



Excavation and Conservation at Volubilis, 2004

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with Ali Ait Kaci, Helen Dawson, Alaa el Habashi, Dorian Fuller Guy
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The 2004 seasons spread over a full ten weeks, giving us a more efficient use of the spaces and opportunities the site offers. The conservation team, led by Alaa el Habashi, had a ten day start on the excavation team in March. We then overlapped for a week, allowing us to exchange information and students. The rest of the excavation team arrived in the beginning of April, and continued digging through the month. During the season paleobotanical work was carried out by Dorian Fuller and Qin Ling, with excellent results, including the introduction of cotton cultivation during the early Islamic period. Fatima-Zohr Harif studied the coins from all the excavations. Victoria Amoroz Ruiz continued her study of the pottery, this year in collaboration with Abdallah Fili, while Ratiba Rigalma catalogued the small finds. A second conservation season took place in August, almost completing the restoration of the vault of the hot room of the baths. We hope to be able to add two weeks of pottery study before Christmas, in order to be well advanced on the publication before the final season in April of next year. This year was thus extremely productive, and our knowledge and understanding of the site has grown apace. The following report covers excavation, work on the finds, and conservation. It should be noted that collaboration between the Moroccan and British teams (added to this year by members from Algeria, China, Egypt, Italy, Romania, Spain and the US) is excellent, with important exchange of information and skills, not to mention solid friendships on all sides.

Site D

Under the joint direction of Hassan Limane and Ali Ait Kaci, the complex stratigraphy of Site D, within the walls of the medieval town, is now much clearer. The earliest, and as yet unexcavated, phase that we have been able to observe is a massive destruction layer composed of falls of mud brick and stone masonry at least 1.5 m. deep. Within this, later cuts and pits reveal standing walls, but no fuller plans are yet available. The date of this destruction remains obscure. Our earliest calibrated AMS date from the upper occupation is AD 542 to 633, which suggests that the reoccupation of the site dates to the sixth century, the same period in which Akerraz suggests that the late Roman rampart was built. The idea of an abandonment in the fifth century ties in with the lack of coin or pottery finds from the second half of the fifth century, although this remains to be confirmed by further excavation.

The destruction of all the buildings on the site would have left an irregular surface with abundant clay from the mud bricks, and large blocks of building material. The first activities visible are thus the creation of flat spaces on which to build, and the digging of pits to recover earth and stones for new buildings. The earliest of these buildings is found in the lower half of the site, where room F is partially preserved (fig. 1). This is a long room measuring 3.5 x 9m. and paved with a succession of hard white plaster floors. The walls, too, were plastered. There is no certainty as to the position of the door, as the walls have been partially eroded away. However, a space to the south of the room, K, may have been

partially covered with a lean-to roof. This space may have housed a stable or, perhaps, a workshop, as the large stone vat containing lime and the carefully posed stone in the corner seems to suggest. To the north of the building were cut large pits filled with ash mixed with bone, pottery and a few ceramic wasters. The fills strongly suggest ceramic production on the site, although it is unlikely that the pits were themselves kilns, as the earth into which they were cut does not appear burned. Among the finds from these pits a sherd of a *jarrito tipo pequino* suggests a ninth century date.

A new structure, B, was built next to F, again involving the terracing of the

hillside (fig. 4) Measuring 10 x 5.2, its construction is very typical of the Roman walls of the site, with re-used orthostats marking the door and regular, coursed stone masonry up to a height of 1 m. Over this we must imagine that the upper parts of the walls were built in *pisé de terre* or mud brick and that the ceiling was of perishable materials, such as reeds on a wooden frame covered with earth, as there were no stones or tiles in the destruction material covering the floor. One door opened onto an empty space to the east, flanked by the wall of F, while another opened onto more irregular terrain uphill to the north. This may have been used for stabling. In a second phase, the large room was divided down the middle by an irregular stone wall, and the western room was paved with flat stones, while the eastern room was covered with a plaster of pink earth mixed with a little lime. We may suggest that this was a functional division between domestic space and stabling or storage.

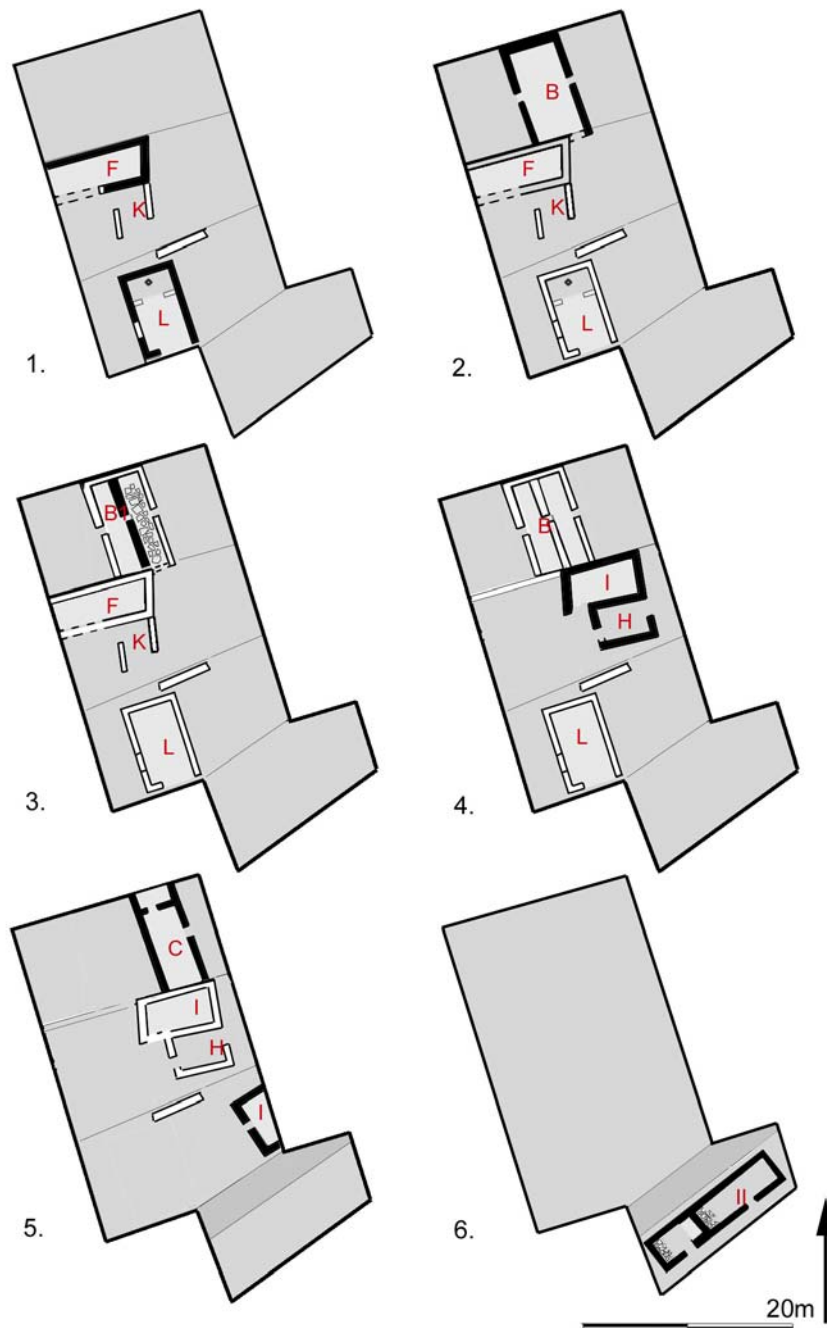


Fig. 1. Site D, phase plan.

A third building, L, has less clear stratigraphic links to F, but it may be assumed to be of roughly the same period. Here, the initial terracing clearly revealed earlier buildings, for two of the walls were built along walls founded much deeper. The other walls were roughly built, without foundations and reinforced at intervals with wooden posts. The floor of the room was cut down slightly into the surrounding clay. Measuring 8.5 x 4.2m., the plan of the building is relatively clear, although, again, the position of the door is uncertain: it was probably to the south. The southern 2/3 of the space was floored in beaten-earth, with a hearth and a domestic silo to the west. A dividing wall separates this space from a room with a very irregular



Fig. 2: Building L, from the south

floor 30 cm. below the level of the main room. Traces of burning are found in one corner, but in general this space is so rough as to suggest that it was used for storage or animals, an hypothesis which should be confirmed by phosphate testing. A large post-hole occupies the center of this space.(fig. 5) The general arrangement of the whole building strongly suggests the individual units studied in the Kabylie by Pierre Bourdieu: the posthole would have held the main roof beam, as well as providing support for a loft above the stable/work space. The only notable difference is the orientation of the building, with the entrance door on the short side, facing south. Outside the structure to the west were three cylindrical silos, while the area to the east was badly cut by large, irregular pits that may have been used to extract earth

for the construction of the upper walls. A rough wall seems to have separated this property from that of F, to the north, although its line is now only indicated by a few blocks. Apart from this we have no sure indications of property boundaries, although there are no certain doors between B-C and F-E. The property divisions may have been reinforced by light wooden barriers or thorns, which have left no traces.

In a subsequent phase all three buildings were replaced by similar units further up the hill, excavated in previous years. B was replaced by C, which re-used its east wall, rebuilding in crude masonry based on large spoliated blocks. F was replaced by E, of roughly the same size, and also floored with white plaster. Entered from the south, a hearth was found against the south wall, and a domestic silo almost 1.6 m. deep in the southeast corner of the room. Outside we may again suggest a lean-to room used for stabling, while a large cylindrical silo to the southeast may have belonged to the same property. Finally, L was replaced by I, partially excavated to the east of the site. To the south of room I the modern track covers a road running downhill, with carefully constructed drainage channels on either side. From the

surface of this road a silver dihrām of Idriss I (fig. 6) suggests a possible date for its construction, while an AMS date ranging from AD 818 to 902 gives a general idea of the date of this occupation.

The site thus reveals what seem to be three individual properties, each composed of a single rectangular building, subdivided in two cases into domestic space and stabling or workrooms. The central property seems to have had an annexe in both phases, and may have been connected to pottery production. There is no trace of violence in the abandonment of the three properties, but the general lack of tenth century pottery suggests that by that time the town had retracted from this more peripheral area.

Site B (Helen Dawson, Guy Hunt, Tarik Moujoud)

This year the site around the Islamic baths, which we take to be the settlement created by Idris I, was expanded, with a broad new area exploring building I under the direction of Helen Dawson, and an extension to the west of the bath building to confirm that there were no annexed structures. This, and the continuing excavation of the area to the north of the building, was directed by Guy Hunt. Finally, Tarik Moujoud continued his excavation of a deep trench linking the site to the Roman walls. The whole area uncovered now measures almost 2000 sq. m.



Fig. 3. Area 4000, looking west.

To the west of the baths, towards the oued, no further buildings were recovered, although a stony compacted surface may indicate a road. This seems to have been the western limit of the site, confirming the evidence of the small sondage carried out to the southwest in 2001. To the north, enclosed between the two wings of the baths and the rampart, lies the large open area occupied by pits. At least 10 of these were substantial grain silos, cylindrical in form and as much as 2 metres in diameter, with depths of up to 2 metres. Only in a few cases was any treatment of the sides observed, although in one case a clay coating filled in the spaces between the gravels of the underlying alluvial deposits. These pits appear to follow relatively regular alignments, and in general do not cut each other. This suggests that they were roughly

contemporary. Although we initially interpreted this area as the site of a market, it now seems clear that the pits formed part of an *agadir*, or area of collective grain storage. Such spaces were in use in the area until recent times: today, in the nearby village of Ferdassa, an area now used for housing is known to be ‘the area for silos’. Such underground storage is particularly necessary to protect the grain from the periodic attacks of locusts. At Volubilis, the area was bounded by the baths, the city walls, and traces of a wall running north from the baths. A gate in this wall formed by two massive orthostats apparently gave access to this area, although we cannot be certain of its northern limit.

In the area to the south of the baths a series of orthogonal walls delimit what we now see to be at least three separate properties, occupied by large buildings characterized by courtyards. The first of these was excavated over the period 2001-2003, while the other two were revealed during the 2004 season. The most completely excavated of these buildings abuts the bath complex. It comprises two wings, separated by a wide cobbled courtyard: over all, it measures 26 x 20 metres. The two wings are both well-built, with walls in a mixture of orthostats and coursed rubble masonry: their upper sectors were presumably in *pisé de terre*. The excavated area of the western wing comprises two rooms each partially paved with irregular stone slabs set in a beaten – earth surface. The eastern room opened directly onto a cobbled street to the east, with another door leading onto the courtyard. Here the paving consisted of a series of plastered floors, of which the lowest was a fine pink clay mixed with earth and lime.

Against the south wall a section of this floor about a meter wide was raised 20cm. It is not clear whether this division was the result of the deliberate creation of a bench, or whether the presence of cushions or rugs at this end impeded the wear that took place elsewhere in the room: in either case this area would have been used for seating. On the walls were traces of a fine grey lime plaster painted red, similar to the red paint in the hot room of the baths.

The courtyard was reached by a large door marked by two orthostats at the southeast corner of the building. This door is angled at 45° to the other walls of



Fig.4. The west wing of Building I, with the entrance to the courtyard.

the building, and led in from a large space, as yet unexcavated, that may represent a sort of forecourt, or area in which livestock was kept.. The south wall of the courtyard does not present any visible doors, so the range of rooms to the south of it must belong to another property, although there is only a single party wall between them. This building had at least two ranges of rooms opening, again, onto a single courtyard. These were 2 m. wide, on the north and west sides of the court. No floors have yet been reached in this structure. A further property, apparently distinct from the first two, lies in the south-east corner o the excavation. A courtyard apparently occupied its northern sector, although nothing is visible of this apart from a hearth built against the west wall.

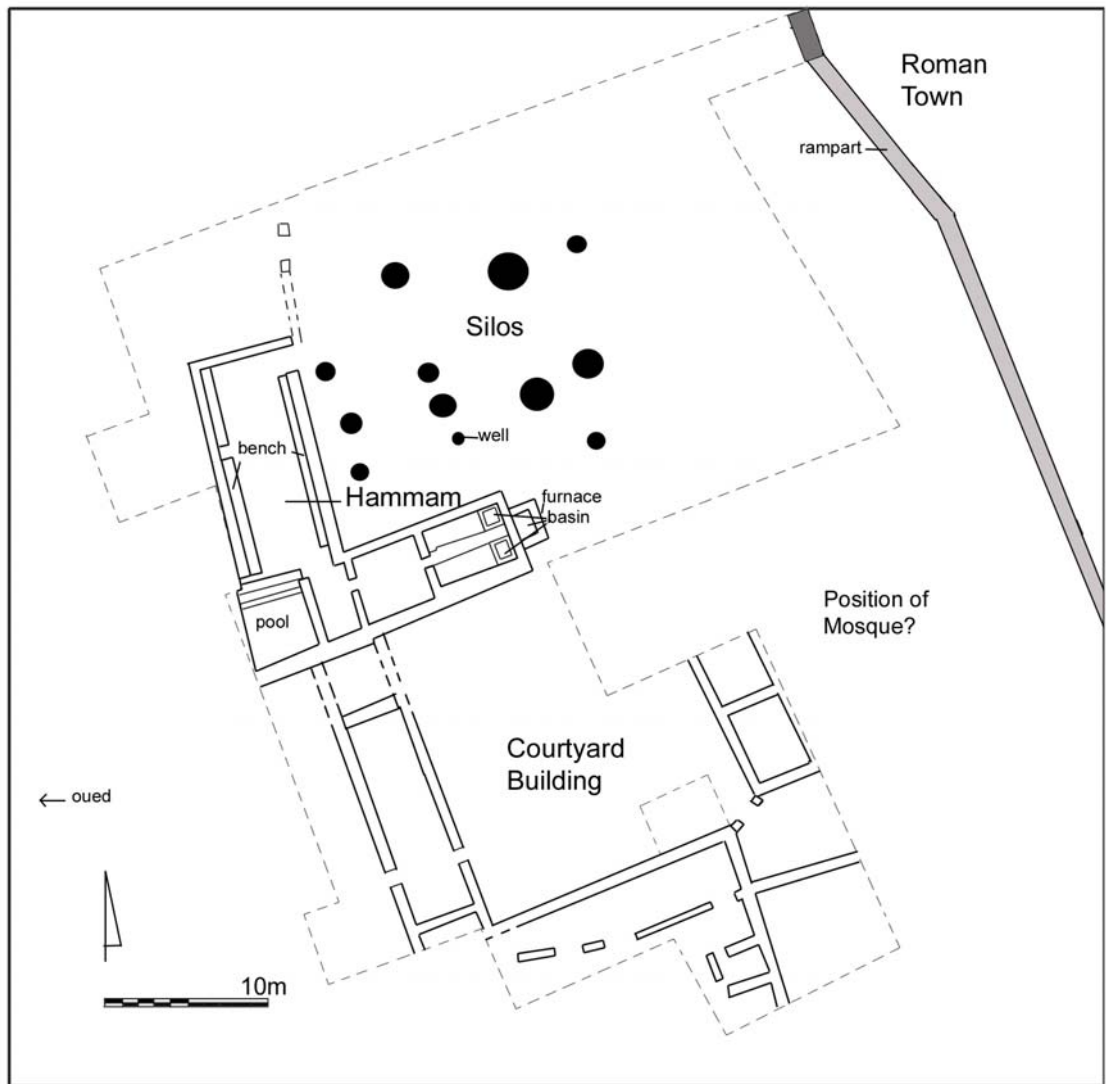


Fig. 4. Site B, phase 1 (ca. 790)

All of these buildings went through considerable changes in the course of their occupation. In the case of the first building, the eastern wing was subdivided at some point, and repaved with a sequence of three floors. The courtyard seems to have undergone a rapid accumulation of earth between two phases of cobbling, possibly due to alluvial deposition. At a later stage a one-roomed structure was built at the north end of the courtyard, free standing but acting, in effect, as a northern wing. The southern house was abandoned and destroyed; its place was taken later by a new wing along roughly the same plan, with two long, adjoining rooms with doors opening to the south. A posthole in the center of one of these suggests that the roof was partially sustained by posts.

To the north of the baths the collective granary went out of use, and was replaced by a

number of houses, apparently composed of one or two rooms. We have a very patchy view of this phase, due to the damage caused by the earlier excavations. However, the house excavated near the rampart gives us a good view of the plan of these buildings: again, two substantial rooms are placed end to end, with a door on the north side. In the case of this building the east wall apparently abutted the rampart itself, at this point partially destroyed, with its facing removed and only the rubble core still standing. This house used partial paving on its floors, set into the usual pinkish plaster. Outside it lay a horseshoe-shaped basin, lined with hydraulic mortar. Traces of two other such basins were found on the site. Their explanation is not certain: possibly they were used for washing, although they might be interpreted as watering troughs for animals. Some of the smaller pits may belong to this phase, but, in general, the larger silos are sealed by walls or layers associated with the domestic use of the site. Finally, the bath building, too, seem to have been abandoned, as later walls cross it at two points. A thin layer of yellow clay seems to separate the use of the baths from the domestic occupation of the site. This may have been due to disastrous flooding: in fact, the orthostats of the west wall of the *frigidarium*, the wall nearest to the Oued Khomane, are sharply tilted to the north, suggesting the violent thrust caused by the torrent.



Fig. 5. The house next to the Roman rampart, c. 900.

The phases of the site both to the north and to the south of the baths seem to be relatively consistent, and the broad outlines of the occupation are clear. The earlier structures consist of a collective granary, a bath complex and, to the south, three very substantial buildings with large courtyards and orthogonal plans. That closest to the baths may have been a public building, as its door, opening directly onto the street, and the high quality of its floors and interior walls seems to suggest. The huge courtyard points in the same direction. It may indeed be a very impoverished version of the *dar al-imarah*, or governor's palace. This would suggest that the mosque is to be found between this building and the rampart. In a subsequent phase, separated, perhaps, by a period of alluvial deposition, all of these structures were replaced by relatively poorer buildings, of a domestic nature.

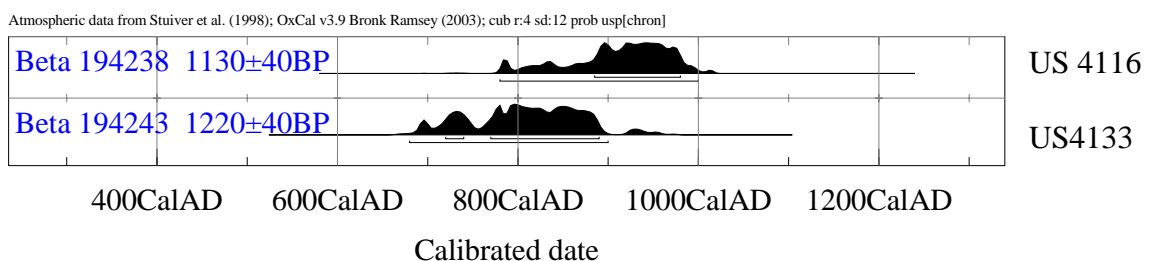
Our knowledge of the chronology of these phases of settlement remains to be confirmed by the study of the pottery and the coins. Most of the coins are pre-Idrisid, but their use could have continued well into the ninth century. Those found by el Khayari under the baths are still under examination: as this is certainly the earliest building on the site its date is key for the interpretation of the rest. The pottery from the earliest layers associated with the courtyard south of the baths is consistent with a late eighth century date, while the latest pottery on the site was found associated with the reoccupation of the southern building, and dates to the eleventh century A.D. A radiocarbon date from a later hearth north of the baths gives AD

763 AD to 829, while one of the early pits is dated AD 790-890.. Our tentative conclusion is that the first occupation of this site dates from the time of Idriss I, in spite of the many residual coins from an earlier period. An interruption, perhaps due to flooding may have occurred some time in the ninth century. The site was reoccupied sometime later by a series of houses, which remained in occupation until the eleventh century. Again, we seem to see a gap in the occupation during the tenth century. All this is still very preliminary, and awaits confirmation from the further study of the pottery and coins.

Archaeobotanical work, 2004

During the 2004 fieldseason, approximately 25 additional archaeobotanical samples were processed through flotation, largely from area B. Laboratory work on this material indicates the dominance of cereal remains, in particular barley and free-threshing wheat. The few preserved rachis remains indicate the presence of durum wheat, although we would assume that bread wheat is also present. In addition the glume wheat emmer is present in lesser amounts. Once again pulses, in particular broad bean and lentils are also present. Grapes and figs are recurrent fruits, with a few olive remains. Of interest is the small presence of apparent rye grains, as this cereal is traditionally rare in Morocco and largely confined to hill regions such as the Atlas mountains, which may suggest that it was being traded to Volubilis. The presence of fish vertebrae in the samples from context 4058 could also indicate an imported food stuff, and trade item, as it must have been salted or otherwise preserved.

Another import is of particular note. Amongst the plant remains from area B are substantial quantities of cotton seed fragments, especially from contexts 4016, 4133 and 4022, which include the secondary fills of the storage pits in the open area that is interpreted as a collective storage area. As cotton is not a traditional cultivar of the Mediterranean zone of Morocco, it is possible that this crop was imported to the site as a raw material. It was perhaps in this part of the site in which the redistribution or purchase of this material was confined, as no remains have been noted yet in samples from area B. Two specimens of cotton were submitted for direct AMS-radiocarbon dating, and produce results that when calibrated fall between the late 8th and the 10th centuries AD.



A couple of other provisional distinctions between the assemblages of areas B and D may also be of interest, although full quantitative remains to be finished. Area D has significantly higher quantities of flax seed, which has only be identified in one sample from Area B. While this probably served as a oilseed crop in addition to use for fibres, it is worth considering that the higher quantities in Area D also related the redistribution of flax as a raw material for textile production, which may have taken place in the area. By contrast olive stone remains are rare in Area D but more common in Area B. This suggests that in Area B olives were a regular item of consumption and may have been part of the domestic economy, whereas those social groups responsible for the remains from Area D may have consumed olives largely as processed oil, if at all.

The next stage of analysis will see the completion of seed identifications and quantitative analysis as well as identification of wood species represented by charcoal. Since firewood is likely to reflect those species which can be readily collected from the immediate environment, this may provide a gauge of the nature of forest and shrub cover on the hills behind Volubilis and along the oued. Botanical survey in the Volubilis landscape indicates that very little native woodland exists in the area. Very few of the evergreen oaks that we would expect to be part of the natural hill flora in the area can be found today, where the lower slopes are covered with planted olives with an admixture of carob, which is probably derived from the natural woodland. Higher slopes often have pine plantations for modern timber extraction. The wood charcoal from samples selected through the sequence at Volubilis will allow us to assess the extent to which the deforestation encountered today was also present at different times in the past during the site's occupation. The state of vegetation on the hills in turn will have affected the extent of erosion and sediment input into the surrounding plains and oued during different periods.

Management Planning, GIS, and Conservation Activities

Management planning (Abdelkader Chergui, Hassan Limane, Gaetano Palumbo)

A study commissioned last year on tourism issues in Volubilis, containing suggestions on routes and itineraries in the Jebel Zerhoun/ Moulay Idriss region was completed by Hassan Limane and Abdelkader Chergui. The study will be included as part of the tourism perspectives in the management planning studies. Another study commissioned to Mohammed Ayad of Mohammed V University in Rabat, a stakeholder and economic analysis of the Volubilis region is not yet completed. The fieldwork consisted in interviews to local administrators and managers, and to local community representatives. The final report will be delivered during the fall of 2004.

The management planning studies however did not proceed as programmed in 2004 given to the fact that it was not possible to organize a management planning meeting between the representatives of the Ministry of Culture and of the Institute of Archaeology of UCL. This stop unfortunately meant that the Ministry proceeded with studies concerning infrastructure development in the administration area without the possibility of an input from UCL. The project presented by architect Tarik Oualalou (commissioned by the Ministry of Culture) was unfortunately not shown to the UCL team, who learned from its existence from independent reports. The UCL team also learned that a tender to Moroccan firms was launched in early September for the demolition of the present administration buildings and the execution of the new project.

As the agreement signed in October 2003 between UCL and the Ministry of Culture involved the collaboration of the two institutions in all issues of management planning including projects for new infrastructure, UCL is presently trying to verify the conditions for collaboration in the matter of management planning.

Walls at Risk database (Matthew Reynolds)

On the last two missions, the main focus of the GIS work was to get in place a GIS for the monitoring of the condition of walls at Volubilis. This aspect of the work is of importance for the ongoing management of the site, and GIS provides an invaluable tool to aid such work, assist prioritisation, and enable the most efficient use of resources for conservation of the site. It will also be the foundation for further research and help in achieving an understanding of the cause of problems and provide guidance for solutions.

The second aim of the monitoring process is for the entire recording system to be used and maintained locally. To this end, two approaches are being taken that should ensure this. The first is to develop a user-friendly recording system, database and GIS that are easily usable and which can be updated and modified locally. The second is to provide training to the Volubilis site staff so that they are able to use these systems.

Recording forms

The recording process consists of two parts, a map and a report form. The map covers all the known walls of Volubilis, and each wall is in the process of being assigned a number. This process began with the work in summer 2003 and, due to the size of the site, is ongoing. The form at present covers all likely issues that might be of concern for the condition of the walls, though it is still at an early stage and it is anticipated that refinements may be necessary as the project proceeds, and already Abdelkader Chergui and Abdessalam Zizouni have made some small changes to the recording process. To date, Abdessalam Zizouni has been able to proceed with the recording process with no problems.

Database

The database for the project is designed to enable all of the data from the forms to be made available in a digital format. The database will be the environment where any non-spatial analysis of data will take place. A true database environment is the easiest, most effective and reliable environment in which to do such analysis. In order to ensure that the records are consistent in terms used, pick-lists are incorporated throughout the database to constrain data to consistent terms used in the monitoring system. A basic version of the database was created in 2003, but in the April 2004 mission it was enhanced. The current version of the database allows data entry in both English and French. The pick-list terms are also completely updateable by the user, so it may now be updated and managed by the Volubilis administration. Training in the use of the database was carried out to a certain extent during the August 2004 mission, and the administrative staff seems at ease with the system.

GIS

The GIS for the project is currently in an ESRI ArcGIS package, though the shapefiles are usable in ESRI's ArcView. The GIS, at present, is focused around the data entry of the monitoring records. To this end, it consists only of a file representing the walls on the site. Each of these walls is in the process of being tagged with the numbers allocated during the monitoring process. The number of the wall is linked to the external database to allow the data from the monitoring process to be available as it is entered. The training of staff to be able to do this is the longest and most difficult aspect of this project, due to conflicting staff obligations. Unfortunately, ArcGIS is not a very user-friendly package to those that are not trained in its use. Therefore, it will take a little time to train the staff to make necessary changes and to ensure that it is being done correctly. So far, Abdelkader Chergui, Abdessalam Zizouni and some of the secretarial staff have been introduced to the process, but more training will be required. The process is not a complicated one, so it is envisaged that this will take not more than around a week of actual training to ensure that it is done correctly.

Future directions

Due to the short duration of the missions, most of the time is spent in actually implementing the systems and person to person training. However, now that the first stage of the system is nearly complete, it is intended to produce a guidebook to the use and maintenance of the database and GIS. This will initially be written in English, but a translation will be provided into French and Arabic. It is also important at this stage to document the system fully in order that new users and developers will be able to modify it.

The aim of the work is to provide a system that is as user-friendly as possible, and to this end, it is recognised that ArcGIS and Access are not the ideal environments for this. A more user-friendly system might be implemented using web-technology. Chloe Jackson of UCL is currently being introduced to the system, and may be able to help in that regard. Such a system will have the added advantage of remote access, maintenance and monitoring. Details of this will be discussed during the fall.

Regarding the use of the GIS, once the digital data is up to date, the system will be ready to show the regions of greatest conservation attention, and it is envisaged that it will be a great help in assisting management decisions. Maps showing vegetation, tourist paths and infrastructures will also show where these may have a negative impact on the ancient ruins. At a smaller scale, each mosaic will be placed on the database and its conservation problems may be interrogated by the user either collectively (e.g. by showing all the mosaics with problems of broken edges) or individually (e.g. by asking the database to show the extent on a certain mosaic of its edge losses). In addition, the monitoring process will be an ongoing one, which over time should begin to show where the rates of degradation are severest. This will prove to be of a great value to the overall maintenance cycles, allowing the administration to address priorities and use its personnel in the most efficient and effective manner.

Conservation

The monitoring of mosaic conditions continued under Abdessalam Zizouni's work, while Mohammed Alilou, site surveyor, developed a methodology for the monitoring of movements in the North-West quarter of Volubilis. His regular monitoring for a year did not show any evidence of continuous movements in the upper slopes of Volubilis. This seems to confirm the idea that the soil movements in that area are resulting from discrete episodes rather than a constant sliding. Monitoring is now continuing to verify the hypothesis.

A collaboration with Prof. Abdelilah Dekayir of Meknes University has generated important information concerning the composition of the mortars of the Islamic hammam. Further work is being carried out to obtain information on the characterization and conservation problems of mosaic tesserae on site. The study will be delivered during late fall 2004.

Finally, a short mission during the month of October is being conducted by Tarik Moujoud, PhD candidate at UCL, to report on the space and conservation needs of the archaeological materials presently in the storerooms of the site. This information will be transmitted to the Ministry of Culture for consideration in the final preparation of plans involving the construction of new facilities.

The Restoration and the *mise en valeur* of the Idrissid hammam (Alaa el Habashi)

The Project

The Idrissid Hammam (bath), the only standing structure that has remains of a roof in the Idrissid district, is sought as a means for representing the existence of an early Islamic settlement outside the city walls of the Roman city of Volubilis. The preservation and the presentation of the Hammam highlights the historic and technological transition that Morocco witnessed during the early ages of Islam (Umayyad, and Idrissid). The conservation of the site also offers a center outside the Roman walls from which the visitors to Volubilis would be introduced to the continuity of urban life in Volubilis up until the end of the 8th century, if not beyond.

The general preservation ideology is detailed in several practical conservation and restoration schemes, each targeting the various architectural spaces of the Hammam with different levels of intervention. While strict conservation approaches were selected for rooms 1 (the room with benches), 2 (the cold basin) and 3 (the vestibule), where almost no walls survived, higher levels of intervention such as filling the gaps, restoration, and reconstruction were adopted in the cases of rooms 4 (the warm room), 5 (the hot basins), and 6 (the heating chamber) where most of the architectural elements either survive or left enough physical evidence to permit us to understand them.

A committee of professionals representing the Moroccan Institute of Patrimony, the Volubilis Conservancy, University College of London, and the World Monuments Fund agreed on the following conservation and restoration measures:

1. Stabilizing and conserving the historic remains of rooms 1, 2, and 3 along with the restoration of the floor slabs of rooms 1 and 3 to facilitate accessibility to the interior spaces of the building;
2. Conserving the remains of the vaults existing in room 4 by consolidating them and reintegrating their structural stability using stainless steel rods;
3. Restoring the collapsed vault of room 5 using light materials on a reversible structure; partially restoring the hypocaust; consolidating and partially restoring the walls and the floors of rooms 4, 5 and 6; restoring the hot basin; and lastly setting the interior spaces for a low traffic of visitors. The plan also includes the design, the implementation and the fixation of a series of information panels, and guiding signs, and proposing a walking trail that leads visitors from within the walls of Volubilis to the site of the Idrissid District.

Works Achieved during previous missions (March 2004)

- Completed a 1/20 architectural survey of all the built surfaces (walls, floors, ceilings and roofs) of the structure, superimposing the conditions and the deterioration procedures that all of these architectural elements are exhibiting.
- Trained students of INSAP to perform survey drawings, to document conditions, and to ink their drawings. The students were also exposed to various preservation philosophical questions and a wide variety of practical conservation issues, and techniques.
- Completed photo-documentation of the state of the building before any intervention using a high-resolution digital photography.
- Sampled the different mortars used in the building of the Hammam, analyzed them in the laboratories of the Geology department of Meknes University, to identify the components and their ratios in the mix of each mortar.
- Prepared and tested several mixes of mortar using locally available materials in order to design mortars that are compatible with the ones that exist in the Hammam.
- Built a basin protected from rainwater for the preparation of mortars needed for conservation (e.g. slaking the lime, washing and sieving the sand, and preparing the different mortar dry mixes).
- Removed all the vegetations that grew around and within the structures, and cleaned all the dust and debris that accumulated on the surfaces of the walls, and on the various floors of the building. All living and dead plants and their roots were removed. A special care was devoted in the removal of the roots found in the masonry of the walls not to disturb the structural conditions of the structure. In some incidents, a temporary shoring was installed while the removal was taking place in order to assure the stability of the walls.
- Removed wasps nests found in the building.
- Recovered, cleaned, and protected all the fired bricks that were used in the building the hypocaust, and found loose on the floors the building, especially in room No. 5 their possible reintegration in the partial reconstruction of the bath heating system.

- Cleaning, grouting, filling, and re-pointing the interior walls of room 5.

Tasks accomplished during Jul.-Aug. 2004

It was agreed that during the mission of Jul.-Aug. 2004 that the following tasks would be undertaken:

Completing masonry grouting, deep filling of joints, and re-pointing,
Rebuilding missing masonry in areas of structural defects,
Partially reconstructing the northern and southern walls of room 5,
Restoration of the vault of room 5 using a light and reversible roofing system.

In order to tackle those tasks, the following materials were purchased, and prepared:

- **Lime**

A truck load of quick lime (1000 KG) was purchased and transferred to Volubilis. Only half the quantity was hydrated in the material preparation basin. The lime, which is of a good quality with a very low percentage of rocks, was then slaked, sieved through fine sieves and prepared for use.

- **Sand**

A truck load of Mussawa sand (3 m³) was purchased. Mortar tests indicated that Mussawa sand is the best available in the area of Volubilis, as its salt contents is relatively low. The colour of Mussawa sand also matches the colour of the historic mortars that exist in the Idrissid Hammam. The sand was then sieved into two categories: the fine which was sieved through a 0.5 mm sieve, and the coarse sieved through a 5mm sieve. The two categories were spread into different compartments in the lower section of the material preparation basin. Sieved sands were then washed several times in order to lower their salt contents, and to separate all organic materials from it. The drying process takes two to three sunny days, a duration that should be considered in the process of the work to avoid shortage during the work.

- **Crushed limestone**

Crushed limestone was purchased in bags from the construction material store at Meknes. It is locally known by "*Chamot*." It comes in 50 KG bags. The crushed limestone is sieved through 1mm sieve. The fine grains are used in the grout and the re-pointing, and the coarse grains are used as charges for the finish hydraulic mortar that protects the vault.

- **Bentonite**

Bentonite is locally known as "*brique refractaire*." It is available at the construction material store at Meknes. The fine particles of the bentonite is used as an additive for the grout mortar to increase its fluidity in order to achieve maximum intrusion into the interconnected voids of the walls to be grouted. It also reduces the shrinkage rate of the grout mortar during its setting.

- **Fly ash**

Locally known as "*ramad*," and it is usually collected from the ovens of local bakery or functioning baths. The ash used in our operations comes in sacs from a bakery in Moulay Idriss. It is necessary to inform the workers of the oven a day before collecting the ash so that they would reserve it and pack it. The oven does not usually operate in the weekend. The ash is then sieved through a 1mm sieve in order to prepare it for the mix.

- **Wood**

A wide variety of local and imported soft and hard woods is available in the market in Meknes and in the vicinity of Moulay Idriss. Red wood (*Bois rouge*) is the most popular soft wood that is used in construction and in the making of doors and windows in modern buildings. Cedar wood, grown in the Azrou region is the one locally available hardwood, and is available in several categories according its quality and maximum dimensions. This was selected because it could be replaced in the future, and its light weight, and resistance to compression make it ideal for the purpose. It also has a natural resistance against termites, and, if maintained well, can

survive for long time. It was decided to treat all the exposed surfaces of the wooden pieces of the vaulted frames with bee wax dissolved in turpentine.

- Reeds

Reed, locally known as “*qasab*,” grows along the creek that runs on the southern and western side of Volubilis. The reed is usually harvested at the end of the rainy season, and left to dry during the summer time. It is traditionally used in several construction activities, the most common of which in the area of Zarhoun is in fencing. It is also used for weaving mats to cover sheds in front of shops. Weaving reeds is so traditionally rooted that almost most of the workers involved in the building construction knew how to do it. There are also specialists, locally known as “*qassab*.” Reed mats were selected to cover the structural wooden vaulted frames, as they are light, and, if intricately woven, sufficiently flexible for the profile sought for the vault of the Hammam. Since it is a traditionally rooted craft, reed mats can be reproduce in the future if necessary. Moreover, mats offer the option of either leaving them exposed internally or covering them with a continuous layer of gypsum plaster. In order to achieve a certain longevity for the material and to prevent termite to attack it, the reeds, after being cleaned and sliced, were submerged for 24 hours in a diluted solution of sulphuric acid. The treated reeds were then washed, dried, and woven into three 5.50 x 2.08 M mats. The dimensions of the mattes were calculated so that they would cover the vaulted structures with at least 10 CM of overlap.



Abdil Nabi, the qassab, weaving one of the three 5.50x2.08 M reed mattes used in covering the newly construction vault (Photo: A. el-Habashi)

- Water

A 150 lt. water tank of 150 litres was left on site. The water needed for construction and conservation purposes were then brought from the creek to the west of the Hammam.

- Limestone blocks

The limestone blocks necessary for the reconstruction of the walls were assembled from the

vicinity of the working site, as those proved to be the most compatible in colour and composition to the one used in the original construction of the monument. Selection was based on size. The blocks selected were relatively smaller than the ones existing in the wall so that they could be easily distinguished from masonry of the existing walls. All the blocks were cleaned before use.

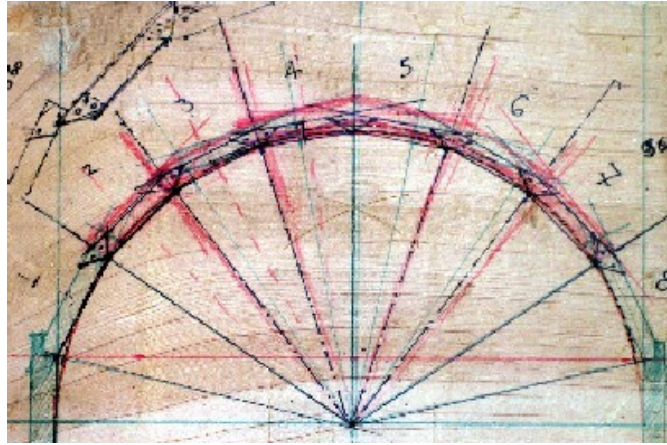
- **Tools and equipment**

Tools and equipment necessary to accomplish the works included one unit of four meters high light steel scaffolding which could be easily assembled and dismantled, dental stainless steel tools used in the filling the walls with mortars and in finishing the re-pointing surfaces. a long hose and a shower head used at the material preparation basin to slake the quick lime and wash the sand, good quality plastic to cover the material preparation basin to prevent rainwater spoiling prepared mixes, trowels, mortar sacs, sieves, spray bottles, sponges, and other necessary tools and equipment Moreover, safety equipment such as hard hats, goggles, latex gloves, and respirators were supplied to the workers to assure their safety.

Consolidating the walls

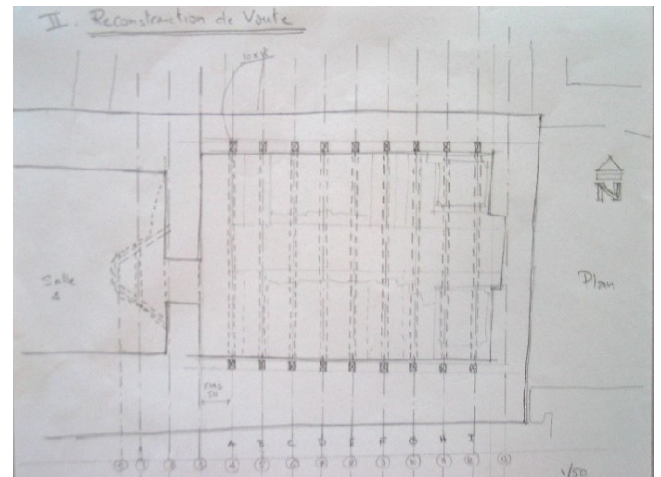
All the standing and the ruined walls of the monuments were consolidated and reinforced externally and internally.¹ Basic steps were followed on both the interior and the exterior faces of the walls. The first is to clean the walls section by section from all the accumulated debris, to remove all intruding vegetation or living insects, and to clear as much as possible the dust and the clay that filled the joints, the original lime mortar used in the construction. In most cases the original lime mortar used in the construction was reached at about 4 to 6 CMS deep into the joints. In few areas of the walls, especially the lowermost courses where the highest contact with water and other weathering parameters, the mortar had totally disintegrated and was replaced with an accumulation of debris, clay, and insect nest, reptiles and empty snail shells. In areas where the deep cleaning affected the stability of the masonry units, the masonry was either cleaned to a maximum depth of 10 to 15 CMS, a sufficient depth to fill with new mortar and to reintegrate the structural integrity of the wall, or dismantled to reach behind the masonry units, which were then rebuilt into their exact position after filling the void with the new mortar. In areas where the voids in the walls were interconnected and difficult to reach they were grouted with a lime mortar of sand: lime : stone dust (*chamot*) : ash : bentonite (3:2:1/2:1/2:1/4). These areas were mostly located in the topmost courses of the existing walls. If the voids in the walls were shallow, there were deep filled with a lime-based mortar of sand : lime : stone dust (*chamot*) : ash (3:2:1/2:1/2). In areas where the walls experienced partial collapses that could affect its structural stability (e.g. the exterior of the southern façade of room 4), a reconstruction was sought using compatible type of limestone blocks, but smaller in size in order to be distinguished from the original construction. All reconstructed areas were recessed from the original planes of the walls for the purpose of identification. All the walls were then re-pointed using a mortar similar to the one used in the deep filling but with finer particles of sand. The re-pointing was dressed with dental tools to be recessed at least 1 CM from the exterior plane of the masonry blocks. Vault Reconstruction

¹ The interior of room 4 are not yet completed as the space of room 4 was used as an on-site workshop for the carpenter to make the wooden frames of the newly reconstructed vault of room 5.



Drawing of the design of the wooden frames as modified on site to suite the exact dimensions of room 5 and to follow the profile of the existing vault in room 4 (A. el-Habashi)

As agreed in the work plan, a lightweight vault is to be reconstructed over room 5, and extended to join with the eastern side of the existing vault in room 4. In order to achieve this, nine structural wooden frames were designed in such a manner that they would rest on wooden posts (8x15 CMS in section), supported by a leveled area of the ruined walls. In areas where the remains of the vault still exist, a wooden seat fixed on top of these received the wooden vaulted frames. No wall reconstruction were sought to even the posts heights. Each of the posts, therefore, was tailored exactly to fit into its designed position. Minimum leveling using crushed bricks and lime mortar was enough to provide the seats required for the posts. The profile of the ruined walls is, therefore, conserved in order to emphasize on the fact that the new roof is a new intervention that is totally reversible.



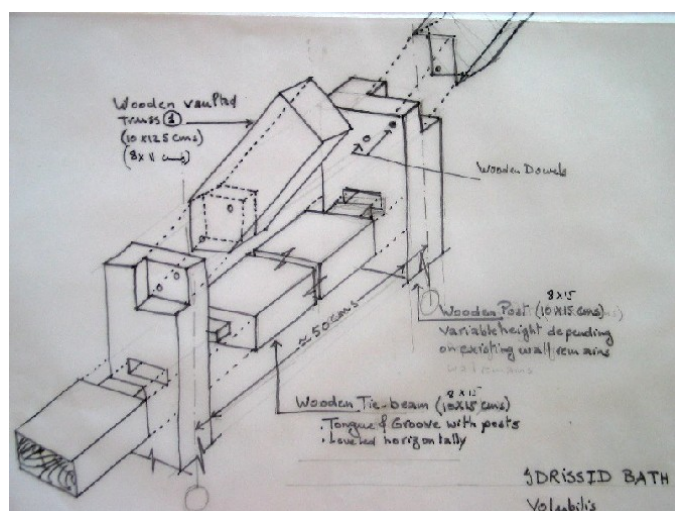
Left: The carpenter and his assistant fixing the posts directly on the ruined walls. Note the different height of the posts to compensate the uneven profile of the ruined walls (A. el-Habashi);

Right: the plan of room 5 with the design of the nine vaulted wooden frames (A. el-Habashi)

It should be emphasized the frames rest on the walls without any means of fixing them. It is only the weight of the frames along with its covering roof that is keeping it in place. Two tie beams fix the top of the arched frames to the top of the wall that separate rooms 4 and 5. The purpose of these is to prevent any horizontal displacement of the frames. The span between the axes of the frames is 50 cm., so that the frames provide sufficient support for the covering mats and the layer of roofing mortar above without any bowing or deflection of the woven reeds.

Assembling joints are designed in such a way that two consecutive members are dovetailed to sustain the compression forces exerted onto them without the use of nails. Wooden dowels were used to assure the stability of the joints and to fix them in their particular spatial position.² Each wooden arched frame consists of eight wooden members that are dovetailed to each other and to the two extremities to the wooden posts. The assemblage of the arched frames is quite easy and takes few minutes if all the joints are well prepared.

After the construction of the nine arched frames, the reed mats were laid on top and fixed onto the frames with temporary fixing ties.³ The mats sat on the southern wall of room 5 and on a temporary wooden beam that marks the northern ends of the exterior of the vault profile. The reason for using a temporary beam at the northern side of the wall was to avoid reconstructing the northern wall to reach the level of the vault. If the committee members agree, the temporary wooden beam will be replaced with a permanent wooden ledger that will be fixed directly to the posts that are newly placed on the northern wall of the room.



Left: Design of assemblage joints between posts, wooden tie, and frame members (by A. el-Habashi);
Right: the erection of the first wooden frame at the west of room 5.⁴

The fixed mats were plastered over from the exterior only. It was necessary to first closing all the gaps between the woven reeds with a very thin layer of gypsum, applied as a thick paste by hand. The reason for using the gypsum is to prevent the water content of the roof mortar from infiltrating through the gaps and the pores of the reeds and reaching the wooden frames, causing water damages. The exterior was then plastered over the reed mats with a lime based hydraulic mortar that consists of fine sand : coarse sand: lime : crushed stone : ash (2:1:2:1:2). The finished surface of the plaster is well worked out to prevent the appearance of shrinkage cracking.

² It should be noted that a total of 486 dowels were made for the construction of the nine arched frames and their posts. All of these dowels were drilled manually because no electricity is available on site. It was, therefore, a time consuming operation.

³ At the end of the mission, only two mats are fixed in their places, and the third is still on the ground. To prevent any rainwater from reaching the wooden frames the area of the third mat is temporarily covered with a plastic cover until its permanent fixation and plastering.

⁴ All the nine arched frames were completed by the end of the mission, and mostly covered with reed mats. All the process was photo-documented, and the photographs were saved in the mission computer. There was no time before my departure to have a copy of these photographs on a CD, and that is why this report lacks a photograph of the status of the monument as it was left at the end of the mission.

Tasks to be undertaken before the start of the rainy season

It is important to complete the following tasks before the rainy season in order to prevent rainwater from reaching the wooden frames and damaging them:

- 1) Fix the third reed mat in place
- 2) Decide on either re-constructing the northern wall of room 5, or leaving it as is.
- 3) If the decision is to leave the northern wall as is, the temporary wooden beam should be removed and replaced with a permanent support fixed to the nine northern posts.
- 4) Plaster over the third mat, and finishing up the plaster of the entire new roof, designing roof conduits into the thickness of the plaster that would discharge water directly away from the exterior of the walls.
- 5) Apply a second layer of beeswax dissolved on turpentine on the surface of the newly constructed wooden elements.