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## **Approaching past landscape management in the field: pluridisciplinary and multiscale studies in the Pasargadae region (Fars province, Iran)**

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### **Pasargadae beyond the monuments: hidden landscapes**

Pasargadae, founded under the rule of Cyrus the Great around 550 BCE, was the earliest capital of the province of Pārsa in the Achaemenid period. For a long time, the archaeology of Pasargadae was restricted to the well-known and still visible monuments standing in a supposedly barren plain and distributed over about 6 km<sup>2</sup>. Dominated by emptiness, the areas between the royal constructions appearing to be virtually unbuilt, the Pasargadae monumental landscape was long considered no more than the background of a “nomad camp” (Herzfeld, 1935, p. 28). After his work on the site during the 1960s, D. Stronach (1978; 1990) demonstrated that the development of Pasargadae was carefully planned as a garden extending between the columned buildings and which structured the royal space. In other words, all the known and excavated constructions on the site have to be considered as landmarks of a larger relandscaping project. A park of several hundred of hectares surrounded the capital of Cyrus as R. Boucharlat has suggested since his work on the site in the 2000s (first suggested in Boucharlat, 2007, p. 458 and then in the subsequent articles Boucharlat, 2011; 2014a; 2016; Benech, Boucharlat, and Gondet, 2012).

More broadly, the foundation of Pasargadae was certainly supported by a large-scale territorial development. The capital served as the central place for managing the exploitation of the surrounding plain even after the Cyrus reign when Persepolis, founded by Darius around 520 BCE, became the main center of Pārsa. As a matter of fact, the Persepolis archives attest that Pasargadae was a component of the Achaemenid administrative network. As well as being the main symbolic place of worship in memory of Cyrus, it appears that Pasargadae was also named by using the Elamite term *partetaš*. This term should be considered in the Persepolis administrative context as “a production and storage unit” (Henkelmann, 2008, p. 433).<sup>1</sup> Pasargadae was in charge of its surrounding territory, carefully improved and managed. In a first instance, the Pasargadae region does not seem ideal. It is located in a mountainous environment, the south-eastern part of the Zagros range, and in a semi-arid climate. However, the area benefits from large arable and watered lands. It stands in the south-western part of a basin, the Pasargadae or Morghab Plain, about 3x20 km in size. The basin is filled with fine alluvial sediments brought by the Pulvar River that runs from north-east to south-west across the plain and flows 1 km east of the Pasargadae site.

These preliminary considerations demonstrate that the lavish edifices of Cyrus are only the visible elements of past landscapes that extend hidden in between and far beyond them. For reconstructing Pasargadae, the area of several square kilometers delineated by the royal monuments needs to be investigated. Moreover, to understand how the capital used and impacted its territory, the whole Pasargadae plain has to be taken into consideration. On the other hand, what could be called the “urban” area of Pasargadae may not be clearly distinguished from its territory. Pasargadae was built as

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<sup>1</sup> On the role of Pasargadae after the reign of Cyrus see the synthetic view provided by Henkelmann, 2012, p. 940. More recently, Boucharlat, 2016 also discussed in detail the topic of the *paridaidā/partetaš/paradeisos* in the Achaemenid Empire, and particularly at Pasargadae, from an archaeologist’s point of view.

an open layout and dominated by green areas. We also notice the absence of well-defined limits, like ramparts, between the ‘city’ and its surrounding territory. The ‘urbanized’ space and the exploitation of the related territory are closely entangled. Therefore, the archaeological study of Pasargadae necessarily entails large-scale approaches from the site towards the whole plain.

Since its creation in 1999, the Iranian-French archaeological project in the Fars province focuses mainly on a comprehensive study of Pasargadae and its territory. The current phase of the program,<sup>2</sup> resumed in 2015 after a break between 2009 and 2014, continues to explore these objectives. The very nature of Pasargadae makes it important to implement an integrated program of landscape archaeology. In the context of the present volume, gathering colleagues of various disciplines to provide their expertise on the topic of environmental and socio-economic history of Ancient Pārsa, we aim to shed light on the peculiarities of such a program with several years of fieldwork experience in the present-day South Iranian context. We aim to provide an overview of complementary approaches to be implemented in the field during three campaigns from 2015 to 2017, after the preliminary results and feedback regarding the capacity of archaeology for reconstructing the past Persian landscapes. While focusing on the 1<sup>st</sup> millennium BCE and on the region of Pasargadae, our ongoing project on landscape archaeology faces challenges that are common to the whole ancient province of Pārsa. These challenges will be generally discussed before we narrow the scope to the Pasargadae region.

### **Challenges for developing landscape archaeology in ancient Pārsa**

With today’s archaeological tools, approaching the environmental and socio-economic dynamics of ancient Pārsa, more or less the present-day Fars province, is much more challenging for at least four reasons.

Firstly, it is simply linked with working within the frontiers of one of the core regions of several civilizations of Ancient Iran. Testimonies of this rich history are numerous in the Fars province which concentrates many archaeological masterpieces. Approaching the past landscape of Ancient Pārsa means working on areas where places like Tol-e Malyan/Anshan for the Elamite era, Pasargadae and Persepolis/Parsa for the Achaemenid period, Firuzabad and Bishapur for the Sassanid period, are major sites occupying the attention of the archaeologists. These sites were also administrative centers in charge of the successive territorial developments. This is well demonstrated by various written sources and above all by administrative archives illustrating how territories were improved and managed.<sup>3</sup> Their analysis permits fairly detailed studies of the territorial management patterns and finally of the ancient landscapes. Armed with this textual evidence archeologists are often asked to find and to discuss the corresponding remains in the field. However, these remains are often ‘elusive’, to cite a

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<sup>2</sup>The current project is jointly managed by Kouros Mohammadkhani and Sébastien Gondet. 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 Seyyed Mohammad Beheshti. The project benefits from the help of the RICHT International and Legal Affairs Office headed by Monir Kholghi. The scientific program was built under the supervision and with the agreement of the Iranian Centre for Archaeological Research (ICAR), the archaeology department of the RICHT, headed by Hamideh Choubak. The fieldwork is supported by the Pasargadae World Heritage Site Office headed by Hamid Fadaei. The project takes place in 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 funding of the 2015-2017 campaigns was mainly provided by the Foreign Ministry Committee for International Archaeological Researches as well as by the French Agency for Research (ANR) through the ANR-DFG project “Paradise” (ANR-16-FRAL-0011-01). The fieldwork was also supported by the French Research Institute in Iran (IFRI), by the Lyon 2 University/National Centre for Scientific Research (CNRS) Archéorient team, affiliated with the Maison de l’Orient et de la Méditerranée Research Centre. Laboratory analyses are supported by the IMBE lab of Aix/Marseille University (France) and the CITERES lab of Tours University (France).

<sup>3</sup> See Stolper, 1984 for Anshan; Henkelman, 2013 for a synthetic view on Persepolis and Pārsa; Miri, 2009 for an overview of the Sassanian administrative material available for Ancient Pārsa.

term often used in the context of the Achaemenid period.<sup>4</sup> In Pārsa/Persepolis, because of the lack of data outside of the main monumental clusters, we are far from being able to detail territorial dynamics. As a consequence, the place of archaeology is often restricted to discussions about the monuments and rarely about the past territorial development patterns; a topic on which a fruitful dialog could be built with the other historical sciences. In order to be committed to writing its part of the history of Pārsa, archaeology has to broaden its scope beyond the monuments. Despite the weight of scholarly traditions, the first challenge for archaeology of Ancient Pārsa is above all to firmly reorient its objectives.

Using properly adapted and reoriented archaeological approaches for revealing material data on past regional evolutions is the second main challenge to introduce. The first step is to broaden the scale of the archaeological studies to be carried out in Ancient Pārsa. In Fars, a few regional surveys have been conducted since the seminal work of A. Stein (1936) and L. Vanden Berghe (1959). As these scholars were more interested in periods earlier than the 1<sup>st</sup> millennium BCE, for which monumentality is less dominant in archaeological debates, knowledge for the later phases of regional settlement patterns has for a long time remained rather poor. The survey of William M. Sumner in the Kur River Basin, i.e. the Mardasht/Persepolis plain, during the late 1960s, is undoubtedly considered a breaking point. By surveying all the visible tepe mounds, he reconstructed the regional development dynamics on the *longue-durée* as late as 1<sup>st</sup> millennium BCE. This robust dataset allowed him to publish the first attempt to cross-study archaeological and written sources for reconstructing the settlement patterns in the Persepolis Plain during the Achaemenid period (Sumner, 1986). Nevertheless, these data brought to light problems. Like Boucharlat (2005, p. 226-228) observed, the site density becomes lower from the 1<sup>st</sup> millennium BCE when it is compared to the archaeological data on the earlier periods. This conclusion runs counter to the above-mentioned textual evidence as well as to the presence of large sites demonstrating the development of Pārsa from the Achaemenid period.

Changing survey objectives means building efficient methodology. From the time of Sumner until recently (Alizadeh, 2003), the surveys only focused on the visible ‘sites’ being defined in our context as tepes, i.e. artificial mounds erected by the overlaying successions of mud-brick architectural construction and erosion phases during a long period. The ‘offsite’, which is defined by J. Bintliff (2000, p. 200) as “the entire artefactual landsurface” of a studied area, remained mostly unsurveyed. However, it is certainly from these ‘offsite’ areas that data on the settlement patterns from the second half of the 1<sup>st</sup> millennium might be gathered. The Iron Age ‘hiatus’ in Pārsa during the first half of the 1<sup>st</sup> millennium could imply a break in the earlier continuous sedentary occupation of the tepes and then, for the following periods, a changing settlement pattern excluding the reoccupation of the tepes. One of the main lessons from several recent multipurpose archaeological projects accomplished in Fars (Potts *et al.* (eds.), 2006; Boucharlat, De Schacht and Gondet, 2012; Askari-Chaverdi, 2013; Askari-Chaverdi and Callieri (eds.), 2017) is the necessity to systematically survey the ‘site’ – the visible architectural remains like tepe or monuments still standing – and the ‘offsite’ – the surrounding cultivated flat fields – in order to reveal data on these periods. Also, in the last decade, palaeoenvironmental studies provided seminal proxy data on the ancient regional human occupation. For example, palaeobotanic studies on Fars lacustrine sediment archives provided critical evidence on the substantial development of tree farming in Fars from the Achaemenid (Djamali *et al.*, 2011). In terms of renewed methodology, the analysis of both artifacts and ecofacts has to be integrated within the regional archaeological projects.

The fourth main challenge for archaeology is this comprehensive and painstaking approach to the territories, needed especially in the present-day Fars landscape. When working on past landscapes, the starting point is of course the actual situation and in Fars we face what T. Wilkinson (2003, p. 41-43)

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<sup>4</sup> Among an extensive bibliography on this topic introduced by Sancisi-Weerdenburg, 1990 see the recent considerations of Briant, 2015 in an article focusing on the Anatolian case and, on the specific topic of elusive archaeological sources, see Briant and Boucharlat, 2005; Boucharlat, 2007.

defined as “landscapes of destruction” in his discourse on landscape taphonomy in the Near East. Across the mountainous and mostly barren environment of Central Zagros, the fluvial valleys are the main living areas. They offer arable lands and semi-permanent to permanent water resources. Consequently, these areas have inevitably welcomed the main part of human activities since the beginning of farming in Fars about nine millennia ago. The present landscape of Fars is a result of this long human transformation of the environment. Unfortunately, for a period of 50 years or so, we might say that the landscape history of Fars has accelerated. Modern farming has led to the quick obliteration of inherited landscapes through the development of intensive and mechanized practices. For example in the Persepolis plain, land use rationalization and changing irrigation techniques have led to lasting reshaping of the land. This change deeply impacted the archaeological remains. For example, we estimate that the main part of the 50 Achaemenid sites surveyed by Sumner (1986) in the Persepolis plain have disappeared since the late 1960’s (Boucharlat, De Schacht, and Gondet, 2012, p. 256-257). Across Fars, modern farming has caused the leveling of many tepes. The ‘sites’ become ‘offsite’ data, that is to say concentrations of ceramics sherds distributed over the newly flattened fields. Researching in this context increases the need for systematic and cross-disciplinary approaches for collecting any remaining archaeological data.

This review introduces the need to implement integrated and systematic multi-data, multiscale, and multidisciplinary archaeological studies in Fars. In other words, such an approach means to put into practice landscape archaeology as defined by Wilkinson (2003, p. 4): “Landscape archaeology attempts to describe, interpret, and understand the development of the cultural features that occur on the surface of the earth. This includes both human settlements as well as the land between or beyond them. [...] ecological, economic, cultural, political and symbolic features of landscapes are all treated to provide a broad and varied picture of cultural change through time.”

## **Archaeological research in the territory of Pasargadae: previous conclusions and current approaches**

### *Beyond the monuments: recent trends in archaeology of Fars*

During the last two decades, several archaeological projects have brought new knowledge on the Fars province. Several Iranian and Iranian-international programs began to apply landscape archaeology at various degrees and brought to light new data on the regional settlement dynamics. In other words, they did not only focus on monumental constructions but contextualize them through comprehensive reconstructions of their past surrounding landscape. In this frame of mind, archaeologists were particularly active in the Achaemenid capitals. While D. Stronach’s work (1978) focused on the studies of the monuments, he also paid attention to the larger occupation layout within the Pasargadae site as well as gathering a small amount of evidence on nearby settlement dynamics. Later, from 1999 to 2009, the first phase of the Iranian-French project was implemented in the Pasargadae region. Focusing on large-scale surveys over the site and its surroundings, the first goal was to better map the ancient layout of Pasargadae (Boucharlat and Benech, 2002; Benech, Boucharlat and Gondet, 2012). Meanwhile, an Iranian-Italian team worked on assessing a more definitive and accurate chronology of the occupation phases at Pasargadae on the Tol-i Takht hill (Askari-Chaverdi and Callieri, 2010). This work on and around Pasargadae has to be considered in a larger framework for re-evaluating the second half of 1<sup>st</sup> millennium BCE occupation dynamics, especially in the Persepolis (Boucharlat, De Schacht, and Gondet, 2012; Askari-Chaverdi and Callieri (eds.), 2017). Beginning their work from the royal monumental areas, the teams gradually revealed a richer surrounding landscape, by identifying associated green, settlement, or activities areas around the Persepolis Terrace. These works firmly demonstrated that the landscape around the royal capitals had been carefully managed and improved throughout the Achaemenid period and later.

Looking at the particular Pasargadae region draws also our attention to another recent trend in Iranian archaeology. Thanks to the considerable development of rescue archaeology since the 2000s, a lot of new critical data are brought to light.<sup>5</sup> They extend the notion of archaeological heritage and, consequently, draw new research perspectives. Several rescue archaeology programs were carried out near Pasargadae at a scale that remains unrivaled in Fars. Most important is the rescue archaeology project in the Tang-i Bulaghi valley. The systematic investigation of several endangered sites brought to light much unexpected data, especially about the settlement patterns during the Achaemenid period. Based on these results, we built our current program of studies over the whole Pasargadae plain (Fig. 1).

#### *Tang-i Bulaghi rescue archaeology project (2004-2007) as the base for reconstructing the territory of Pasargadae*

The Tang-i Bulaghi gate is located 3 km south of Pasargadae and the valley itself is about 10 km in length (Fig. 1). It corresponds to the Pulvar River channel towards the south-west. After leaving the Pasargadae Plain and running along this valley, the river flows into the Saadat Shahr plain and further towards the Persepolis/Marvdasht Plain. Apart from being the most straightforward route from Pasargadae to Persepolis, the valley also adds an important farming value as it is filled with thick river terraces. After the initial north-east section of narrow gorge, the valley opens out towards a basin called Bulaghi Plain providing large arable areas. From 2004 to 2007, at the same time as the construction of a water dam across the Pulvar River, the Iranian Center for Archaeological Research managed an ambitious Iranian-international rescue archaeology project in the valley. The objective was to systematically excavate and document sites threatened by flooding (Fazeli Nashli, 2009).

The first pedestrian survey of the Bulaghi valley led to the recording of 121 archaeological sites (Atayi, 2003) and was completed in 2005 and 2007 (Yamauchi and Nishiyama, 2008). While few sites were assigned to the Achaemenid period, the subsequent salvage excavations revealed Achaemenid layers even on sites where they were unrecorded during earlier surveys. For example, Achaemenid occupation was found in an Epipaleolithic rock shelter site (Adachi, 2008; Adachi and Zeidi, 2009). Actually, the several teams involved in the project brought to light eight Achaemenid to post-Achaemenid settlements. One of these sites is a building with columned porticoes located near the gate of the Bulaghi Valley (Atayi and Boucharlat, 2009). The other sites are related to farming activities. Isolated farmsteads were brought to light, sometimes associated with storage buildings (Askari Chaverdi and Callieri, 2006; 2009; (eds.), 2016; Helwing and Seyedin, 2009; Asadi and Kaim, 2009). Finally, two canals run on both sides of the valley. They are supposed to be Achaemenid in date and to have supplied water to all the above-mentioned settlements (Boucharlat and Atayi, 2009, pp. 23-32). Waiting for final excavation reports, interpretation of this dataset is still under discussion. Taking into account the presence of a building with aristocratic features, i.e. columned porticoes, near the entrance of the valley, Boucharlat (2011, 2014a) suggested that the Tang-i Bulaghi was home to a second *partetaš* beside Pasargadae.<sup>6</sup> Whether a pleasant place for the aristocrats of Pasargadae and/or the central place of an extended estate encompassing all the excavated farmsteads, the columned building could have been considered a seat of power in this valley. From here, the Achaemenid rulers would have managed the development of this network of rural settlements as well as the infrastructures, the water canals, and the supporting farming.

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<sup>5</sup> For example, see mentions of the numerous rescue archaeology projects implemented in the early 2000's and their main conclusions in Azarnoush and Helwing, 2005; synthetic view of the current trends in Iranian archaeological research in Mousavi, 2013, p. 11-13.

<sup>6</sup> See the alternative interpretation of Atayi, 2006 suggesting the building is one of the resting places within a Bulaghi valley hunting ground.

In the framework of our current archaeological project in the Pasargadae region, the Tang-i Bulaghi project allows us to draw various conclusions. The first one is to firmly demonstrate that the territory around Pasargadae was extensively managed. Revealing the past landscape of the Tang-i Bulaghi is to be considered a window on a broader territorial development during the Achaemenid period that still needs to be more widely investigated. Also, the second main outcome from this rescue project is to have brought to light, for the first time in the Fars region, the remains and the plans of Achaemenid/post-Achaemenid rural sites. After almost one century of scientific research on the Achaemenid period in Fars, we are finally able to better define what a ‘normal’ settlement was. Considering results from the Bulaghi Valley rescue excavations, the Achaemenid and/or post-Achaemenid settlements are rather isolated and quite small in size. Only one hamlet was revealed (Askari Chaverdi and Callieri (eds.), 2016) and villages are absent. The construction materials are too varied and specific architectural techniques cannot be assigned to this ordinary Achaemenid architecture. All these sites appear to be new foundations and the thickness of the archaeological deposit is often small with generally a rather short occupation phase. To resume their shared characteristics, the Achaemenid to post-Achaemenid settlements seem generally small, flat, and do not present a high density of artifacts or recognizable architectural features. It was only through systematic survey and study of the whole archaeological remains, driven by the threat of flooding, that archaeologists could have revealed this unexpected and rich landscape. In the framework of a regional survey, these morphological characteristics make these sites difficult to find and record. This itself could explain why the map of the Achaemenid sites in Fars seems so “empty”. Only systematic and scrupulous surveys of all field and foothills are able to reveal this type of settlement.

In the present landscape, the most visible evidence for the territorial improvement of the Tang-i Bulaghi are canals. Taking into account the above-described archaeological context, the construction of these water infrastructures may have been simultaneous to the Achaemenid phase of the valley’s important development. However their period of use still remains to be more accurately dated. Subsequently, and thanks to a collaboration of the Iranian-French project with the Ghent University (Belgium), a synthetic study of hydraulic features was carried out in the Pasargadae region on several sites and mentioned by W. Kleiss (1988; 2000). It revealed segments of a particularly rich waterscape around Pasargadae (Wilkinson *et al.*, 2012, p. 165-167). In 2008 and 2009, rescue excavations and pluri-disciplinary studies were carried out on two dams located upstream of the Pasargadae plain and threatened by modern activities: Sad-i Shahidabad and Sad-i Didegan (De Schacht *et al.*, 2012). Both dams have regulating systems of sluice gates, which were excavated and were built with ashlar blocks without mortar. It was suggested that these dams regulated the flow of the Pulvar River and of its tributaries upstream from the Pasargadae plain, probably for preventing flooding and securing water inflow for farming. Architectural studies and conclusive C14 dating carried out on these dams proved they belong to the Achaemenid period (De Schacht *et al.*, 2012, p. 93-Tab.1). These data show the potential of studying ancient water infrastructures for reconstructing past landscapes in the Pasargadae region. Being massive constructions, they are among the well preserved remains of the past territorial development.

Previous rescue archaeology programs also included the first attempt at regional palaeoenvironmental studies. Geomorphologic analyses demonstrate important changes in the river regime during the Holocene era. This study is critical as river regimes impact the availability of water as well as regional landforms and arable land availability through the creation of alluvial terraces (Rigot, 2010; De Schacht *et al.*, 2012). Terraces may also have covered the earliest settlements as demonstrated by the Chalcolithic ones in the Bulaghi Valley (Helwing, Makki and Seyedin, 2010). These preliminary data also provided evidence of the anthropogenic impact on the natural landscape by the regulation of water courses or by removing and changing the vegetation assemblage.

### *Current program (from 2015) of the joint Iranian-French archaeological project on the territory of Pasargadae*

As mentioned in the introduction, for the Achaemenid period, the lavish royal monuments of Pārsa cannot be entirely interpreted without regional contextualization. In the particular context of the Pasargadae region, our main conclusion concerning the Bulaghi and Pasargadae archaeological projects is to demonstrate the potential of the area for creating landscape archaeology programs. Thus detailed by Boucharlat (2014b, p. 53-57), these contributions henceforth lead us in implementing further multipurpose and pluri-disciplinary (excavation, survey, and palaeoenvironmental study) programs integrating both the local and regional scales.

In the framework of the second phase of the joint Iranian-French project in the Pasargadae region, we put into place a renewed archaeological project focusing both on the protected area of the capital and its immediate surroundings as well as on its whole territory, i.e. the Pasargadae plain (Gondet *et al.*, 2016). Our goal is to assess the impact of the founding of Pasargadae on its surrounding landscape by aiming to reconstruct the regional dynamics on the *longue-durée*, before and after the Achaemenid period. In the following parts, we will focus on the 2015-2017 fieldwork applied at the territorial scale while at the same time extending the mapping of the Pasargadae site. Set aside after the 2008 campaign, this latest mapping work on Cyrus' capital combines geophysical, topographical, and surface pottery sherds analyses. The obtained results on Pasargadae will need to be incorporated into a comprehensive and multi-scale reconstruction of the regional landscape. We have already shown that its extent is larger than the core protected area inscribed to the Unesco World Heritage List and its open layout avoids defining a clear limit between the site and its territory.

The current program on the territory of Pasargadae is based on the above-detailed reassessments of existing evidence for beginning a regional landscape archaeology project adapted to the particular environmental and archaeological context. It is also in line with the three main research topics designed after the former Bulaghi project that highlighted the potential for combining analysis of settlements and water infrastructures networks as well as palaeoenvironmental changes. Compared to the previous scattered work, all the studies are gathered within a same program following shared objectives in order to comprehensively reconstruct the past landscape. Methods and purposes have also been extended towards new approaches to the archaeological landscape of the Pasargadae region. We implement a fieldwork program integrating: systematic pedestrian surveys, analysis of hydraulic infrastructures, and geoarchaeological and palaeobotanical studies (Fig. 1). Linked to one another, research objectives are the following:

(1) Concerning the regional survey, the goal is to draw the archaeological map of the surroundings of Pasargadae from the Tang-i Bulaghi gate to the south towards the hill ranges north of Pasargadae. From 2015 to 2017, we systematically surveyed areas mainly located on the right bank of the Pulvar River. In order to add to the archaeological map, we recorded all the visible remains on the surface in a diachronic way which should allow us to reconstruct long-term occupation dynamics around Pasargadae and to evaluate the impact of its foundation on the regional settlement patterns. We also intend to extend our investigation towards the hilly areas where funerary remains are dominant. Consequently, we divided the regional archaeological survey into two complementary tasks: settlement analyses in the plains and on the foothills and funerary landscape analyses in the hill ranges. The goals are to evaluate if the settlement patterns observed in the Tang-i Bulaghi does indeed extend towards the Pasargadae plain and also to approach the rarely studied topic of how funerary practices evolved.

(2) The study of the preserved remains of water infrastructures, dams and canals, is based on their geographical analysis of hydraulic infrastructures through accurate mapping and their contextualization within the regional hydrology. We also sampled sediment on these constructions for more precise dating through the OSL method. This task started in 2017 and focused on all the hydraulic remains located downstream of the Shahidabad and Didegan dams, investigated in 2008-2009. During this first campaign, we focused our effort on the long canal called Dju-i Dokhtar running east of the Pasargadae



plain as well as on two dams located upstream, Alafi 1 and 2. The final objective of this task is a systematic re-evaluation of the Pasargadae regional waterscape, including the canals of the Bulaghi valley, in order to determine if the hydraulic remains shaped together a contemporary network developed at the scale of the Pulvar watershed or if they correspond to distinct local needs for water as well as distinct phases of water resources management.

(3) The palaeoenvironmental studies aim to continue the geoarchaeological analysis started during the Tang-i Bulaghi project and reconstructing more accurately the Holocene river dynamics. In 2016 and 2017, sediment sampling, stratigraphic section studies, and topographic work were carried out on river terraces of the Pulvar River at two strategic points: the first 4 km upstream from Pasargadae; the second downstream in the Bulaghi Valley. Hereafter, tributaries will also be included in this geomorphological study. At the same time, the topic of the history of regional vegetation in the Pasargadae region is of critical importance as change in the vegetation cover may help to explain river dynamics. Palaeobotanical data are also proxy on the anthropogenic impact on its environment through the introduction of cultivation practices and or grazing. In 2016 and 2017, two soundings were opened at Pasargadae, into the sedimentary filling of a large pond revealed by the geophysical survey made southeast of the Royal Garden. Sediment was collected for pollen analysis and to help reconstruct the local vegetation history, on the scale of the Pasargadae park, as well as the regional vegetation history. One of the main questions concerning environmental changes is their accurate chronology. This topic is a common issue to all tasks because it challenges our ability to accurately link human and environmental dynamics in order to determine a comprehensive reconstruction of the Pasargadae landscape history.

## **Pedestrian surveys and archaeological mapping around Pasargadae**

### *Settlement patterns*

Systematic pedestrian surveys carried out from 2015 to 2017 around Pasargadae led us to record 64 settlement sites (Fig. 2). The visible remains are mainly of two natures: ceramic scatters and/or foundation walls visible on the surface. Concerning the dating of the settlements, pottery sherds are the main material to be taken into account. During the pedestrian survey phases, we estimated the dating within broad chronological ranges. During the following campaigns, we aim to concentrate on the systematic collection and analysis of pottery sherds on strategic sites, i.e. those presenting artifacts related to the 1<sup>st</sup> millennium BCE. The identification of sherd assemblages is another research question we face in absence of an accurate regional pottery typo-chronology. For the 1<sup>st</sup> millennium BCE, we approach this question through systematic collections and afterwards a relative analysis of surface sherd assemblages at Pasargadae (Gondet *et al.*, 2016). This information will be combined with comparative studies of material coming from excavations in the area (Tol-i Takht hill and Tang-i Bulaghi) or in the Fars region (Persepolis West, cf. Askari-Chaverdi and Callieri (eds.), 2017, and Mamasani District, cf. Potts *et al.* (eds.), 2006). This work will serve as a reference for correlating settlement dynamics at Pasargadae with those in its surrounding territory. In the framework of the current phase of mapping archaeological remains, we date the sites respectively from three broad periods: Chalcolithic/Bronze Age, Achaemenid/post-Achaemenid, and Islamic. A fourth category corresponds to sites where we are not able to estimate dating because of a lack of recognizable artifacts on the surface.

There are few sites supposedly Achaemenid, and/or post-Achaemenid. Within a circle of about 2 km around the Pasargadae protected site, 11 sites are assigned to this period. The densest concentrations of Achaemenid/post-Achaemenid settlements were recorded east of Pasargadae. They correspond to 6 areas of ceramic scatters in the cultivated fields. They might be remains of inhabited sectors linked to the Pasargadae development towards the Pulvar riverbed. Similar to the above description from the Bulaghi valley excavation, the 5 remaining Achaemenid/post-Achaemenid sites are generally small, the

largest being 0.5 ha. However pottery densities are often difficult to be accurately mapped since they correspond to loose pottery scatters most often located in cultivated fields, the subsurface being usually very disturbed by successive farming work. Due to the present ‘landscape of destruction’ context, it is hard and time-consuming to find the remaining traces of such settlements which have left poor traces on the surface.

From preliminary data analyses, it appears that hillsides and fields north and north-west of Pasargadae were settled mostly from the Islamic periods. In the other directions, the chronology of the settlement dynamics is broader, especially around the protected Pasargadae site where several Chalcolithic to Bronze Age sites have been recorded. Apart from the east side of Pasargadae, where artifact scatters could be related to sprawling ‘urbanized’ areas around the royal constructions, it is still hard to produce a comprehensive overview of the 1<sup>st</sup> millennium BCE regional settlement patterns. The network of settlements seems at least sparser than the one recorded in the Bulaghi Valley. On the one hand, it might be explained by taphonomic processes. In terms of settlement dynamics during the 1<sup>st</sup> millennium BCE, it might also be interpreted as a process of the concentration of human activities around large sites like Pasargadae, and eventually Miyan Djade, located some kilometers to the south-east and which will be more detailed below. However concerning the settlement patterns, the data still needs to be completed in order to be further interpreted. The results of the present pedestrian surveys are to be considered as bases for implementing further studies like geophysical or topographical surveys or surface material collection necessary to better characterize the chronology, morphology and function of the settlements.

### *Funerary landscape*

We focused the survey of the funerary remains on ranges located north of Pasargadae (Fig. 3) where tomb remains are particularly numerous and have never been systematically surveyed and recorded.<sup>7</sup> This task will allow us to build a complete overview of funerary practices in the region because this topic remains poorly documented in Fars province.<sup>8</sup> Cairn-like remains dominate the funerary landscape,<sup>9</sup> with 585 of them recorded during the 2015-2017 campaigns. In addition, we recorded 27 subterranean graves not marked by cairns and well preserved from looting. Because they are easily visible, the cairns were almost all looted and partly to fully destroyed. Consequently, only through systematic surveying, description, and study of the last remaining surface material and architectural features of the cairns will we be able to provide a consistent dataset for documenting funerary practices and their dating.

Five main areas, or fields, of cairns were recorded. They are distributed over five hill ranges located north and north-east of Pasargadae. A sixth area was mapped south-west of Pasargadae near the Bulaghi valley gate.<sup>10</sup> Preliminary analysis of data allows us to observe recurring organization patterns. The cairns are mainly located on the hillsides adjacent to the flat and arable lands of the plain. The

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<sup>7</sup> Located north of Abolvardi village, the archaeological remains from the Tol-i Gholam hill range were first mapped by Yamauchi and Nishiyama, 2009, p. 204-210. They produced two maps of the area showing numerous cairns: *ibid.*, p. 206-Fig. 11.21 and 207-Fig. 11.22. However, *ibid.*, p. 173 do not add details beyond the survey methods combining remote sensing with satellite images and field cross-checking. Since the areas systemically surveyed in the field are not defined and the gazetteer of recorded sites is not published, we decided to systematically resurvey the area.

<sup>8</sup> See the synthetic overview of funerary practices in Ancient Iran by Farjamirad, 2015, p. 5 and 11 on the rarity of data observed for Fars. Lack of data on the particular Pasargadae/Morghab Region is observed by Boucharlat, 1989, p. 682.

<sup>9</sup> They are defined as above ground burials made of stone piles; see Farjamirad 2015, p. 11-36 for an overview of the characteristics of cairns and their evolution from the post-Achaemenid period, and Boucharlat, 1989 for an attempt at cairn typology.

<sup>10</sup> Yamauchi and Nishiyama, 2009, p. 179-181 mapped many cairns on the Bulaghi valley bottom and its slopes. They were already reported by Stronach, 1978, p. 167 and dated back to Parthian period. See also Atayi and Boucharlat, 2009, p. 29 for cairns built on Bulaghi water canals sections. Cairns on the Bulaghi valley bottom prove that these funerary constructions were not restricted to higher grounds.

largest cairns, up to 14 m in diameter, stand on hill tops and crests, the smaller ones on slopes. In 2015, human bones were collected on the surface in some of these cairns, located north of the Abolvardi village, and teeth were selected for dating. The two C14 results provided dating from the post-Achaemenid/Early-Parthian to Late-Parthian periods.<sup>11</sup> This result is compatible with rare diagnostic potsherds that we recovered from cairns in the same area. The most interesting find was a piece of painted pottery known as “festoon ware” that could be dated to the post-Achaemenid and Seleucid period. Other C14 analyses are planned on the human remains collected in 2016 and 2017 because more dating is needed for securing the chronology of cairn usage. Archaeological data on funerary remains and spatial analysis of survey results may complete the lack of information for occupation periods from post-Achaemenid to Parthian, poorly documented in Central Fars.

### **Approaching hydraulic infrastructures in the Pasargadae plain**

Downstream of the Shahidabad and Didegan dams (Fig. 1), remains of hydraulic infrastructures are numerous but still not fully studied.<sup>12</sup> We started our comprehensive research on past waterscapes by carrying out surveys and mapping of Dju-i Dokhtar, both from fieldwork and aerial images. This canal and its related features were known (Stronach, 1978: Fig. 3-Islamic canal; Karami and Talebian, 2013, p. 231-232 and 236-Map 9) but accurate archaeological data and a comprehensive analysis were still lacking. We will focus below on the 2017 cartographic work of this construction, the first step of a broader study integrating geoarchaeological data on past hydrological dynamics of the left bank of the Pulvar River, as well as a geographical analysis of catchment basins drained by the Dju-i Dokhtar canal. During the 2017 mission, we carried out surveys along its whole course and mapped its preserved parts from the field (Fig. 4). We designed longitudinal profiles for calculating the canal’s slope and cross-sections for understanding building techniques. For the destroyed parts, we completed the mapping thanks to the 1960s CORONA satellite pictures taken before the construction of the motorway and railway that were the main reasons only parts of the canal remain today.

The Dju-i Dokhtar canal was supplied by one of the main right bank tributaries of the Pulvar. Near the valley end of this tributary, about 4.5 km north-east of Pasargadae, we found remains of a small dam, built in the streambed and made by a mix of earth and stone preserved in sections of the river terraces. Next to this dam, we mapped parts of the stone-built water inlet. Downstream, the canal followed the foothills. Its course was no more than 17 km long ‘as the crow flies’, but its main path, following level lines, was 28.8 km long, 35 km in total when counting the doubled and tripled sections. We observed that its course split into two or three branches when reaching non-permanent side streams. The second upper course may have served for collecting rainwater runoff flowing from these streams. We estimated an average canal slope of about 0.88 m/km (0.088 %), based on the altitudes of its inlet and outlet. At its beginning, the canal base was stone-built and 1.5 m in width. Then the canal became gradually larger and was exclusively dug into the ground. About 3 km from the outlet, the canal is about 4 m deep while it crosses higher hills. At this location, the channel with its embankments reached a maximum width of 70 m. These observations demonstrate the huge investment in building this canal as well as knowledge in water engineering. Regarding its chronology, a large section that was cut across the canal when building the motorway allowed us to collect sediment samples from the infilling and the embankment for OSL dating, which are still being processed. The outlet of the canal corresponds to a reservoir upstream of the badly damaged Saadat Shahr dam. This dam has a north-west/south-east orientation; it is 500 m long, about 40 m in its maximum preserved width, and between 7 and 8 m high. The dam is built upstream the gate of a narrow gorge leading to the downstream Saadat

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<sup>11</sup> Dating provided by the University Lyon 1 CDR on cairns PPS-C-15101 and PPS-C-15124. Samples yield ages between 361 and 168 BC for the first cairn and between 25 and 175 AD for the second.

<sup>12</sup> In the Tang-i Bulaghi, soundings were opened across water canals, providing data on these constructions, cf. Atayi and Boucharlat, 2009, p. 23-32.

Shahr plain and might have regulated water inflow of one of the main tributaries of the Pulvar river coming from the south-east. The large antique dams in the Pasargadae region were systematically built upstream of each of the intermountain sedimentary plains and designed a water management plan maybe conceived at the scale of the Pulvar River catchment basin. We hope the campaign of sediment sampling for OSL dating carried out on all the dams will allow us to discuss this hypothesis in terms of chronology.

Located halfway along the canal and connected to it, the Miyan Djade site appears as a major site (Fig. 5). Between 2005 and 2007, the team of the Pasargadae World Heritage Conservation and Research Center made test soundings and geophysical surveys in the framework of a rescue archaeology program implemented while the site was badly damaged by the construction of a gas station and further farming development (Zareh Kordshuli and Mohammadi, 2012). Limited in size, the soundings brought to light few architectural remains but a huge number of pottery sherds, mainly storage jars, which the excavators dated back to the Achaemenid period. As precise dating of this type of common ceramic is still difficult, we might only consider the ceramic assemblage related to the historic periods. Like for the canal's course, 2017 mapping work was established by combining fieldwork and analyses of older aerial images<sup>13</sup> taken prior to major disturbances.

Miyan Djade is a large site that extended over more than a hundred hectares. It consists of a combination of square and rectangular buildings of varied sizes, canals and ditches, pottery scatters, and one mound on the western part (Fig. 5). The clearest features are a complex of four square buildings, probably for storage, given the large amount of storage jar fragments found both on their surface and in looting holes. Beside these buildings to the east, long features, corresponding to very low dykes in the field, followed a rectangular grid. The east side of this construction overlaps the western Dju-i Dokhtar canal course, which is doubled near Miyan Djade, even tripled on a very short distance. The easternmost and larger canal course is connected with a perpendicular one, running east to west into the site and probably supplying other facilities, possibly hydraulic, visible on the aerial pictures and located south-east of the tepe. We may observe that the morphology of the site is quite unique for the region. Its characteristics, especially its size, are very different from what appeared in the Bulaghi Valley or the Pasargadae plain where Achaemenid to post-Achaemenid settlements are rather small. As a preliminary interpretation, we suggest a large farming estate connected to and watered by the canal.

Better dating of this settlement is of critical importance. We will approach this topic through forthcoming studies of surface artefacts combined with a reexamination of excavation materials. Besides revealing their building chronology, dating will enable us to understand the relative chronology and the links between the Saadat Shahr dam, the Miyan Djade site and the Dju-i Dokhtar canal. The latter could have been built specifically for supplying water to the Miyan Djade estate as well as the downstream reservoir; on the contrary, the Miyan Djade development may have taken advantage of a previously existing canal and the purpose of the downstream dam may initially have been only to control natural stream inflow. Then, results from the OSL sampling campaign on the canal and the dam, begun in 2017, should bring chronological data allowing us to understand if all the above hydraulic infrastructures belong, or do not belong, to a connected water system.

## **Analysing palaeoenvironmental data**

### *Geomorphological analysis of fluvial landforms in the Pasargadae plain*

Started in 2016, the main goal of the geoarchaeological study is to contextualize ancient settlements within the late Holocene geomorphology. The main elements that have shaped and reshaped the natural

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<sup>13</sup> An attempt for mapping the site with old aerial images is published by Zareh Kordshuli and Mohammadi, 2012, p. 85-Fig. 2

landscape for the last 10,000 years are the Pulvar River and its tributaries. In this context, our first objective is to characterize and date the successive phases of the plain's alluvial deposits that shaped the terraces along the riverbed. There is a correlation between the characteristics of the river terraces and the evolution of the river regime. On the one hand, their thickness informs us about the evolving water level through the millennia. On the other hand, their building and erosion phases reflect the main changes in the regional geomorphology. They are linked to the volume of sediment carried by the river, depending both on the river flow and the erosion rate in the catchment basin. Both factors may have natural and/or human origins and are proxy data on the evolution of the surrounding landscape. As an example, sedimentation and terrace building periods may be related to a decreasing vegetation cover due to clearing and/or overgrazing on reliefs surrounding the river.

The first geoarchaeological studies were carried out along the Pulvar River in the framework of the Tang-i Bulaghi rescue program. This preliminary study (Rigot 2010) allowed us to determine three main phases of sediment deposit in the Pasargadae plain that led to the building of three terraces stretching along the Pulvar riverbed (Fig. 6). The highest terrace (T1) which shaped the present mean level of the plain began to uplift 8000 before present (BP), around the Chalcolithic period. This result is consistent with those obtained in the Tang-i Bulaghi valley revealing the presence of a Chalcolithic site covered by fluvial sediments (Helwing, Makki and Seyedin, 2010). The second and lower terrace (T2) started to uplift around 1000 BP. The third terrace (T3) is made of sediment presently deposited by the river. Recent C14 dating<sup>14</sup> on charcoals sampled in the T1 Holocene terrace section under the Shahidabad dam gave new data about its final phase of building. Approximately two meters below the surface of the terrace, a date of 2500 BP has been obtained and constitutes a *terminus post quem* for the subsequent deposits. A date of 4000 BP one meter below is also likely. We may conclude that the flood sediment forming the upper part of T1 was deposited quickly, during just a few centuries, after 2500 BP, that is to say during the second half of the 1<sup>st</sup> millennium BCE. Consequently, during the Achaemenid period, the plain level may have been slightly lower and the riverbed higher than present. The above-suggested scenario, based on C14 dating obtained on charcoals sampled in the terraces sections, still needs to be better defined. However, because of working in a semi-arid environment with a low vegetation cover, the available number of charcoals is insufficient to accurately reconstruct the sediment infilling dynamics of the plain between 8000 and 1000 BP. Then from 2016, we decided to experiment with another method, namely OSL based on the dating of the last exposure of the sediment to sunlight. We focused on sampling terrace sections located in the Tang-i Bulaghi valley where they are particularly well-developed and reach 16 m in height. A fine sampling was obtained by taking sediment at each meter in order to get a precise chronology of the terrace uplifting. Like for the hydraulic features, the OSL dating for geoarchaeological purposes is still being processed. Finally, the main phases of development of the present landforms should be better assessed and we will be able to link them to the human occupation history as reconstructed through current archaeological surveys.

#### *Pollen-based vegetation history*

The objectives of palynological investigations in the Pasargadae region are to reconstruct the vegetation history at local and regional scales. The Pasargadae plain was certainly extensively farmed, at least since the Achaemenid period, with possibly a permanent grazing pressure on the surrounding natural vegetation. Thus, we aimed to reconstruct the history of cultivated species as well as of the natural vegetation cover that may explain some of the geomorphological observations concerning change in sediment transported by the Pulvar river.

In the Pasargadae region, the main challenge was to sample suitable sediment archives with a taphonomic history permitting good pollen preservation. Normally, lakes, marshes, and peat bogs are

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<sup>14</sup> Dating provided by the University Lyon 1 CDR and by the University of Salento CEDAD on charcoals sampled in river terraces during the 2016 campaign.

the usual main sediment archives sampled for pollen analysis. Pollen investigations in lake sediments from the Fars province has already proved to be a critical source of information for reconstructing the history of farming practices (Djamali *et al.*, 2011). The closest surroundings of Pasargadae are not home for any suitable wetland systems for such studies. However, our research on the Pasargadae site brought to light a potentially good sediment archive. The 1999-2008 geophysical survey revealed that the Royal Garden of Pasargadae was edged by a large, man-made trapezoidal basin of about 1.5 ha (Benech, Boucharlat and Gondet, 2012, p. 13-19). This basin was certainly filled with water and even after the Achaemenid remained a wet area. Since it is located next to the Royal Garden, the pollen analysis in the sediment infill was carried out to better reconstruct both the floristic composition at the garden scale and the vegetation change at the regional scale.

Soundings 1.5x1.5 m in size were dug into the infilling of the basin in two different places. We sampled sediment at intervals of 10 cm from the soil surface down to 210 cm depth. The results from one sounding, opened in June 2016, are partly available (Fig. 7). Combined with mineralogical analyses, the pollen study demonstrated changing humidity conditions and bad taphonomic conditions for the preservation of pollen grains in the basin. The pollen spectra suggest the presence of both pastoralism and cereal cultivation. Arboriculture is less evident but this is most probably related to taphonomic processes that destroy more tree pollen than natural steppic plant pollen. At a depth of around 170 cm, a layer rich in pollen grains from various species was analyzed, with possible occurrences of cypress or juniper trees. Pollen from aquatic and subaquatic plants suggests that the basin area was, at least seasonally, inundated. For example, we noted the presence of aquatic/subaquatic plants (*Sparganium*-type, *Cyperaceae*, *Riella*, and *Polygonum aviculare*-type). Subsequently, long dry seasons may have caused the basin area to dry up and the damage of pollen grains in the sediment. In the pollen assemblage, the high percentages of pollen from *Asteraceae* family (*Asteroideae* plus *Centaurea*) indicate bad preservation conditions for pollen grains.

We face the question of dating the sampled deposits. Three C14 dates obtained in the 2016 soundings present an age inversion maybe caused by contamination of charcoals, older or younger, coming from further away through fluvial transportation. Consequently, it is more difficult to establish a solid chronological framework for pollen analysis. As was the case for the river terrace, the samples we took in 2017 for OSL dating in the soundings are still being processed. Also, facing the problem of pollen preservation at Pasargadae, we plan to complete the spatial coverage of the sampling points on the site. As a matter of fact, other experiences in pollen investigation in Iran show that small changes in the water-logged conditions, i.e. duration of annual inundation, play a fundamental role in the pollen differential preservation.

### Concluding remarks

The landscape archaeology program in the Pasargadae region is in a preliminary phase. Fieldwork and data analyses are ongoing. During the next campaigns, we will complement the data by: working further on surface material and mapping the sites recorded during pedestrian surveys, extending the archaeological map around Pasargadae, mapping still undocumented hydraulic facilities, and sampling sediment deposits in and around the plain for geomorphology and palynology. We also plan to introduce other methods of landscape study like remote sensing analysis. We obtained complete, recent satellite image coverage of the region (SPOT and Pléiades)<sup>15</sup> and a research mission to explore the historical aerial pictures from the E.F. Schmidt archives at the Oriental Institute of the University of

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<sup>15</sup> Thanks to the GEOSUD, a project (ANR-10-EQPX-20) of the program “Investissements d’Avenir” administered by the French National Research Agency, and of the program “Initiative for Space Innovative Standards” (ISIS) of the French Centre National d’Études Spatiales (CNES).

Chicago was carried out in February 2019.<sup>16</sup> Aerial and satellite images are useful documents for large-scale mapping of the natural landscape as well as, with the oldest ones, for revealing archaeological features that have disappeared. All these data are complementary pieces for reconstructing as comprehensively as possible the ancient landscapes. As a matter of fact, settlement patterns are closely linked to water management which depends on water availability and changes of river regime; river dynamics could be explained by vegetation history; and vegetation history informs us on farming practices by people living in settlements.

Data obtained in the Pasargadae region until 2017 are encouraging and lead us to the following preliminary conclusions. The water facilities design the backbone of the occupation pattern in the Pasargadae region. Irrigation in semi-arid and mountainous areas is necessary for developing territories and huge investments were made for building water facilities. In the present landscape, they are the most well preserved remains of the regional development and deserve thorough study. The main challenge is their dating, but the OSL method should provide us with accurate chronological data. The regional occupation reconstruction and chronology is still incomplete and we face the intricate question of dating settlement and funerary remains. However, after three campaigns, we continue to fill in the archaeological map step by step and demonstrate that the present landscape still holds potential. The latter is also the main result from the paleoenvironmental studies. The Pasargadae plain sedimentary archives contain information on the past environmental conditions as well as proxy data concerning the human impact on natural landscape.

The project we currently implement needs a team of specialists and especially time for research. There is a long process from the field survey and the definition of promising places to be studied until the final analysis of data, particularly in landscapes deeply impacted by modern activity. Nevertheless systematic and multidisciplinary approaches in the field, i.e., the landscape archaeology approach, are the only way for today’s archaeology to take part to the reconstruction of former complex territorial organizations that may be subsequently combined with data from textual sources.

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<sup>16</sup> An Oriental Institute Collections Research Grant funded the study of the archives of the Persepolis Expedition held in the 1930s.

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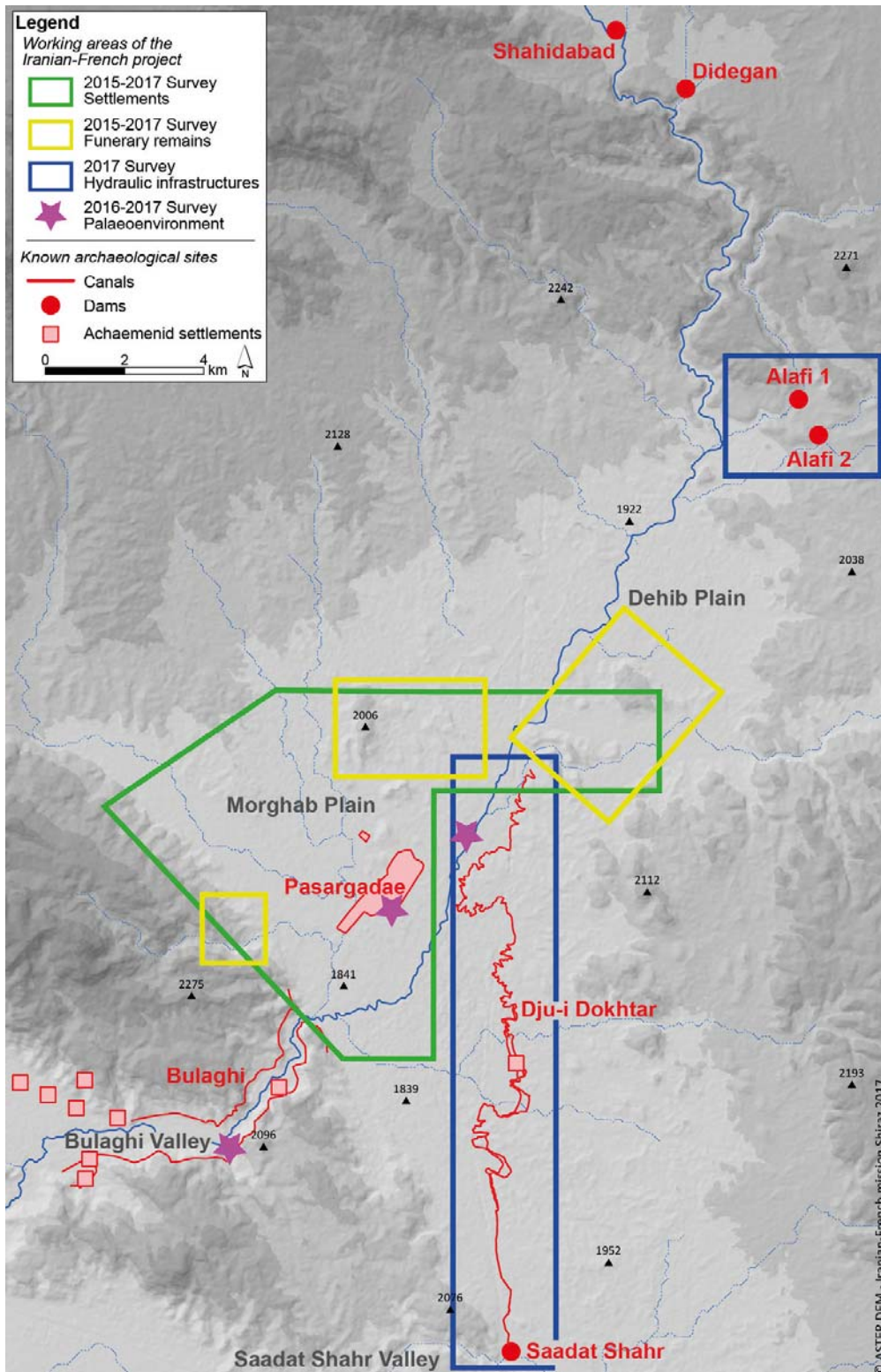


Figure 1: Map of the Pasargadae region, of the known hydraulic features and Achaemenid settlements prior to 2015, and location of the 2015-2017 Iranian-French project working areas.

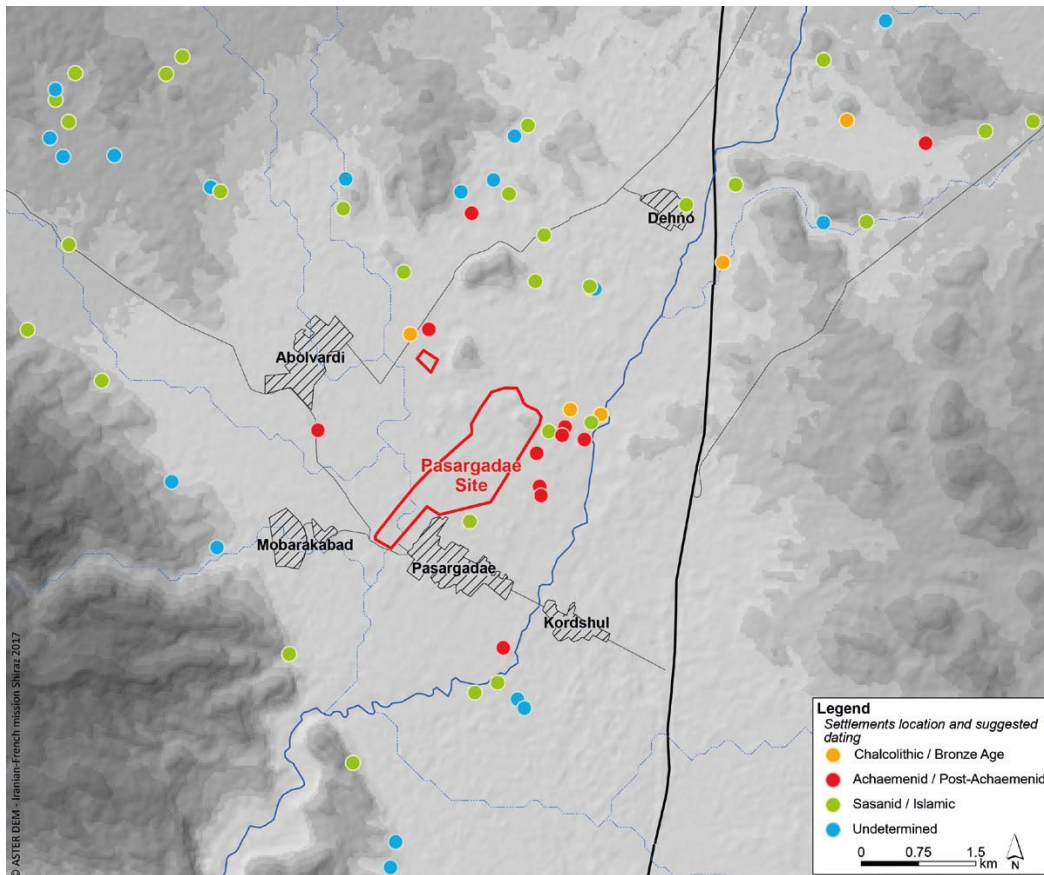


Figure 2: Settlements map in the surroundings of Pasargadae after the 2015-2017 campaigns.

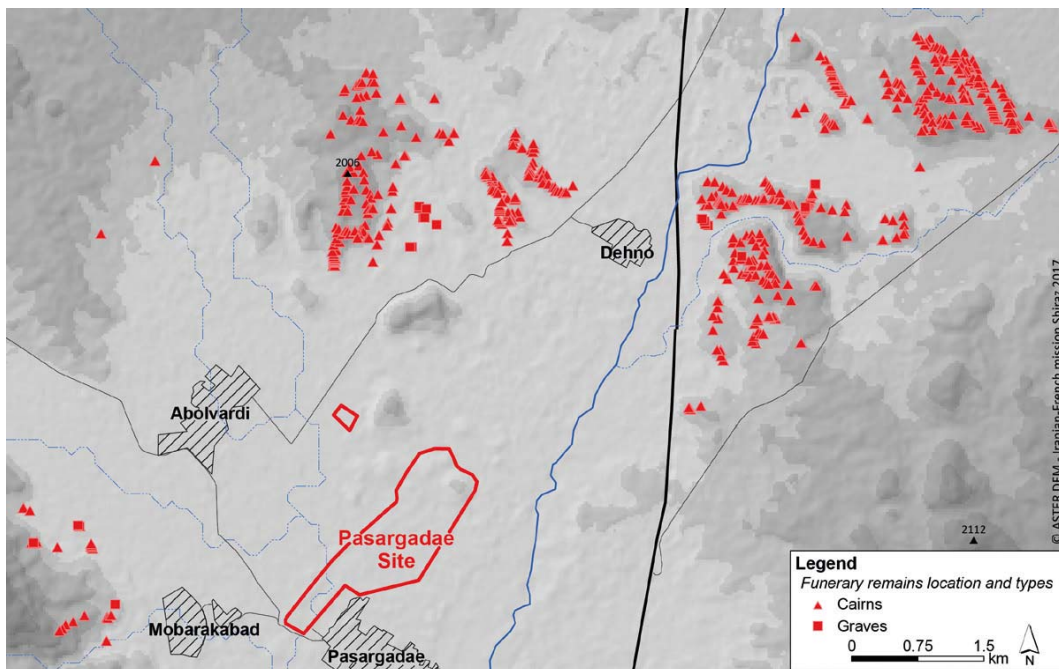


Figure 3: Funerary remains map in the surroundings of Pasargadae after the 2015-2017 campaigns.

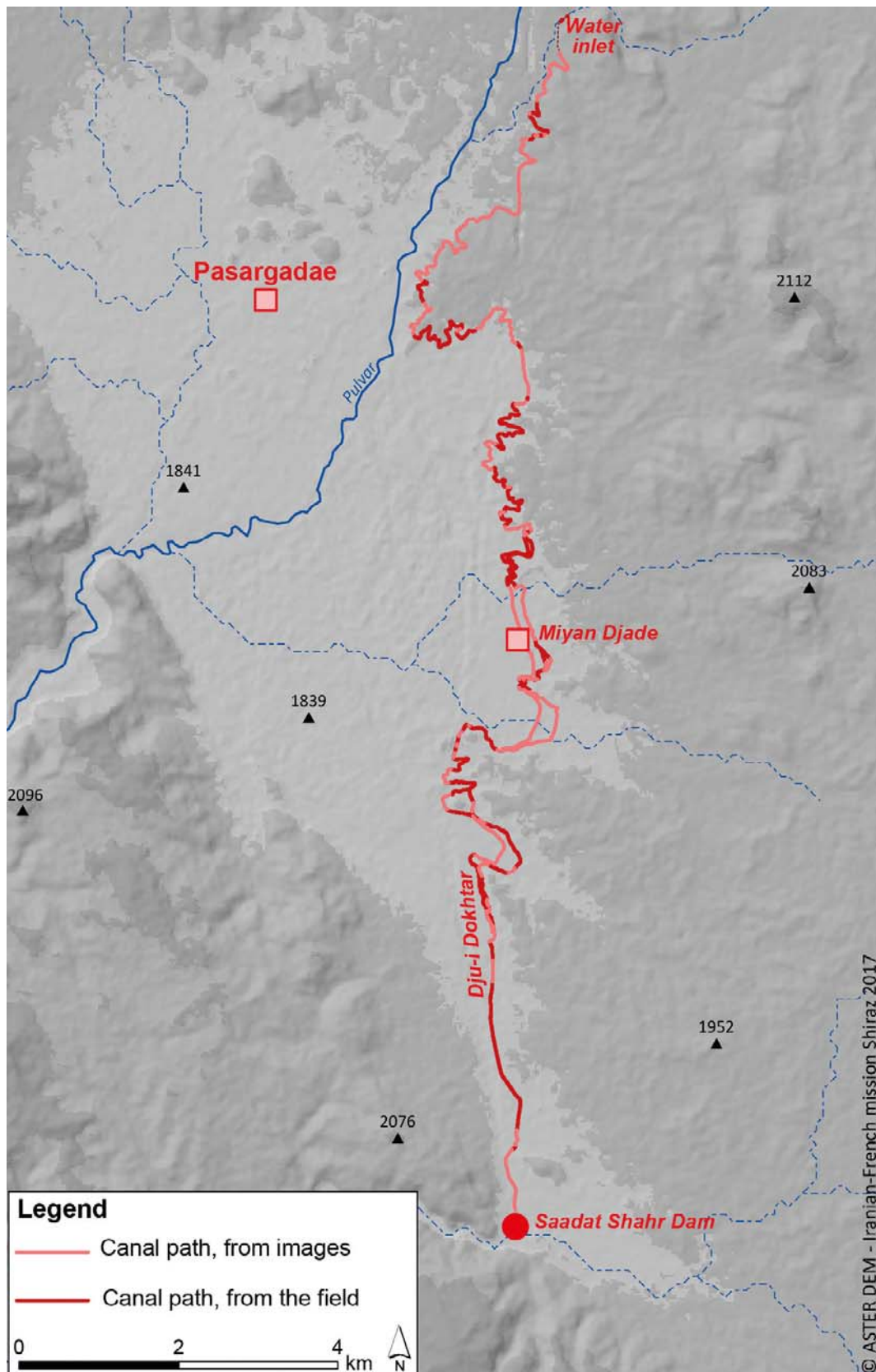


Figure 4: Course of Dju-i Dokhtar mapped from the field and from old aerial pictures.

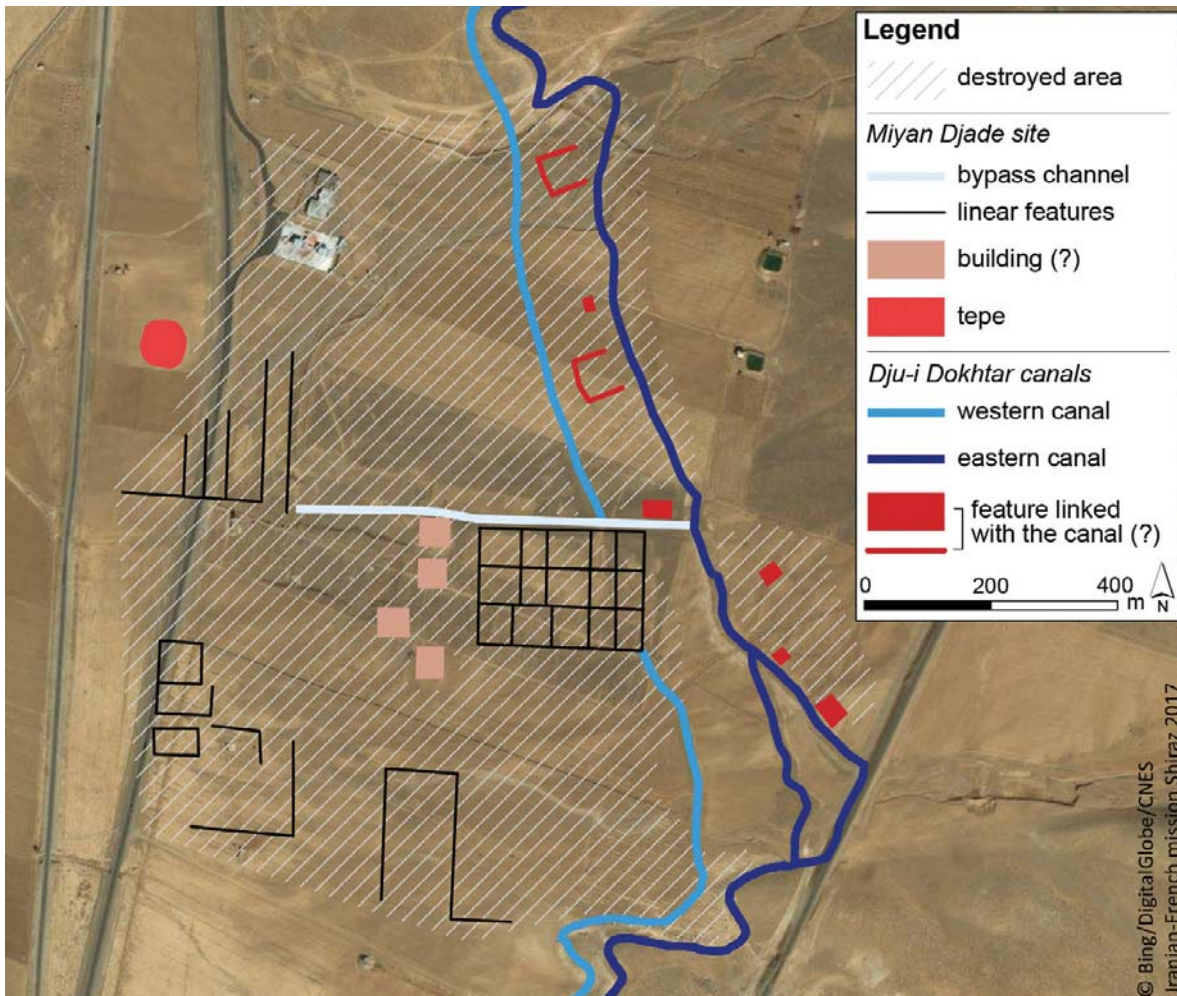


Figure 5: Superposition of features linked to Miyan Djade site as visible on the 1960s images with present-day satellite image.

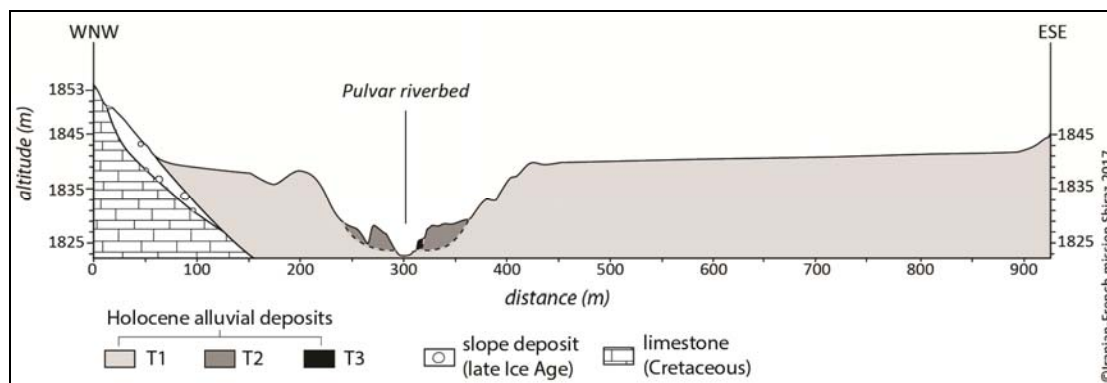


Figure 6: Overlapping Holocene Pulvar river terraces in the Tang-i Bulaghi valley.

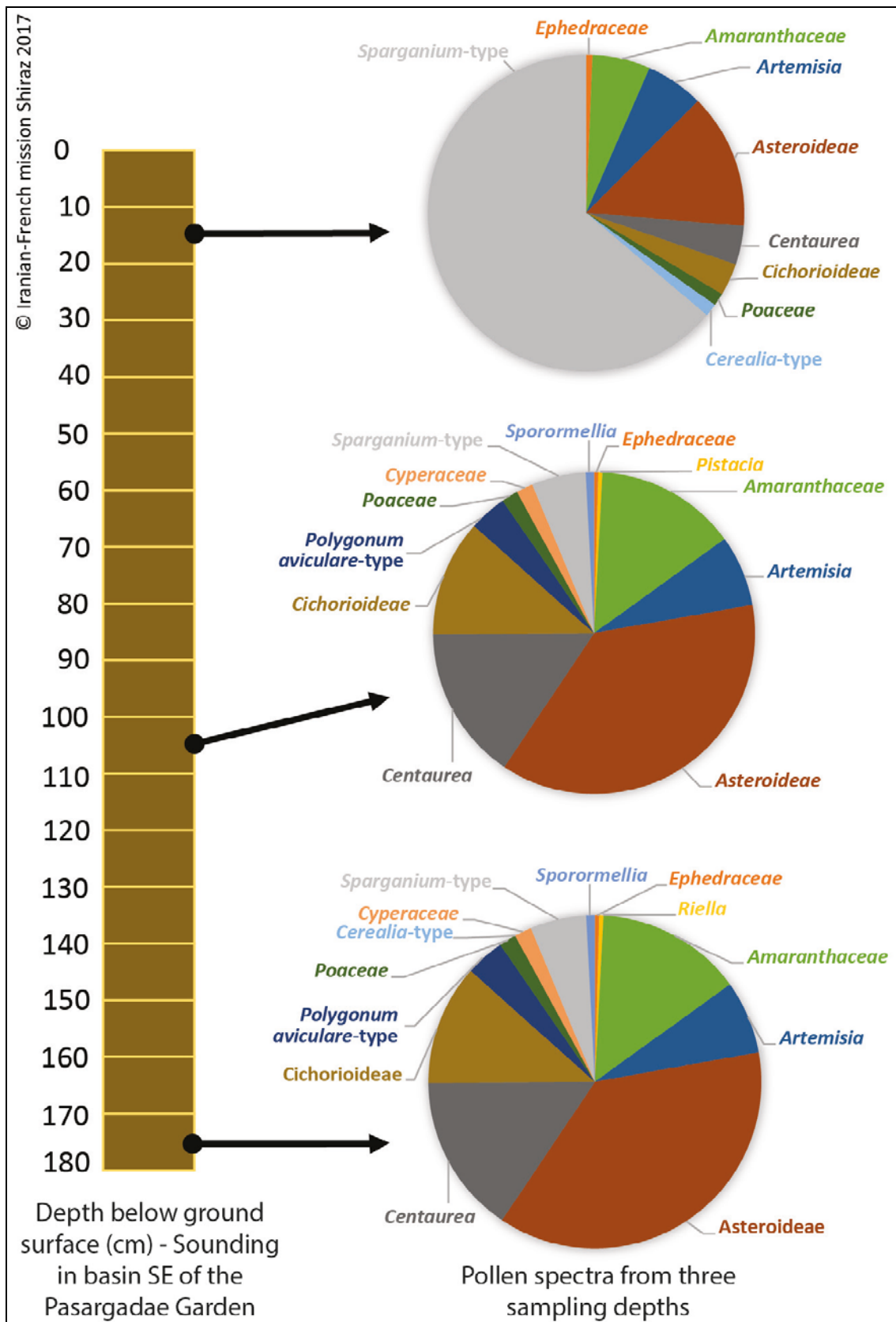


Figure 7: Pie chart of the main pollen types found in samples from a sounding at Pasargadae.