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INTRODUCTION

i. OVERVIEW

After the summer break, the activity in Hatra resumed in September (SBAH supervision). The positive context in which we have worked is briefly described in the first part of the report (Security, Social impact and Communication). In October, field training activities were carried out as detailed in section "Project implementation". In general, we can say that also this new phase of the Hatra project was quite successful.

Mission members actively working in the field:

Adib Fateh Alì (Project Manager and logistic)
Massimo Vidale (Project Co-Director, Trainer on Conservation)
Stefano Campana (Project Co-Director, Trainer on Geomatic technologies applied to cultural heritage)
Ala Anbaki (Iraqi Coordinator)
Rwaed Mufak Mohammed (Iraqi Chief Consultant)
Matteo Sordini (Topographer, laser scanner)
Ken Saito (Topographer, laser scanner)
Stefania Berlioz (Archaeologist)
Mahmood A. Wardi (Trainee in "Practical conservation activities on the Temple of Allat")
Aymen Jasim Mohammed (Trainee in "Practical conservation activities on the Temple of Allat")
Salih Jasim Mohammed (Trainee in "Practical conservation activities on the Temple of Allat")
Wahtban Ali Mohammed (Trainee in "Practical conservation activities on the Temple of Allat")
Omar Khalil Ibrahim (Trainee on "Geomatic technologies applied to cultural heritage: terrestrial and drone-based photogrammetry, laser scanning and GIS")
Alì Abdulamir Abbas (Trainee in "Geomatic technologies applied to cultural heritage: terrestrial and drone-based photogrammetry, laser scanning and GIS")

ii. SECURITY

No security problems have been reported in recent months. Currently there are 5,000 units (National Army and Popular Mobilization Forces) guarding the desert area and the main communication roads in Al-Hadr district. The defense has been further enhanced with the placement of the latest generation of infrared cameras.

The security of the archaeological site was implemented with the closure of the second monumental entrance of the central *Temenos* (Figs- 1-2) and the placement of cabins for the use of the police forces (Figs. 00-00); a fixed masonry post overlooking the entire extension of the site (300 ha) was built on the roof of the Archaeological Police house.

Fig. 1: Central Temenos, eastern wall of the enclosure with the two monumental entrances.

Figs. 2-3: Detail of the northern entrance partially walled and (3) after the assembly of the iron gate.

Fig. 4: Positioning a cabin for the police guards at the main entrance of the central Temenos.

iii. SOCIAL IMPACT

During this year, and in a more intensive and systematic way between September and October, we have established fruitful contacts with Ali Al Makzoumy, one of the major Iraqi tour-operators that promotes cultural tourism and adventure travel in Iraq (https://www.facebook.com/BilWeekend/, more than 58.000 users follow this page). Here one can find the Facebook and Instagram page of the Iraqi travel agency with which we are in contact (we had two meetings via zoom with the owner of the agency: participants were Mr. Ali al Makzoumy, Mr. Rwaed, Adib Fateh Ali and the Sheikh Harrush). With this active operator, also known to the direction of the SBAH in Baghdad, we have already collaborated in the past months by offering facilities for at least three visits to the site of Hatra: two of individual European tourists and one with the participation of 12 tourists mostly European, especially British since Ali Al Makzoumy also lives in Great Britain.

The idea, at present, is to organize weekly visits (potentially, for groups up to 50 Iraqi visitors) for a weekend in the site of Hatra. In this light, we are organizing a project in collaboration and with the active participation of Sheikh Hannush who is also willing to invest his personal money to involve local labor. The main steps of this project can be listed as follows:

- to establish a local working group composed of tour guides, who will provide logistics and organization of weekly tours;
- to identify an area within the large perimeter of the site to install temporary structures for the overnight stay of tourists: tents, cabins, toilets and whatever else might be necessary;
- to organize various activities for tourists during their stay in Hatra, such as:
- to organize excursions within the site, even at night (trekking and visits), and (following)
- traditional dinners and lunches in the camp of the tents;
- performances and events managed by local communities with Arabian horses and camels;
- investing in various ways on the social, economic aspect of the initiative, that however will require a financial intervention of support in order to start it (in particular in the perspective to bring back European tourists). In this perspective, we ha discussed the possibility of restructuring and protecting

an existing tourist receptive structure, at present completely abandoned, but with a noticeable potential attractivity.

Figs. 5-6: Tour groups in Hatra (from United Kingdom, Belgium, and - below - Italy).

iv. COMMUNICATION AND VISIBILITY

ROAD AND TOURIST SIGNS

We have made the necessary road signs along the Mosul- Baghdad Road that will alert travelers to the detour to the World Heritage Site of Hatra. These road signs will be placed in their place in February. Finally, we also made the signs - very similar to the originals that disappeared or damaged during the recent war events - that will indicate to visitors to the site the names of all the main buildings in the central *Temenos*.

Figs. 7- 9: Examples of road and tourist signs.

FROM HTRA TO THE IRAQ MUSEUM OF BAGHDAD: THE CAST OF THE FRIEZE OF ALLAT

Furthermore, we are currently exploring the possibility of making a cast of the main high relief found by Iraqi archaeologists during the dig of the temple of Allat (plus multimedia products and panels). The relief shows the Arab pre-islamic goddess welcomed in Hatra while riding a dromedary, in a highly ceremonial setting. The cast, to be made in partnership with the staff of the Iraq Museum of Baghdad, is made necessary by the following two reasons: first, because its present state of conservation is precarious, after recent damages caused by DAESH occupation. This important historical witness also suffered from decades of storage in unsatisfactory conditions, during which it developed detachments and new cracks, while the iron fittings of the original restoration were bent and partially corroded. Second, because the cast could be taken to the Iraq Museum in Baghdad. Here it is presently kept another important sculptural frieze (the so-called "Musicians' frieze") found in 1974 in the ruins of the same temple is stored (see photo 00). In this way, the two reliefs - the arrival of the goddess on the back of a dromedary, through the Syrian desert, and the Musicians cortege - will finally be visible together in a new musealization. At the same time, we are also considering the pratical possibility of relocating the two friezes in their original context, the ruins of the Temple of Allat itself, thus enriching the turistic fruition of the site.

Fig. 10: The figured frieze of Allat after the cleaning and the first emergency restoration.

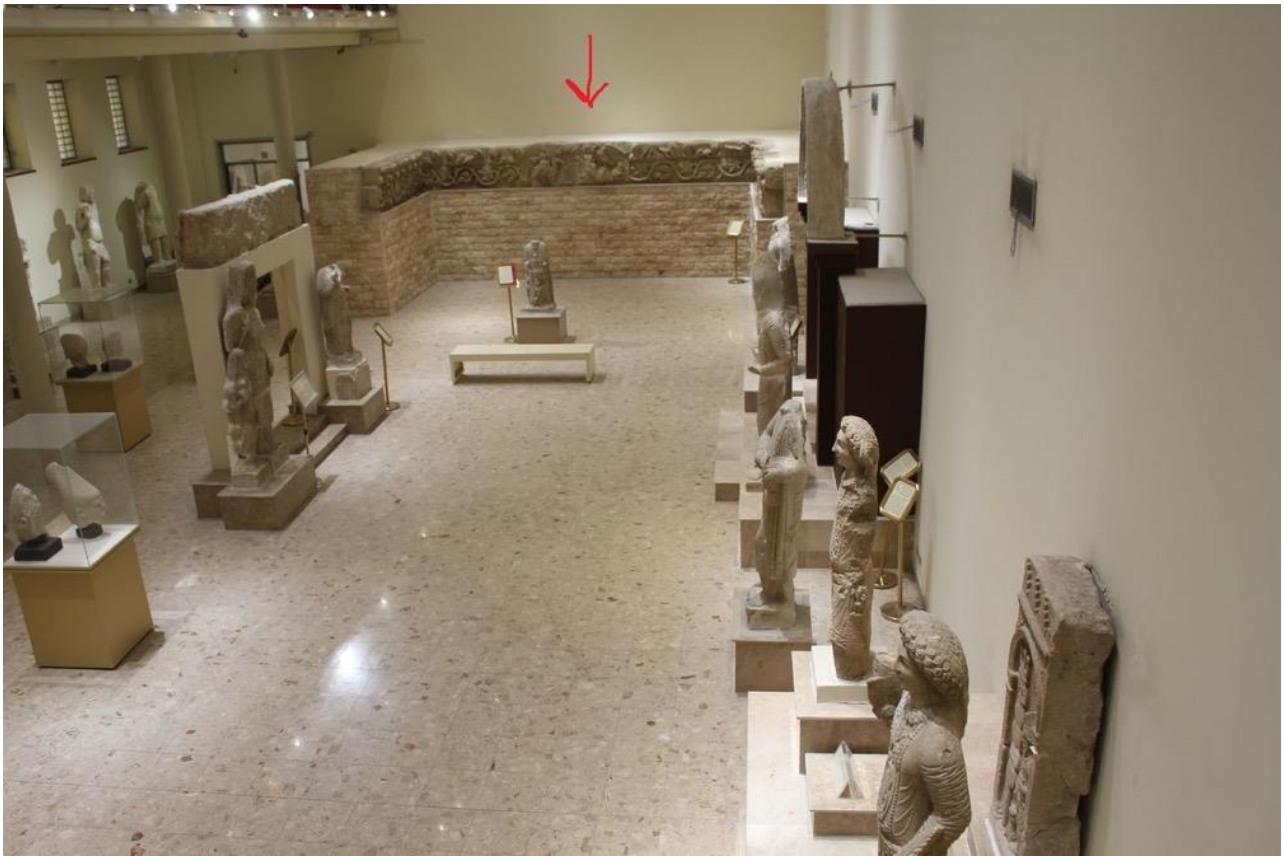


Fig. 11: Iraq Museum, The Parthian gallery. The red arrow points to the location of the so-called "Musicians' frieze" found in the Temple of Allat in 1974.

FOLDING TOURIST BROCHURE AND MULTIMEDIA MATERIALS

At present, there is no way for tourists to get basic information on the history of the site and its architectural heritage while walking among the ruins. As a preliminary strep, we have prepared a simple foldable leaflet, in three different languages (arabic, english, chinese) which will inform vistors on the chronoloy of the site and its historical events, and a simple map to follow, with the location and the names of the principal constructions. At

the same time, we are also busy in the production of multimedia material on the various activities of the project, to be published online in various forms and sites, including the Project's platform "savinghatra" (see above).

ZENODO AND SAVINGHATRA WEBSITE

In order to share the results of the project with the international scientific community, the data related to Hatra (orthophotos, DSM, other topographic and architectural information) will soon be published in www.zenodo.org an open-access repository developed under the European OpenAIRE program and operated by CERN. This platform allows researchers to deposit research papers, data sets, research software, reports, and any other research related digital artifacts. The same procedure had been followed for the results of the team's Nineveh project (2018): https://zenodo.org/record/5731520#.YaJig9aZqs

Immediately after the end of the field activities, back in Italy, we started the implementation of the website www.savinghatra.org

PROJECT TIMPLEMENTATION

I. RESTORATION OF THE HATRA EXPEDITION RESIDENCE (Activity 1)

In the fall, the following activities were conducted, aimed at improving the hospitality potential of the local infrastructures and granting immediate improvements in the local conditions of living and working:

- installation of a heating/air conditioning system in the main hall of the house, the most important common work and meeting place of the compound;
- installation of a console for instrumentation (always in the main hall);

Fig. 12: Heating/air conditioning system.

Fig. 13: HER, main hall, console assembly.

- restoration of the garden fence wall and rebuilding of the access door to the courtyard in front of the laboratory;
- restoration of a pre-existing but abandoned vegetables orchard in front of the restored Police Station, and its protection by the means of an iron wire fence;
- reactivation of the irrigation system, fed from the ancient tanks and wells of Hatra's sanctuary, for irrigation of the restored garden and the vegetable orchard (fig. 00-00)
- for the laboratory, building new shelves for equipment and storage of sculptural and architectural fragments from the area of the Great Iwans Complex and the Temple of the Triad.

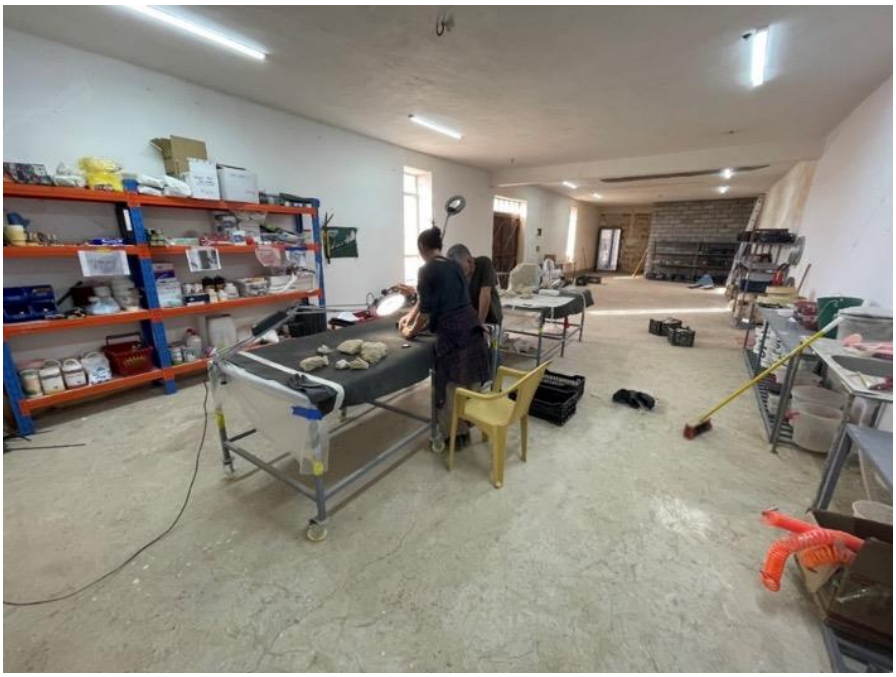


Fig. 14: The restoration lab with the new shelving.

Fig. 15: Restoration of the garden fence wall and rebuilding of the access door to the Lab courtyard.

2. RESTORATION OF ARTIFACTS VANDALIZED BY DAESH (Activity 2)

During the October field campaign, two main activities were carried out under the supervision of S. Berlioz:

- cleaning of the fragments found in the monumental sector of the central Temenos of Hatra (February 2020 - June 2021);
- identification of the pieces and their ordered storage in the laboratory.

Fig. 16: Students cleaning a segment of an arch.

Fig. 16: Identification of the pieces found in the Great Iwans Complex.

Figs. 17- 18: Storage of the sculpted fragments in the laboratory.

GREAT IWAN COMPLEX: REOPENING AND SURVEYING OF ROOMS 8, 10 AND 10a.

In 2003, on the eve of the outbreak of the Second Gulf War, most of the sculptures and fragments on display in the central Temenos of Hatra (fig. 00-00) were deposited inside three cells of the complex of the Great Iwans, immediately walled up in order to prevent theft and damage. These rooms remained closed due to lack of resources at the site.

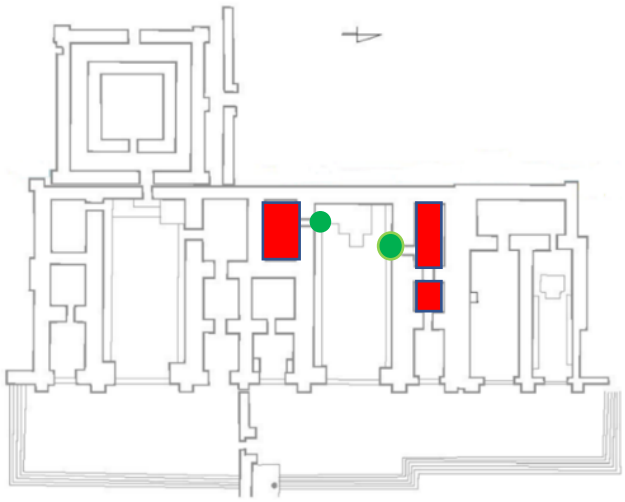
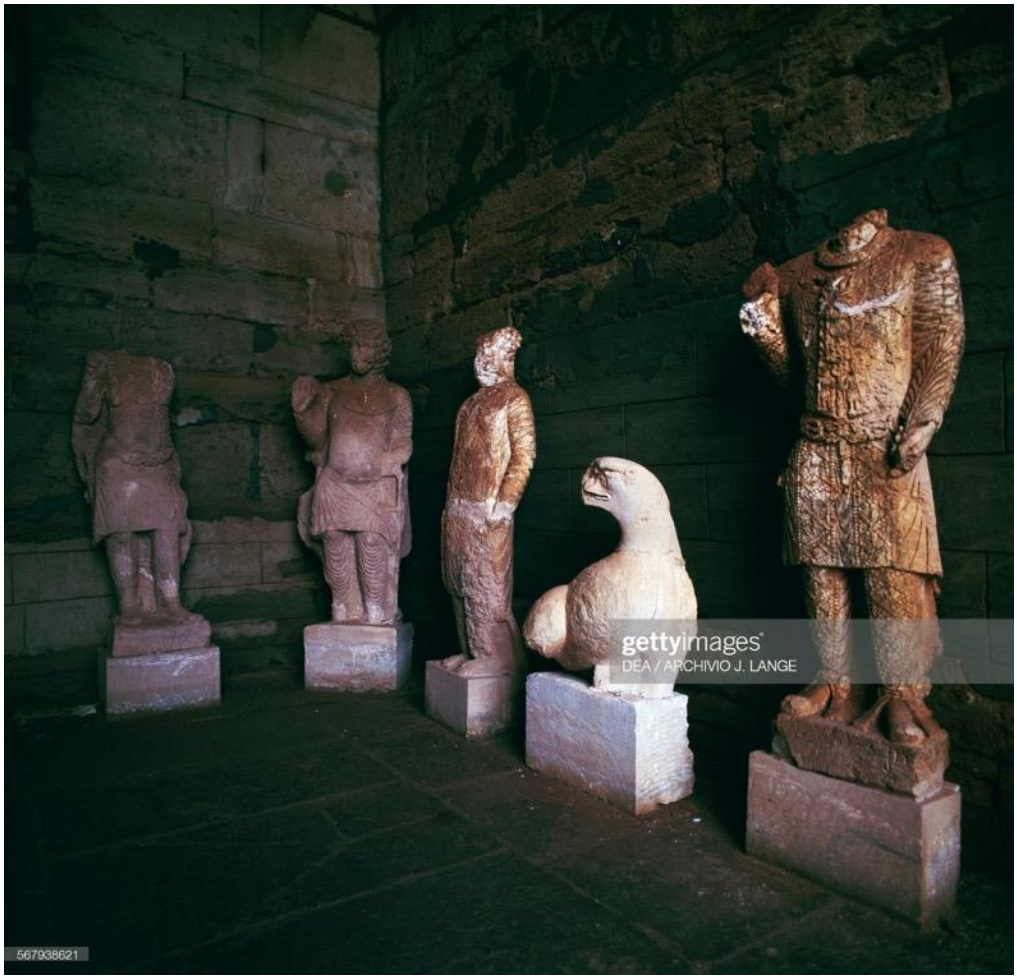


Fig. 19: The Great Iwan Complex: in red the halls (8, 10, and 10a) used by the SBAH from 2003 as a deposit for sculptures. The points in green indicate the location of the new iron gates.

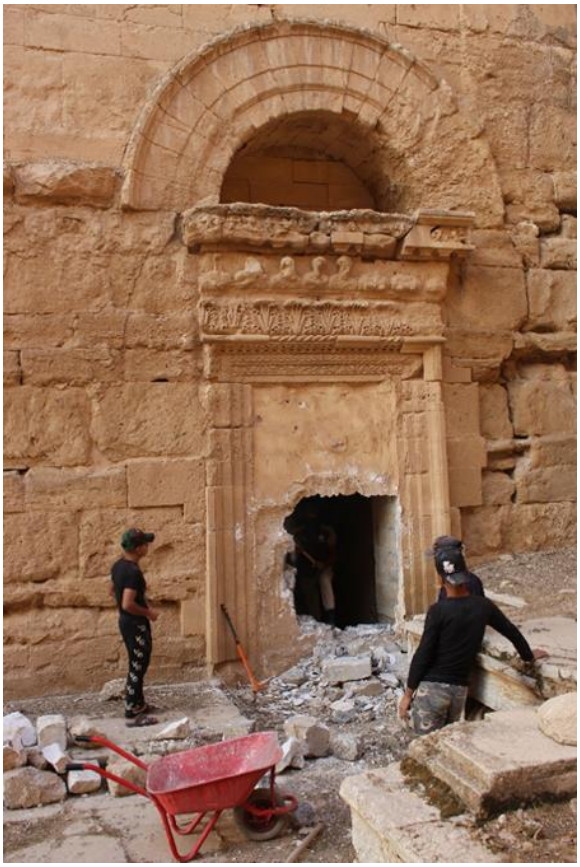
Fig. 20: Sculptures on display in the Great Iwan Complex in an archive photo (Getty Image).

Fig. 21- 22: Sculptures on display in the Great Iwans Complex in archive photos (Getty Image).



During the ISIS occupation, the walled rooms were broken in and the contents severely vandalized. The material was documented photographically, and the entrances closed with iron gates. The keys have been handed over to the Director of the archaeological site and the command of the Archaeological Police. In February the pieces will be catalogued and a recovery plan drawn up.

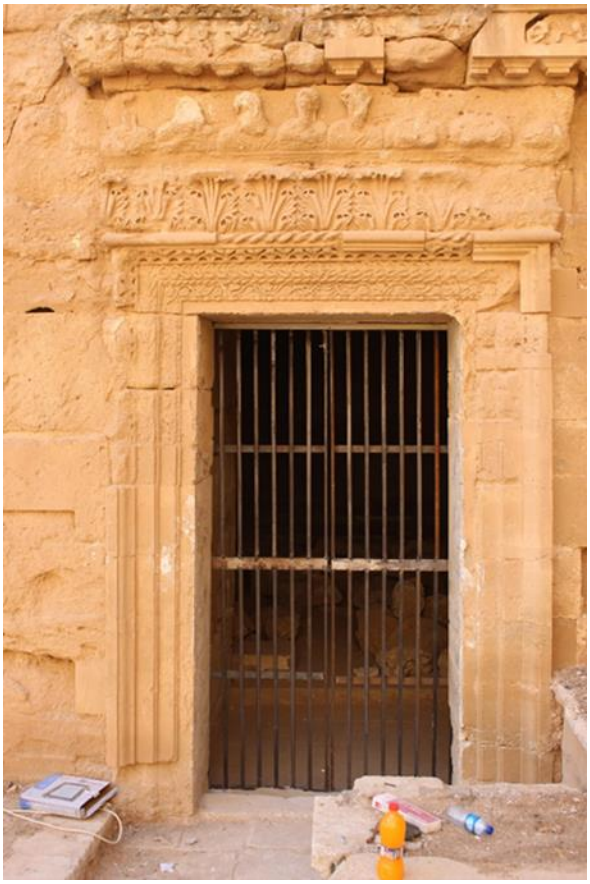
Fig. 23: Great Iwans Complex, North Iwan with the two entrances to halls 8 (on the left) and 10 (on the right).

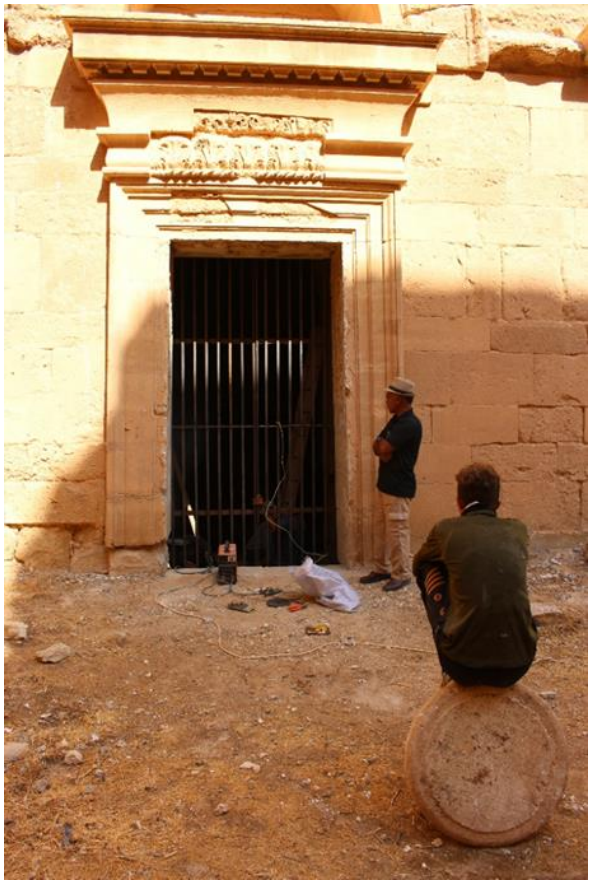


Figs. 24- 25: The opening of the entrance to room 8.

Figs. 30- 32: The opening of the entrance to room 10. Below the detail of the carved panel that decorates the architrave.

Figs. 37- 39: Installation of iron gates to close the hall 8 (on the left) and 10 (on the right).





3. CONSERVATION OF THE TEMPLE OF ALLAT (Activity 3)

The Temple of Allat was the subject of further conservation activities during the last two weeks of October, under the supervision of M. Vidale. The floors of the three iwans of the Temple were finally cleaned of a few grass patches and isolated bushed that had regrown on the alabaster floors after the last cleaning operations. Next, all the cleaned alabaster/gypsum floors and parts of the floors where the alabaster slabs had been removed and only earth was left were covered with non-woven black fabrics, and in turn covered with a 20 cm layer of coarse black sand from the nearby river beds.

Fig. 40: Temple of Allat, view of the central iwan during intervention.

The entrances to the Temple's iwans were temporarily sealed with removable light iron frames and nets, not visible from distance, in order to prevent animals to enter and disturb such protective floors layers. The final effect is of this provisional solution is aesthetically pleasant, but this is not certainly a final solution. In the next visits to the Temple, we should be able to record how far such provisional protection does relent the growth of vegetal organisms, and how fast and how deep it will deteriorate.

In the same contingency, on the damaged and eroded surfaces of two altars of Allat's iwans we prepared a set of a dozen protective patches of mortar (with two different recipies: cement-sand-lime and cement-sand fine clay) in order to test their relative strength, resistence to seasonal weathering and chromatic variations - for the moment - in the winter months (October to February).

Figs. 41- 42: Temple of Allat, the central iwan after intervention.

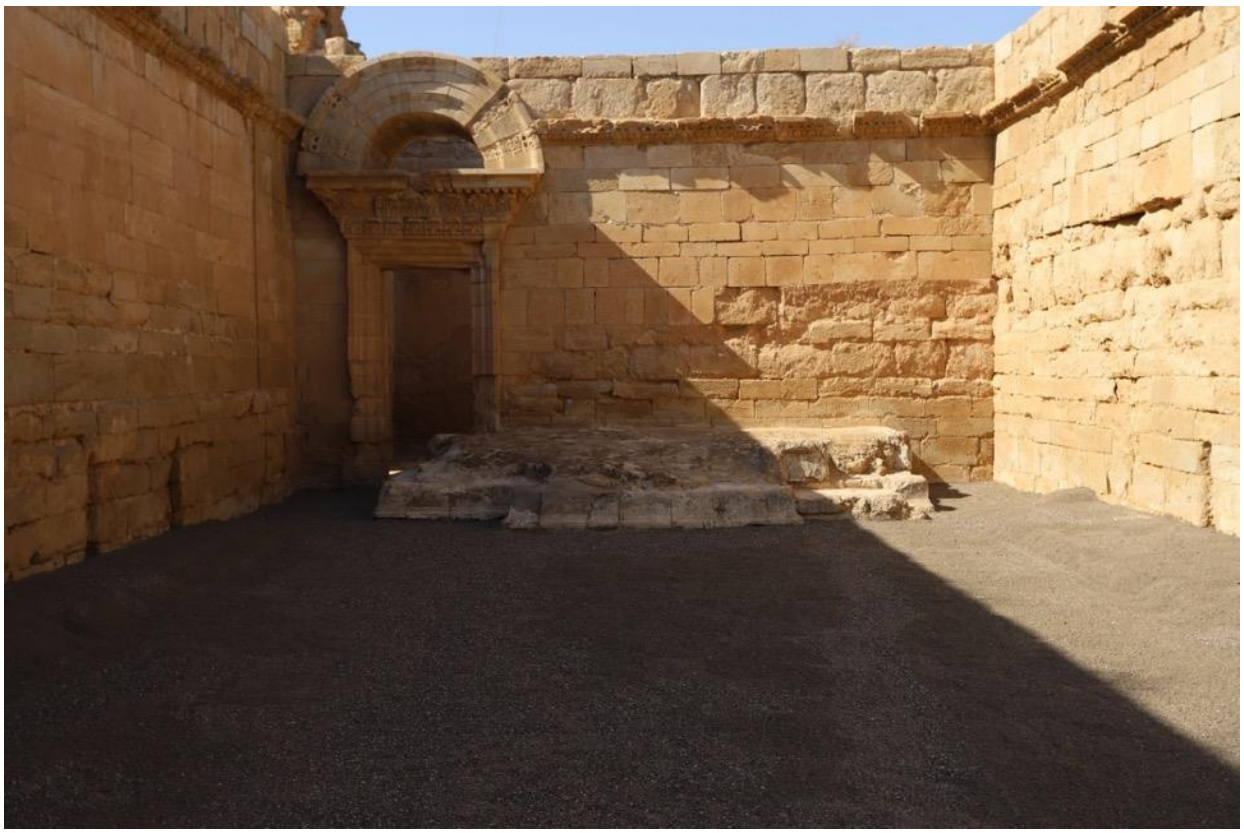


Fig. 43: Temple of Allat, central iwan with the entrance sealed with removable light iron frames and nets.

Fig. 44: Temple of Allat, altar of the central iwan. Students preparing protective patches of mortar.

4. DOCUMENTATION/ DISSEMINATION (ACTIVITY 4)

The survey of the Hatra *Temenos* has been carried out by leading-edge methodologies and technologies, as terrestrial laser scanning, drone-based and terrestrial photogrammetry. Geographic positioning of all the measurements has been achieved through the implementation of a topographic network surveyed by differential Global Navigation Satellite System (GNSS). The integrated survey - laser Scanning and photogrammetry – allowed us to record an extremely accurate 3D model of the temenos including all the monuments. The 3D model represents the primary source of information to implement the analysis of the state of the art including ISIS damage but also the natural deterioration of the monuments and structural problems.

The first step of the field survey was aimed to build a topographic network based on geographic coordinates. As first instance we designed a topographical framework of the site by placing and processing topographic landmarks. The network was aimed to be used as reference for all - present and future - topographic survey activities within the site. After the placement of the landmarks in the ground (by drilling stones and screwing a screw into the stone), measurements have been carried out by GNSS. The survey has been implemented by setting RTK GNSS base and rover. The coordinates of the base station have been calculated by static 24 hours measurement of the vertex. The base acts like a remote base station which you can setup to receive RTCM correction data from. The other landmarks have been measured by the rover connected via UHF radio to the base station. All the reference points have been collected in WGS84 and turned in to the projected reference system UTM38N (EPSG:32638). For each vertex has been created a precise documentation with coordinates and location.

Fig. 45: Setting and measurement session of the GNSS base station and rover system.

Figs. 46-47: Landmark record.

Laser scanning survey has been carried out by Faro Focus Laser Scanner (Image 1). This device is able to scan objects from short range up to wide range (to a maximum of 350 m) with High Dynamic Range (HDR) photo overlay. Data acquisition by laser scanner at Hatra was proceeded in October 2021. Data acquisition was implemented in 11 days (06/10 – 16/10). Within 11 working days we collected 843 scan stations entirely covereing the area of the temenos of Hatra, including both exterior and interior of any building and the defensive walls. The planning of the scans has been scheduled in order to minimize the number of occlusions present in the resulting point cloud and guarantee required resolution and comprehensiveness.

Furthermore, the digital camera integrated within the laser scanner allowed the acquisition of the texture, any pixel is associated with the related x, y, z point feature, obtaining a colored point cloud. The resulting point clouds have been processed by Leica Cyclone software in order to clean the point cloud from useless features and to register all scans in a single-global point cloud.

The Hatra complex is characterized by a high level of geometrical complexity: to carry out a global 3D survey of the surfaces of the buildings the laser scanning survey has been integrated with 3D acquisition techniques based on terrestrial and drone photogrammetric systems. The integration between active and passive sensors allowed us to perform the 3D survey in almost any measuring condition, in order to complete, where necessary, the missing information within the laser global point cloud of the Temenos. Furthermore, the images have been processed to obtain the Ortho-photos. Drone survey has been implemented according to domestic rules of Iraq Civil Aviation Administration: flight operations has been carried out by a certified pilot authorized to flight over critical areas, expert in landscape and cultural heritage survey. Flight operations has been performed at maximum height of 60 meters AGL (Above ground level) and in VLOS (Visual Line of Sight) at maximum 200 meters from the pilot. The drone survey has been carried out choosing a consistent height AGL aimed to obtain a ground resolution between 3- and 5-mm pixel, consistent with the resolution of the laser scanning survey described before.

Fig. 48- 49: Laser scanning activity from the roof of the Great Iwans Complex.

Fig. 50: Point cloud of the whole scanned area of the central Temenos.

The flight plan has been adjusted according to the heights of buildings in order to keep a constant distance between the sensor and the surveyed surface. The flights have been planned according to the standard photogrammetric acquisition pipeline, recording regular strips of vertical images with 80%-90% of forward overlap and 60% of side overlap. A second flight plan has been executed in orthogonal direction respect the previous one, to obtain cross grid images useful to minimize eventual shadow areas due the building elevations. The nadiral flights has been integrated with oblique flights in order to acquire the elevations of whole complex. The image acquisition has been carried out by automatic or manual flight. In case of manual flights, the pilot used the collision sensors to keep a constant distance between the optic sensor and the surfaces. Flight path followed horizontal regular strips to acquire images with 80%-90% of forward overlap and 60% of side overlap. Terrestrial photogrammetric datasets have been produced by using 35mm DSLR cameras equipped with appropriate lenses to respond in the best way to the environmental conditions of the site. In the preliminary phase the camera has been set up to consider the native sensitivity of the sensor, selecting the Adobe RGB color space and defining the format for saving images as uncompressed RAW files. During the acquisition has been used the Lastolite color checker to adjust the colorimetry of the RAW files during the post-processing phase.

Image data processing followed the standard photogrammetric pipeline. All image datasets has been aligned in order to calculate internal and external orientation of the camera. Ground control points has been marked a priori in the images in order to refine the alignment and to maximize the accuracy and precision of the datasets. For every dataset has been chosen a appropriate amount of control point extracted from laser point cloud or acquired with Total station. Using a matching algorithm has been generated a point cloud of the measured surfaces that was oriented in the same coordinate system defined during the topographic campaign. The resulting point cloud has been cleaned and merged with the laser dataset.

The data processing is focused to produce a 3D textured model of the Temenos. Furthermore, the 3D point cloud is used to draw a 2D map and sections of the monument, to highlight the actual state and the degradation/structural problems.

5. EMERGENCY INTERVENTIONS

In October, after an urgent, formal request of SBAH, Mosul Office, the following emergency interventions - not foreseen in our original project - were carried out to secure unsafe structures inside the central temenos:

5.1 PROPYLAEA

We had already emphasized, in the previous report, how the original architrave, placed above the modern lintels was almost completely eroded, and the sculpted features erased, and threatened by a passing-through lesion. As already state, in the immediate future it should be removed and substituted with a new stone replica. The entire vault, on the other hand, is damaged by rain seepage and processes of saline efflorescence. For sake of security, and waiting for future decisions, we temporarily supported the damaged architecture with a horizontal wooden plank supported with two vertical scaffolding pipes.

Fig. 51: Propylaea (western façade) during the inspection.

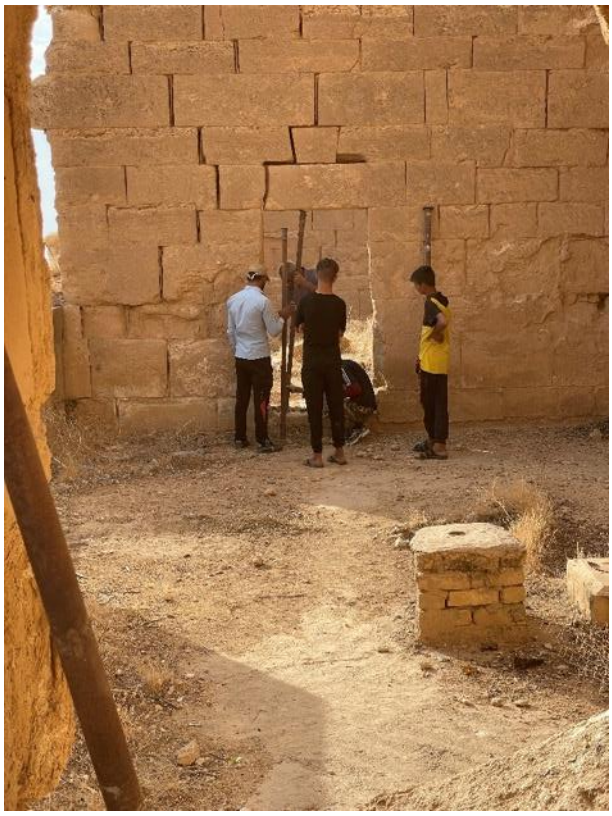
Fig. 52- 53: Eastern and (below) western façades of the lintel.

Figs 54- 55: Propylaea, main door after the emergency intervention.

5.2 GREAT IWANS COMPLEX, SECOND FLOOR

More crumbling lintels can be seen in the doors of some rooms on the second floor of the reconstructed Great Iwans complex. In these cases, as in the access to the Propylaea (see above) the doors have been temporarily fixed by supporting the lintels themselves with scaffolding pipes. Moreover, the accesses to the staircases leading to the second floors of the monumental buildings will be closed because they are dangerous for the visitors who venture to admire the landscape surrounding the archaeological site.

Figs. 56- 59: Crumbling lintel before and after the emergency intervention.



5. 3. CENTRAL TEMENOS, SOUTHERN SIDE

Fig. 60: Central Temenos, detail of the southern side of the enclosure wall, with the areas of intervention: ***1.*** *the room with hemispherical cups;* ***2****. A large room with probable destination of worship, exceptionally accessible from the outside of the enclosure from the road that skirted it to the south.*

In the south-western corner of the main court of the Hatra's urban sanctuary, connected with the porch, in the past was excavated an exceptional square room (the number 1 in fig. 60) whose floor, entirely covered with alabaster rectangular slabs, was surrounded all along the walls by parallelepiped-like blocks made of the same material, on which three continuous rows of hemispherical cups (40 in total) had been excavated. From the bottom of each cup, a lower channel discharged directly onto the room's floor, through an outlet placed in the middle of the face of each block. The function of this special room remains an enigma. After excavation, the room was abandoned in the open, thus gathering aeolian sediments and rain; eventually, abundant grass and bushes grew in the interstices among slabs and blocks, as well as within the cups themselves, with serious consequences for the integrity of this exquisite architecture. The room was entirely cleaned and recorded, waiting for a final decision on the way of protecting and safeguarding its integrity.

Fig. 61: Detail of two hemispherical cups with grass and bushes sinking roots directly into the decayed gypsum features.

Figs. 62- 63: The room during and after excavation/ cleaning.

Other accesses and walls threatened by imminent collapses in the adjacent room (number 2 in fig. 60) were temporarily secured using scaffolding iron pipes and wooden planks.

Fig. 64- 66: Shoring of the unsafe lintels.

A later wall (most probably built in Zengid times), dangerously inclined, has been temporarily supported by scaffolding pipes and a wooden plank. The masonry and building techniques are evidently different and more irregular than those of the original hatrean architecture:

Fig. 67: The later wall supported by scaffolding pipes.