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Chapter 5

Defrag Memories: The 3D Spatial Analysis of the Remains of Commemorative Gestures in the Necropolis of Porta Nocera at Pompeii



François Fouriaux

Abstract The archaeological excavation carried out in 2018 by W. Van Andringa, T. Creissen and H. Duday at Porta Nocera, Pompeii, brought to light a new funerary enclosure. During the excavation, a homogeneous layer was unearthed right below the eruptive deposit layers of 79 AD. This stratum revealed several traces of occupation linked to the funerary enclosure. As the fine excavation of the artifacts proceeded, the position and form of every single fragment unearthed was methodically recorded *in situ* as a supplement to the multidisciplinary studies realised by specialists. This exceptional context of preservation enabled us to implement an innovative 3D spatial analysis of the objects and their fragmentation, in order to understand the nature and frequency of commemorative gestures at the human space-time scale. The use of digital 3D visualisation thus permits us to analyse and demonstrate the existence of certain ephemeral human acts that would otherwise not be perceived. Here, I present the method and first results, which will be integrated into a thesis directed by Prof. W. Van Andringa.

Keywords 3D analysis · Pompeii · Funeral gestures · Microstratigraphy

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5.1 Studying Microstratigraphy with 3D Technologies

In trying to define what archaeology means, we usually talk about space and time, and, more specifically, about space that records past actions. In fact, human activities can be observed in the arrangement and transformation of the material world. Material witnesses (Leroi-Gourhan and Brézillon 1972, 323) to these phenomena have reached the present age thanks to different forms of conservation (in the sub-soil, in architecture, in museums, etc.), whether the medium is a monument, an object, or the earth itself. Some of these material forms of evidence are direct, since they are the result of conscious constructions or modifications of matter. This is the case with inscriptions and paintings, but also with buildings and instances of destruction or rejection. By contrast, other forms of evidence are the unintentional consequences of actions, such as traces on surfaces or the seemingly random dispersion of fragments caused by a set of ritual or technical gestures or social behaviours. Through the study of these traces, archaeologists can approach a part of human history that could not otherwise be observed from other sources, even more explicit ones like texts and pictorial art. In fact, the attentive observation of traces allows us to analyse a very specific time frame, such as the slow and continuous temporality on the scale of a human life, which is not accessible in other ways. This is the temporality of gestures, which is ephemeral by nature. Here we must distinguish between the gesture (the movement of the action), the actor (the operator of the action) and the objects at work in the action (Leroi-Gourhan 1943; Mauss 1950). By studying the material traces produced by the action (in this case, the fragmentation of ceramics), it is possible to come nearer to the gesture. And through the study of the series of gestures, it is possible to come nearer to the practice of the actors in their differences and similarities (Bril 2018; Van Andringa 2021). It is therefore necessary to study the traces carefully, in their complete spatial extension, in an attempt to come nearer to the gestures and practices.

That said, archaeological methods of observation are subject to an important constraint that traditional 2D graphic documentation cannot resolve. This well-known constraint is the irreversibility of the investigative process, which makes archaeology a non-reproducible science. An archaeological site can be considered, from a geometrical point of view, as a volume made up of several entities (Harris 1997), namely the archaeological remains. In this sense, the archaeological site is an aggregate of a multiplicity of juxtaposed remains (Boissinot 2015, 14). In order to observe the relationship between the remains – and in this way understand their chronology – it is necessary to remove some of them, such that they cannot be observed afterwards. This means that, in the field, it is impossible to have a complete vision of the volume of a site, since some elements are hidden by others and others have already been irreversibly displaced by the archaeologist. Archaeologists elaborate successive views of this volume as the excavation progresses, but they never have a direct and comprehensive 3D view. Furthermore, it is necessary to individualise certain units from a continuous volume (i.e. the site), like an anatomist

making a dissection (Leroi-Gourhan 1986; Balm 2016), exploring the layers one by one. In order to understand the formation of the aggregate (Boissinot 2015, 17–33) of remains, it is necessary to classify the archaeological data by shape, function, position and, finally, chronology. By creating synthetic images of the volume, 3D technologies enable us to circumvent this constraint, making it possible to see all the remains in 3D at the same time, with either a complete view or a selected view (e.g. a section), as well as to see the site in its entirety with or without classification.

For this reason, in the last few decades, digital 3D technologies have undergone significant development and been applied extensively within the field of archaeology and cultural heritage. However, this has been done almost exclusively at the scale of monuments and objects. The use of 3D has thus been focused on comprehensive 3D survey methods, like photogrammetry and laser scanning, which are used to visualise monuments (or objects) as they are today, and methods involving 3D restitution and integration into present reality, which are used to visualise monuments as they may have existed at different times in the past. In a recent development, 3D technologies have come to be seen as a research tool that is useful for exploring restitution hypotheses in bulk and for presenting and explaining the inferences underlying the scientific discourse (Ferdani et al. 2020). Archaeological remains are entities that occupy a 3D space in a way that makes it essential to compare them in a real volumetric space in order to validate proposed interpretations and restitutions. For example, an architectural restitution must harmonise with the remains observed, with the environment and with other proposed restitutions. Furthermore, 3D technologies allow us to visualise, in terms of volume, the sequences of construction, destruction and occupation at a given site. In this way, the chronology is displayed as a series of fixed pictures, i.e. of static 3D models that represent the principal phases of the site being studied.

I maintain that digital technologies are useful not only for the purposes of presentation and restitution, but also for very accurate and complex studies, such as microstratigraphic analysis, in order to arrive at a different representation of time, one that is less sequential or at least closer to lived time. This is the reason why we have developed a recording method with a 3D survey that permits us to visualise microstratigraphic phenomena that cannot be seen in any other way. This method has been employed at the necropolis of Porta Nocera at Pompeii during the most recent digging campaigns, when specific questions made necessary an original approach to spatial analysis. Both the excavation and the study are still in progress. In this paper, I present the method employed and the first results.

5.2 Studying Commemorative Gestures

In 2017, in a chapter dedicated to the various forms of memories in the context of the necropolis of Porta Nocera at Pompeii, Henri Duday and William Van Andringa emphasised the distinction between burial and funerary monuments (Duday and

Van Andringa 2017, 75). The former, *sepulcrum*, is the framework where the dead body was deposited, while the latter, *monumentum*, is the edifice built to receive commemorations of the dead. These two constructions reflect two different modalities of the constitution of funeral spaces: on one hand, the need to build a structure to receive the deceased and, on the other, the need to create a space where commemorative acts can be performed. In this text, the authors make a distinction between commemorations which are put on display, like the dedications on the front façade, and personal and private commemorations, such as acts of libation. At the end of the ceremony, and perhaps with a certain frequency after that, gestures of libations and offerings were performed, leaving *in situ* materials used during the act. For example, in sector A of the necropolis of Porta Nocera, the meticulous excavation of three enclosures has revealed the repeated association of objects, such as lamps, *unguentaria* and goblets, with the tombs (Van Andringa et al. 2013). All of them were found broken, their fragments spread on the surface of the soil, around steles that signal the position of the tomb. The recurrence of this fact makes it possible to identify an intentional and systematic deposition of these artifacts linked with the commemoration ritual. Thus, certain types of objects, selected for their function in the ritual and their symbolic value, were broken at the end of the ritual and left in place (Van Andringa 2019).

When it comes to remains of this kind, we can observe a codified ritual practice that does not serve the purpose of long-term exhibition. In fact, the demonstration is the act itself, at the moment when it is performed. The resulting traces, such as the dispersion of the fragments, are not intentional, but nonetheless constitute a testimony to the completed commemoration that we can point to and analyse several centuries later. The attentive observation of these traces permits us to ask certain questions that could not be addressed by appealing to other sources. The first set of questions concerns the temporality of these ritual commemorations. How long after the burial were these gestures performed? What was their frequency? Was it standardised or did it depend on the individual's sensibility? The second set of questions relates to variations in the accomplishment of the ritual. Were individual variants or adaptations possible within the traditional framework of the ritual codes? If so, were they dependent on the social context? And were they the result of an evolution over time?

In order to answer these questions, we assume that, on the basis of the geolocation of the artifacts, it is possible to establish the chronology of the commemorative acts beyond the relative chronology of the constitution of the tombs. We presume that the positions of objects/fragments, when discovered, coincide with their original position, or are not very far from it. Therefore, even if they are found in the same stratigraphic unit, which is commonly interpreted as an indivisible temporal block, fragments can indicate different levels of deposition, slowly covered over by natural sedimentation. In this way, we assume that, on the basis of the 3D positions of the artifacts, it is possible to reconstruct micro-events, such as libations and other offerings, that do not have a significant impact on the space.

5.3 Enter Harris's Matrix

Starting from the twentieth century, following a method of description and recording borrowed and adapted from geology, archaeologists started to pay close attention to the organisation of layers and their stratigraphic relationship (see a synthetic presentation from Lyell (1830) to Wheeler (1954) and Kenyon (1952) in Harris 1997, 1–13; Balm 2016). Activities, both human and natural, modify the surface where they happen, adding or subtracting deposit. This succession of actions leads to an accumulation of the deposit in a logical sequence that can be reconstructed by deduction on the basis of the four stratigraphic laws formulated by Harris in 1979: the law of superposition, the law of original horizontality, the law of original continuity and the law of stratigraphical succession (Harris 1997). Thus, time (i.e. the chronological succession of facts) is, in a way, encapsulated in the deposit. From the meticulous observations and classifications of archaeological remains, and specifically their relationship in space, it is possible to reconstruct the chronology of a site. Consequently, the topology of the units, i.e. their geometrical relationship in three dimensions, allows us to understand the chronological development of an archaeological site and the succession of past actions. For example, we can observe the different stages of the creation of a funeral enclosure by establishing a relationship between the wall footings, soils and different levels of occupation. An additional law, or rather principle of interpretation, is inherited from geology, namely the law of strata identified by fossils (Harris 1997). This principle presumes that materials can be used to date the layer in which they are found.

With this in mind, the archaeologists record their observations in a set of standardised documents that are useful for the description of each step of the archaeological site constitution and, by extension, the chronology of the space studied. They then organise the information in a series of statements in order to produce a sequential analysis. Given that each step in the stratigraphic chronology is characterised by a modification of the physical space, such as the construction of a wall or the deposit of a layer, we can say that this method captures each major stage of the site. In this way, it is possible to follow the development of a site over the long term and understand the succession of events.

However, if we want to investigate actions, gestures and behaviours at the scale of human life, we must deal with another challenge: time is a continuous phenomenon, and hence representing it by means of a sequential schema is not adequate for all situations. Short, everyday actions do not appear in a stratigraphic matrix, because they are found in the same layer, i.e. the same stratigraphic unit. In this way, they are not recognised as events or actions. For example, actions that are produced on the surface of a soil are not perceived, because they are all included, in the best-case scenario, in a single unit described as an occupation layer. In our case study, all the steles of the tombs, to which the commemorative acts were addressed, were progressively submerged by sedimentation. This natural phenomenon led to maintenance operations being carried out in some cases (Duday and Van Andringa 2017), but in others the steles were progressively forgotten, as they sank into the ground.

All the traces and fragments resulting from the commemorative acts are flooded in the sediment, which, from the perspective of a traditional archaeological method, should be recorded as a unique layer. In a classical stratigraphic description, all these gestures are merged into a single stratigraphic unit, in a single moment. In other words, if we want to know what happens when nothing seems to be happening at the stratigraphic level, i.e. between two significant modifications of space, we must construct a thinner chronology. It is only on this scale that we can approach the question of funerary practices, their sequences and their variations.

In fact, gestures and actions do leave some traces in the material world, from which it is possible to reconstruct their dynamism. However, traces, whether in the form of fragments of objects or the deformation of matter, are contained in something that is defined as a stratigraphic unit. From this perspective, the stratigraphic unit represents the smallest part of the site that could be analysed and placed in a chronological order, while the stratigraphic sequence is a succession of stratigraphic units, in which traces are placed on the same chronological level. In the case of the building of a wall or an embankment, we can suppose that the objects were disposed at the same time – or, more precisely, that their presence in the layer is due to the same action. However, in the case of a layer shaped by a continuous deposition, like a level of circulation or an occupational floor made of earth, we cannot reach the same conclusion. Not only is the formation of the layer slower, but it also involves objects and traces that are not made at the same time, by the same actors or through the same actions. There is a chronology that we must bring to light in order to understand the progression and frequency of actions.

The 3D digital technologies offer the opportunity to visualise and analyse *a posteriori* the site volume in its entirety on the basis of the complete documentation. In this way, a 3D document is literally a synthesis. What if this technology could be used to visualise the position of every fragment, of every artifact that filters out sediments? What if, in this way, we could identify surfaces of deposition that cannot be detected in the field because of the uniformity of the sediment? Can we enter Harris's matrix? The exceptional preservation of an enclosure discovered at Pompeii, combined with the meticulous investigation led by the research team and the sharpness of the questions formulated above, provided the opportunity to develop a 3D-based method to analyse objects in this way.

5.4 Case Study

The archaeological excavation carried out in 2018 by W. Van Andringa (École Pratique des Hautes Études, UMR 8546 AOrOc of CNRS), T. Creissen (Éveha international) and H. Duday (Université de Bordeaux, UMR 5199 PACEA of CNRS) at Porta Nocera, Pompeii, brought to light a new funerary enclosure (Fig. 5.1). During the excavation of this enclosure, which has not been disrupted by posterior occupation or by the nearby excavations conducted in 1983 (D'Ambrosio and De Caro 1987), a homogeneous layer was unearthed right below the eruptive deposit layers of 79 AD (Fig. 5.2). This stratum, which covered three steles of which only the

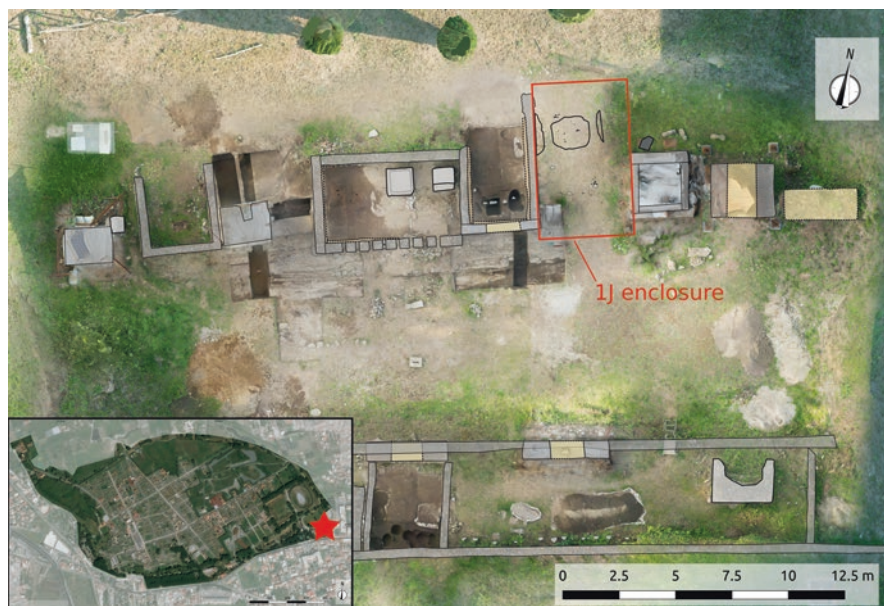


Fig. 5.1 Situation of the enclosure 1J in the necropolis of Porta Nocera/Fondo Pacifico



Fig. 5.2 The enclosure 1J at the time of its discovery, still covered with lapilli



Fig. 5.3 Fragments of ceramics around and against stele 2

upper part was visible after the first stripping, revealed several traces of occupation linked to the funerary enclosure, evoking other spaces of the necropolis that had been previously studied. On the surface of this stratum, a heterogeneous and highly fragmented set of materials (e.g. fragments of ceramics, glass, iron and burned bones) was found. It also presented a very particular distribution. Several concentrations of fragments belonging to the same objects (glass or ceramics) were lying around and against some funerary steles (Fig. 5.3). These steles were partially covered with homogeneous sediment, but were still visible when the aforementioned objects were dropped off. In addition, a cremation area was found in the northern part of the enclosure, which is probably linked with the three tombs.

Finally, the perfect state of preservation of this layer has given us the opportunity to develop an experimental method that makes it possible to have an extremely detailed view of the practices of funeral rites in this sector of the necropolis during the first century of our era.

5.5 Investigation and Recording Method

Faced with this particular situation, we have chosen to excavate this enclosure using a method that makes it possible to record the exact situation of each object and each object fragment. This method, inspired by A. Leroi-Gourhan (Leroi-Gourhan and Brézillon 1972), consists of releasing each artifact from the sediment and leaving the artifacts *in situ* in order to record their exact situation and layout. In order to do

this, it is necessary to perform several extraction passes following the bases of objects and fragments. This method might seem highly arbitrary, but passes are also performed in a way that respects stratigraphical units. In addition, we can consider that the levels excavated in this way (i.e. following the bases of objects) best approximates the original surfaces of deposition of objects that were progressively covered by the slow, long-term sedimentation that has been observed in the necropolis of Sarsina (Ortalli 2008, 143). The application of this method in a sense places the archaeologist in the situation of the hunter guided by traces of the past, as evoked by Tim Ingold (Ingold 2013, 11).

In each pass, we conduct a georeferenced photogrammetric survey and record the position of each fragment and object (2368 units), which is packaged with an ID, inventoried and marked. To check the accuracy of the photogrammetric survey, we also recorded the position of 1151 fragments with a total station during the 2018 campaign: the standard deviation between the two data sets (mean error) is 2.8 mm, which represents half the size of the smallest collected fragments. In addition, all the sediment collected by square metre is wet-sieved through a 1 mm sieve, which makes it possible to pick up the smallest fragments and to locate them at a resolution of one square metre. Environmental studies of the sieved residues, such as carpology and anthracology, are also planned.

The second step involves putting together the fragments to reconstruct objects which are then described and studied by specialists. Links between fragments observed in this way are recorded using their ID. The result is a series of adjacency matrices (one per object), in which all the direct connections between fragments are reported. At the same time, a 3D drawing of the fragments' surfaces is performed using the orthophoto and the DTM derived from the photogrammetric model: each fragment is drawn as a vectorial polygon in QGIS from the orthophoto, then, using the DTM, we compute the altitude of each vertex with a python script that we have developed.

The next step is the realisation of a photogrammetric 3D model of objects, once the reassembly is completed. From this digital document, it is possible to isolate each fragment by cutting out the model following its shape. At the end of this operation, we have a 3D model textured with all the fragments put together. We have written an iterative script that detects the contact between fragments and thus automatically constructs the adjacency matrix. In addition, this step permits us to create a complete 3D model of each fragment and to replace the fragments at their exact location on the 3D photogrammetric model.

In doing so, all fragments, as well as the links between them, can be visualised in a GIS developed with QGIS, as a graph using the software Gephy and in a 3D model that integrates photogrammetric surveys in the software Blender (Fig. 5.4). In order to collect data in the same 3D document, it is necessary to conserve the georeferenced system, but it is difficult to manipulate these coordinates in Blender. We solved this problem by applying a simple geometrical translation to all the documents, in order to bring the data closer to the graphical origin of the software.

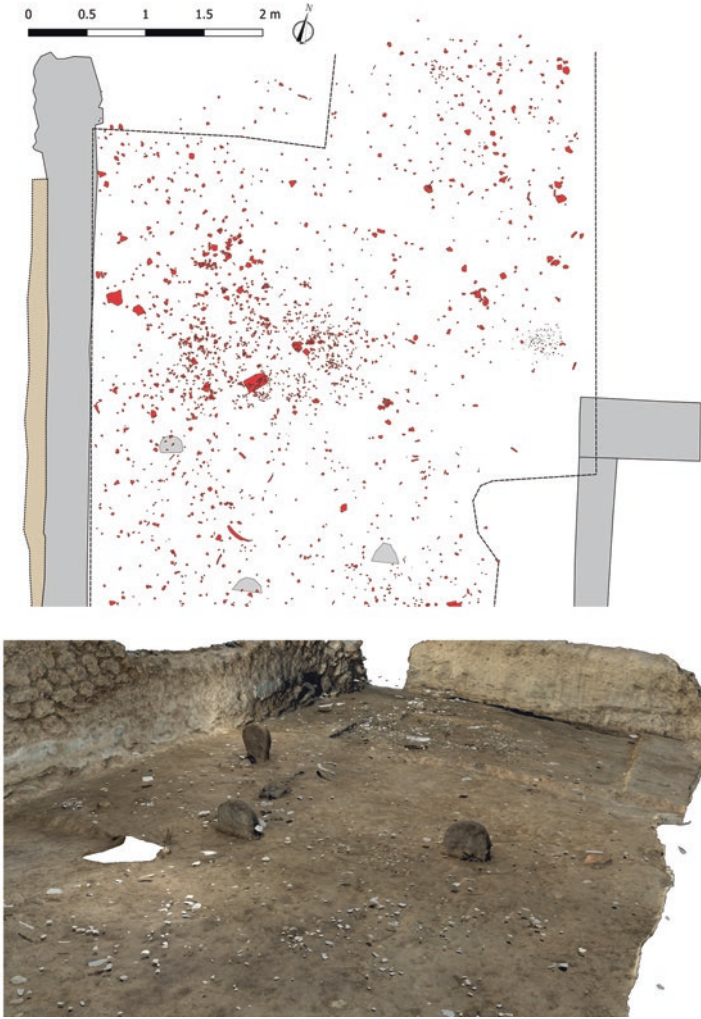


Fig. 5.4 All fragments and objects are drawn and integrated in a GIS and in a 3D model

To a certain extent, we can consider that the 3D file thus obtained is a 3D GIS where each mesh has its ID recorded as its Blender object's name. Thus, it is possible to observe in volume the surface of deposition of each object's fragment, the level of fragmentation and the dispersion of the fragments. We can also compare, in the same view, the surfaces of dispersion of several objects, and thus try to determine a microstratigraphical relationship between them: was this goblet broken and were its fragments dispersed before, at the same time or after another one?

5.6 First Results

The first result is a map that represents all the links between the fragments object by object (Fig. 5.5). This very simple visualisation allows us to see that the objects are heavily localised around certain structures, such as the steles and cremation areas. As mentioned earlier, the progressive sedimentation has submerged objects that were deposited on the surface. In this way, the position of artifacts was fixed at a certain period shortly after their deposition. The confined space in which the fragments were dispersed and the fact that some of them were positioned against steles leads us to suppose that this discovered situation is not very far removed from the initial dispersion, just after the breakage that concluded the commemorative act.

For example, the area covered by the dispersion of fragments of plate I around stela 2, is only 19.4 cm². It is interesting to compare the level of these first fragments with that of the steles. When we visualise our first example in 3D (Fig. 5.6), we can see that the deposition of this object occurred at a moment when the stela was already partially covered by the sediment, i.e. when the surface of the construction of the tombs was no longer visible. For the moment, it is not possible to determine how much time elapsed between the construction of the tomb and this last commemorative gesture. However, this act undoubtedly occurred a long time after the funerals, long enough for the stela to have been scarcely visible. Further excavation work will permit us to see if a commemorative act occurred just after the constitution of the tomb and, perhaps, if there were periodic acts of this type.

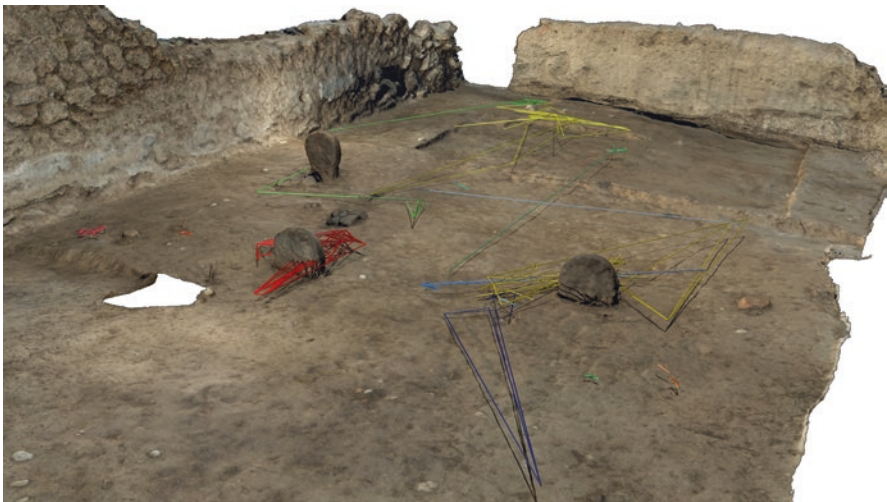


Fig. 5.5 3D representation of all the links between fragments – each colour represents a different object

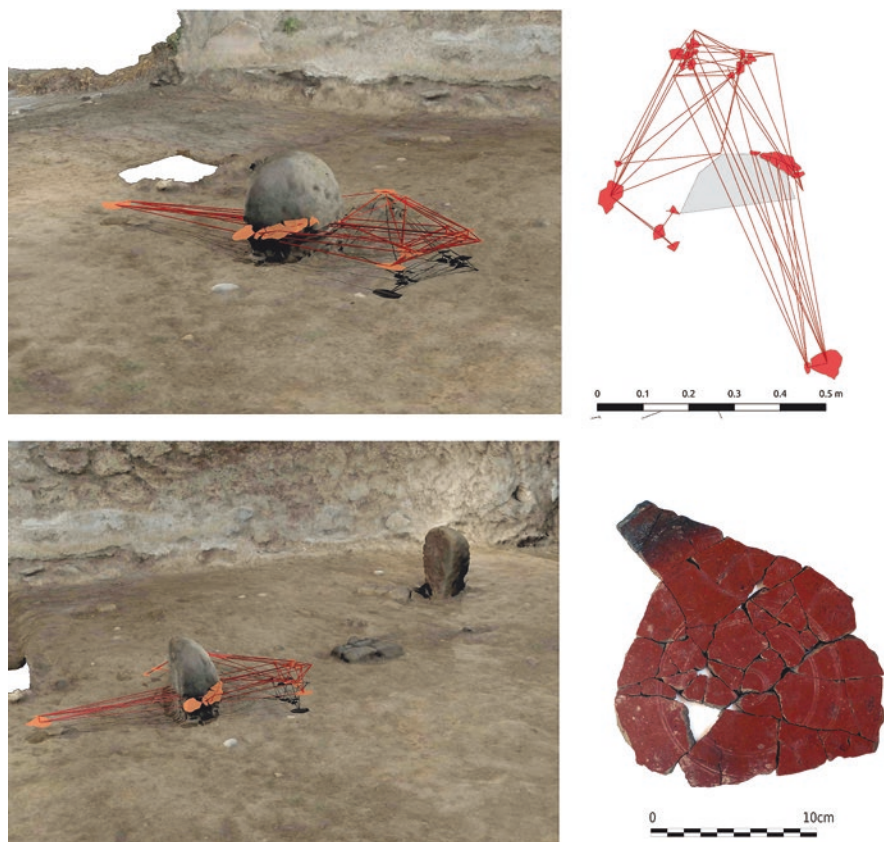


Fig. 5.6 Plan and 3D visualisation of the links between fragments of plate I around stela 2

A second example concerns the distribution of fragments around stela 3 (Fig. 5.7). Three types of object have been identified in the environment of this tomb: one goblet (Fig. 5.8), three glass balsamaries and one small ceramic bottle (unguent). The plan view of these elements shows a clear concentration around the stela, with the dispersion of few fragments at a distance of up to 1.5 metres. From a perspective view, which presents the links between fragments of each object, we can see that the deposition plans of artifacts are intertwined in a fine layer of 5 mm of sediment following the natural north–south sloping of the ground. This 3D visualisation makes it possible to detect the levels of deposition and occupation upon which the commemorative gestures took place. In addition, this digital 3D document permits us to visualise the quasi-simultaneity of the deposition of objects. Thus, we can observe the sequence of the commemoration ritual, which involves almost simultaneously the three types of objects, perhaps in an order that we will be able to determine in the future.

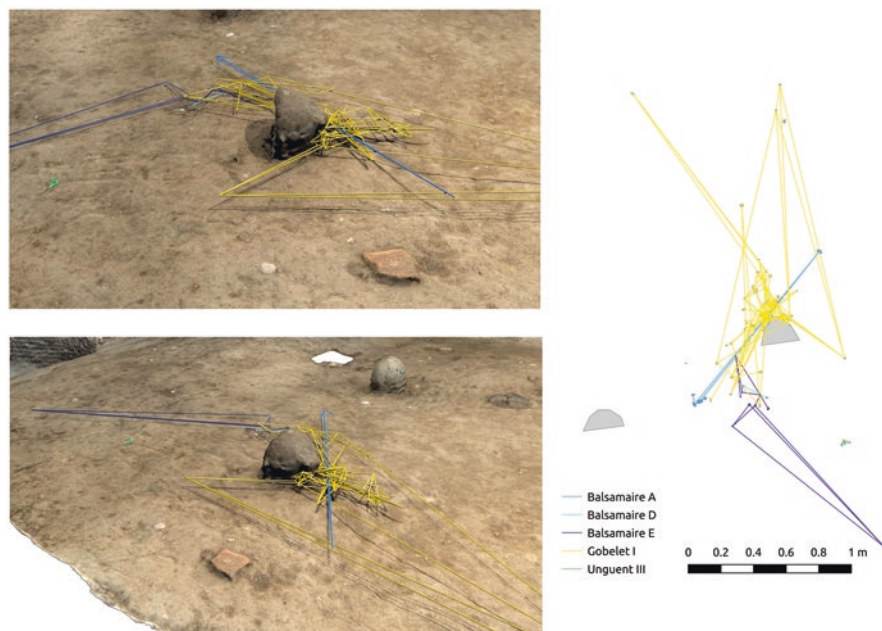


Fig. 5.7 Plan and 3D visualisation of the links between fragments by object around stela 3



Fig. 5.8 Animation showing the reconstruction of goblet 1 from the distribution of its fragments around stela 3

5.7 The 3D Reconstruction of Funerary Gestures

The exceptional context of this funerary enclosure made it possible to highlight all the subtleties of the funerary-commemoration behaviours through a study of the gestures. The method we propose allowed us to detect and document the surfaces of circulation and use of the funeral enclosure. The 3D visualisation of each of the fragments and their connections gave us the chance to show the microstratigraphy of the funeral gestures that we would not otherwise have been able to see. Without calling the Harris method into question, we believe that it is possible in some cases to go further in our stratigraphic analysis, especially by studying the three-dimensional position of fragments of objects. Our approach thus enabled to question the notion of continuous time on a human scale that is too often overlooked in archaeology. Finally, the use of 3D enabled us to visualise and display all the elements in a 3D file, with the exception of the sediment. This synthetic view was only made possible by an extremely meticulous survey and excavation method. Thanks to a highly detailed recording process, it was possible to detect and describe different funeral gestures (<https://www.defragmentations.org/>. Accessed: 01 Jan 2021). The excavation is still in progress, and the results of the coming years will allow us to approximate more precisely the times and frequencies of use of the enclosures of the necropolis.

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