# Amheida: Architectural Conservation and Site Development Work, 2004–2009

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Like many archaeological sites, Amheida poses numerous challenges to both its excavators and its custodians. Certain of these challenges are to be encountered at any site in Egypt, and others are site-specific. The large size of the archaeological area, approximately six square kilometers, makes it difficult to protect from individuals on foot or from animals (Plate 1). Tomb robbers continue to operate at will in the cemeteries south of the core area. The main physical threats to the site, however, come from vehicles, from uncontrolled agricultural expansion, and from new construction. Off-road cars, mechanical diggers, and tractors are all capable of doing a considerable amount of damage to the archaeological remains, whether intentionally or unintentionally. Encroaching cultivation is a particular problem on the western and southern boundaries of the site, and all the land to the east of the main asphalt road (where some archaeology was also located) has gone under cultivation within the last two years. The long-term damage caused by the transformation of the site into an island surrounded by heavily irrigated areas is yet to be seen. A more immediate impact is visible to the north of the site, where the Bedouin village has expanded dramatically in the last twenty years around the most northerly standing remains.

Aside from human threats, the surviving mud brick architecture of the site, where standing above ground level, is highly vulnerable to erosion by the strong winds prevalent in the oasis (Zielinski 1999, 186). The bricks themselves have, in many cases, been already weakened from within by the activities of termites in search of edible organic tempers. The quality of mud- and lime-based plasters used on the walls is generally not very high, and plaster layers are prone to detachment within a few years of excavation. For all of these reasons and more, excavated contexts are routinely backfilled at the conclusion of each season. At the same time, both the excavators and the local inspectorate of the Supreme Council of Antiquities (henceforth SCA) are interested in finding ways to present the results of the excavation to a growing number of visitors to the oasis as well as to the interested local population.

The guardianship of Amheida has been the responsibility of the Pharaonic Sector of the SCA since the site was first registered by Prime Ministerial Decree No. 1599 in 1995. Another monument on the site is also registered separately with the Islamic and Coptic Sector: the domed tomb of Sheikh al-Dahawy, of unknown date, to the south. Certain aspects of managing and developing the site, however, have been undertaken by the institutions holding the concession for its archaeological exploration: first Columbia University, during the period to 2007 and thereafter the Institute for the Study of the Ancient World, New York University. This work has had three main components: the protection of the boundaries, the conservation of standing remains, and the development of off-site facilities for both those who work there and those who may visit the site in the future. These three components are considered sequentially below.

## 1. Boundary Protection

Although archaeological remains also lie outside the boundaries controlled by the SCA, there is little realistic hope of protecting anything from the threats described above beyond the zone declared to be in possession of the Government. Efforts are ongoing to guarantee the integrity of at least the core area of the site where the bulk of remains are found. A new guardhouse has been constructed by the SCA in the southern part of the site. This is presently unoccupied, but will one day provide

protection additional to that already offered by the existing guardhouse on the northeast edge of the site (an area which has a good view of the road but almost no view of the most vulnerable areas). Further measures presently being executed are guided by a desire not to totally compromise the relationship with the local population using the surrounding land, or the appearance of the site when viewed from adjacent areas (such as the asphalt road). Two different physical barriers are being tested at present: the first a barbed wire fence that is clad in reed matting, and a rammed earth wall construction. The construction of traditional palm-rib fencing has proved too expensive to implement and additionally requires more maintenance than can be expected from the SCA. A metal fence boundary is economically unfeasible given the length required, and is furthermore considered unsightly. Stake boundaries have been installed on the western and southern areas of the site, where shifting sand makes the construction of other barriers difficult. The north boundary has been established in a similar way, with an additional "inner" fence of barbed wire on firmer ground designed to prevent tractors from entering.

## 2. Architectural Conservation

Three structures on the site have so far received architectural conservation treatment. All date to the Roman period of occupation, and all are constructed of mud bricks with mud mortar. The bricks are of the standard Roman size in the oasis, that is to say around 35 x 17 x 8 cm for wall masonry and 36 x 21 x 6 cm for vaults. Walls are invariably constructed in "English" bond, formed of alternating courses of headers and stretchers. The three structures discussed below are a pyramid, a tower, and a house. The first two are the largest, most complete, buildings at the site and the last is an excavated structure mostly surviving below ground level.

### The Pyramid

In the nineteenth century, Edmonstone, Drovetti, and Wilkinson all noted the pyramid of Amheida, but it was the American Egyptologist Herbert Winlock who was the first to publish a photograph of it at the beginning of the twentieth century (Winlock 1936, 25–26 and plate 16). This shows it to have been in an already dilapidated condition in 1908. Despite this, the pyramid is the best-preserved and largest example of a Roman pyramid in Egypt. It shares the same external characteristics as other pyramids in the area, notably those at Bir al-Shagala in Mut. It has a square base of approximately seven square meters and 2.2 meters in height, from which rises the sloping section of the structure. This survives in places to a height of eight meters. This has a relatively steep angle of inclination of approximately sixty degrees. The pyramid is built of solid masonry above ground level. It is not known what the substructure contains, but it is likely that there are tomb chambers below. The pyramids at Bir al-Shagala follow the same profile but have a different design, with vaulted rooms within them (above and below ground level) that are extensively decorated with wall-paintings on lime plaster. They also preserve traces of an external two-coat render of mud plaster covered with a lime based finishing coat. A second pyramid of comparable size exists at Amheida, some 500 meters to the south of the one described here, but it has substantially collapsed today. This was made of a reddish mud brick from clay that was quarried immediately adjacent to it, and also had a solid superstructure.

The pyramid stands on a low hill on the eastern edge of the site and is surrounded by the remains of a cluster of mud brick buildings, as yet unexcavated. These are most likely the remnants of an élite necropolis. Prior to conservation, the best-preserved faces of the podium and pyramid were those on the east, south and north sides (Plate 2). There had been significant wind erosion on the north side, and robbers had destroyed major areas of brickwork in the lower areas, particularly in the corners, causing further masonry collapse. The southeast corner of the pyramid itself was well preserved to a relatively high level. The remains of the west side of the structure were in a seriously unstable condition, however, either due to the undermining activities of robbers or subsidence caused by the structural failure of internal chambers. There was the real possibility of the collapse of this section of the structure. No external plaster survived anywhere on the pyramid.

In 2005 the pyramid was surveyed and recorded through photogrammetry prior to any work being undertaken.[1] The objectives of the intervention were the preservation of as much as possible of the original structure through consolidation. New bricks, matching the dimensions of the original Roman bricks but without the inclusion of straw (to avoid termite infestation), were made on site for this purpose (35 x 17 x 8 cm after some cleaning and squaring up). Shrinkage when drying does not seem to be a significant factor when making bricks out of local *tafl*, unlike bricks that are made of Nile silt. As bricks made without temper are relatively brittle, there was a considerable breakage rate. This was rendered insignificant, however, due to the

[1] Work carried out by F. Congedo and V. De Santis.

volume of bricks required for masonry infill within the core of the pyramid. Approximately fifteen thousand bricks were ultimately used in the two campaigns of work on the pyramid. The mortar used in the consolidation works was a mud mortar made from a combination of imported *tafl*, old crushed fragmentary bricks from the collapse of the pyramid, and a small percentage of fly-ash. The local masons who worked on the project desired the inclusion of the latter on the grounds of increasing the plasticity of the mortar and its hardness once dry. It cannot, however, be said that the inclusion of fly-ash had any demonstrable scientifically-grounded advantage.

Consolidation of the northeast and southeast corners of the pyramid, which had been seriously damaged by the penetration of robbers' holes, commenced in 2006 (Plate 3). These holes had caused the collapse of significant sections of the corners, leaving the remains in a highly unstable condition. Some clearance of the robbers' holes was carried out to establish a secure base for new brickwork, but threat of further collapse prevented a full excavation of these holes from being carried out. An investigation of a large robbers' tunnel immediately to the south of the pyramid proved that this shaft was substantially blocked by fallen rocks, and it would have been hazardous to reopen it, as the rock is extremely friable in this area. This tunnel was accordingly backfilled. A limited excavation of the southeast section of the pyramid revealed the presence of the original corner, allowing the dimensions of the base to be accurately established in conjunction with the surviving few courses of the northeast corner. The line of the south face of the pyramid was also found through excavation, while the north and east faces were still partially visible above ground level. Severely wind-eroded bricks on the faces were replaced with new bricks wherever a secure bond between old and new brickwork was required. The brickwork was carried up to a temporary level of one meter on the northeast corner. In the southeast corner the brickwork was continued to a height of 2.2 meters, which formed the plinth for the original angled setback of the pyramid. The setback itself was reconstructed to a height of 1.2 meters above this base line.

Work was continued in 2007 on consolidating the northwest and southwest corners of the pyramid, which had been seriously damaged by the loss of bonded masonry, either as a result of the structural failure of the western half of the pyramid due to subsidence, or due to anthropogenic causes. On the north face, the consolidation of the remainder of the base that had not been attempted in the previous campaign was carried out to the height of the top of the plinth and the sloping setback. This included the extension of the existing consolidated masonry on the northeast corner. The original foundation course was only partly evident, and the length of the wall to be reconstructed on this face was arrived at by an interpolation of the dimension of the existing, known, east face of the pyramid. Above the line of the square base, a second tier of masonry consolidation was executed, following the sloping profile of the pyramid. This incorporated elements of surviving solid original masonry but did not extend all the way to the northwest corner. The entire northwestern corner itself, up to the full height of the plinth, was rebuilt over the collapsed fill of the original structure. This seemed to be the only way to proceed in view of the general instability of the remains.

The northeastern corner of the pyramid was also rebuilt above the line of the base, following an angle of inclination that was arrived at by eye rather than any geometrical calculation. This had to reconcile the two distinct angles used in the construction of the original pyramid: an initial, extremely steep angle which, at a height of approximately 1.2 meters above the top of the plinth, was adjusted to a lesser angle. This was presumably done, as at the Bent Pyramid of Dahshur, to correct the angle of inclination once it was realised that it would result in an excessive, not to say impractical, total height for the completed structure. The correction also suggests that the construction was started without any prior mathematical calculation of the precise angle of inclination. A single line for the corner was therefore adopted, set back by between 10 and 15 centimeters, which permits the easy appreciation of this subtle feature of the original construction (Plate 4). Another feature of the original building that was replicated in the consolidated sections of the base was the use of diagonal courses of masonry within the core of the structure. These courses appeared randomly in the original structure, and were presumably intended to provide greater strength through cross-bonding the brickwork.

The consolidation of the second tier of masonry on the north side of the pyramid was designed to deny visitors the opportunity of climbing the pyramid after conservation and at the same time to provide for scaffolding access to the top of the structure during the works. The crown of the surviving masonry on the east face was capped with new brickwork to retard erosion. This capping, combined with the rebuilt north-east corner of the structure, contributes greatly to the realisation of the overall silhouette of the pyramid while adding as little new material as possible (Plates 5 and 6).

The Tower

The tower is the last surviving above-surface mud brick features at the extreme north end of Amheida. Its dating is uncertain but is likely to be from the second–fourth century CE. Although it now in the process of being surrounded with modern houses of the adjacent Bedouin village, this is a comparatively recent phenomenon dating to the last twenty years. The villagers refer to the building as the "Deir" or "Monastery", though this appellation can only be generic. The original use of the structure may have been as a funerary monument, though this can only be ascertained through future excavation. There are some parallels to the general appearance of the tower in other towers existing in Dakhleh at Kellis (mud brick) and in the Fayyum at Dionysias (fired brick). The tower had partially collapsed at an unknown point in time, and some of the mud bricks from the collapse form a crust to the north, south, and east of the surviving structure.

The tower has a rectangular plan of approximately 4 x 5 meters that is roughly oriented north-south. This orientation is almost exactly the same as that of the pyramid, which may or may not be coincidental. The tower stands to a height of slightly over five meters on an existing mound of *tafl* that has been cut to suit the foundations of the building. The east-west walls are at least twenty centimeters thicker than the north-south walls (80 cm as opposed to 60 cm). This may be related to the fact that to the north and south are isolated remnants of mud brick east-west walls constructed upon sections of the mound left standing when it was cut to receive the foundations of the tower. It is not known whether these walls might be the survivals of a raised vaulted platform that occupied the ground at least to the north and south of the tower, if not all around the tower, forming a kind of podium that gave access to the interior at a higher level.

In section, the tower contains a three-meter-high continuous pendentive domed chamber (estimated from floor to crown of the vault), above a north-south barrel-vaulted space that is now partially filled with collapsed unexcavated material (springing of vault to crown estimated at 1.25 meters). The barrel-vault was constructed before the perimeter walls had risen above the level of the springing of the vault, as the brickwork of the walls above this datum extends inwards to close the gap between the vault and the enclosing wall. The lower part of the tower, containing the barrel vault, is built plumb, while the upper section, containing the dome, is built on a slight batter. Judging from the surviving brickwork, the lower vault did not extend across the full length of the interior, but only occupied the northern two-thirds of the available space. The remaining third must have served as a point of access and been covered in a different way, perhaps with timber beams, mats, and mud. The barrel vault is an elliptical inclined vault whose horizontal thrust is directed against the north wall. The most striking feature of the interior is the surviving section of the pendentive vault of the upper chamber. This is elliptical in plan, and has four narrow (6 cm) offset bands of brickwork, each one brick thick, that project 2 centimeters into the space. These are surmounted by a further rebate belonging to the brickwork of the concentric rings of the dome itself. The pendentive brickwork is laid in inward sloping courses, the bottom three courses being stretchers and the uppermost course headers. Parts of the original mud plaster and lime wash survive on the rebates of these offset bands, as well as on the pendentives of the dome, suggesting that the interior was at one time entirely limewashed. The mud bricks used in the construction measure 35 x 18 x 7 cm for the walls, laid in alternating courses of headers and stretchers as is typical for the Roman period. The lower vault seems to have been made out of the same sized bricks, without using thinner vaulting bricks. The bricks have a reasonable percentage of chaff temper, not all of which has been consumed by insects. The rebated pendentive springings of the dome appear to be made with bricks of larger dimensions (36 x 21 x 6 cm) although the concentric rings of the dome are built with the same bricks as used in the walls. The arches of each side of the dome are not exact semicircles but have two centers.

The original entrance to the tower was at the floor level of the upper chamber, either to the north or the south. Both of these sides of the structure have substantial areas of loss in their fabric, but the relatively narrow area of loss on the north suggests that it is more likely that the entrance was on the south, where most of the wall has fallen away. This may mean that a niche may have occupied the lost area of brickwork on the north, as niches are most commonly and conveniently broken out to form doorways in the subsequent life of buildings in the Oases. Various robber holes and areas of collapse in the perimeter of the structure make a reconstruction of its original appearance difficult, but it seems that the exterior of the building was ornamented with pilasters. These are about 30 cm wide and must have originally projected some 10 cm from the face of each wall; they are located at the corners and at the centres of each respective elevation, excepting the south where the missing wall precludes any reconstruction except a stylistic one. The presence of the pilasters would indicate further, now lost, decoration in the form of bases and capitals and a cornice (perhaps a simple cavetto

and torus moulding). The original entrance, now lost, may also have been framed by pilasters and had its own cornice. The height of the bases of the pilasters is aligned with the top of a set back of the section of the building corresponding with the assumed internal floor level above the barrel vault. A lower setback exists of 90 cm, or twelve brick courses, from external ground level. The exterior walls were undoubtedly originally plastered with mud and limewashed. A number of cracks were observed in the structure, the most severe being on the west flank wall running the full height of the structure.

Following the preliminary survey (Plate 7) and photogrammetric recording, consolidation work proceeded in 2007 using the same materials and techniques employed on the structure of the pyramid. All openings due to collapse in the perimeter wall were filled with mud brick in mud mortar to match the original bonding pattern as far as possible (Plate 8). On the north side, the infill provided the opportunity to reconstruct a section of the external pilaster on the external wall, and a shallow arched niche (hypothetical) on the internal wall. This niche (53 x 90 cm to apex of niche head) is slightly off-centered, being centered instead on the area of loss. The rebuilt wall follows the batter of the external façade. On the south side, a painted steel grille double door with padlock was installed at the presumed level of the original entrance. Acacia wood (*sunt*) lintels, treated against insect attack with sump oil, were provided for this opening. Access to the interior is now only gained by ladder. The springings of the pendentive dome were consolidated or reconstructed following the original design of four consecutive rebates (Plate 9). The fifth rebate was created in the same manner, rather than following the original concentric rings of infill brickwork for reasons of ease of construction. This work was mostly carried out on the south internal elevation above the new door, but a small section of the east elevation was also repaired in the same way. After consideration it was decided not to stitch the crack on the west flank wall, as the areas of surrounding masonry had been consolidated. No sign of further movement has subsequently been detected.

The House

During the period of the excavations of the Roman house of Serenos,[2] a minimum of mud brick consolidation work was executed in tandem with archaeological documentation and in situ conservation of the wall paintings on plaster that still adhered to some of the internal surfaces.[3] This was intended to improve the stability of the structure and to facilitate the compartmentalised "room by room" method of excavation and backfill. New brickwork was used in the reinstatement of the missing south wall of the main domed room of the house (Plate 10). The existing bonding pattern was replicated wherever possible, although the original brickwork was of a variable character with many inconsistencies in sizes and coursing of bricks. Elsewhere, new mud brick blocking walls were built to divide the excavated from the unexcavated areas and to create a series of protected compartments within the area of the house. A temporary shelter was also built over the main space of the house, made of timber and palm ribs, to discourage unauthorized excavation and viewing out of season.

Agreement between concerned parties was reached in 2007 not to leave the excavated remains open to visitors owing to their extreme fragility. A similar reason lay behind the decision not to detach the wall-paintings but to leave them in situ. It was, however, further agreed with the SCA that due to its great intrinsic interest a full-scale replica of the house would be constructed off site to serve as a visitors' center (see below).

## 3. Site Development

The future development of Amheida is predicated on the continuation of archaeological activity there and the anticipated increase in the number of visitors to the site, both of which are encouraged by the SCA. In order to serve both these functions, an incremental development plan for the construction of new facilities is currently being implemented. This has so far received funding from Columbia University, the Institute for the Study of the Ancient World (New York University), the American Research Center in Egypt, and the Royal Netherlands Embassy in Cairo. The physical focus for the new buildings that comprise this development is the northeast sector of the site, immediately adjacent to the existing guard house and close to the asphalt road (Plate 11). The area occupied by these buildings is flanked to the east by a modern raised water channel, and is archaeologically devoid of interest. The buildings are single story structures and include an expedition workroom and store, a small mosque, a site conservation room, composting toilets, a display and storage facility for stone blocks retrieved from the damaged temple on the site, and a replica of the house of Serenos. The workroom, mosque and

[2] See Paola Davoli, this volume, for a full description of the house and its contents.

[3] See Constance Silver, this volume, for a description of conservation work on the painted plaster.

replica are constructed out of mud bricks, and the other structures out of fired brick with lime mortar and lime external render. Water, supplied through a gravity fed pipe from the nearby water channel, and electricity have both been brought to this area. The limited waste-water generated by a single sink is channelled to a remote soak-away pit filled with gravel. The toilets are naturally ventilated dry-drop toilets raised over composting chambers. An area for vehicle parking has also been provided outside the line of the fence running along the eastern perimeter next to the compound. The two most important components of this complex are considered separately below.

Replica of the House of Serenos (see Plates 12–15)

The replica of the house of Serenos is intended to convey an overall sense of the scale, spatiality, and materiality of the original structure.[4] It was constructed in three separate phases, each lasting about three weeks, separated by some months to allow sufficient time for the structure to dry out and settle. At the time of writing, the replication of the painted decoration of the interior had not been commenced, so this will not form a part of the description that follows. When completed, the replica is intended to function as a visitors' center for the site and will contain displays in two rooms that are related to the history and culture of the site as well as archaeology and the creation of the replica itself. One room is intended to serve as a ticket office, and a panorama of the site is visible from the roof terrace of the house, providing visitors with a good idea of its appearance without having to walk across it.

Enough of the original house has survived to allow for an extrapolation to be made of the primary architecture composed of elliptical vaults, a continuous pendentive dome, and a staircase. Other archaeological evidence was found to suggest that two other rooms were roofed with timber logs and palm ribs. The collapse of vaults within rooms seemed, when excavated, to suggest that the building was a single story structure: not enough debris was found to account for a second story, although the staircase could easily have been continued up to another floor. The thickness of walls and size of bricks used in both walls and vaults were copied from the original as exactly as possible, and the building was laid out to the same orientation as the original. Plaster finishes on wall surfaces, either single-coat mud plaster of two-coat mud and lime/gypsum plaster were mimicked as closely as possible, as was the disposition of niches. Secondary uses, evident in niches hacked into original decorated plaster surfaces, were not replicated. The stair treads in the replica were made of a similar low-temperature fired brick pavior to those seen in the original house.

A considerable number of assumptions were made, however, about the appearance of the original structure that were based wherever possible on a study of parallels. This particularly concerns the appearance of secondary architectural elements such as door and window openings and the doors themselves. Extant examples of door openings in the domestic architecture of the Khargeh Oasis[5] show that they were typically spanned by a combination of a shallow arch on the inside and a flat timber lintel on the outside. This was presumably done to minimize the use of wood. The timber used for lintels was locally derived acacia or olive wood. No doors have survived from Roman period houses in Dakhleh or Khargeh: the only known complete exempla derive from the University of Michigan excavations at Karanis (Kom Aushim) in the Fayyum (Husselman 1979, plates 52–56). These are doors made of split palm logs bound together by palm fibre rope, and panelled wood doors with ogival moulded rebates: two very different materials and qualities of finish, both of which operated on the projecting pivot principle. The presence of moulded rebates indicates an advanced level of woodworking skill. To demonstrate this variety of finish, a number of different types of door were installed in the house, namely: split palm log planks fixed to acacia rails with hand made nails; *gambuzia* (plum tree) plank and rail doors with hand made nails; acacia plank doors salvaged from demolished traditional buildings in Dakhleh; panelled doors made from pitch pine (a substitute for sycomore). The panelled doors were reserved in the replica for the most important room of the house, namely the room with a dome. Door locks and latches were made from a variety of local woods, according to traditional designs for which parallels were also found in Karanis. The shelves used in certain niches and on the central landing of the staircase were made from planks of *nabkh* (Christ's Thorn) wood. The design of paired window openings with a steeply chamfered internal sill was copied from buildings in Khargeh. The presence of an oculus of some kind in the central domed chamber is supported by the presumed requirement for light to see the elaborate wall paintings in this room. The niche in this space is conjectural, but is justified by the discovery of elaborate moulded plaster fragments in the collapsed fill of the room, and the common use of

[4] See N. Warner, forthcoming, for a fuller description of the building of the replica.

[5] Warner forthcoming reference

honorific niches at high level in the domestic architecture of Khargeh.

As well as these assumptions, some modifications to the design of the original dwelling have been made in order to ensure visitor safety, the durability of the finished structure, and the economic viability of the project. Stairs descending into the house from the adjacent streets were omitted in the replica, as were the raised sills on door thresholds, because they constituted a trip hazard. Doors leading from the vestibule to the central room, and from there to the staircase, were left out for reasons of ease of circulation. The enclosed viewing terrace on the west side of the building was constructed on a secondary timber structure and deck covered with a crushed fired brick and mud mortar screed laid to fall to palm-log gutters. This was built over the vaults here because of the potential risk of collapse should a large number of people stand on the vaults directly at any one time. The empty spaces between the remaining vaults to the east were partly filled with small polystyrene cubes and crushed mud bricks in order to reduce the dead load imposed on the vaults. This was a substitution for the lightweight organic material that was traditionally used to fill such spaces, which is attractive to insects. The strip foundations of the replica were made of limestone rubble set in lime mortar rather than mud bricks in mud mortar. The floor was finished with a lime screed rather than mud plaster to provide a longer lasting surface. Window openings and light wells were fitted with mesh in steel frames to prevent the entry of birds. The oculus of the central dome was covered with glass for the same reason, as was another light well. Timbers used in roofing were casuarina, which was only introduced into Egypt in the nineteenth century. This was done because of availability and cost: the equivalent original spaces were probably roofed in palm logs. Economic reasons also meant that the new doors were not finished with an adze as can be seen in the finish of the salvaged acacia plank doors. Power tools were also used to create the circular openings for door pivots for reasons of speed and accuracy. A limited electrical supply was installed at key points within the building to provide power and artificial light if needed, notably in a room that was designated for future office use and another intended for the display of exhibition panels and other didactic material.

The construction of the replica also enabled some experimental archaeology to take place. A total of 100,000 mud bricks were made for the building, of which roughly two-thirds were used in wall construction and the remainder in vaults. An inedible substitute for chaff was used in the composition of the larger bricks used in walls: chopped-up fibreglass. This proved to have very little effect on improving the brittleness of the bricks as fibreglass lacked the natural stiffness of chaff so essential to the making of a durable mud brick. A temper of animal dung was not employed for the reason that it, too, is organic and might attract insects. The making of the mud bricks clearly demonstrated the vast amount of raw materials needed for their manufacture as well as the large area required to lay them out to dry. The amount of mud required to build an entire town, and the industrial scale of production of mud bricks, is something that is generally little appreciated. After experimentation, it also became clear that mortar of a different, more elastic, consistency was required for the construction of the vaults of the structure compared to the walls. This had a different color, due to the increased sand content of the mix.

The building of seven inclined elliptical vaults and the continuous pendentive dome was another aspect of the reconstruction that proved instructive. The tradition of constructing elliptical vaults in Egypt has only been maintained to a small degree in Nubian vernacular architecture. Following the Roman period, it seems that vaulting went out of fashion in the oases, as well as in the rest of Egypt. Perhaps this was because flat roofs supported by timber logs or beams were so much easier to construct, and perhaps it was because of the increased availability of wood, or a combination of these two factors. The architect Hassan Fathy adopted the elliptical vault as an intrinsic part of his architecture, but his vaults, built by Nubian masons, were lightweight constructions compared to the heavyweight vaults of the Pharaonic or Roman periods, which used mud bricks that were at least three times the size of modern bricks. The two architectures are environmentally dissimilar as well: Nubian vaults are exposed, and well ventilated below, while Roman vaults are only seen from within and support a mass of insulating material.

None of the bricklayers who worked on the replica had any experience of constructing vaults without the use of formwork, and they had varying success in emulating the work of their Roman predecessors, which is not altogether surprising. The length of time taken to construct a vault over a space of 2.9 x 3.7 meters was seven days; presumably a Roman bricklayer would have managed it in half the time. By contrast, the bricklayers averaged 300 bricks a day when constructing walls. A single bricklayer constructed the pendentive dome over a period of three weeks. His task was complicated by the fact that the base

of the dome was not square, but measured 5.5 x 4.83 meters. This irregularity results in unequal pendentives. To construct the dome, a pivoting, hinged pole was used, fixed at the centre of the space at the same height as the springing of the pendentives. This not only determined the diameter of the sphere of the dome, but also dictated the inward inclination of each ring of bricks in the structure. As the dome increased in height, so did the time required to wait before the addition of the next ring, owing to the increased vertical angle at which the bricks were laid and consequent risk of slippage despite the fact that the joints between the bricks were well packed with pottery sherds using as "chinking".

The original house was completely plastered with a mud plaster, inside and out. The mud plaster used in the replica was made of sieved granular *sebakh* with sand. The spaces that had painted decoration all had a second layer of lime plaster or lime wash applied to them. Lime wash was also used as borders to niches and doors, as they would have reflected light (whether from the sun or candles). In some areas it remains unclear why certain areas were treated with lime. The choice of the composition of the white lime-based secondary plaster was made after extensive testing of different combinations of lime and gypsum and dust from the site. The lime used had been slaked and sieved and stored in sealed plastic barrels for fourteen months prior to use. The gypsum was ordinary bagged gypsum, and the dust was added to the plaster mix in order to dull the extreme whiteness of the finish. The original plaster in the villa was also "off-white" due to impurities. Not only did the modern equivalent have to match in appearance, but it also had to be more successful than its ancient counterpart in adhering to the mud plaster beneath it. The composition of the plaster eventually used was 6 equal parts lime to 3 of gypsum to a half-cup of dust mixed with 2 cups of water. All the plaster was applied with metal trowels and finished with wooden floats. Vaulted rooms treated in this manner were given a further brush application of lime wash. The main domed room of the house was, by contrast, only treated with a two-coat brush application of lime wash.

Temple Block Display and Storage Facility

A total number of some 400 sandstone blocks and fragments with relief decoration have thus far been recovered from the remains of a multi-phase temple on the highest point of the site.[6] These blocks vary in size: not all of them are decorated, and only a few linked scenes have thus far been identified. They indicate that the lower courses of a decorated sanctuary constructed by Domitian has the potential to be reconstructed, and that a coherent display of other Roman period blocks and Saite period blocks could also be created. A few of the blocks are distinctive architectural elements such as door-jambs or cornice fragments, but the majority are wall-facing blocks. It is expected that more blocks will emerge from excavations in future years, and these will also require storage. From the point of view of visitor information, the temple blocks are a useful vehicle for explaining the long history of the site, and its repeated rebuildings.

Owing to the strong winds and harsh sun of the oasis, the blocks could not be left exposed as in many other open-air block display areas around Egypt. The blocks have consequently caused major storage problems since the moment of their discovery, and have been repeatedly moved from the site to distant storage locations around the oasis. This problem was solved in 2008–09 by the construction of a purpose-built block storage and presentation space next to the other site facilities. This building follows an east-west orientation, believed to mirror the orientation of the original temple. Thus, the blocks in storage can, wherever possible, be located with reference to their assumed original orientation on different walls of the temple.

The facility has a fired brick perimeter wall, 2.5 meters in height and one and a half bricks thick, which is plastered with a sandy coloured lime plaster internally and externally. The building has a single entrance on the east side for security reasons. The roof is a steel structure supported by four steel posts internally, with a cantilever extending beyond the perimeter wall to provide further shade. All steelwork is painted beige. The surface of the roof is a white cement screed seven centimeters thick laid over a bitumen membrane above sheets of 18 mm thick composite wooden board. The roof is supported off the perimeter wall by steel posts one meter high, and the space between the roof and the wall filled with a steel grille and mesh to prevent unauthorised access to the building and stop birds from nesting inside. This design also permits the interior to be naturally lit and ventilated (Plate 16).

Within the exterior wall runs a bench of fired brick, 40 cm wide. This bench is plastered with lime plaster to match the interior wall. Two other wider benches, 5 meters long and 1 meter wide, each designed to take a double row of blocks, lie either side of the central feature of the space, which is a bench built on the plan of a chapel. This is intended to serve as the base for the reconstruction of the sanctuary of Domitian in the temple. The reconstruction will be made using a total of approximately fifty blocks and fragments in three

[6] See O. Kaper, this volume.

courses with blank infills where appropriate set into a fired brick wall using lime mortar and lime plaster. A total of seventy linear meters of bench are available for block storage/display. On the walls above the perimeter bench are two horizontal lines of steel angles that support plank shelving for further block storage. It is imagined that less informative blocks will occupy these upper levels, while the more significant blocks will be positioned on the benches below. The plank shelving provides an additional seventy linear meters of storage, and is omitted from the east wall either side of the entrance door. Here it is ultimately proposed to mount bilingual visitor information panels on 2 mm thick etched aluminium sheets bolted to the wall.

## Conclusion

The construction of all facilities within the new site compound was completed by the end of 2009 (Plate 17), leaving further work in future seasons to secure the boundaries of the site. The provision of visitor information in the replica of the house of Serenos and the Temple Block Display Facility is expected to evolve in the light of future discoveries on site. At the present planning stage, the display of and in the house is intended to convey information about daily life in Amheida, while the Temple Block Display will provide an overview of the development of the site as a whole. Additional specialist displays on other themes can be created as and when the information becomes available.

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Plates:

Fig.1 General site plan showing location of key elements.

Fig.2 The pyramid prior to consolidation (author's photos).

Fig.3 The north-east corner of the pyramid after the first season's consolidation (author's photo).

Fig.4 The north-east corner of the pyramid after consolidation showing change of in angle of inclination of original brickwork (author's photo).

Fig.5 View of pyramid from south-east after consolidation (author's photo).

Fig.6 Aerial view of consolidated pyramid from the north (photo: John Ruffle).

Fig.7 Rectified photography of tower elevations before consolidation (photos: Fabrizio Pavia and Silvia Maggioni).

Fig.8 Views of tower elevations after consolidation (author's photos).

Fig.9 Rebated pendentive dome of tower after consolidation (author's photo).

Fig.10 House of Serenos: consolidation of mud brick masonry of south wall in progress (author's photo).

Fig.11 Location plan of new site facilities (author's drawing).

Fig.12 Exterior view of replica of the house of Serenos from north-east (author's photo).

Fig.13 Interior view of pendentive dome with oculus, replica of the house of Serenos (author's photo).

Fig.14 Interior view of main circulation space, replica of the house of Serenos (author's photo).

Fig.15 Exterior view of roof showing dome, lightwells, and viewing terrace, replica of the house of Serenos (author's photo).

Fig.16 Exterior and interior views of the temple block storage and display facility (author's photo).

Fig.17 General view of site complex from south-east showing (from left to right) the replica of the house of Serenos, the temple block storage and display facility, the guardhouse and the composting toilets (author's photo).