals, particularly the coins, and we also have restored many of our glass fragments. Following preservation, our spectacular artifact repertoire has been turned over to the Jordanian Department of Antiquities for future conservation efforts. All of our artifact databases are on-line in *Open Context*.

Other

A shoddy set of elevated planks linking the Upper Temenos to the Lower Temenos West Triple Colonnade had been used for years to move from one part of the precinct to the other. This elevated 'bridge' was a precarious passage until it was solidly rebuilt in 2005-2006. In the 2004 season, during excavation of the south-west ramp, we uncovered the West Walkway Wall, which prevented tourist access from the temple South Passageway to the West Plaza of the temple precinct. Using recycled Ottoman railroad ties, wooden stairs were constructed-providing safe access across the wall from one area to the other. This accomplished two purposes; the wall was preserved and safe passage was assured.

At the onset of the 2004 excavations, it became clear that tourists were abusing both the Baroque Room Complex and the Residential Quarter. In 2006, it became apparent that the East Perimeter Wall Room A was also being physically abused by tourists. In order to curtail such degradation, we installed gates barring access to these out-of-the-way areas.

To preserve the archaeological integrity of the site, bold lines were painted in prominent areas of conservation within the Temple interior in order to differentiate *in situ* remains from the present level of consolidation, as shown in FIG. 29. In 2007 we installed 37 informative bilingual Arabic and English signs around the site for tourists.



29. Bold painted lines between original and restored ashlar blocks.

Conclusion

This article has addressed the changes and challenges of preserving the unique architecture of the Petra Great Temple. In respecting its appearance as we found it, our interventions have been intentionally subtle. Our aim is to preserve the precinct and the Great Temple as a partial ruin so that visitors can interpret it for themselves. Unfortunately there has been seismic damage, coupled with perilous infiltration of water, air and salts that has led to the deterioration of much of the standing architecture. There will always be consolidation and preservation work to be done, but we view our achievements as beginning the process of intervention for the site's preservation. We are proud of our efforts over the years.

Progress for the protection of a site must involve, rational planning for public use and access to the site. The long-term benefits of this have been considerable, not only for the aesthetic value of the archaeological remains, but also for public understanding of its architectural statement. Overall, conservation efforts at the Petra Great Temple have been relentless, insuring the annual renewal of the site's structural stability and the preservation of its unique architectural and decorative features. During the years of excavation, conservation has permitted a deeper understanding of architectural developments nearly 2000 years old. We have restored or protected every wall and most of the sculpture-enabling us to examine the structure of the Great Temple in a form close to its original incarnation and to draw substantiated conclusions about its construction and the lives of its inhabitants. At its heart, conservation is a means of cultural and physical preservation-an unspoken tribute to the ancient Nabataean creators of this commanding edifice and

a promise for the continued study and enjoyment of its splendor today. If we can protect the site and promote the sustainability of archaeological ecosystems at Petra, whilst at the same time conserving and preserving the site for the use and benefit of future generations, we will have achieved our goal. Petra and the Great Temple will remain with us as long as we succeed in protecting their legacy. One of the crucial by-products of excavation is the state the archaeological site is left in after excavation. Because archaeology is a destructive science, how does the site live on after it has been excavated and preliminarily preserved?

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Our artifact databases, phasing charts, trench and artifact drawings, aerial photographs, annual trench and site plans, *ADAJ* annual reports and trench and special project excavation reports can all be accessed on *Open Context: http://www.opencontext.org/*

Our web-page can be found at: *http://www.brown.edu/Departments/Anthropology/Petra/*