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# Field Report on the 2016 Archaeological Project of the Joint Iran-France Project on Pasargadae and its Surrounding Territory

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## Abstract

This article reports on the 2016 activities of the second campaign of the ongoing Iran-France archaeological project at Pasargadae and its surroundings. The main goal of this project is to reveal and analyze the Achaemenid cityscape and regional management integrated into the long occupation history of the area. In 2016, new insights on the site and its territory were provided by data coming from newly implemented approaches: surface ceramics analyses, aerial survey and remote sensing, and palaeoenvironmental studies. We also extended our large-scale mapping of the site through combined topographic and geophysical survey approaches. The systematic mapping of the archaeological landscape, settlement pattern and funerary remaining around the site was also continued. We also present some preliminary results of pollen and sediment analyses of the filling deposits in the large basin which delaminates the Pasargadae Royal Garden to the southeast.

**Keywords:** Pasargadae, landscape archaeology, field report, Achaemenid, post-Achaemenid, Sassanid/early-Islamic.

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## Goals of the Iran-France Project in the Pasargadae Region: An Overview

This joint article is a report on the main results obtained during the summer and fall campaigns of 2016 of the Iran-France archaeological project at Pasargadae, a city founded by Cyrus the Great around 550 BCE, and its surrounding territory. A report on the first campaign in the Fall of 2015 was published in 2016 in the first volume of the present journal (Gondet *et al.* 2016). The article published in 2016 details the activities and the contributions of the first phase of the Iran-France project carried out at Pasargadae (1999-2009) which provided new insights on the layout of the site (Gondet *et al.* 2016, 62-66) and enabled us to complete the reconstruction of the site drawing on the former excavations and studies (Herzfeld 1929-30; Sami 1956; Stronach 1978). It also deals with the main topics approached in the framework of the present Iran-France project which was resumed in 2015 (Gondet *et al.* 2016, 66-69), and also inevitably with the results obtained in 2015. Thus, in this report, we provide only a short overview of the project's framework and focus on a detailed presentation of the objectives of the year 2016 and the results of the two campaigns which were implemented during this year.

After five campaigns of fieldwork were carried out from 1999 to 2009 (Boucharlat 2003, 2009, 2011; Boucharlat and Benech 2002; Benech *et al.* 2012; Mohammadkhani 2006), we suggest that Pasargadae needs to be seen as a city developed over a wide area, at least 300 ha, following an open and diffused layout. The several Achaemenid royal monuments, them being palaces, pavilions, Tomb of Cyrus, the so-called Zendan-e Soleiman Tower complex, and the so-called Sacred Precinct, as well as the attached settled sectors encompassing the population and their activities were certainly distributed within a large park, i.e. a "paradise", shaped by green areas of different nature: gardens including the central Royal Garden, fields, and also orchards. Pasargadae was conceived by Cyrus as a large re-landscaping project that created an original and lush cityscape, where the garden took a prominent place (Stronach 1990), in contrast to the former examples of cities in the Ancient Near East often seen with a dense and walled urban core. It is more than likely that Darius, some 30 years later, followed the same model to found the city of Persepolis, or Parsa as it is named in the Persepolis Fortification Tablets, that would replace Pasargadae as the main center of Persia province (Askari Chaverdi and Callieri 2012; Askari Chaverdi *et al.* 2013; Boucharlat *et al.* 2012; Talebian 2008).

These assumptions served as the starting point for our current program that is focused on combined and complementary landscape archaeology approaches. The main topics for that phase of the project begun in 2015, around the investigation of Pasargadae and its surrounding territory are: (1) defining the urbanization processes and the layout of the town-plan; (2) outlining the limits of the Pasargadae urban area by mapping the settlement pattern of its nearby territory; (3) documenting the chronological dynamics of the urban and territorial development; (4) analyzing the water management network at the scale of the Pasargadae plain catchment basin; (5) characterizing palaeoenvironmental settings and changes and determining the human impact on these processes. Our final goal for the current project is the overall reconstruction of the ancient city of Pasargadae in the context of its anthropogenic and natural landscape. We focus our studies on the

Achaemenid period but with a look towards the reconstructed territorial dynamics of the *longue durée* to better approach the impact of the foundation of Pasargadae, which should be seen as a rupture from the regional development of earlier periods and which in part steered the occupation patterns of later periods.

### **Framework and Objectives of the 2016 Campaign: Continuity and Changes from 2015**

In 2015, the research of the Iran-France team studied two different scales: the site in and around the protected area of Pasargadae, and the local plain and foothills surrounding the site. During the spring of 2016, we began to broaden our approach to the previous landscape to include a regional scale by starting new palaeoenvironmental and geoarchaeological studies aiming to reconstruct the previous environmental changes and the human impact on them over the Pasargadae watershed. Because the 2016 springtime campaign consisted of preliminary visits and expertise to build the future 2017 fieldwork, this article does not deal with the regional scale. However, the specialists involved in the environmental studies also implemented sediment analysis of soil samples from Pasargadae and the results are reported here. The 2016 campaign continued the work started in 2015 as well as aiming to widen our knowledge of the site and its territory, especially concerning the chronology of the occupation phases and the environmental setting.

At Pasargadae, from 2015, our project aims to continue our 1999-2009 archaeological work based on a wide mapping of the cityscape through the use of combined survey methods, especially geophysical one, complemented by accurate topographical mapping, implemented in and around the protected areas of Pasargadae. During the 2015 and 2016 season, we extended the areas surveyed with the same geophysical magnetic method that was used over the site from 1999 to 2009. This implementation of the standard magnetic method provides us with a base map and about 80 of them have been surveyed since 1999. It served, firstly, to reveal the large-scale layout of the site and secondly to select areas of interest to start new approaches as implemented since 2015. In 2015, we started to collect surface ceramics in targeted locations identified on the basis of the geophysical results as possible settlement areas. In 2015, the mapping and the recording of the ceramic sherds allowed us to assert the presence of inhabited sectors to the southeast of the Royal Garden (Gondet *et al.* 2016, 76-78; see fig.5), beyond the large basin revealed by the earlier magnetic surveys, and to the north of Tol-e Takht hill where a layout of dense buildings was already found within an area outlined by the remains of a mud-brick fortification line. In 2016, we continued the operation of sherd collection over the southern slope of Tol-e Takht hill where a new settled and densely built area had been revealed in 2015 (*ibid.*, 73-74). We also sorted the diagnostic sherds from our 2015 and 2016 surveys following a form and ware typology developed during the campaign of fall 2016. This descriptive study enabled us to implement ceramic comparisons and statistical analyses that have brought to light critical data for enlightening the chronology and the evolving settlement pattern of Pasargadae, which shall be detailed below.

In 2016, Pasargadae was also mapped through a topographical survey. This continued the work which was started in 2015 (*ibid.*, 74-76), but in 2016 we added real-time differential GPS, as well as a picture coverage campaign of the whole Pasargadae area from the air using two types of UAV and on the ground of the monuments with cameras fixed on a pole or hand-held ones. This mapping, complementary to that implemented with magnetic methods, allows us to accurately document the current landscape of the site and to better interpret the results from geophysics, as well as to reveal new settlement locations or landscaping features enhancing our reconstruction of the past layout of Pasargadae. This in-depth study of the ancient layout of Pasargadae was also carried out through the implementation of a new electromagnetic geophysical survey method. The electromagnetic instruments provide us with measures of the changes of two different properties of the subsoil: the magnetic susceptibility which is a magnetic property that can be closely linked to human activities; and the electrical conductivity that mostly depends on the subsoil sediment grain size and therefore is particularly effective for identifying water-laid deposits. It was tested in 2016 on several spots across Pasargadae to better outline the settlement areas and to better map the ancient hydrography. Finally, in 2016 we implemented sediment studies of samples taken in the large basin outlining the southeastern limits of the Royal Garden. Pollen analyses were conducted as this basin would be a potential reservoir for proxy pollen data providing information about the history of nearby vegetation, particularly those parts across the park of Pasargadae. At the same time, the nature of the sediment was analyzed in order to assess the environmental settings of the filling deposit. Radiocarbon dating was also performed to get insights on the depositional chronology in the basin.

In the surroundings of the protected site of Pasargadae, we extended our field-walking survey which was started in 2015 (*ibid.*, 78-83). The main goal was to compose a comprehensive map of the archaeological data of the plain and the foothills around the city within a circle of circa 5 km radius. The surveys are systematic, i.e. all the visible archaeological data are recorded. By recording and mapping all archaeological remains in this area, we intend to place Pasargadae within the local settlement dynamics of its surrounding territory, and then to evaluate the impact of its foundation on the earlier system as well as the possible continuation of the Achaemenid customs of territorial management during the later periods. Like the 2015 research, two teams surveyed the surroundings of Pasargadae: one focused on the foothills and the plain for mapping settlements and waterworks; the other focused on the slopes and the hilltops where funerary remains are prevailing. They extended the 2015 surveyed areas towards the west and northeast of the site of Pasargadae. Some targeted accurate topographical mapping of waterworks and aerial survey by UAV were also undertaken.

## **Mapping and Analyzing the Cityscape of Pasargadae**

### *Geophysical Survey Between the Royal Garden and Tol-e Takht hill*

The strategy for the 2016 magnetic survey was to map that part of the plain located in between the areas surveyed in 2015 southeast of Tol-e Takht hill and those which

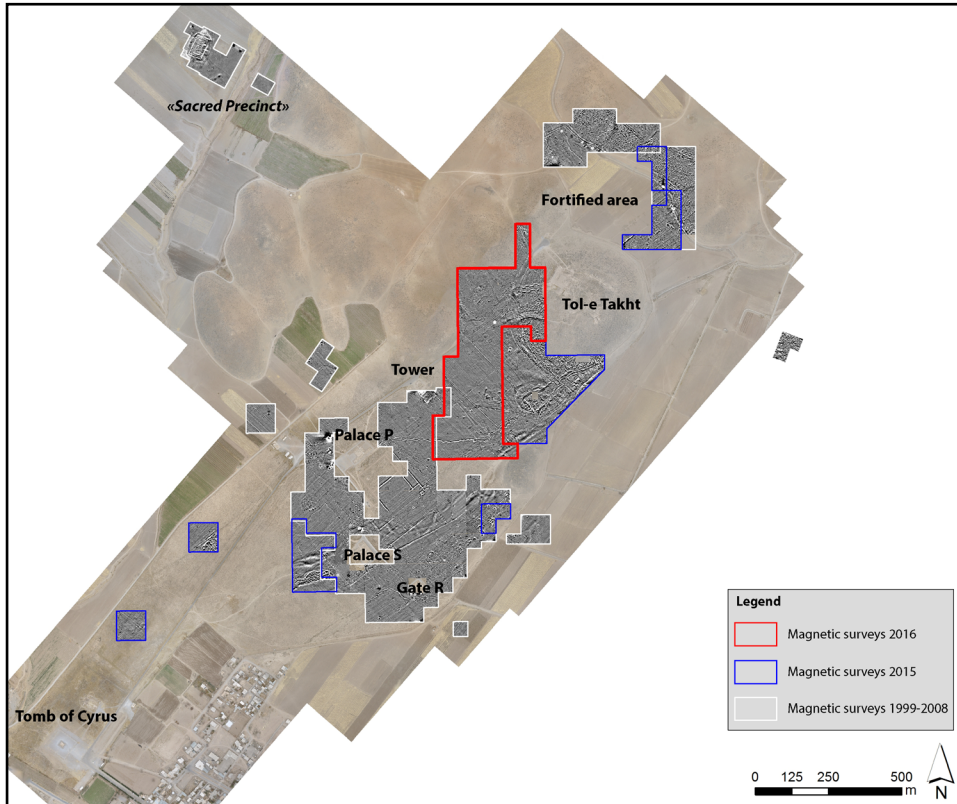


Figure 1: Overview of the results of the magnetic survey carried out over Pasargadae and its surroundings since 1999. The 2015 and the new 2016 surveyed areas are respectively plotted in blue and red and the magnetogram dynamics is  $-2/+2$  nT/m from white to black (Benech *et al.* 2012 for survey prior to 2015; 2016 survey carried out by Y. Biere, S. Gondet, K. Mohammadhani, and E. Roustaei Farsi; the aerial image used as base map is an orthorectified and georeferenced composition of pictures taken by UAV produced by Iconem in 2016).

were investigated from 1999 to 2008 inside and around the Royal Garden (Fig. 1). Our aim was to extend our mapping of the park of Pasargadae and to determine if some of the landscaping features revealed by our former research, especially the ditch network in between the palace P and the Tower complex, go on towards the northeast. We also extended the survey of Tol-e Takht southern hillslope towards the northwest to enhance mapping of the settled and densely built area revealed in 2015 in this sector. The surface surveyed over Pasargadae in 2016 is of 16.5 ha.

In the plain area located between Tol-e Takht foothill and the Royal Garden, the results of the magnetic survey are, above all, related to ancient landscaping features. As it has already been observed (Benech *et al.* 2012, 20-23), the main difficulty with this type of features is to link them to one of the periods of occupation of the site, since this area was

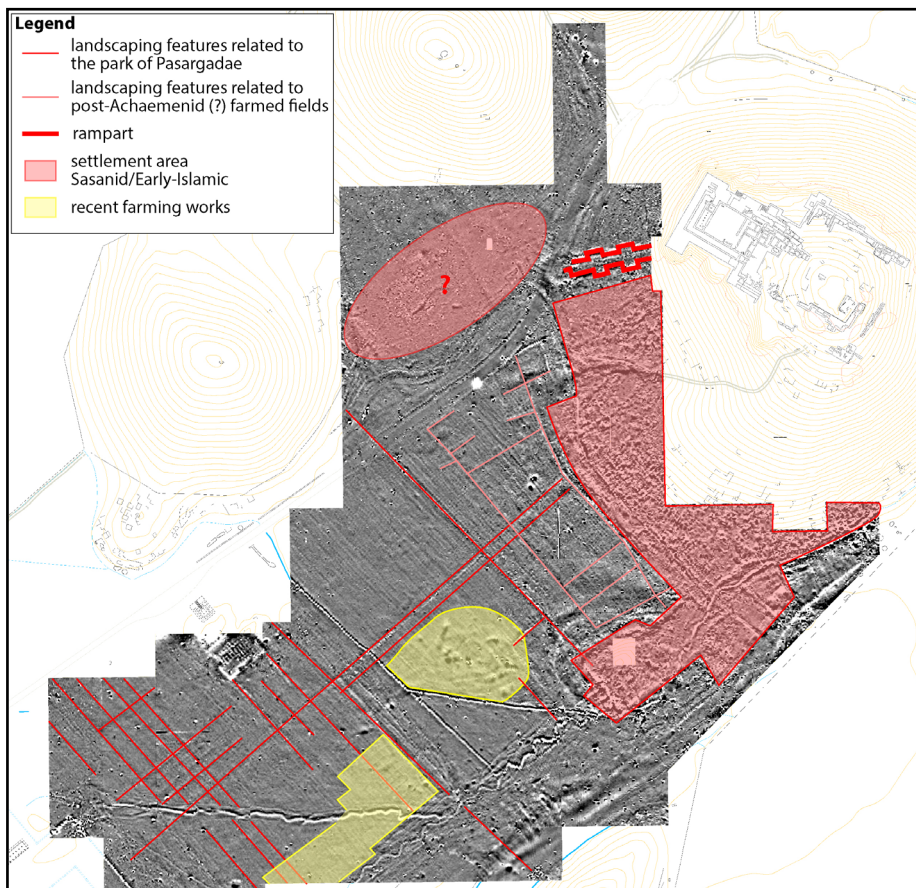


Figure 2: Sketch interpretation drawing of the 2016 magnetic map southwest of Tol-e Takht hill.

under cultivation until recently. The linear magnetic anomalies revealed could be related to the layout of the Achaemenid park as well as to the later farming activities that recently correspond to ploughing lines, for the most part. In the first instance, the overlaying of the magnetic map with those produced by the topographic survey and the aerial picture coverage enables us to differentiate the most recent features. The shape and the value of the magnetic signals also give insights into the nature of the revealed structures. We can suggest ascribing some of these long linear features to the Achaemenid park landscaping by analyzing their orientation compared to the known monuments and the stone canal network of the Royal Garden as well as their connection to some of these constructions.

Taking into account these selection criteria, we suggest ascribing some of the long linear features revealed after the 2016 survey taken place in the Achaemenid park layout (red lines on Fig. 2). Over the newly surveyed area, the dense grid of ditches revealed by

our previous survey, which was carried out in between the Royal Garden and the Tower complex, does not extend towards the northeast. It does not mean that it did not exist, but that it may have been levelled by recent farming activities. What remains is probably the deeper residues of the major axis, the backbones of the park layout, from which was a dense network of ditches were developed likely to have followed a similar pattern with the one revealed near the Tower complex. The most visible line is continuous across all the plain in the middle of the surveyed area from the foothill to the Royal Garden. This line overlays what we have suggested identifying as the southeastern side of a courtyard or a garden located beyond the Tower and its associated large building (Benech *et al.* 2012, 22). In the same way, we can observe that the northeastern and the southeastern limits of this space extend towards the southeast. These limits are sections of longer features, probably drains or canals that crossed the northeastern part of the park. These results demonstrate that the possible landscaped space shaping the southeastern part of the Tower complex would have been fully inserted within the overall drainage network of the park. Looking back to the longest southwest/northeast linear features, a second parallel one 7 m aside is visible from the Tower complex area to the Tol-e Takht hill. Because of the changing nature of the related magnetic anomaly along its course, it is difficult to suggest a firm interpretation. We might be facing a second parallel ditch dug for draining the northeast part of the park. In the future, the establishment of targeted and small tests soundings across these lines, following the same strategy which was implemented to the west of Persepolis after geophysical surveys in the area (Askari Chaverdi and Callieri 2012), will be able to give more accurate data on the dating and the nature of these features. However, after the 2016 survey, we suggest that the park certainly extended as far as the Tol-e Takht southern hillslope. Next to the foothill area, features (pink lines on Fig. 2), probably plots limits, are certainly related to a later period. They are not in the same orientation as those described above and seem to reproduce a farming pattern also visible along the eastern Tol-e Takht hillslope on the topographic map and aerial pictures.

The survey carried out on the southwestern part of Tol-e Takht hillslope revealed other interesting results. They enabled us to confirm an extension towards the north of the settled area. This was brought to light in 2015 research on the southern hillslope (transparent red area on Fig. 2). The magnetic map shows also that this settled area was certainly bounded by a strong rampart wall corresponding to double and parallel lines of limestone visible on some sections on the surface (thick red lines on Fig. 2). These two rows of stones delineate a corridor of circa 10 m in width. The walls are marked by face to face projecting sections that were almost certainly towers. Two such towers are visible, separated by 18 m, and their rectangular inner space is regular in size circa 15x20 m. Towards the southeast, the remains of the fortification disappear where it crosses the modern road leading to Tol-e Takht hill. Thus, we are presently not able to delineate the rampart beyond the road. Aside from a possible complete levelling due to later block removal, the remains of the fortification might correspond to some of the linear anomalies amongst the several parallels and strong anomalies running along the foothill of Tol-e Takht hill. Some later features, in particular, a large canal, run along



the foothill and have certainly disturbed the possible remains of the rampart line. This hypothesis would make sense since towards the north the fortification determines a clear limit for the settled area which was built to protect it. We suggested that this settled area was concentrated on the hillslope and did not extend towards the plain, thus the continuation of the rampart might indeed run somewhere along the foothill. Finally, taking into account the construction techniques, massive stone wall foundations, and the plan of this newly discovered fortification wall, we suggest that it was not linked to the single line mud brick fortification, north of Tol-e Takht. It may have formed a part of another rampart system, certainly later in Sassanid/Early-Islamic period with what the ceramic analyses demonstrate and also the abutting monumental stone platform on the Achaemenid.

As for the concluding remarks concerning the geophysical surveys, the electromagnetic survey provided interesting results, confirming the presence of an inhabited area to the southeast of the basin. It is now demonstrated that the human activities in the Pasargadae area enhanced the soil magnetism still recordable through geophysical surveys despite a deep levelling of the architectural remains due to later farming activities. We intend to extend the electromagnetic surveys towards the east in order to see if a layout of similar magnetic zoning, i.e. other settled sectors, might be seen further in the plain.

#### *Topographic Survey on Tol-e Takht Hillslope*

In 2016, the topographic work was continued towards the north of Pasargadae and covered an area of circa 105 ha centered on Tol-e Takht hill and including the north fortified area.

The most striking results of the topographical work were obtained on the southern hillslope of Tol-e Takht. Our survey revealed an almost 10 ha densely built area located on the southern slope of the hill (Fig. 3). This result, as well as the 2016 surface ceramics density map across the same area, confirms the suggestion raised by the 2015 geophysical surveys that there was an ancient settled area located south of the monumental platform. During the 2016 survey, a part of the ancient layout of this area was also revealed thanks to aerial pictures taken by drone after a snow event as will be discussed below. Our systematic mapping of the building remains visible on the surface demonstrated that this construction is mainly located at the foot of the southern and eastern hillslopes. Settled areas were also identified in the upper part of the hillslope, but they seem more sparsely inhabited. This might be explained due to the presence of numerous limestone outcrops which prevented construction. The settlement pattern along the bottom part of the hillslope is made of rectangular buildings. On the whole, their walls form a grid plan that closely follows the natural landform. This plan was partially identified by the 2015 geophysical survey and was confirmed by the topographic analyses as well as by the aerial pictures taken after the 2016 snow event.

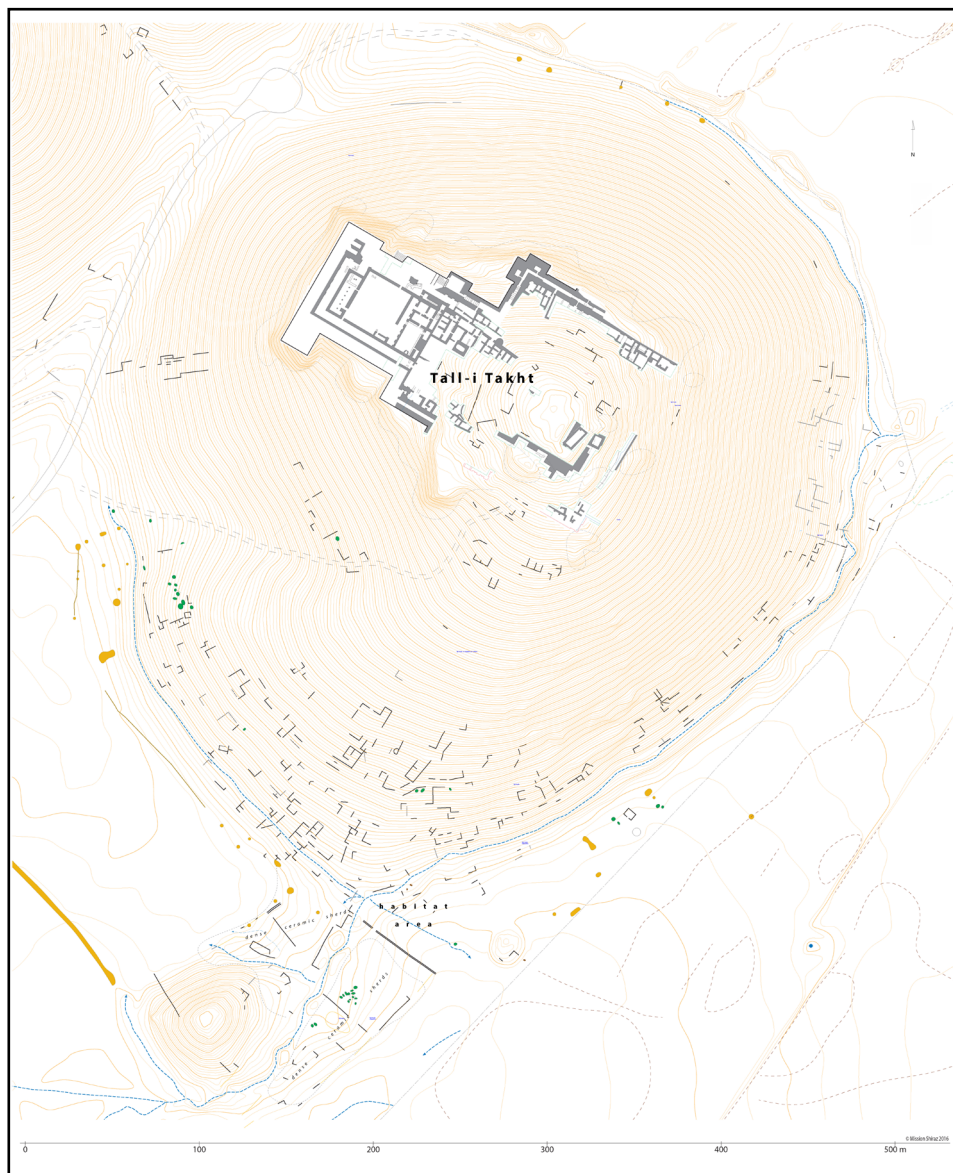


Figure 3: Results of the topographic survey carried out around Tol-e Takht hillslopes showing all the archaeological remains visible on the surface. Black lines are remains of building foundations, brown shapes are heaps of stones, and green dots are tombs. The level lines are extracted from the topographic plan of the site created and kindly shared by the Pasargadae World Heritage Site (field survey jointly carried out by D. Laisney and Samaneh Nazifi; CAD by D. Laisney).

*3D modelling of the site and aerial remote sensing around Tol-e Takht*

Three members of the Iconem Society took part in the campaign of fall, 2016. The goal was to acquire a series of pictures to produce 3D and multiscalar modelling of the whole site of Pasargadae. Thanks to the technology developed by Iconem, the managers of the site and the scientific community will be able to use this 3D digital documentation of the site of Pasargadae, either by using the classical 2D documentation extracted from the models or by navigating through this 3D, taking measurements or elevations. The photographic documentation merges three different levels of resolution: a coarse resolution for the natural landscape (high altitude UAV), 1 cm accuracy for the architecture (low altitude UAV), and 1 mm accuracy for architectural details of significant interest (camera fixed on a pole and ground pictures with a high resolution camera). After processing workflow of the pictures, these input data are processed into 3D documentation in the form of point clouds and textured meshes, which have been merged into a single 3D space within a georeferenced coordinate system. The area covered by the high altitude drone is 10.29 km<sup>2</sup> encompassing the whole Pasargadae protected area, the fortified zone to the north, and the so-called Sacred Precinct to the northwest. Over this area, a large-scale 3D model as well as an orthorectified photography (base map of Fig. 1) were produced. Because of the high number of images, processing is still in progress and the final multiscalar digital model which will be usable for everybody working on the site is still under construction.

During the stay of the Iconem members at Pasargadae, we were lucky that a snow event occurred on the 25<sup>th</sup> of November 2016. The next day, the Iconem team photographed the site with the high altitude drone, and, because the snow melts faster along the buried foundations of buildings, especially on the hillslopes, well-defined structures were clearly revealed in the photos. An explanation for this phenomenon is that the remains of the walls retained the heat longer than the surrounding soil. The photos provide us with striking documentation of the buried architecture as we can observe the detailed layout of large parts of the ancient settled areas, mainly over Tol-e Takht southern slope and within the north fortified area, with higher resolution than with the previous survey techniques. In the fortified area (Fig. 4), the layout appears accurately and extensively. In its northernmost part, the pattern of elongated buildings, made up of a series of quite regularly spaced walls delineating large courtyards, suggested by the previous geophysical survey is confirmed by the results of the 2016 aerial survey. In the settled area located on the southern Tol-e Takht hillslope, the snow had already melted by and large when we took the photos. Nevertheless, the snow images revealed some parts of the layout of this area which were difficult to detail on the magnetic maps. These exceptional photographs overlaid with the different layers of other data (magnetic and topographical) allow us to get a more comprehensive view of the organization pattern south and north of Tol-e Takht hill (Fig. 14).

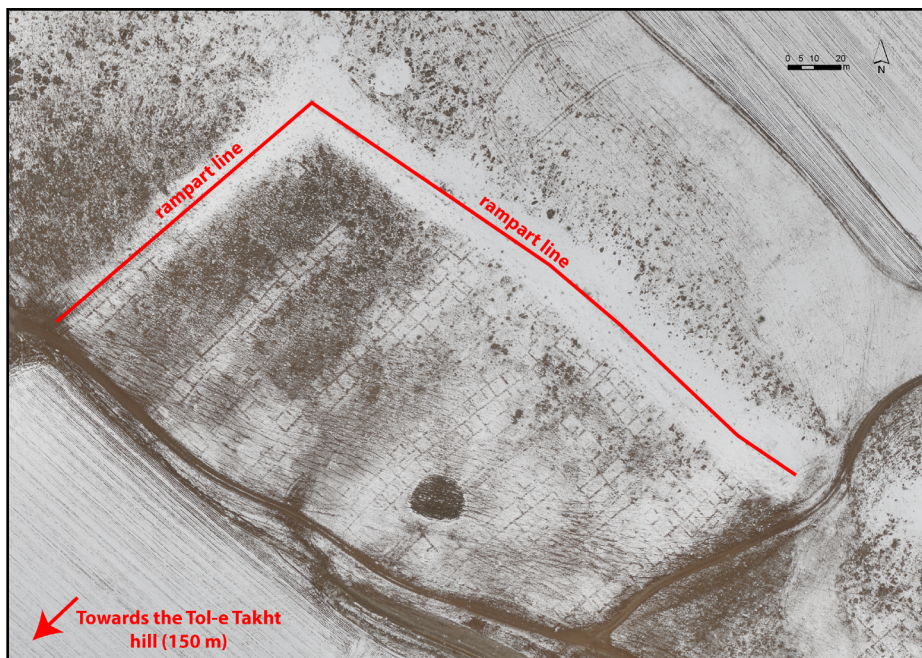


Figure 4: Orthophotography of the north corner of the fortified area located beyond Tol-e Takht hill. Photograph taken after snow event, the differential melting of the snow along the buried structures revealed the layout of this settled area (data acquisition and processing by Iconem).

#### *Surface Ceramics Mapping and Typological Analysis*

Our first goal for collecting ceramics was to ascertain the existence of permanently settled areas after their definition through the geophysical survey. Secondly, we used the collection of diagnostic sherds to evaluate the function and chronology of the inhabited districts. Given the results of the 2015 magnetic survey, in 2016 we decided to collect surface ceramics across the newly discovered settled area located on the southern slope of Tol-e Takht hill. The 2016 ceramic collection was carried out along two lines of 20x20 m squares, the longest crossing Tol-e Takht hillslope from the southeast to the northwest. There is almost complete convergence between the results of the sherd density maps and the geophysical survey as was the case for the 2015 collection across the southeast Royal Garden area, beyond the basin, and across the western part of the north fortified area located beyond Tol-e Takht (Fig. 5). The highest sherd densities on the south Tol-e Takht hillslope overlay the areas of settlement seen initially in 2015 on the magnetic maps, and then better mapped through the 2016 aerial and topographic survey, as discussed above. Although the transects of the ceramic survey extended beyond the slope of the hill towards the plain, the highest sherd densities occur in squares located on the foothills. Further northwest, in the plain, the sherd densities drastically decrease. This confirms the

fact that the plain to the northwest of Tol-e Takht hill was certainly never lastingly settled, and that settlement was concentrated solely on the hillslope. The sherd density map also establishes the presence of a settlement along the second shorter pick-up transect staked further south. The highest densities overlay concentrations of architectural features visible on both magnetic and topographic maps. The subsequent ceramic analyses, as detailed below, do not demonstrate significant differences with the diagnostic sherds assemblages from the hillslope. As was suggested by the results of the 2015 surveys, it is probable that the settled area south of Tol-e Takht projected some 200 m southwards

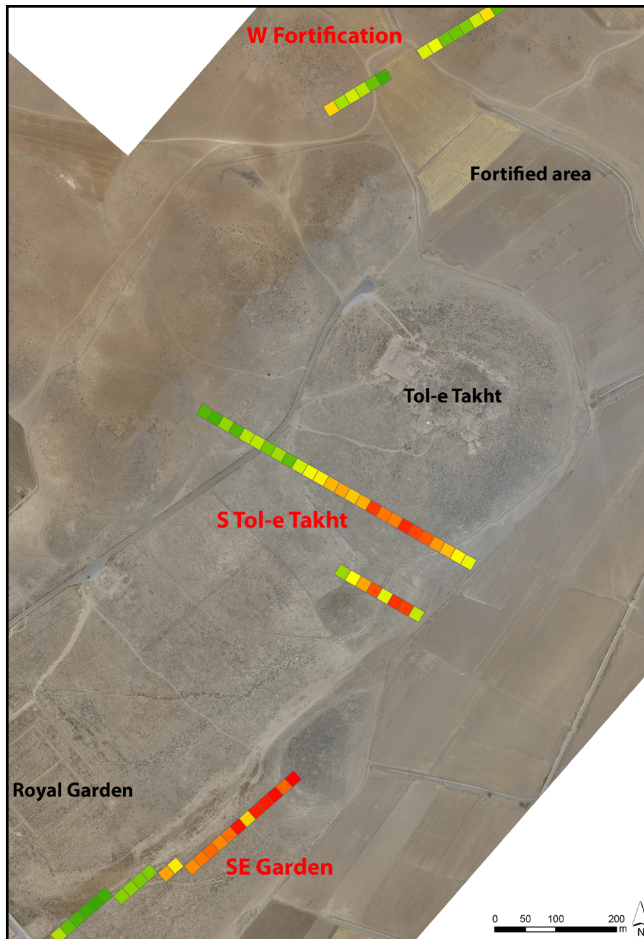


Figure 5: Location map of the 2015 ceramic collection survey (W Fortification and SE Garden) and in 2016 (S Tol-e Takht) showing higher densities on the settled areas distributed over the northeast part of Pasargadae. Color chart ranges from 0 (deep green) to 2.5 (deep red) sherds/ $m^2$  (field sherds collection by all the team members, CAD S. Gondet)

beyond the hillslope and encompassed a small hill still rising at 10 m above the plain level (see also Fig. 2 and the outlining of the settled area south of Tol-e Takht platform).

In 2015 we recorded and drew the diagnostic sherds, and in 2016 we started the substantial work of typological classification and analysis. The goal was the reorganization of the ceramic recording system for the material collected from the surveys of 2015 and 2016 using a new system of typological recording which is able to determine depositional processes as well as chronological and functional patterns of distribution. From the 2015 and 2016 ceramic surveys, 715 diagnostic ceramic sherds were selected and formed the basis for both the Pasargadae form and ware type descriptions. The finer breakdown into stylistic types, created by the project from the 2015 and 2016 collections (form type), is based on the form and orientation of the rim, the length of the neck, body shape when present, and any consistent decorative features. Ware type descriptions (fabric colour and texture) and surface finishing (slip, burnish, and glaze) were recorded independently. It was possible to create 53 form types and 49 ware types. At the same time, experience had shown that the standard Munsell soil colour charts that are traditionally used for ceramic analysis did not have the range of values specific to ceramics at Pasargadae and were highly subject to analyst subjectivity. In order to further standardize the recording system, 18 standardized colour sample swatches were therefore created with paints specifically to match ceramic fabric colours found at Pasargadae.

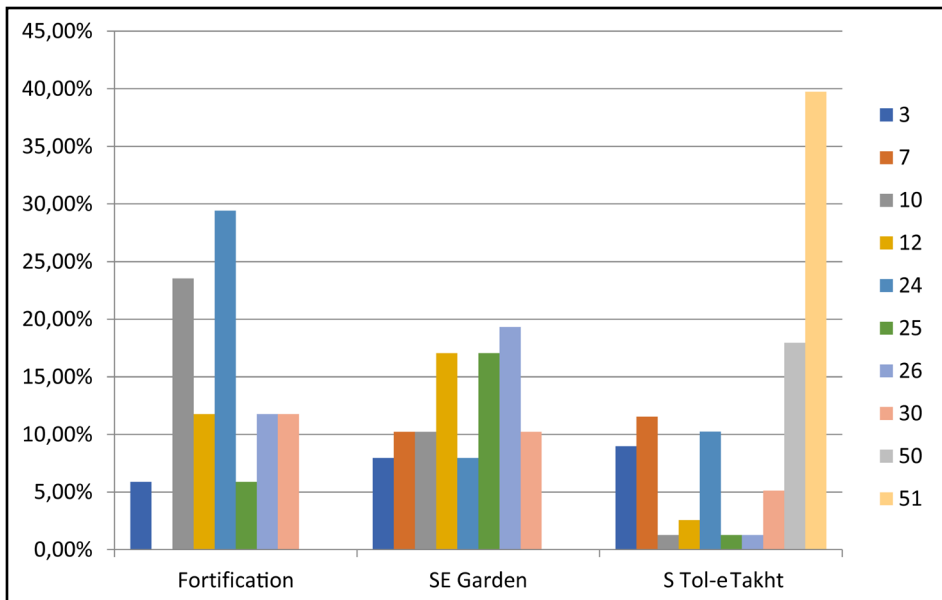


Figure 6: Form type distribution over Pasargadae sorted by area. Types with more than 10 examples among all collected sherds (data acquisition managed by H. Gopnik with the help of Sare Nematolabi Nia and of Habibeh Abbasi, analysis by H. Gopnik).

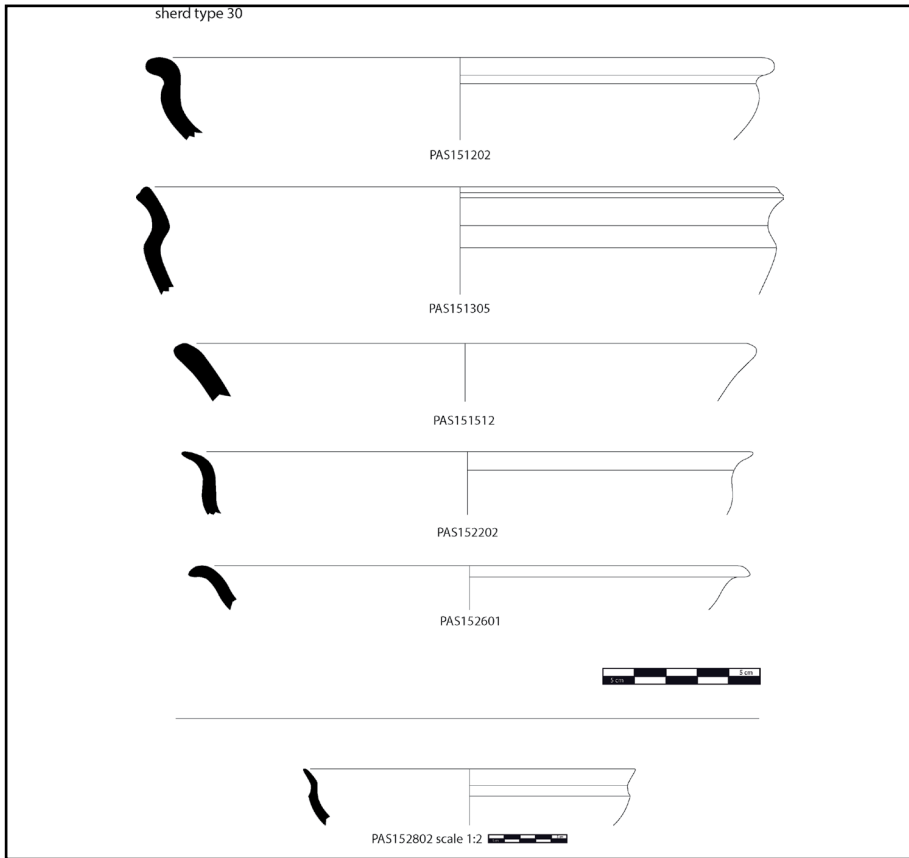


Figure 7: Carinate bowls of the Achaemenid/post-Achaemenid period from the surface collection. The final illustration (PAS152802) is from the north Fortification area and the others are from the east garden area (CAD by F. Notter-Truxa).

While the distribution of form types (Fig. 6) is more or less even across the site, certain types are markedly concentrated in certain areas. Fine, small ware bowls with unturned rims (type 24 on Fig. 6), the ubiquitous plain rim bowl that in other regions, particularly in southwest Iran, is the marker of the Iron Age, is found in significantly greater proportions in the Fortification area than in either the southeast garden or the southern Tol-e Takht. Carinate bowl (type 30, Fig. 7), often considered in Persia as the best marker of the Achaemenid/post-Achaemenid period, is present in similar proportions in either the southeast garden (9 sherds and 11% of the total diagnostics) or the west Fortification sectors (2 sherds and 10% of the total diagnostics). Pithos rim with applied ridges (type 51), the typical late Sassanian-Early Islamic ribbed jar, is found exclusively in the south Tol-e Takht area. These forms have different functional associations in terms of food service and storing, but are also almost certainly indicative of a chronological difference between the areas.

Ware types (Fig. 8) are also dispersed over the site with two major exceptions. A ware with an orange to red fabric and core with medium temper (type 8 on fig. 8) used for rolled-rim jars is found in higher proportions in the west Fortification area. A ware with a buff fabric and core with medium to coarse temper (type 41) used to make large jars occurs almost exclusively in the south Tol-e Takht area. Again each of these ware types can be taken as a chronological indicator, with the red-orange fabric associated with the Achaemenid to Post-Achaemenid periods at the site and the coarser buff fabric with the later Sassanian or Early Islamic periods. Finally, the slip colours mirror this pattern as vessels in the west Fortification area were more frequently red-slipped than those in the southeast garden and south Tol-e Takht areas where there were buff slips appeared.

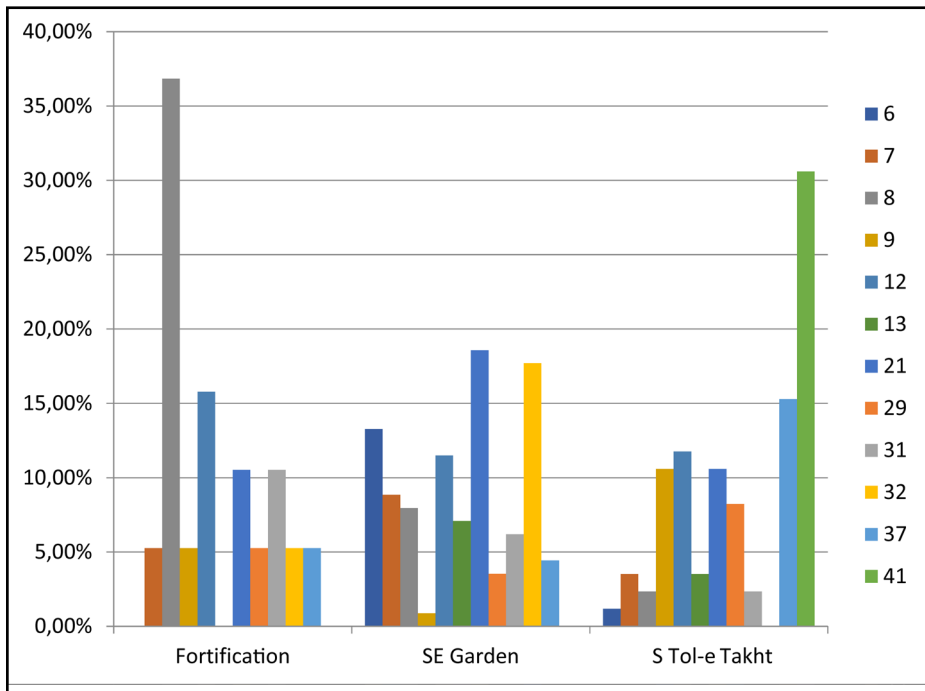


Figure 8: Ware type distribution over Pasargadae sorted by area. Types with more than 10 examples. Data acquisition managed by H. Gopnik with the help of Sare Nematolahi Nia and of Habibeh Abbasi, analysis by H. Gopnik.

Concerning chronology, the ceramics collected from the surface in 2015 and 2016 spanned the range of types illustrated in Stronach's publication of the site (Stronach 1978). Almost all can find shape parallels in Stronach's Period II and III plates (Achaemenid and Post-Achaemenid) which are not stratigraphically differentiated in terms of the pottery. Plain rim bowls (*ibid.* fig. 109), carinate bowls (*ibid.* fig. 106-107), ledge rim bowls (*ibid.* fig. 111), rolled-rim jars (*ibid.* fig. 117-119), everted rim jars (*ibid.* fig. 120), and folded-rim jars (*ibid.* fig. 117-119) are found in all three areas of the site. The major and notable exceptions to this widespread dispersion are the large pithos rims (above-mentioned type



51, for example, plus type 50 on fig. 6) which appear almost exclusively in the south Tol-e Takht area and are directly paralleled by Stronach's Period IV (*ibid.* fig. 123-124) which he dates to the Early Islamic period but which also bear strong parallels to Late Sassanian assemblages from other sites (Whitcomb 1985). Time was lacking in 2016 to accurately analyze the decorated sherds from 2016, nevertheless, our preliminary observations lead us to suggest that decorated ceramics are more frequent in the south Tol-e Takht area. In addition to the ribbed jars, the finer ceramics sometimes include incised decorations similar to known Late Sassanian/Early-Islamic examples. Indeed, the parallels between the south Tol-e Takht collection associated with the architecture recovered from magnetometry, from topography and from the aerial photos taken of the 2016 snow event, and Stronach's Period IV occupation on the summit of Tol-e Takht are so close and compelling that it seems clear that this was one continuous occupation over the top and southern slope of Tol-e Takht hill.

To sum up, the surface ceramics collected from the pedestrian ceramic collection surveys of 2015 and 2016 form complex but discernible patterns of distribution. As stated above, the assemblage from the south Tol-e Takht area is related to the Late Sassanian/Early Islamic period. The west Fortification area was the smallest assemblage collected (46 diagnostic sherds), but the concentration of plain-rim bowls, red-brown fabrics, and red slips distinguished this small assemblage from the others. This distinction may be either chronological or functional (or both). Given the small number of sherds in the collection, the north fortified area needs further study through new surface surveys in the 2017 season. However, this preliminary insight is of critical importance because it suggests that the north fortified settled area may be dated to a period distinct from the two other areas. It is also worth noting that such a fortified area, compared to the much more open layout revealed in the plain and assigned to the Achaemenid period, might be considered as an "anomaly". The north fortified area might be related to a distinct period in the history of Pasargadae (maybe post-Achaemenid as suggested by Benech and Boucharlat 2002, 26-29). Nevertheless, to further examine this hypothesis, we are faced with a lack of accurate chronological data that would come from a better assessment of the ceramic typochronology of Tol-e Takht sequence (see the attempts of Askari Chaverdi and Callieri 2010) or from absolute dating of the occupation layer by means of test soundings within this area. The east garden area was the least well-defined assemblage, and the new 2016 analysis shows a more intricate pattern than supposed after the 2015 season (Gondet *et al.* 2016, 76-78). We suggested an assemblage very similar to those of Period II and III of Stronach. Then the 2016 analysis tends towards a combination of several different periods of occupation. The absence of the most distinctive Period IV forms seems to suggest that it includes an earlier occupation than the south Tol-e Takht, although the predominance of buff slips distinguishes it from the west Fortification and perhaps might suggest an important settlement period of later date. However, the presence of Period II-III pottery still enables us to suppose a first occupation of the area contemporary to the Achaemenid/post-Achaemenid period. We also need to observe that it is well inserted within the Achaemenid layout. It is indeed

restricted to the southeastern side of the basin outlining one of the limits of the Royal Garden, and it was built far from Gate R, the entrance point to the royal area. It seems to have been founded as a settled district at some distance from the Royal Area, a characteristic that was already observed west of the Persepolis Terrace where settled and populated districts are placed far from the Royal Precinct (Boucharlat *et al.* 2012).

#### *Pollen and Sediment Analysis in the Basin*

In June 2016, palaeoenvironmental studies were implemented at Pasargadae at the same time as preliminary surveys in the plain for organizing further studies on geomorphology and hydrology. We intended to study the sediments of the large basin southeast of the Royal Garden in terms of pollen preservation and potential to use pollen analysis for reconstructing the vegetation and landscape of Pasargadae and its park. Complementary sediment analyses were also carried out in order to shed light on the sedimentary history of the basin. Several test samples were taken in the basin, most particularly samples at 10 cm intervals along a vertical section of a hand-made pit (80x80 cm wide and 180 cm deep) located about 100 m northeast of the bridge stepping across the basin in the axis of Gate R.

The pollen percentages in three analyzed samples (10-20 cm, 100-110 cm, and 170-180 cm) show a dominance of terrestrial herbaceous species whose pollen grains are particularly resistant to oxidation and pedogenic processes (Fig. 9). In the lowermost sample, tree pollen surprisingly displays the highest frequencies. Amongst these tree species, *Cupressaceae* pollen is most probably coming from cypress trees (Sarv in Persian) because the other producer of this pollen type, i.e. juniper (Sarv-e Kuhi in Persian), is very rare in the Zagros region. This result demonstrates also a clear issue of preservation related to the depth of the samples in the studied profile. Normally, with increasing depth, pollen grains are degraded. However, the lowermost sample is exceptionally rich in all types of pollen grains from tree to fragile aquatic pollen. This lower sample also contains many diverse non-pollen objects (NPPs on fig. 9) related to a dominating aquatic environment. All pollen and NPPs data suggest that the water-logged conditions in the basin prevailed over a long period. The permanent aquatic conditions, supposedly dating to the Achaemenid period when the basin was flooded, go as far down as 180 cm and deeper. This assumption is consistent with the evaluation of its depth of 1.5 m, suggested by geophysics (Benech *et al.* 2012: 13) and observed from the base level of the bridge columns which are 2 m below the uppermost point of the side retaining walls (Stronach 1978: 113-16). For future work in the basin, we intend to go deeper in order to sample the full thickness of this supposed Achaemenid water-logged layer. However, the recently received radiocarbon dates for two charcoal samples taken at 110 and 150 cm were quite inconsistent with this assumption as they respectively date back to  $4350 \pm 35$  BP (cal 3030-2896 BCE) and  $4530 \pm 35$  BP (cal 3362-3101 BCE). They are earlier than the Achaemenid period by more than 2,000 years and it would mean that the Achaemenid layer would be above 110 cm. At that point, we believe that we probably have dated

	Pollen types	Pollen counts			Pollen percentages			
		10-20 cm	100-110 cm	170-180 cm	10-20 cm	100-110 cm	170-180 cm	
Trees and shrubs	<i>Calligonum</i> -type	0	0	1	0	0	0,42372881	
	Cupressaceae	0	0	4	0	0	1,69491525	
	Ephedraceae	1	1	2	0,641026	0,41841004	0,84745763	
	<i>Pinus</i>	0	0	3	0	0	1,27118644	
	<i>Pistacia</i>	0	1	2	0	0,41841004	0,84745763	
	<i>Quercus</i>	0	0	9	0	0	3,81355932	
	<i>Ulmus</i>	0	0	1	0	0	0,42372881	
	Aconitum-group	0	0	1	0	0	0,42372881	
Terrestrial herbs	Amaranthaceae	9	34	21	5,769231	14,2259414	8,89830508	
	Apiaceae	0	1	0	0	0,41841004	0	
	<i>Artemisia</i>	9	17	7	5,769231	7,11297071	2,96610169	
	Asteroidae	21	89	31	13,46154	37,2384937	13,1355932	
	<i>Centaurea</i>	6	37	5	3,846154	15,4811715	2,11864407	
	<i>Cousinia</i>	0	1	4	0	0,41841004	1,69491525	
	Caryophyllaceae	0	0	1	0	0	0,42372881	
	Cichorioideae	5	28	10	3,205128	11,7154812	4,23728814	
	<i>Matthiola</i>	1	0	0	0,641026	0	0	
	<i>Plantago lanceolata</i> -type	0	0	1	0	0	0,42372881	
	Plumbaginaceae	0	0	1	0	0	0,42372881	
	<i>Polygonum aviculare</i> -type	0	9	75	0	3,76569038	31,779661	
	Poaceae	2	4	20	1,282051	1,67364017	8,47457627	
	Cerealia-type	2	0	7	1,282051	0	2,96610169	
	<i>Triticum</i> -type	2	0	4	1,282051	0	1,69491525	
	<i>Amygdalus/Prunus</i> -type	0	0	1	0	0	0,42372881	
	<i>Scilla</i> -type	0	0	1	0	0	0,42372881	
	<i>Valerianella</i>	0	0	1	0	0	0,42372881	
	Aquatic and sub-aquatic plants	Cyperaceae	0	4	9	0	1,67364017	3,81355932
		<i>Sparganium</i> -type	97	13	9	62,17949	5,43933054	3,81355932
<i>Riella</i>		0	0	4	0	0	1,69491525	
Trilet		0	0	1	0	0	0,42372881	
Pollen Sum		156	239	236	159	239	236	
	NPPs							
	<i>Sporormiella</i>		2	10	0	0,83	4,23	
	Indeterminable	38	73	29	24	30	12	

Figure 9: Pollen counts and percentages of three samples from the Pasargadae main basin (data acquisition and analysis by M. Djamali).

reworked earlier charcoals samples coming from the surroundings. This problem with dating will possibly be overcome by samples for OSL which would be more adapted to date the type of sediment filling the basin.

After being sampled for pollen analysis, the sediment was analyzed in order to determine the filling process of the basin. Grain size analysis and mineralogy (count of minerals) of each sample were completed (Fig. 10). The rate of organic matter and calcimeter were also measured in order to accurately characterize the deposit and its environment. While the filling process of the basin can be generally explained by a slow flooding phenomenon, a detailed examination of the grain size graphs shows a peak of sand near 1 m in depth. It might be associated with more intense geomorphological processes, i.e. more intense water flow and increasing erosion on the nearby slopes. This geomorphological episode, which still needs to be accurately dated and linked to the regional past environmental dynamics, is also revealed in the organic matter and

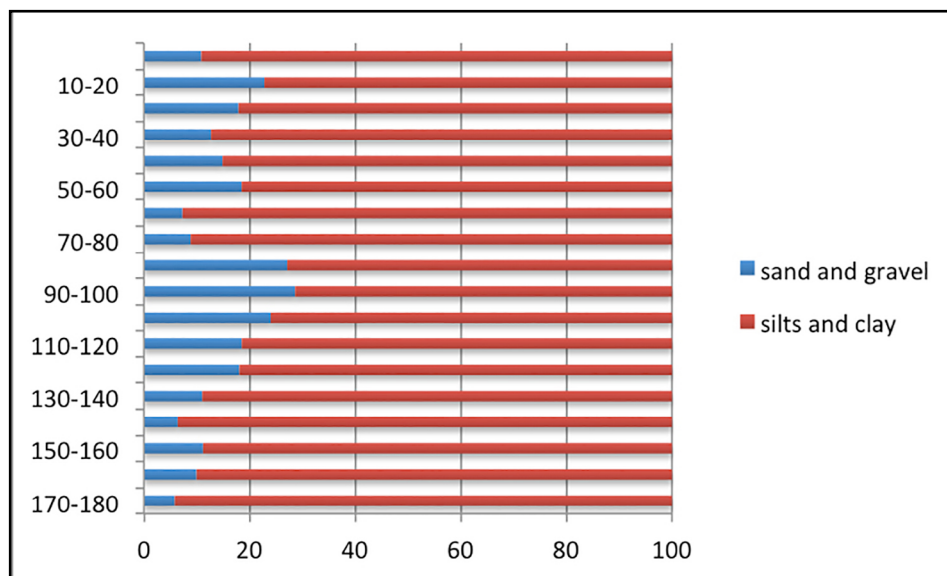


Figure 10: Graph of the two main classes of grain size for the 18 samples from the sounding dug in the Pasargadae basin southeast of the Royal Garden (data acquisition and analysis by J.-B. Rigot with the help of A. Coullin at the Tours University).

calcimeter analysis. Altogether these results show complementarity of the paleobotanical and sedimentology approaches to better characterize the filling sediment of the basin and to reconstruct both past vegetation and geomorphology of the site.

## Mapping the Territory Surrounding Pasargadae

### *Survey of the Past Settlement Pattern*

In 2016, we extended the archaeological fieldwalking survey of the territory surrounding Pasargadae northwest and west of the site, i.e. from the north of the Abolvardi village as far as the gate of the Tang-e Bolaghi valley south to the Mobarakabad village (Fig. 11). At the same time, we further documented through topographic and geophysical surveys some sites and waterworks mapped during the 2015 season to the north of the Abolvardi village.

After the 2016 survey of the foothills, side valleys and fields located west and northwest of Pasargadae, we found 19 settlements, i.e. points of observation presenting remains of permanent or long-lasting dwellings or human activities (Fig. 11). Generally speaking, these sites are difficult or impossible to date as the surface pottery sherds are often rare and much eroded. For the most part they consist of wall foundations visible on the surface. All sites seem to date to a period range from Sassanian to the late Islamic with a possible zoning between the northern and the southern part of the surveyed zone. We did not find visible traces of earlier occupation comprising the Achaemenid

period. To the north we mapped the highest density of settlements (PPS-S-16001 to 14 on fig. 11) corresponding to isolated dwellings, located quite systematically in small dry side valleys. They all seem to be dated to the Sassanian/Early-Islamic periods and would shape a network of interrelated farmsteads. In the southern part of the surveyed zone, the archaeological landscape is quite different. The settlements (PPS-S-16015 to 19 on fig. 11) correspond to clustered buildings (35 dwellings maximum for PPS-S\_16016) shaping small villages or hamlets regularly distributed along the foothill north of the Tang-e Bolaghi gate. Given the scarcity of diagnostic ceramics, these settlements would date to the late Islamic period. The site PPS-S-16015 is of note as several heaps of iron slag were visible on its surface. With another Islamic site located in the Tang-e Bolaghi valley, they are, for the moment, the only suggestion of craft activities in the Pasargadae plain from all periods.

Another objective of our fieldwalking survey of the settlement pattern around Pasargadae is to focus on the remains of waterworks. The hydraulic network north and northwest of Pasargadae is dominated by qanats (Fig. 12) while in other parts of the plain we had mostly mapped open-air canals. We mapped three, maybe four, distinct qanat lines. The longest ones are located in the large dry river beds lateral to the main Pulvar

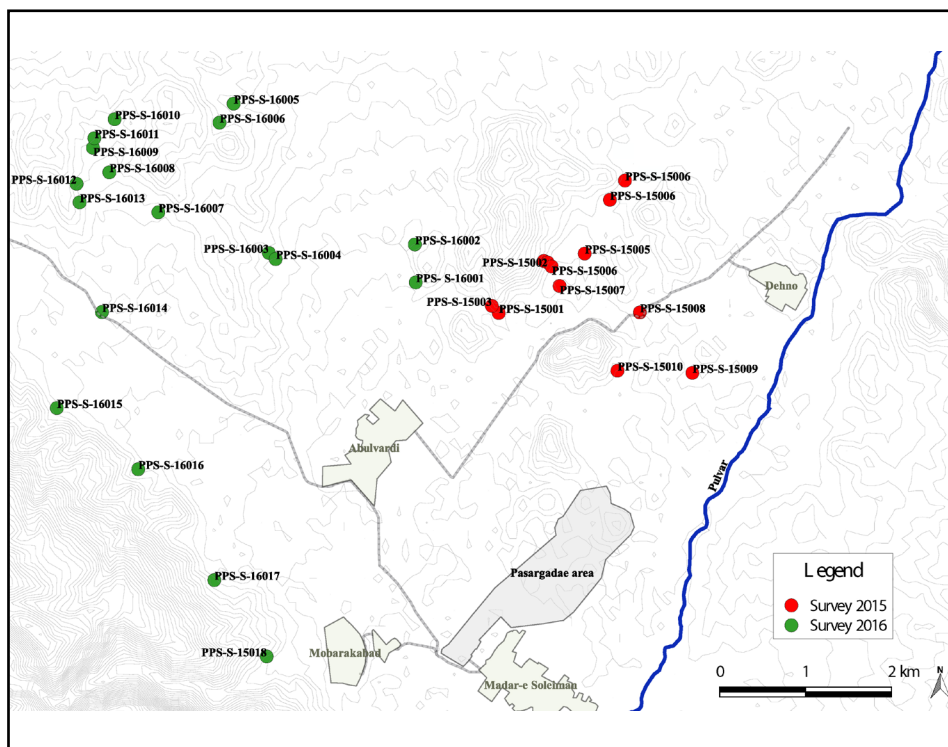


Figure 11: Settlement map from the 2015 and 2016 survey campaigns over the north and west of Pasargadae (survey management by N. Ibroerrida with the help of all team members, CAD by N. Ibroerrida).

valley and had been fed by the underflow running below the present pebble surface. They seem recent to sub-recent networks, nowadays they are abandoned, like for the southernmost one where concrete open-air canals running from the last qanat shaft towards the Mobarakabad village are still visible. The two smallest qanats were mapped to the northwest of Mobarakabad. They run on the foothill and were certainly connected to the late Islamic settlement observed in the area.

Giving our main focus to mapping the settlement pattern around Pasargadae around the Achaemenid period, the 2016 fieldwalking survey demonstrated that the northwest of the site was not settled. Given the existing data for this period, the settlements were placed on or next to the flat arable lands, as we observed in 2015 north to the Abolvardi village (Gondet *et al.* 2016, 78-80), in Miyan Djade southeast of Pasargadae (Zare Kordshouli and Akbari 2013) or in the Dasht-e Bolaghi basin (Boucharlat and Fazeli Nashli 2009). The hilly and quite bare environment that was surveyed in 2016 is, however, surprisingly quite rich in archaeological remains of later date, maybe when qanat networks were developed to supply these settlements and the surrounding fields with water.

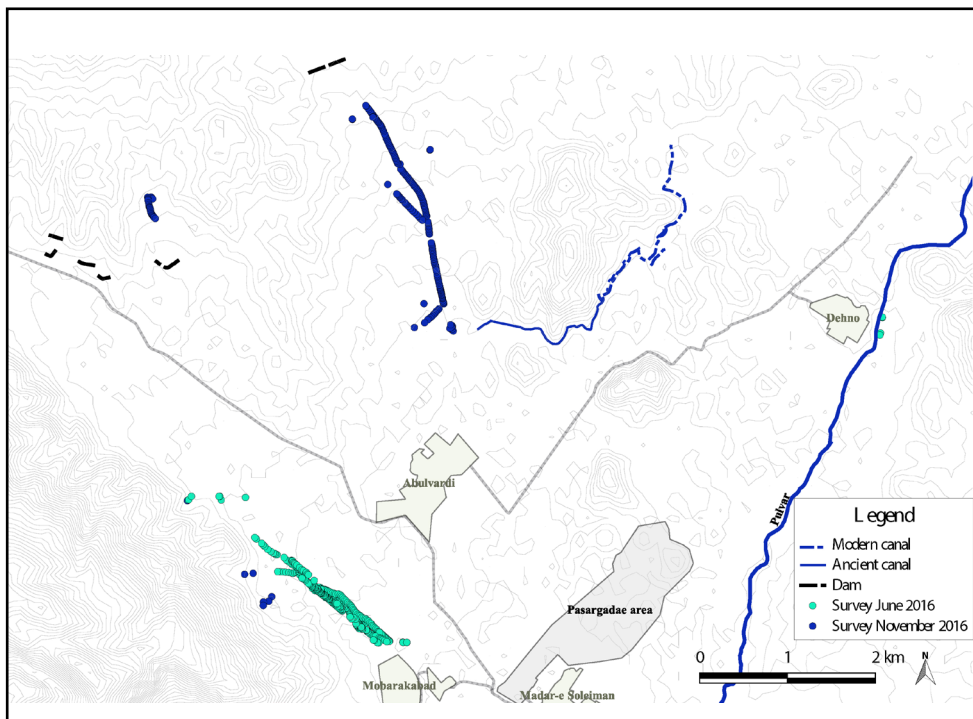


Figure 12: Qanats and waterworks mapped from the 2015 and 2016 survey campaigns over the north and west of Pasargadae (June 2016 survey of qanats by D. Dumas and J.-B. Rigot, fall 2016 survey management by N. Ibnouerrida with the help of all team members, CAD by N. Ibnouerrida).

*Survey of the Funerary Cairns*

Funerary remains in the Pasargadae plain are one of the major archaeological features that are yet to be systematically studied. Amongst them, cairns dominated the funerary landscape. Cairns were largely evidenced from Tol-e Gholam and Tang-e Bolaghi situated to the north and southwest of Pasargadae. In 2015, we limited our work to the hill range of Tol-e Gholam to the north of Pasargadae and of Abolvardi village (Fig. 13). In 2016, we extended the survey of the funerary remains towards the east of the Tol-e Gholam area, beyond the village of Dehno, towards Qaderabad. At the same time, we recorded some funerary remains to the north and west found during the settlement survey.

The cairns on the eastern Dehno hills respect the same classification built in 2015. The cairns were sorted into three classes in terms of their size: small (ca. 2 m to 5 m in diameter), medium (ca. 5.5 m to 9 m in diameter), and big (ca. 10 m to 15 m in diameter). They generally consist of a rectangular stone-built burial chamber that was sealed with stone slabs and covered by rubble stones. Most cairns contain one burial chamber, but in big cairns sometimes the number of chambers might reach two or three. Like Tol-e Gholam hills, the majority of the cairns have been looted and disturbed; therefore, in most cases, it is difficult to understand the main shape of the chambers or their directions.

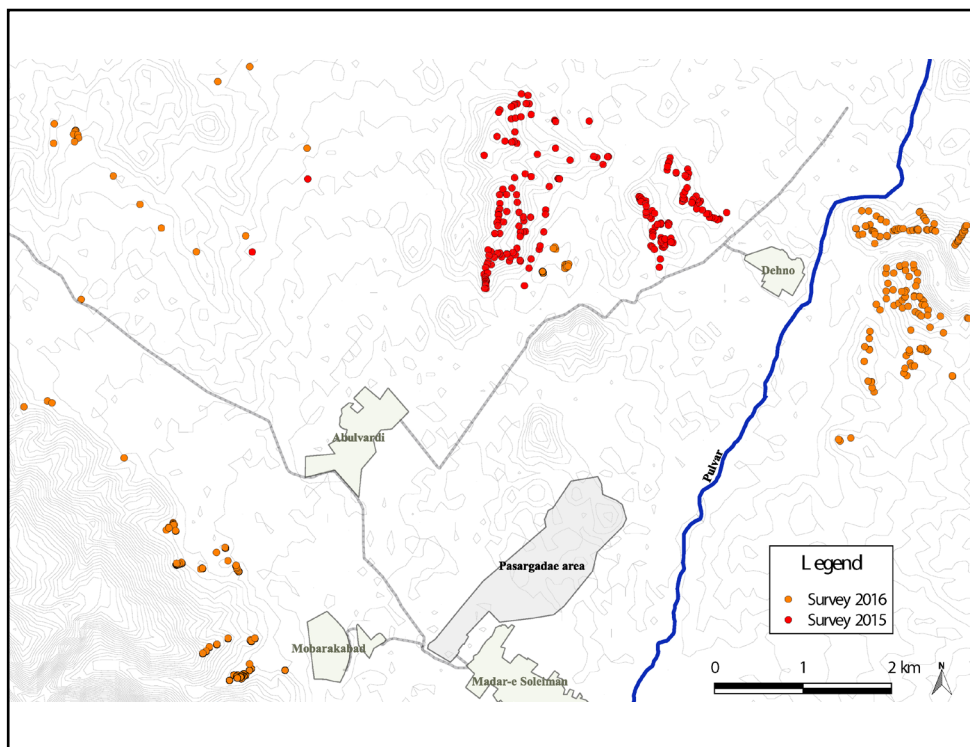


Figure 13: Funerary remains distribution map around Pasargadae resulting from the 2015 and 2016 survey (2016 survey management by M. Farjamirad with the help of H. Etminan, CAD by N. Ibnoerrida).

In the Dehno area, the distribution pattern of the cairns, construction materials and their plans are very similar to those of Tol-e Gholam. As observed in 2015, the biggest cairns are located on the summit of the hills and the smallest are in the foothills or the lower parts of the hills. An interesting and particular feature of the big cairns surveyed in 2016 is the regular presence of a small flattened cairn next to them.

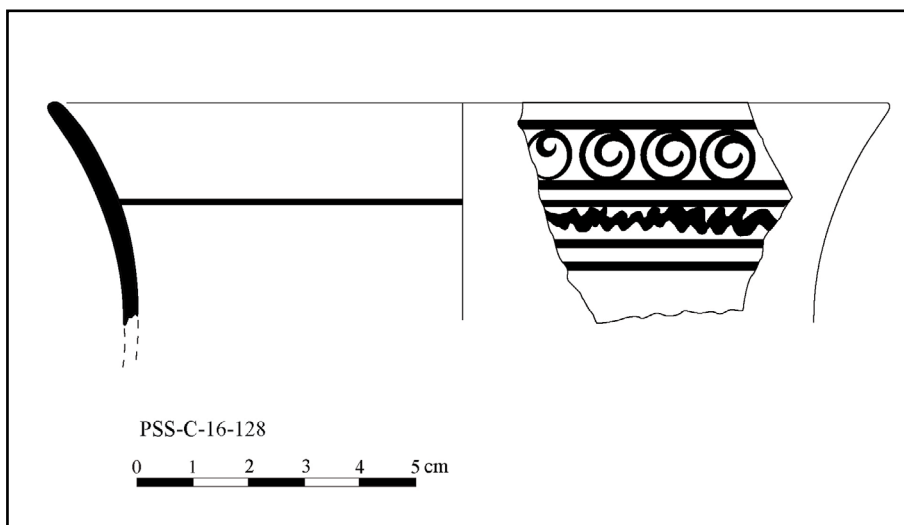


Figure 14: Partho-Sasanian beaker recovered from cairn PSS-C-16128 in the Dehno/Qaderabad area northeast of Pasargadae (CAD M. Farjamirad).

In the Dehno area, an unidentified type of coarse pottery is scattered all over the hills on or around the funerary cairns. Many of these potsherds are small and eroded pieces that do not offer any possibility for relative dating. Among this quite uniform ceramic assemblage, the discovery of pieces of a painted beaker from one of the large cairns on the northern side of the hill was notable. This is a fine light red slip ware painted in brown with hanging spirals and curvilinear motives (Fig. 14). This pottery has many parallels in the Partho-Sasanian layer of Tepe Yahya (Lamberg-Karlovsky 1970, 10-fig. 4). The production of this pottery might have begun during the 1<sup>st</sup> century and continued until 4<sup>th</sup> century AD (Haerincx 1983, 230). Last year, one piece of post-Achaemenid/Seleucid festoon ware was found in the Tol-e Gholam area (Gondet *et al.* 2016, 80-83) and this new piece of evidence demonstrates that these burial cairns are probably multiperiod and post-Achaemenid. Concerning the chronology of these funerary remains, teeth and bones found in 2015 are presently under analysis by a French laboratory specialized in dating small volumes of datable material.

On the northern foothills of the Dehno area, we recognized five circular tombs (between 1.6 m and 2.7 m diameter) covered with crushed stones. Another find was a possible Islamic cemetery situated to the west of the hills.



### Concluding remarks

Aside from continued progress in composing an archaeological map of the territory surrounding Pasargadae, which has enabled us to outline the settlement dynamics as well as the funerary customs around the site, the 2016 campaign was particularly fruitful for a better understanding of the cityscape and, above all, its evolution. Parts of our results are still preliminary and need further analyses and data, but the new insights from the 2016 campaign of the Iran-French project are of particular importance. We have demonstrated that Tol-e Takht platform served as a base structure, a stronghold, for two fortified settlements of distinct periods: one newly revealed to the south, and a second one, known since the seminal 1930's survey of E.F. Schmidt (Schmidt 1940), to the north. The layout of these two areas, already partly identified thanks to our previous geophysical surveys, has been accurately revealed in 2016 through the exceptional aerial pictures taken after a snow event (Fig. 15).

After combined analysis of the surveys and of the surface ceramic sherds, we believe that the south Tol-e Takht occupied area dates to the Sassanid/Early-Islamic era and was an important settlement of at least 10 ha defended by strong ramparts. The settled area associated with the fortification to the north of Tol-e Takht was more accurately delineated in 2016, although the layout of aligned regular sized rooms revealed in its western part still remains without comparison. The analysis of the surface pottery collected in 2015 does not provide a firm dating of this area, since the diagnostic types are related to both the Achaemenid and post-Achaemenid periods. Nevertheless, ceramic analyses revealed slight differences with the assemblages studied in the plain and the east Garden settled area. Together with the fact that the northern fortified complex does not seem to fit within the much more open Achaemenid city plan of the plain in the southwest of Tol-e Takht hill, this ceramic data suggests that there was a different period of occupation towards the northwest of the hill that may be post-Achaemenid in its date. If this hypothesis is correct, Tol-e Takht might have served as the pivotal point for two important settlements after the Achaemenid period. The Achaemenid foundation of Pasargadae may have been the starting point for the presence of long-lasting local centers in the area. The characteristic of Pasargadae, compared to other multiperiod sites, is that the successive periods of occupation did not overlay one another but shifted through time over the area of the site, Tol-e Takht summit being the only place where they were superimposed as recovered by D. Stronach. Finally, our work in 2016 enabled us to complete the plan of the Achaemenid period occupation by demonstrating that the park of Pasargadae extended as far as Tol-e Takht southern foothill. The ceramic analyses of the surface sherds from the east garden area attest to an Achaemenid/post-Achaemenid settlement, although later still undefined periods of occupation were also revealed. Given our current understanding of the spatial organization of the site, we continue to suggest that the east garden area was one of the sectors occupied by the general populace of Pasargadae.

In the 2017 campaign we will further examine these hypotheses. We will focus on constructing a better characterization of the occupation in the north fortified area, and we will start the mapping of the southwestern part of the protected site. We also aim to

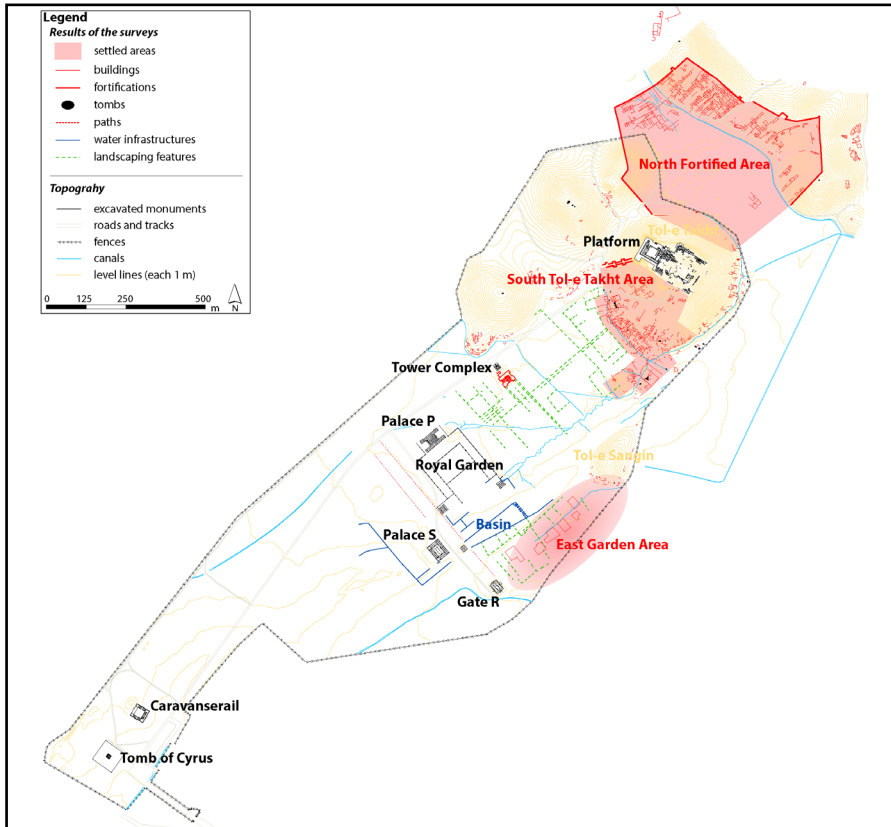


Figure 15: Archaeological map of Pasargadae (protected site and north fortified area), location of the settled areas of Achaemenid/post-Achaemenid (east garden and north fortified area) and Sassanid/Early-Islamic date (South Tol-e Takht), outlines of the features revealed by magnetic survey since 1999, topographic features since 2015 and aerial remote sensing in 2016. The southwest part of the site is still not mapped and will be surveyed during our future campaigns (C.AD S. Gondet).

combine our efforts with those of the excavation project started in 2016, headed by Dr. Ali Mousavi, and focused on the Tower surroundings and the so-called Sacred Precinct. By joining the small and the large scale through supplementary targeted soundings of strategic areas revealed by our survey project, we will be able to reconstruct together a comprehensive picture of Pasargadae from its founding in the Achaemenid period through its many later occupations.

### Acknowledgements

Identical to the research done in 2015, the 2016 fieldwork was managed by Dr. Kouros Mohammadkhani (Shahid Beheshti University) and Dr. Sébastien Gondet (UMR 5133 Archéorient – Maison de l’Orient et de la Méditerranée, CNRS/Lyon 2 University).

It was implemented under the agreement of the Iranian Cultural Heritage, Handicrafts & Tourism Organization (ICHTO) and its Research Institute for Cultural Heritage and Tourism (RICHT) headed by Dr. Seyyed Mohammad Beheshti. Once again, the project has benefited from the great help of RICHT office for International and Legal Affairs headed by Dr. Monir Kholghi. The scientific program has been built under the supervision and in close collaboration with the Iranian Centre for Archaeological Research (ICAR), and the archaeology department of the RICHT, headed by Dr. Hamideh Choubak. The fieldwork was designed with and supported by the Pasargadae World Heritage Site led by Eng. Hamid Fadaei. In 2016, like previously done, this institution brought critical support by providing access to its facilities and by the active involvement of two of its archaeologists in the fieldwork (Eng. Hamid Reza Karami and Eng. Farhad Zare Kordshouli). The entire project takes place within the framework of a Memorandum of Understanding for academic and research collaborations signed by the RICHT and the University Lyon 2 in 2015. For the French part, the 2016 funding was mainly provided by the Foreign Ministry office for international archaeological collaborations. The 2016 campaign was also supported by the French Research Institute in Iran (IFRI), by the Lyon 2 University/National Centre for Scientific Research (CNRS) Archéorient team, a lab part of the Maison de l'Orient et de la Méditerranée Research Centre. In order to enrich our approaches of the complex ancient landscape of Pasargadae, new collaborations were built in 2016 with Emory University of Atlanta (Prof. Hilary Gopnik, archaeologist of the Iron Age and Achaemenid periods in Ancient Iran); the IMBE lab of Aix/Marseille University (Dr. Morteza Djamali, palaeobotanist); the CITERES lab of Tours University (Prof. Jean-Baptiste Rigot, geoarchaeologist); Société Iconem specialized in the 3D modelling by photogrammetry of the Heritage sites. The 2016 archaeological work of the Iran-France project at Pasargadae and its surrounding territory was implemented during two periods: from the 18<sup>th</sup> and the 27<sup>th</sup> of June (palaeoenvironmental studies) and from the 5<sup>th</sup> to the 30<sup>th</sup> of November (archaeological work).<sup>1</sup>

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1. The 2016 team consisted of 25 scientific members. Aside from the authors of the present article, the team included: a hydrologist (Prof. Dominique Dumas – UMR 5600 EVS and Lyon 3 University), two specialists of photogrammetry (Eng. Philippe Barthélémy and Eng. Romain Riouffet – Société Iconem); two archaeo-geophysicists (Eng. Yves Biere – UMR 5133 Archéorient and Lyon 2 University and Eng. Ebrahim Roustaei Farsi – Independent researcher); and eight undergraduate and postgraduate students in archaeology (Habibeh Abbasi – Art University of Shiraz, Mahdieh Dashtaki – University of Tehran, Hossein Etminan – Shahid Beheshti University, Nazeli Falahi – University of Tehran, Eng. Maryam Hoseini – Art University of Shiraz, Eng. Monireh Mir Dehghan – Shahid Beheshti University, Mahtab Moradi – University of Tehran, Samaneh Nazif - Shahid Beheshti University).

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