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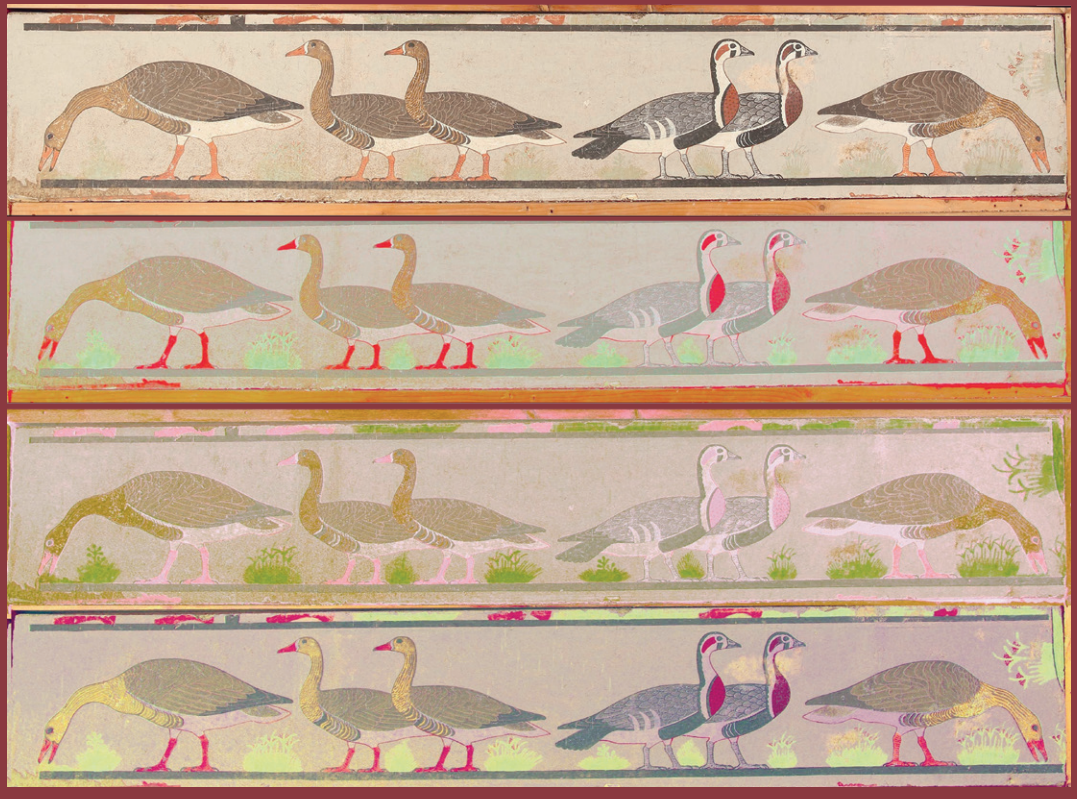

Institut français d'archéologie orientale

Ministry of Tourism and Antiquities

VII

ARCHAEOLOGICAL SCIENCE AND TECHNOLOGY

Janet Davey*, Richard Based*

A Unique Radiological Study of Eleven Ancient Egyptian Graeco-Roman Child Mummies

In a forensic radiological study of eleven child mummies from the Graeco-Roman Period of ancient Egypt, it was observed that the bodies of the children had been mummified in the same way as the mummies from the Pharaonic Period (ca. 3000–332 BCE).[1] This study was part of a unique, wider radiological study of fourteen Graeco-Roman children's mummies using modern medical technology, which produced data to aid further studies of mummified children's remains.[2]

Attempts at mummification have been identified on bodies dating from the Pre-Dynastic Period and, during the Pharaonic Period, techniques evolved and improved to a standard where the bodies have survived in good condition to the present day.[3] The recording of mummification practices in ancient texts provided guidelines to the possible methodology used to preserve each body and determine whether it was subjected to evisceration and excerebration. Herodotus and Diodorus Siculus describe various methods of mummification, from the most elaborate to the simplest.[4]

Mummified bodies provide a unique, if limited, resource for non-invasive and non-destructive medical and scientific methods to investigate how the ancient Egyptians lived and, in some cases, how they died.[5] With the development of high-resolution Helical Computerised Tomography (CT) scanning techniques and associated advanced visualisation software, it has been possible to virtually examine mummified bodies using rapid acquisition data for 3D volumetric images and multi-planar reconstructions. In addition, precise anatomical data and virtual endoscopy, for internal views of specific areas of interest within the body, enabled more precise analysis of areas of interest.[6]

The specific objectives of the project were to collect information from the macroscopic and radiological investigations. These included gender, approximate age at death, dental condition, signs of disease, *peri-mortem* and *post-mortem* injuries, cause of death and specific mummification practices used in the Graeco-Roman Period of ancient Egypt 332 BCE–ca. 395 CE.[7]

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1. Hawass, Saleem 2016.
2. Villa et al. 2015.
3. Oras et al. 2020
4. Diodorus Siculus, *The Historical Library*; Herodotus, *The Histories*.
5. Adams, Alsop 2008.
6. Thali et al. 2007.
7. Ikram, Dodson (ed.) 1998.

MATERIALS AND METHODS

To begin the project, it was necessary to carry out investigations into museum collections to find mummies that would be suitable for CT scanning. Six mummies were selected from the human remains collection in the British Museum. Mummies 3, 4 and 5 were unwrapped and easily identifiable as suitable subjects for CT scanning (table 1). For the remaining three mummies (6, 7 and 8), exising X-rays from the British Museum were viewed for selection of suitable mummies whose skeletons were in good condition and whose bodies were not obscured by inorganic matter. The six mummies were scanned at BMI Blackheath Hospital (London), using a Toshiba Aquilion 64 (Toshiba Medical Systems Corporation, Tochigi, Japan).

Mummies 1 and 2 were CT scanned at The Peter MacCallum Cancer Hospital (Melbourne, Australia) and later at the Victorian Institute of Forensic Medicine (Melbourne, Australia), using a Toshiba Aquilion 16 slice Helical scanner. Mummy 11, from the Nicholson Museum at the University of Sydney, was CT scanned at Central Sydney Imaging, using a Toshiba scanner and Aquilion 64 software 3.2. Post-scanning was carried out on a Vitrea Advance Visualisation solution 4.1.

The CT scan data for mummy 9 was provided by Dr Marteen Raven of the Leiden Museum (Netherlands). An original investigation had been carried out by the museum, which provided comparative data for this more recent study.[8] The CT scan data for mummy 10 was provided by Dr Paul Brown of the National Biocomputation Center, Stanford University (Standford, USA) and the Rosicrucian Museum (San Jose, USA).

Fig. 1. The application of Siemens Syngo.via Advanced Visualisation Software (version VA30), on CT scan images of mummy 6 showing the mummified body within an anthropoid cartonnage coffin.

All CT scan data were uploaded into a Toshiba Vitrea 2 (Virtual Images, Minnetonka, MN, USA) from 64 × 0.5 advanced visualisation software and later to Siemens Syngo.via Advanced Visualisation Software (version VA30) (fig. 1). The advanced visualisation software allowed for virtual volume rendered 3D multi-planar reconstructions images of bodies. In addition, the virtual endoscopy function allowed the visualisation of specific areas of interest in the body.[9]

In addition to the publications of Herodotus and Diodorus Siculus, more recent publications on the use of modern medical and scientific technology were consulted for information on mummification practices and the use of modern medical technology to virtually examine mummified bodies.[10]

8. Raven, Taconis 2005.
9. Dirnhofer et al. 2006.
10. Cesarani et al. 2003.

RESULTS AND DISCUSSION

MACROSCOPIC INVESTIGATION OF UNWRAPPED MUMMIES

Where the mummified remains had been unwrapped, macroscopic investigations provided additional information about the condition of the external aspects of the mummified bodies. These included the three unwrapped British Museum mummies 3, 4 and 5 (table 1). In these mummies there did not appear to be any external evidence of evisceration in the form of an incision in the inguinal region on the lower left side of the bodies. The external aspects of the bodies showed traces of gold leaf application on the faces and bodies. Gold leaf was also identified on the face of mummy 1. A probable *post-mortem* defect was visible in the facial features of the child. This may have been caused by a sharp object when the body was decapitated after burial. The hair of the child appeared to have been treated with henna to obtain a light red colour. In contrast, the hair of mummies 3 to 5 described above was fair and not coloured with henna. The reason for the fair hair is unknown, but it suggests an ethnic origin rather than the result of a mummification procedure such as the application of natron.[11]

EVISCERATION AND EXCEREBRATION

Removal of the brain was identified in mummies 1, 2, 6, 7, 9, 10 and 11. Where the brain had not been removed there remained evidence of the organ in the form of a small mass in the lower posterior aspect of the cranial cavity.

Some form of evisceration was viewed in the CT scans of mummies 2, 6, 7, 8, 9, 10, and 11. All these bodies were well preserved, but due to some inclusions and artefacts in the CT scans, it was not always possible to determine precisely which organs had been removed or remained *in situ*.[12]

ARRANGEMENT OF BODIES

The ancient records do not mention any specific arrangement of the bodies prior to the wrapping procedure. In all the mummies, the cervical vertebrae were hyperflexed and the chin was angled down towards the sternum. The reason why this position of the head was preferred is unknown but may be related to keeping the head in a position allowing minimal movement and ease of wrapping. The position of the head was originally thought to be a possible indicator of the presence of children's mummies in the Graeco-Roman Period, but there is no definitive evidence to date.

In female mummies 3 and 4, the limbs were arranged in the opposite way to male mummy 5. Without further research, it was not possible to determine whether the arrangement of the limbs was an indication of gender or just a preference of the embalmers, as the presentation of the bodies appeared to be identical, except for the positions of the limbs.

11. Davey, Spring 2020.
12. Craig, Davey 2009.

DENTAL DEVELOPMENT AND ESTIMATION OF AGE

CT scan images and, in some cases, intra-oral images of the teeth were analysed to determine the approximate age of each child.[13] A definitive age could not be determined as no comparative data existed for ancient Egyptian population. The approximate dental age of the children varied between 18 months and 6 years at the time of death.[14] In general, the teeth of the mummies were in good condition and in correct alignment. In several cases, including mummy 10, the teeth were missing from their sockets but were visible either in the oral cavity, under the upper lip or in the back of the pharynx. In the oral cavity of mummy 1 there was evidence of tooth extraction within weeks before the death of the child, with minimal healing visible on the CT images. The cause of death is unknown, but the possibility of infection after the tooth extraction procedure cannot be discounted.

DETERMINATION OF SEX

Although macroscopic examination determined the sex of the two female mummies 3 and 4 from the British Museum, macroscopic examination of the structure of the external genitalia of the unwrapped mummy 5 was inconclusive. This appears to be due to the application of natron during mummification, which may have caused the anatomical integrity of the genitals to be lost.[15] In this case, as in the case of the wrapped mummies, and in the absence of DNA testing, the best non-invasive method of determining sex was to examine the virtual 3D reconstructions from the CT scans.[16] Mummy 5 was identified as a male, as were mummies 6, 7, 8, 9 and 11. The images of the mummified remains of mummies 1, 2 and 10 lacked sufficient information from the CT scans to determine the sex of each child.

CAUSE OF DEATH AND INJURIES

In the case of mummy 1 described above, the cause of death by infection may be confirmed histological tests on the tissue. Mummy 8 showed evidence of a *peri-mortem* injury to the apex of the skull in the 3D reconstructions that was not compatible with life.[17] The head injury had bevelled edges that suggested a blow to the head with a sharp object. The brain had not been removed.[18]

All mummies except 1, 2, 3, 4 and 5 showed evidence of excerebration *via* the cribriform plate of the ethmoid bone. The damage to the skulls of mummies 2 and 7 appears to be related to mummification methods or unexplained *post-mortem* damage. Mummy 7 had been excerebrated, but the route of brain removal appeared to be *via* the anterior fontanelle rather than *via* the cribriform plate of the ethmoid bone. A displacement of the mandible was visible in mummy 4, but the cause or timing of this injury cannot be determined.

13. Bassed, Hill 2010; Bassed, Bott 2016.
14. AlQahtani, Hector, Liversidge 2010.
15. Abdel-Maksoud, el-Amin 2011.
16. Hawass et al. 2010; Davey, Stewart, Drummer 2013.
17. Fornaciari 2018.
18. Davey, Drummer 2016.

Evidence of evisceration was visible in the CT scans of mummies 2, 6, 7, 8 9, 10 and 11. The removal of specific organs delayed purification until the body could be covered with natron. In many cases, this operation was assisted by the placement of linen bags of natron that were inserted into the thoracic and abdominal cavities. Before the wrapping of the body the bags would be removed and discarded.

As the cause of death of most of the mummies could not be determined, the possibility that disease was the cause of death cannot be discounted. Other life-threatening perils faced by children, such as incurable diseases, ingestion of lethal substances, drowning and domestic or external violence, cannot be ruled out as causes of death.[19]

INCLUSIONS

The most common inclusion observed in the CT scans was fabric that had the structural integrity of linen. This was found in mouths, abdomens and cranial cavities. In some instances, it may have been used as a packing material to provide bulk after the removal of internal organs. Unidentified non-organic material was also observed in the thoracic and abdominal regions, which may have also have contributed to the body shape. In the wrappings of mummy 2, what appears to be a support structure made of sand and soil was identified. An adult toe bone was identified in the cranial cavity of this mummy. The reason for the inclusion of this foreign object remains unknown.[20]

Mummies 7 and 9 also contained a foreign object in the form of a rigid, straight inclusion in the penis. As with the toe bone the purpose or reason for these objects is unknown. A more readily identifiable object adorned the right wrist of mummy 7. It was identified as a bracelet that was not made of precious metal such as gold, according to the Vitrea 2 Hounsfield number function used to determine the density of the object which was 751 HU.[21]

Inclusions have been identified in many mummy studies, including that of Grafton Elliot Smith when he examined the Royal Mummies. Packing used to restore the face and body of the deceased to a more lifelike state was common and the inclusions of jewellery and favourite objects have been extensively recorded.[22]

STANDARD OF MUMMIFICATION

The results of the mummification methods observed in the macroscopic and radiological examinations of the mummies indicate that the standard of mummification of these Graeco-Roman children's mummies was sufficient to preserve the external aspects of the bodies in an acceptable condition. The anatomical and skeletal integrity of the bodies suggest that the embalmers were competent and skilled. Where there was some disarray in the skeleton, the cause may have been *post-mortem* and possibly due to the application of bandages to a small, eviscerated body. Removal of the body from the tomb, poor handling or unwrapping for sale may also have damaged the mummy.[23]

19. Bianucci et al. 2008.
20. Davey, Craig 2003.
21. Villa, Lynnerup 2012.
22. Smith 1912; Reeves 1990.
23. Davey et al. 2014.

CONCLUSION

Macroscopic examination of the bodies and the use of non-invasive, non-destructive CT scanning and advanced visualisation computer software enabled the analysis of data from the mummified bodies of children from the Graeco-Roman Period. The data confirmed that the preservation of the bodies was exceptional, but that not all children mummies were eviscerated or excerebrated. Hyperflexion of the cervical spine was present in all mummies and inclusions were common. The sex and approximate age were determined in the majority of child mummies, but the possible cause of death remained elusive.

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No.	Name	Sex	Age (Approx)	Eviscerated	Excerebrated	Injuries	Hyper-flexed spine	Inclusions
1	AIA 1	U/K	6–7	N/A	Y	Y	Y	Y
2	AIA 2	U/K	3–4	Y	Y	Y	Y	Y
3	EA30362 BM	F	5–6	N	N	Y	Y	N
4	EA30363	`F	6–7	N	U/K	Y	Y	N
5	EA30364	M	4–5	N	U/K	Y	Y	N
6	EA22108	M	1.5–2.5	Y	Y	Y	Y	Y
7	EA6723	M	1.5–2.5	Y	Y	Y	Y	Y
8	EA4053	M	1.5–4.5	Y	N	Y	Y	Y

No.	Name	Sex	Age (Approx)	Eviscerated	Excerebrated	Injuries	Hyper-flexed spine	Inclusions
9	AMM27C	M	1.5–3	Y	Y	Y	Y	Y
10	RC22	U/K	4–5	Y	Y	Y	Y	Y
11	NMR26	M	5–7	Y	Y	Y	Y	Y

Key: AIA = Australian Institute of Archaeology; BM = British Museum; RC = Rosicrucian Museum; NM = Nicholson Museum, University of Sydney; AMM = Leiden Museum Netherlands
Y = Yes; N = No; U/K = Unknown; M = Male; F = Female

Table 1. Sources, data and results of macroscopic and radiological investigations.

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Eid Mertah*, Wafaa Mohamed**

A Large Gilded and Inlaid Bronze Statue of Osiris

Imaging and Spectroscopy of a Piece in the Basement of the Cairo Museum

Metal sculpture is attested in Egypt throughout its history, but in large numbers only during the 1st millennium BC.[1] Before this period, only scarce specimens came to us[2]. Although most bronze statues from earlier periods have probably disappeared, it seems nonetheless that the "golden age" of metallic statuary in Egypt begins with the Third Intermediate Period and continues throughout the Late and Ptolemaic Periods, i.e. the whole 1st millennium BC.[3] These periods also witness to an increasing importance of the cult of Osiris. This expansion takes place in vast religious changes partly marked by the development of personal piety, inaugurated in the New Kingdom, expressing the will to establish a personal relationship between the gods and the individuals. The prosperity of the country was seen as depending on the manner in which the rituals for the deities, Osiris in particular, were observed. Without the processing of such rites, the political and social order was in danger.[4]

Among the innumerable bronzes produced during the 1st millennium BC, the effigies of the god Osiris are particularly notable.[5] They were found by thousands buried under the floor of some religious precincts, for example at the Serapeum of Saqqara, in Medinet Habu, Sais, Karnak or Ayn Manawir, among other sites. Today, few Egyptian collections around the world do not contain bronzes representing this specific deity, which probably shows that many other undocumented contexts delivered similar pieces.

Osiris was prominent in both royal ideology and popular religion as the god of death, resurrection and fertility. Despite the stylistic varieties of these statues, they present a certain consistency in their iconography: the god is represented (usually standing, less often seated) in a shroud, hands on the chest holding the *heqa* and *nekhekh* sceptres, and wearing the *atef* crown.[6] The sizes of these statues

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1. Hill (ed.) 2007, p. 52.
2. Ziegler 1987, p. 86.
3. Bianchi 1990, pp. 63–66.
4. The rituals that had to be fulfilled to ensure the protection of the cosmic and political order are described in the "Papyrus Jumilhac" (translation Vandier 1961, p. 130).
5. Wilkinson 2003, pp. 46–47.
6. Griffiths 1982, cols. 623–633; Wilkinson 2003, pp. 118–123.

also vary considerably from a few centimetres high to several statues reaching around one meter in height.[7] The stylistic features also testify differences in period and production (body proportions, facial features, surface treatment, etc.). Although most bronzes representing Osiris have no known provenance today, a certain quantity has been found in excavations—many of them are now kept in the Egyptian Museum in Cairo.[8] This provides us with a valuable basis for suggesting origins to unprovenanced pieces.

This study brings further scientific elements of comparison between these (groups of) statues, and helps to give more precise dates and provenances. In addition to the style, iconography and onomastic, we indeed intend to analyse and compare the chemical components of the alloys, inlays and gilding of these statues, as well as their manufacturing processes.

1. BEGINNING OF THE PROJECT: A CASE STUDY

This project began with the study of a large statue (JE 100381) from this group that was in urgent need of restoration. The statue depicts the god Osiris in his traditional attitude, standing in his shroud, forearms crossed on the chest, right wrist over the left one. It was broken at the waistlevel, in the area where the metal layer is thinnest and weakest. After examination and analyses, the statue was cleaned from its crust (a 0,3–0,5cm thick layer of corrosion mixed with soil, most likely from the archaeological ground). The removal of this crust revealed important remains of the gilding layer. Originally, the statue was made in one piece, produced using the hollow cast technique. It was cast around a clay core, which is still in place. To this body were attached, as separate pieces, the white or *atef* crown, the beard, the sceptres and the base. The beard, now missing, was fixed by means of a tenon, in the shape of a parallelepiped stick (0,8 × 0,7 × at least 1cm deep), which is still in place, inserted into the hole under the chin. The crown was inserted above the forehead, which still has a sort of recessed edge, allowing the attachment to be secured. Small fragments of the sceptres, once inserted into holes within the hands, are still in place. The lower extremities of the sceptres, however, visible under the hands, were cast together with the statue's body (fig. 1).

1.1. THE ALLOY

The statue was made of "bronze", an alloy of copper with variable amounts of tin and sometimes lead.[9] This can provide us with useful data for comparison, and maybe postulate that the statues

7. Among the largest are: Paris, E 33130 (77cm high without the crown); New York, MMA 10.175.133 (76cm high); London, BM EA 60719 (83cm high without the crown and lower part of the legs); London, BM EA 60718 (89cm high without the base); Leiden, AB 161 (105cm high without the base); as well as several other bronze statues of Osiris in the basement of the Egyptian Museum, still unpublished.

8. Daressy 1897; Daressy 1906.

9. Previous studies on bronze statues from the 1st millennium BC provide useful comparisons. See Cowell 1986; Ogden 2000, pp. 148–176; Delange, Meyohas, Aucouturier 2005, pp. 109–112; McArthur, Taylor, Craddock 2015, p. 112; Hill, Schorsch 2005, pp. 163–195; Hill, Schorsch 2016, pp. 251–307; Hill 2019, pp. 35–49.

belong to similar dating or provenance groups. Examination of the chemical composition of the alloys may also give us indications concerning periods and provenance of a piece, since it is possible that the local conditions had an impact on the composition of the objects produced.[10]

The statue in the Cairo Museum (JE 100381) is relatively large, this is probably the reason why the ratio of the alloy components varied slightly during the pouring of the metal within the mould. It was particularly important in this case to analyse several spots on the statue, by a nondestructive method using portable XRay fluorescence (pXRF). The statue is made of a threecomponent alloy comprising copper, lead and tin with an average of 76,8% copper, 19,1% lead, 2,09% tin, in addition to some other impurities such as iron, antimony, silver, chrome, zinc and vanadium. The percentage of lead is particularly high. It is interesting to note that these results are very similar to those obtained on a parallel example by a team from the British Museum when studying another statue of Osiris, very similar in appearance (dimensions, style, iconography, manufacturing process and ornamentation).[11]

The proportions between the components of an alloy can be revealing evidence to consider when studying groups and proposing dating or provenance, but this needs further investigation, based on largescale analyses. Jack Ogden,[12] for example, proposed that lead content often increases over time, from as low as 5% during the Third Intermediate Period to over 20% during the Late Period and even more thereafter. These observations deserve further investigation, since they do not fit with the results we have been able to obtain so far from the dated pieces studied at the Egyptian Museum, which show a wider range of criteria to be considered, rather than an exclusive chronological one.

During the casting of the statue, the molten metal was poured into the mould, which was placed upside down. Lead, as a heavy element, is systematically concentrated in the lower parts during the casting process. Consequently, it is expected to be present in a higher percentage in the upper part of the statue. We could also observe that lead was present in higher concentration in the areas where the walls of the casting were the thinnest. As the British Museum team observed, this could be because "the lead would have had difficulty flowing through the narrow space"[13] and therefore accumulated in these areas (in this case, in the middle area of the back, where the walls are only 0,1cm thick) (fig. 2).

1.2. THE INLAYS AND GILDING

The eyes, eyebrows and chin straps consist of cavities that still contain some remains of Egyptian blue[14] and lapis lazuli inlays. The left eye retained a larger portion of Egyptian blue, while the right one is still covered with a sand layer, which we decided to let in place.

The cleaning revealed remains of gold leaves on the lips, right cheek, neck, chest and left hand. This repartition suggests that much of the surface of the statue was once gilded. The gold leaves

10. Scott, Dodd 2002, pp. 283–239.
11. McArthur, Taylor, Craddock 2015, p. 112.
12. Ogden 2000, pp. 154–155.
13. McArthur, Taylor, Craddock 2015, p. 112.
14. Eastaugh, Walsh, Chaplin, Siddal 2004, pp. 147–148.

were carefully applied to the statue. There is evidence from other examples with smooth surfaces that gilding was often applied directly to the bronze.[15] In the present case, however, the craftsmen put a thin layer of calcium carbonate as a preparation layer in order to fix the gold.

One particularity we encountered was that a blue paste was used to set the inlays of the eyes, eyelids, eyebrows and chin straps. It consisted of Egyptian blue, according to multispectral imaging (fig. 3). Ancient craftsmen used this blue paste under lapis lazuli inlays to fit well when filling any gaps between the inlays and the metal edges. It is interesting to note this, although the aforementioned case of the British Museum statue does not seem to document such a presence of Egyptian blue paste. Investigations carried out by one of the authors of the present article at the Egyptian Museum identified the use of a similar paste under lapis lazuli or blue glass inlays on objects from Tutankhamun's funerary goods.[16] It is also documented on other, as yet unpublished, bronze statue fragments, which are currently being studied as part of the current project on Osiris statues. On the Tutankhamun objects, as well as on other bronzes of the 1st millennium BC, it was also possible to observe the presence of a coloured pigment based-cement for the paste, which allowed stone or glass inlays to be fixed in the corresponding colours (red, yellow, etc.).

1.3. DATING

In the present case, as the statue is uninscribed and its provenance is unknown, it is mainly stylistic analyses that can help us date it. The face has idealised features, dominated by extremely large, formerly inlaid eyes, prolonged by thick makeup lines, which constitute the main focus of the face. The cheeks are smooth. The nose is sharp at its birth, and shows an aquiline profile. The small mouth draws a shy smile, while the corners of the mouth consist of two circular depressions. All these features are typical of the artwork of the Third Intermediate Period,[17] especially the royal metal masks found in Tanis (21st Dynasty, 1076–944 BC), probably the closest welldated material. Without trying to go too precisely in the dating of this Osiris statue, we will postulate here that it belongs to the Third Intermediate Period, the phase of Egyptian history that constitutes the apogee moment for both the technique and the output of bronze sculpture.[18]

2. DISCUSSION

Hopefully, the current study might serve as a starting point for research not only for conservators, but also for archaeologists and Egyptologists. The corpus of metal statues is indeed extremely large and still little studied. Too often, in museums and books, bronze statues are labelled as "Late Period," without any precision. Nevertheless, the whole 1st millennium BC is a rich period of production

15. See for example the statue of Karomama at the Louvre, inv. N 500 (Delange, Meyohas, Aucouturier 2005, p. 102), the statue of Osiris at the Metropolitan Museum, New York, inv. 56.16.2 (Tiribilli 2016, p. 127).
16. In the framework of the investigations currently carried out by Christian Eckmann, Katja Broschat and Eid Mertah at the Egyptian Museum, Cairo.
17. Brandl 2009, pp. 51–89.
18. See Hill, M., "Heights of Artistry: The Third Intermediate Period (ca. 1070664 B.C.)", in Hill (ed.) 2007, pp. 51–63.

of metal artefacts, and such an approximate dating can no longer be considered satisfactory. It is possible to refine such a dating by crossdating. Similar analyses of the alloy and inlays compositions, as well as the study of the manufacturing process, can be combined with a stylistic approach. The results will allow scholars to establish a good reference typology, and help them to date the objects through a confrontation with pieces found in archaeological context. It may even provide clues as to possible provenances, if the analyses are made on a sufficiently large corpus of objects.

An exhaustive study of all Osiris statues is of course impossible, as it would require several lifetimes. In the framework of the current research, we are focusing on pieces that include gilded or inlaid ornamentation, as they provide additional information compared to those made exclusively in metal. They also contain valuable evidence allowing us to better understand the technologies available to ancient craftsmen. Wherever possible, we also focus on pieces coming from an archaeological context. In addition, as conservators working at the Egyptian Museum, we take into consideration all the pieces in the basement that need priority treatment. A feature that we also hope to investigate is the succession of events that a statue may have experienced during its "life." Indeed, the archaeological contexts in Egypt often indicate that a long gap—several centuries or more—could separate the production of a statue from its burial or abandonment. During this time, several actions and modifications may have taken place, sometimes with intentional destruction at the end of its use. The study of these various stages of a statue's existence may be visible on its surface, perhaps through repairs or changes in ornamentation, or traces of defacing.

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Fig. 1. Statue of Osiris found in 2013 in the basement of the Egyptian Museum, Cairo. It was recently given the inventory number JE 100381. Bronze, with traces of gilding and inlays (lapis lazuli and Egyptian blue). H. 84,4cm; W. 24,1cm; D. 15,8cm (after restoration).
The two photos on the left show the statue before restoration, still broken into two parts and covered with corrosion; the two middle ones, the statue after cleaning; the last one, on the right, the statue after cleaning and a virtual reconstruction of the crown, the beard and the sceptres.

Fig. 2. Section of the statue's body, by CT scan, showing the variation in thickness of the metal walls. The thinnest area corresponds to the back of the sculpture.

Fig. 3. Egyptian blue is clearly mapped in many areas by multispectral imaging (IRF mode), thanks to the pigment's exceptional nearinfrared luminescence emission.

Antonio Muñoz Herrera*

Digitalization of the Graffiti in the Royal Cache Wadi

The C2 Method

C2 *Project* is a Spanish-Egyptian mission, directed by José-R. Pérez-Accino (Universidad Complutense, Madrid) and Hisham el-Leithy (CEDAE, Ministry of Tourism and Antiquities, Egypt), currently working at the Royal Cachette wadi, immediately south of Deir el-Bahari bay, in Luxor West Bank. The project has so far carried out three campaigns, in 2017, 2019 and 2020, to survey the graffiti in the area and to try to identify and understand the human activity there in antiquity.

The site has seen previous interventions: the *Royal Cache* (TT 320) was found probably around 1871 by the Abd el-Rassoul brothers and explored and emptied in 1881 by Emile Brugsch and Ahmed Kamal, and published by Gaston Maspero.[1] Subsequent relevant archaeological actions were carried out. In 1920, Ambrose Lansing (under Herbert Winlock direction), from the Metropolitan Museum of New York, began some archaeological surveys at the entrance of the wadi and also around TT 320, including the cleaning of the tomb's shaft.[2] Recently, a German-Russian mission directed by Erhart Graefe and Galina Belova re-examined the tomb.[3] This project focused on the study of the mentioned tomb and its characteristics.

The only other traces of human activity previously attested in the wadi were the graffiti. Wilhelm Spiegelberg was the first scholar interested in these inscriptions. He identified a high number of them in a survey carried out in 1895 and published in 1921.[4] Afterwards, Jaroslav Černý continued the research on graffiti (1956).[5] During 1960s, a monumental recompilation of graffiti started to be published, and later a new survey to identify all the graffiti of the Theban mountain was carried out by the Documentation Centre of Ancient Egypt (CEDAE), directed by Jaroslav Černý and Abd el-Aziz Fahmy Sadek, and published in booklets (1974).[6] This publication is the starting point of our work due to its detailed cartography and the amount of information provided. The name "C2" was coined in the survey done by this Egyptian-French expedition.

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1. Maspero 1889.
2. Winlock 1942.
3. Graefe, Belova 2010.
4. Spiegelberg 1921.
5. Černý 1956.
6. Sadek 1974.

1. GEOGRAPHY OF THE SITE

From a geographical point of view, the wadi seems to be one of the most relevant sites in the West Bank. It was the scenario of one of the most spectacular discoveries in the History of Archaeology, known worldwide: the *cachette* of royal mummies, discovered in 1881. The site is located in the center of the necropolis, just behind the hill of Sheikh Abd el-Qurna and adjacent to Deir el-Bahari bay. Moreover, in a wider context the wadi is important as part of the path leading to the Valley of the Kings (apart from the path starting from Dra Abu el-Naga and another one starting from Deir el-Medina).[7] It is noteworthy to mention that while this wadi is the only area of the necropolis with only one tomb, it is surrounded by the Middle Kingdom ones located on the neighboring hills. It is remarkable that most of the Middle Kingdom tombs from Sheikh Abd el-Qurna are directly oriented to this wadi. There is another tomb near TT 320, tomb MMA 1103 (whose owner is unknown but apparently was an important individual because of the tomb's features), which is located in the south wall, close to the path running in front of the wadi.[8]

From a physical perspective, the wadi shows interesting features. It is almost a perfectly square natural formation, with a Southeast orientation (SE), and conforms a symmetrical formation in the middle of the necropolis, with two big natural walls (or 'arms') emerging from the mountain.

Geologically, it gives some clues about the activity in the wadi. There is a mass of natural *debris* (talus) accumulated at both sides of the wadi (North and South), but there is also an accumulation of loose ground at the NE end, which does not seem to be of natural origins, but rather the product of recent human activity. The flattening of this area was a consequence of Lansing actions in 1920.[9] Furthermore, there are further remains of their activity. It is possible to know, thanks to the brief reports, that Lansing ordered the excavation of parallel trenches along the North and South walls of the site, probably in his search for a grave. These trenches can still be perceived today and they probably modified the archaeological stratigraphy of the wadi. However, we can now assume that in many areas of the site Lansing never reached the archaeological levels, as the trenches were made in the natural *debris* (and not too deep), on top of the archaeological horizon, so possible remains of human activity in antiquity might be waiting there.

2. PROJECT NEEDS AND METHODOLOGY DESIGN

In order to have a better understanding of the location of TT 320 and the motivations of the election of this place as the last resting place of Egyptian pharaohs, any piece of information is important. The team of *Universidad Complutense de Madrid*, together with the CEDAE team, is focusing on identifying human activity in the wadi and detecting new *graffiti*, not recorded previously.

7. Pimpaud 2014.
8. Kurz 1973, V, p. 196; Winlock 1942, pp. 32–33.
9. C2 Project had access recently to the 'Metropolitan Museum Archive' and could confirm, through the old photographs taken in January 1920 campaign, the activity carried out by Lansing and the flattening of the debris during his excavation.

The project has carried out three archaeological campaigns so far (2017, 2019 and 2020), and the results will let a re-evaluation of several 'paradigms' associated with the wadi by traditional historiography in connection to TT 320.

The methodology had to be carefully designed, since the field conditions are extreme in many occasions. In an open-air site (with high temperatures and very sunlight concerns), every weather condition was considered to develop the documentation method. Moreover, the needs were far more than the climate ones. First of all, the project team had to digitalize all the previous works linked to the graffiti in the wadi to be used as main sources. A database was created, based on the files used by the *Graffiti de la Montagne Thebaine* (from now on *GMT*)/CEDAE team, and adding new information necessary for our current research (i.e. details of the photographs made by the 'C2 team' corresponding to each graffito). One of the aims of the project has been the role of the landscape in the area, so the methodology needs a tool to manage and analyze the different landscape features together with the graffiti database. Therefore, a GIS was implemented in combination with 3D models and Ultra High Definition photographs made by mosaics (fig. 1).

Several documentation methodologies have been developed through the past decades and many others have been recently created with the emergence of new technologies. Different projects in Egypt have used these methods, and therefore we have adapted some of them to the features of the site, putting together and adding our current needs. In order to register and document the graffiti correctly, we took the 'Chicago House Method' as our starting point, since it is the most developed epigraphic methodology to date,[10] and added its 'workflow' to our method. John Darnell's work on graffiti in the Western Wadis[11] was also very helpful in understanding the difficulties of working on graffiti in big open areas and in specific hard-to-reach locations.

Several approaches have been developed for the last years regarding the application of GIS to the Egyptological field. Usually applied to tombs studies, GIS is a very powerful tool for not only geographical and physical interpretations of the tomb's role within a space, but also for symbolic and semiotic meanings inferred from this data. The research carried out by María Angeles Jímenez-Higueras,[12] Brice Pimpaud,[13] Peter Piccione[14] or 'The Walking Dead Project at Saqqara',[15] shows the capability of these tools in Egyptological research. Our project intends to apply this perspective to the study of ancient graffiti and their role and meanings within the wadi as a whole. The study of Sławomir Rzepka using analogical tools[16] was a very interesting approach to this kind of studies.

10. Vértes 2017.
11. Darnell 2002a ; Darnell 2013 ; Darnell 2002b.
12. Jiménez-Higueras 2016.
13. Pimpaud 2014.
14. Piccione, Levine [n.d.].
15. Staring 2011; *The Walking Dead*.
16. Rzepka 2014.

3. THE C2 METHOD

Having in mind all the peculiarities of the site, the C2 project developed its own methodology, mixing current methods, developing new techniques and creating a new workflow. Before the arrival at the site, the team had already compiled a corpus of the graffiti in the wadi in a 'Record sheet', based on the information published by Cerny & Sadek in the work *Graffiti de la Montagne Thébaine*[17] and combined with the traditional work of Spiegelberg.[18] These record sheets have been the basis of the fieldwork, letting us check the position and the state of preservation of the previously recorded graffiti. As a result of the collation of these forms with the current situation of the graffiti, a new, more detailed form will be used in future campaigns. Nevertheless, the study of the statistics of the graffiti shows that the wadi, quite small in size when compared to other areas in the Theban mountain, holds about 12% of the total of the graffiti in the area, which is quite significant.

3.1. WORKFLOW

The mission identified the topographical markers and numbers left by previous surveyors. This allowed us to delimitate the sections mentioned in *GTM* and locate the published graffiti. The markings were mostly clear, written in pencil, and have therefore stood the test of time (including erosion of wind or rain). We have identified all the sections contained in the GMT survey. Despite the fragility of the stone, already described in the first report by Maspero,[19] the graffiti are still in place and more or less easily visible. Therefore, the stone, though apparently fragile, is very stable; otherwise, the graffiti would not have been preserved at all.

Firstly, the graffiti were recorded throughout the mentioned record sheet filled *in situ* with all the visible features of the graffiti at that time (fig. 2). The graffiti were also recorded photographically from different perspectives. Then, the images were analysed using different software. Besides Photoshop (with all its filters), we applied D-Stretch: a very common software use in Palaeolithic Rock-art and a very useful tool to reveal marks in the rock not observable for the human eye.

Once each graffiti was accurately documented and analysed, the drawing process started using an established methodology consisting of creating its layout through the 'Procreate Software for iPad Pro (fig. 3), following the 'Chicago House methodology'.[20] Also, a selection of the most interesting graffiti from a historical or art historical point of view was made, and these graffiti were subjected to different treatments (i.e. Photoshop or D-Stretch). In the 2020 campaign, RTI technique was also applied to the graffiti documentation, achieving a step forward in the documentation of this kind of archaeological record, thanks to the collaboration of Catherine Picket.

17. Sadek 1974.
18. Spiegelberg 1921.
19. Maspero 1889.
20. Vértes 2017, pp. 121–138.

3.2. DATABASE

The corpus of registered graffiti has been included in a multifactorial database, in order to develop statistics and graphics of the graffiti registered so far. The database will presumably grow in the near future, adding not only quantitative features, but also photographs, documentation and bibliography available of every graffiti documented.

3.3. GIS

Since the 'Royal Cachette Wadi' is a very interesting site from the perspective of landscape archaeology, the project has created GIS documentation. By including the graffiti database into a georeferenced map (fig. 4), the spatial, visual or geographical analysis will be carried out easily. The possibility of creating a wholly visual and referenced database using GIS technology might prove very useful to increase the hypotheses and inferences regarding the role of landscape in the Theban region. Furthermore, the final aim of the project would be the creation of a map of the whole Theban necropolis, with all the graffiti registered so far in order to comprehend this kind of activity in the mountain.[21]

3.4. OPEN ACCESS DATABASE

One of the aims of the project is the creation of an open-access database of the graffiti, maybe linked to other projects developed by Dr. Piccione or Dr. Jiménez-Higueras, who are currently analysing other aspects of the Theban necropolis using GIS tools as well. The mutual collaboration in order to create and unify a GIS database is essential.

3.5. TRAINING PROGRAM

During the 2019 campaign, several researchers from CEDAE, the SCA office in Luxor and the Complutense University team have attended a 25-hour course on the QGIS (Geographical Information System) program. At the end of the course the attendants passed a final practical exam. The 'C2 Project' is promoting QGIS, a free access tool, as its main spatial analysis tool. We plan to train Egyptian students and researchers, as well as SCA inspectors interested in the QHIS, with this software, so that they acquire basic skills that they can use in their own research. The existence of a free software is really essential to make the use of advanced analysis and tools possible for anyone with a small budget. Thus, the course was developed with QGIS (the most powerful free geographic software).

The course was carried out through theoretical and practical sessions and allowed the students to get an official certificate issued by Complutense University of Madrid.

21. We thank Dr. María Ángeles Jiménez-Higueras (member of the 'Djehuty Project') for kindly providing the maps and documentation used in her research.

4. FIRST RESULTS AND CONCLUSION

Although only the initial phase in the development of this method has been fulfilled, several interesting results have been achieved.[22] A re-interpretation of the hunting scene graffito (no. 3652)[23] has been done, having in mind its location, its visibility and its role as a possible 'liminal area' marker[24].

One of the new graffiti discovered by the C2 project representing a female figurine (no. 8001), has been interpreted as an example of 'space appropriation', because of its position in the prominent rock surface, immediately above TT 320 shaft.[25]

Moreover, the relation between one of the newest graffiti (no. 8002) and a symbolic geological formation recently recognized in the Royal Cachette wadi (next to a libation table and several textual religious graffiti) has been attested thanks to the use of this method.[26]

To sum up, this paper has tried to show the use and results of this method, which will be fully developed in the near future, hopefully in collaboration with other teams, and involving different perspectives as well.

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22. Pérez-Accino, el-Leithy 2019; Vivas Sainz 2019.
23. Sadek 1974, pp. 24–25; Sadek, Shimy 1974, p. 13.
24. See the contribution by I. Vivas Sainz in this volume.
25. Pérez-Accino, Vivas Sainz 2022.
26. Pérez-Accino et al. 2020.

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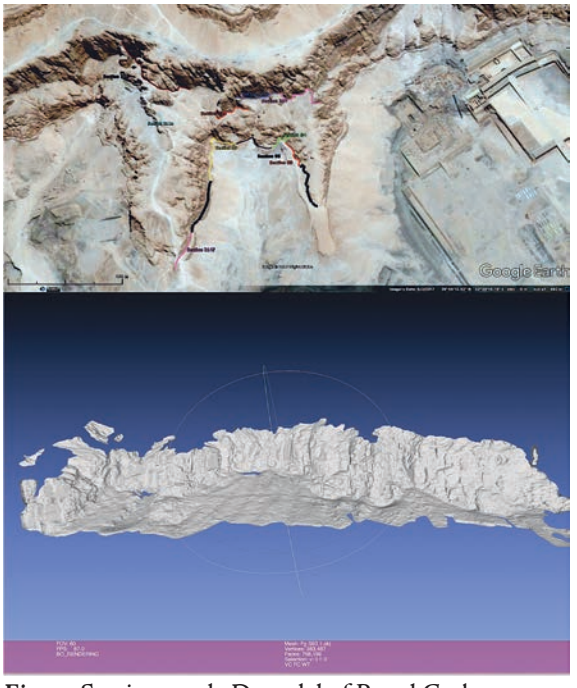

Fig. 1. Sections and 3D model of Royal Cachette Wadi.

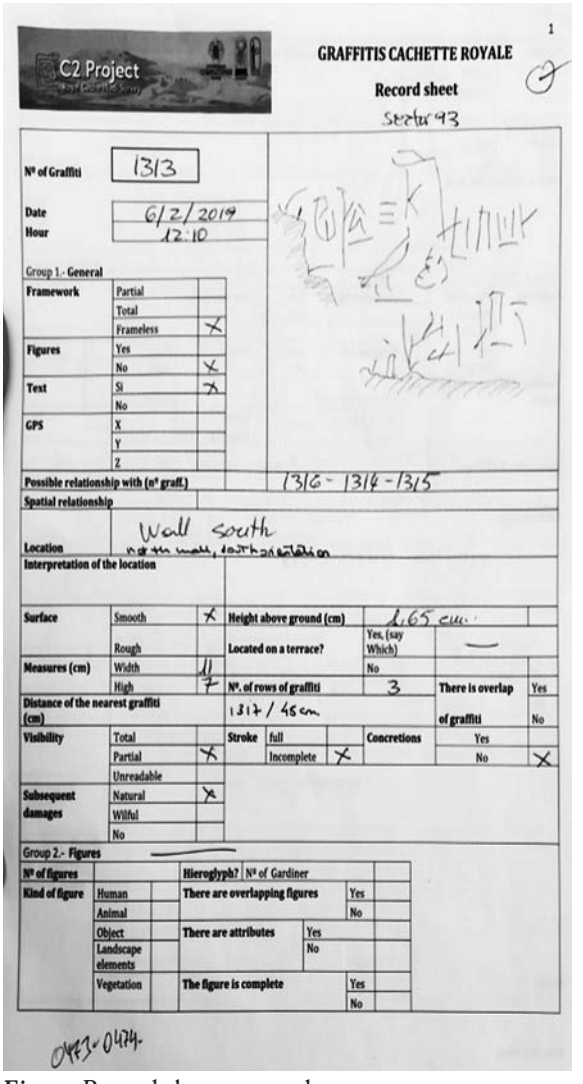

Fig. 2. Record sheets example.

Fig. 3. Graffiti with Dstrecht and first drawing.

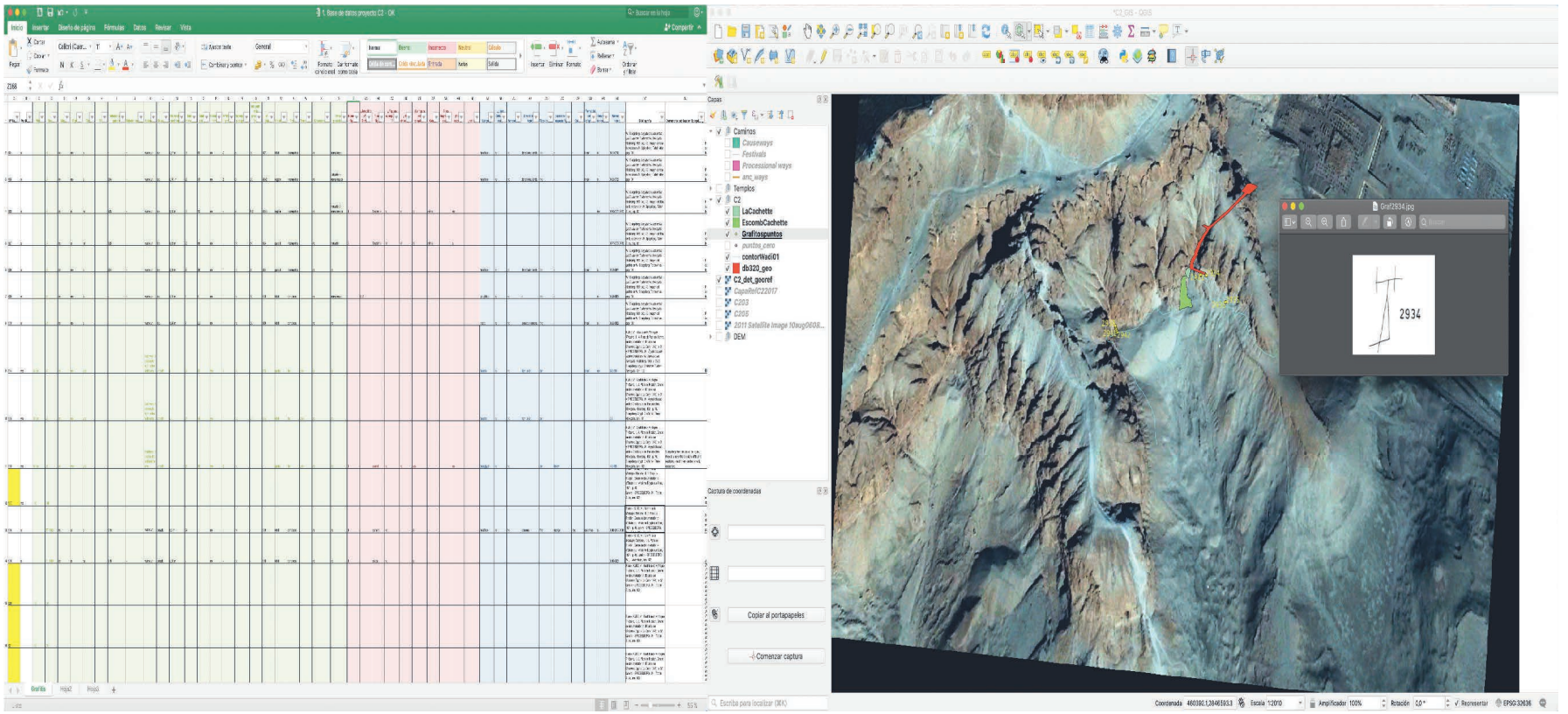

Fig. 4. Database and GIS example.

Danielle O. Phelps*

The Spatial Distribution of the Post-Amarna Tombs in the Valley of the Kings

The tombs in the Valley of the Kings follow a predictable pattern. The Eighteenth Dynasty (ca. 1500–1295 BCE)[1] saw kings place their tombs in a separate branch of the wadi, using tomb placement to align or distance themselves from their predecessors[2] or they constructed "family cemeteries" within the larger necropolis.[3] On initial inspection, the spatial distribution of post Amarna Period tombs (ca. 1336–1295 BCE; KV 5, 54, 55, 56, 57, 58, and 63), located on the eastern wadi's floor of the Valley of the Kings, subverts these standards, including the famous tomb of Tutankhamun (KV 62). Instead the tombs appear to be visibly clustered along the valley floor. This paper examines the spatial distribution of the post-Amarna tombs through the utilization of Geographic Information Systems (GIS) analyses. Three issues are examined: the location of the tombs within a hydrological model of the Valley of the Kings, if the tombs were spatially clustered, and their visibility to one another. These issues are critical to understand if post-Amarna tombs, including Tutankhamun's tomb (KV 62), were intentionally placed in a location that welcomed the "heretic" Amarna kings back into the traditional royal necropolis. Their location in the valley floor may also serve as a means to help conceal and forget some of the apostate rulers who upended the orthodox practices.

The Valley of the Kings is composed of two valleys, or wadis, that lay west of the Nile in Upper Egypt. It was a socially constructed landscape in which royal and elite individuals used the cemetery to preserve social memories[4] and promote family connections with the king for generations after death.[5] The 18th Dynasty established the eastern wadi as the royal necropolis, which was continually used for 500 years with 65 excavated tombs. Three types of tombs are found in the Valley of the Kings: royal tombs, small-corridor tombs, and pit/shaft tombs.[6] The architectural design of the 24 royal tombs shows a variety of chambers, corridors, and halls. However, not all royal tombs

* Arizona State Museum, University of Arizona.
1. Dates used in this paper are based on Shaw (ed.) 2000, p. 485.
2. Roehrig 2016.
3. Reeves 1990; Thomas 1996.
4. Chapman 2000; Connerton 2008.
5. Bickel 2016.
6. Dodson 2016; Wilkinson, Weeks (eds.) 2016.

have the same number of components or the same chambers. The entrances of the royal tombs also do not follow a typical pattern of opening to the eastern sky, as observed in Old Kingdom mastabas,[7] instead the random patterning of entrances is due to the natural landscape.[8]

Previous dynasties were known to separate cemeteries from one another, especially when a new ruling family came into power, to physically mark a new location as a new beginning from that of the previous ruler or to claim new land as territory for the king.[9] The selection of a new branch also disassociated the new reign from the previous one, especially if the previous reign was viewed as unorthodox.[10] A new location also helped in the formation of new political identities and histories as observed with the royal burials in Amarna during the reign of Akhenaten.[11]

The location of Tutankhamun's tomb is an exception to the patterns observed in the Valley of the Kings. It is not in his own branch, nor in a branch of the western wadi near his prestigious grandfather's tomb, Amenhotep III (KV 22). Tutankhamun was buried in a small-corridor tomb on the main floor of the eastern valley. His tomb does not have any subsidiary tombs surrounding it, though several other small-corridor tombs (KV 5, 54, 56, 55, and 63) are in proximity.[12] The spatial distribution of the post-Amarna tombs requires the use of GIS to understand the relationships between them.

1. GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND SPATIAL ANALYSES

Geographic Information Systems (GIS) are databases used for analyzing spatial data that add new understanding of the geographic and human experience within the landscape as multiple layers. It also allows for the reconstruction and interpretation of place meanings at a deeper level.[13] While some studies have used GIS in Egyptology,[14] the application of GIS to Thebes and its necropolis is still in its infancy.[15]

To examine the spatial distribution of the post-Amarna tombs in the Valley of the Kings, paper maps were digitized to perform spatial analyses because there are no readily available digital maps. The plans for each valley were projected at 1:25000 contour level of 10-meter intervals.[16] A geodatabase was created to contain the spatial data and attributes of the associated tombs, such as the KV number, dynasty, owner of the tomb, type of tomb, coordinates, elevation, and architectural features. With a completed digitized map and feature classes, a Digital Elevation Model (DEM),

7. Snape 2011.
8. Cross 2008; Cross 2014.
9. Dodson 2016.
10. Roehrig 2016.
11. Kemp 2016.
12. The other post-Amarna tombs, KV 57 and 58, were most likely constructed during the reign of Horemheb.
13. Llobera 2001.
14. Rowland, Hassan 2003.
15. Burns, Fronabarger, Whitley 2008; Ramzi 2015; Pimpaud 2012.
16. Weeks (ed.) 2003.

which is a digital depiction of elevation data of a terrain with a resolution of 10 meters, was created and became the basis for the spatial analyses that include the creation of a hydrological model, the Average Nearest Neighbor (ANN) analysis, and visibility analyses.

The first two spatial analyses are based on proximity to certain features in the landscape: streams and the tombs themselves. A hydrological model allows for the modeling of water flow patterns that occurred during torrential rains in the Valley of the Kings. The model also examines the proximity of the post-Amarna tombs to ephemeral streams. The Average Nearest Neighbor (ANN) measures the distance between each feature and its nearest neighbor, then calculates the average of these distances. The average is compared to an expected distance based on a hypothetical, random distribution of features in the same area. It shows if the features are randomly distributed or clustered.

A viewshed analysis shows the geographical area visible around a specific location. For this study, it was pertinent to understand if the post-Amarna tombs were visible to one another and to other 18th Dynasty tombs. If they were visible, then it would indicate that the tombs were part of the larger social landscape of the 18th Dynasty royal burials. The components of a viewshed analysis includes the use of DEMs and viewpoints. The viewpoint concerns the viewpoint of an individual standing at the entrance of the tomb and his or her visibility of the surrounding tombs. Random points are created to compare the probability of distributions from the study points which are the tombs in the Valley of the Kings. Statistical significance is tested using the Kolmogorov-Smirnov (K-S) two-sample statistical test, which is a non-parametric test that uses continuous variable data to compare the probability of distributions from specific data with a random sample.[17] The null hypothesis is that both samples come from a population with the same distribution. The sample size affects the point at which the difference between samples becomes significant.[18]

2. RESULTS OF SPATIAL ANALYSES

The hydrological analysis shows that the post-Amarna tombs are exclusively found along the stream path (fig. 1). The results from the Kolmogorov-Smirnov (K-S) two-sample statistical test is statistically significant ($p < 0.000$). The post-Amarna tombs favored locations near the stream paths. Any tomb placed on the valley floor would eventually be covered by sediments that raised the ground level to its current height.[19] The post-Amarna tombs are in locations that would be covered by floodwater and sand, thus 'erasing' them from the necropolis. The people interred in the tombs would still be a part of the broader royal group, but their physical presence in the valley would be concealed and forgotten with time.

Just as the hydrological model data are statistically significant, the Average Nearest Neighbor (ANN) results for the post-Amarna tombs are also statistically significant.[20] The post-Amarna tombs were intentionally clustered. Four of the post-Amarna tombs, KV 5, 55, 62, and 63, can be considered a core group in that they were all constructed fairly closely in time with a similar elevation,

17. Smith, Cochrane 2011. The K-S statistic is examines the empirical distribution functions of the two samples: the study and the control.
18. Wheatley 1995, pp. 174.
19. Cross 2008.
20. The results shows a z-score -2.17168, $p < 0.03$.

their entrances being around 170m below sea level.[21] The spatial analyses suggest that the tombs represent a modified family cemetery as seen in the tomb placement of the earlier 18th Dynasty. It was modified because there was not one royal tomb with subsidiary tombs; instead it was composed of two small-corridor size tombs that contained burials of kings, KV 62 and 55.[22] KV 63 would have been a subsidiary tomb. KV 5's first chambers were probably another small-corridor tomb but it was usurped by Ramesses II for his own children's burials. The other three post-Amarna tombs in the eastern valley were constructed after the core group, as evidenced by their similar higher elevation levels.[23]

The results of the viewsheds of the visibility of the other post-Amarna tombs to other dynastic tombs in the eastern valley suggest that they too were intended to be part of the larger family cemetery and not secluded. They show that the entrances to the post-Amarna tombs would have been visible to many tombs dating to the 18th Dynasty. Though their location was on the bottom of the valley floor, they still were part of the larger Thutmoside necropolis.

3. IMPLICATIONS

The spatial distribution of the post-Amarna tombs suggests that they were built around the same time and used to house the burials and burial equipment of the deceased royal Amarna family members. The person responsible for this modified family cemetery was most certainly Ay, the successor to the throne of Tutankhamun.[24] Ay had dueling motivations: he constructed the post-Amarna tombs to honor his obligations as heir to the throne, thus displaying his adherence to tradition, and on the other hand, he also used the locations to ensure that the heretic rulers would be visibly erased along with their social memory after his legitimacy had been established.

Ay, as a vizier of Tutankhamun, was likely responsible for the restoration of the traditional Egyptian mortuary cult after it was expunged during the reign of Akhenaten. He was also probably responsible for the construction of royal tombs in the Valley of the Kings when the royal court was reinstated in Thebes. Ay may have been faced with the need to construct a number of tombs in a short time to house the royal burials from Amarna, in addition to the sudden death of Tutankhamun. Tombs could be built in a relatively short time when the tomb builders were pressed for time, such as the tomb of Ramesses I (KV 16) which was built in about a year.[25] Additional evidence is the hurried construction of the walls in KV 62.[26] Only the burial chamber was decorated and the other chambers were left bare. KV 55's similarity in architectural plans and lack of decoration are further proof of a hurried construction.[27] The burial remains indicate that it belonged to the secondary burial of a member of the royal family, either Akhenaten or Smenkhkare. KV 63 was simply a pit tomb that contained the overflow of another post-Amarna burial and could easily

21. Litherland 2014.
22. Bell 1990.
23. Weeks (ed.) 2003.
24. Kawai 2010.
25. Altenmüller 2016.
26. Carter 1927, p. 26.
27. Robins 2007.

have been constructed in a short period of time. The core post-Amarna period tombs, KV 5, 55, 62, and 63, thus represent an attempt at a modified "family cemetery" with specific immediate family members of the Amarna royal family, including Tutankhamun and the individual from KV 55, built in a relatively short period of time. The post-Amarna tombs represent the return to the normative royal mortuary practices with burials in the 18th Dynasty royal necropolis as a family cemetery.

It was necessary to reintroduce the Amarna kings back into the fold of the orthodox and traditional mortuary practices in order for them to be considered legitimate. The easiest way to become legitimate in the eyes of the gods and the ancestors would be the interment in the middle of the sacred burial ground. The Valley of the Kings was a location steeped in tradition, a connection with the past and ancestors, and became a "symbolic resource and an essential component of the ritual impact of a [specific] place, a dimension of meaning manipulated to legitimize new political or social ideologies."[28] Thus, using a tomb in the middle of the eastern wadi would not only be to honor Tutankhamun, but also help with the legitimacy of his successor, Ay. Its location harkened back to the traditional mortuary practices abandoned by Akhenaten.

CONCLUSION

Ay's restoration practices helped in gaining the trust of the priesthoods and, with them, their power and influence that helped in his claim to the throne. Ay's erasure of the Amarna royal family members occurred not only through the dismantling of their temples and building projects,[29] but also with the placement and concealment of their tombs in the Valley of the Kings. Ay's use of memory helped with the advancement of his own agenda. The elimination of these controversial figures from social memory and record allowed the construction of a new narrative during the reign of Ay, which was eventually overtaken by Horemheb. Ay was ensuring the formation of a new historical narrative that helped cement his claim to the throne; however, Ay would suffer from similar tactics as his reign ended, and his adversary drew upon the power of social memory and space to erase him from the narrative.

28. Richards 1999, p. 84.
29. Eaton-Krauss, Murnane 1991.

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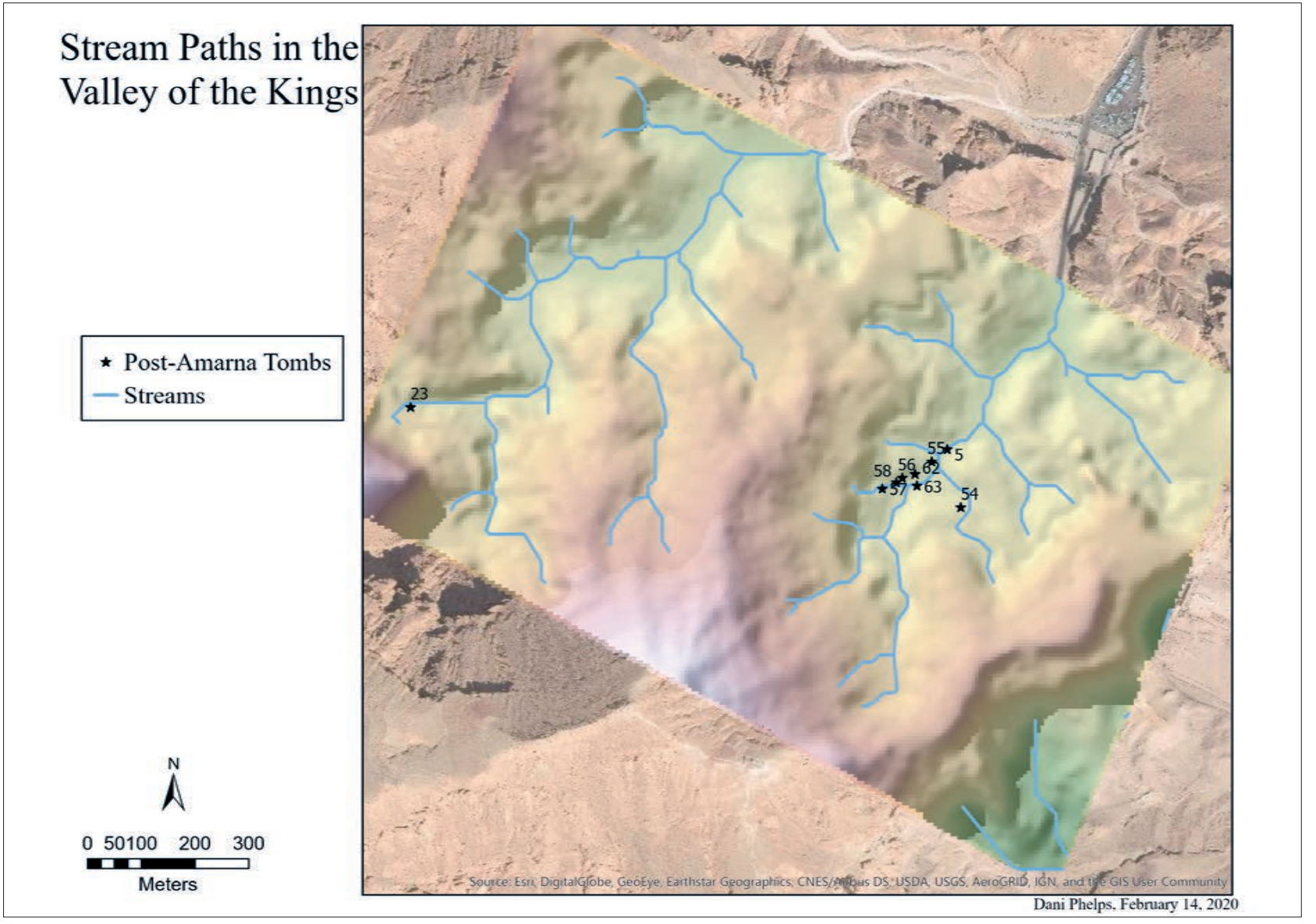
Stream Paths in the Valley of the Kings
Post-Amarna Tombs
Streams
23
55
5
56
62
58
57
63
54
N
0 50100 200 300
Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Dani Phelps, February 14, 2020

Fig. 1.

Lorenzo Uggetti*

GESHAEM – The Graeco-Egyptian State

Hellenistic Archives from Egyptian Mummies**

The aim of the following paper is to present goals and first results of the scientific initiative GESHAEM—the Graeco-Egyptian State: Hellenistic Archives from Egyptian Mummies. It is coordinated by Marie-Pierre Chaufray, research fellow in papyrology of the French National Centre for Scientific Research (CNRS), hosted by the Ausonius Institute at Bordeaux Montaigne University (UMR 5607) and funded by the European Research Council (ERC–StG 758907). The purpose of the project is to enhance our knowledge of the administration of the Fayyum during the first centuries of the Ptolemaic rule, thanks to the study of the Jouguet collection.

Between 1900 and 1902, the French Government financially supported Pierre Jouguet for two excavation campaigns in the Fayyum. After having briefly explored Medinet Madi, he went to the South-Western sites of Medinet Ghôran and Medinet en-Nahas, the latter identified with the ancient Magdôla thanks to an inscription found *in situ*. In their cemeteries he discovered more than three hundred mummy *cartonnages* in total: they were usually made of linen cloths or palm tree fibres, but these materials were often replaced by reused papyrus sheets, covered with plaster and then painted.[1] For this reason, many scholars of that period turned their attention to these objects more for their textual content, especially for literary works unattested in manuscript tradition, than for their inherent value as archaeological finds.[2] As a result, most of them were dismantled soon after their discovery: this operating procedure explains why many of these texts are fragmentary, but at the same time allowed to find, for instance, an otherwise lost comedy by

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1. Jouguet 1901, pp. 380–385, 401–406 and 411; Jouguet 1902, pp. 346–355; Jouguet, Collart, Lesquier 1928, pp. 1–2; Chaufray 2018, pp. 47–50; Jacques 2022, pp. 569–571; Uggetti 2022a, p. 326.
2. Jouguet 1901, pp. 380–381; Jouguet 1902, pp. 347–349; Chaufray 2018, p. 47.

Menander.[3] The greatest part of these *cartonnages* (of which 363 pieces were inventoried just from Ghôran)[4] and papyri are now kept in the Papyrological Institute of Sorbonne University, founded in 1920 by Jouguet himself in Paris.[5]

Nonetheless, around twenty *cartonnages* remain in good condition overall: one of the aims of GESHAEM is not only to restore them, but also to study them in their own right, analysing both their form and their painted decoration.[6] As an example, two fragments were missing from a painted breastplate:[7] one of them has been rediscovered and reattached in its former position, while a photograph of the other one has been found in a periodical of 1963.[8]

Other items rest in poor condition. Some were already dismantled and the plaster was removed from the most part of them: therefore, it is quite hard even to recognise the different elements of the original *cartonnage*. In such cases, the goal is to preserve the extant decoration as much as possible, whenever still visible and, without damaging it, to extract papyrus fragments from the inner layers. Each step of the process is documented by a condition and restoration report with photographs. After cleaning and consolidating the decoration, the latter is covered with a temporary facing, in order to protect it while extracting papyrus fragments from the back of the *cartonnage*, except for the last one directly supporting the plaster. At the end of the papyrus extraction procedure, made possible by a controlled introduction of humidity, the decoration support might be reinforced with a permanent lining on its back and the facing on the front is removed.[9]

Texts from *cartonnages* discovered by Jouguet are in both Greek and Demotic. Most of them date from the 3rd and 2nd centuries BC and consist essentially of records from administrative archives. The new papyri receive an inventory number and both colour and infrared photographs are taken for each side, as well as for other fragments extracted before the beginning of the project, but still unpublished.[10] The names of these photos, the inventory numbers and the size of the newly obtained documents are all noted in the restoration reports, thus providing the opportunity to track back the origin of each fragment as much as possible.

The project website (geshaem.huma-num.fr) will host an open-access corpus of the papyri in eXtensible Markup Language (XML).[11] The textual content is encoded following the EpiDoc guidelines, which specifies a subset of the Text Encoding Initiative's standard for the representation of texts in digital form. Special attention is given to the description of the materiality of the papyrus and of the writing, because they are crucial for another goal of GESHAEM: developing a digital

3. Blanchard, Bataille 1964, pp. 103–176.
4. Chaufray 2018, p. 48; Jacques 2022, pp. 571 and 573.
5. Husson 2007, p. 144; Uggetti 2022a, p. 326.
6. In charge of this part of the project is Raphaël Meffre, research fellow in Egyptology of the CNRS in Paris.
7. Jacques 2019, Inv. Sorb. 2769+2832.
8. Jacques 2022, pp. 577 and 582.
9. Uggetti 2022a, pp. 328–329. Pavlos Kapetanakis, papyrus conservator within the project GESHAEM, will publish a conservation article explaining in more detail the treatment performed.
10. The photographs are taken by Adam Bülow-Jacobsen, professor emeritus in papyrology and specialist in colour and infrared photography.
11. Uggetti 2022a, p. 329; Chaufray, Uggetti in press. The conception and realisation of both the structure of the database and the project website are due to Nathalie Prévôt, Ingénieure d'études in digital humanities at the CNRS in Bordeaux.

instrument for automatic image processing, which will facilitate the task of joining the fragments.[12] Every papyrus will be represented by one XML file and four photographs: it is thus vital to tag the text entries for each surface (recto and verso)[13] and to recall them unambiguously in the metadata describing the pictures,[14] in order to combine consistently all visual and textual information.

In order to prevent the algorithm from suggesting incoherent joints, the surface layout description mentions the number of columns and lines,[15] as well as the presence of margins.[16] Other useful elements for ruling out false connections, pointed out before the single units of ancient text, are the distinction between Egyptian Demotic and Ancient Greek as the language employed[17] and the orientation of the writing with respect to the direction of the fibres, establishing if it goes along (perfibral) or across them (transfibral).[18] Moreover, the metadata show whether the writing instrument is a brush or pen, the changes in handwriting[19] and peculiar elements such as *kollêseis*, that is areas where two sheets were slightly superposed and glued together during the manufacturing of ancient papyrus rolls.[20] This last kind of information is useful when two different fragments, which cannot be joined together, present a *kollêsis* with the same approximate distance: this means that they might belong to the same vertical section, even if a gap remains between them.

External authority lists call attention to recurrent elements within the corpus. Other than a record of contract clauses, useful for synoptic comparisons, the ones referring to the people and to the places mentioned in the textual content of the documents.[21] Establish correspondences

12. Entrusted with this task is Antoine Pirrone, who had his PhD at Bordeaux University funded by the project. Some preliminary results have been published by Pirrone, Beurton-Aimar, Journet 2019, pp. 78–83; Pirrone, Beurton-Aimar, Journet 2021, pp. 219–234.

13. Example for the recto: / TEI / text / body / div type="edition" / div n="1" type="textpart" subtype="fragment" / div n="r" type="textpart" ana="#perfibral" xml:id="FILENAME-recto". See Chaufray, Uggetti in press.

14. Example for a colour photo of the recto: / TEI / facsimile / surface corresp="#FILENAME-recto" / graphic url="https://www.nakala.fr/iiif/PHOTONUMBER" / desc type="R_CL". See Chaufray, Uggetti in press.

15. A five-lines column would be indicated as follows: / TEI / teiHeader / fileDesc / sourceDesc / msDesc / physDesc / objectDesc / layoutDesc / layout xml:id="FILENAME-1" columns="1" writtenLines="5". See Uggetti 2022a, p. 330; Chaufray, Uggetti in press.

16. An upper margin on the recto would be marked as: / TEI / teiHeader / fileDesc / sourceDesc / msDesc / physDesc / objectDesc / layoutDesc / layout corresp="#FILENAME-recto" / dimensions type="margin" n="top". See Uggetti 2022a, p. 330; Chaufray, Uggetti in press.

17. Univocally defined after THOT - Thesauri & Ontology for Documenting Ancient Egyptian Resources. An example for Demotic: / TEI / teiHeader / profileDesc / langUsage / language ident="egy-egyd" / ref target="http://thot.philo.ulg.ac.be/concept/thot-15". See Uggetti 2022a, pp. 329–330; Chaufray, Uggetti in press.

18. For instance, if the recto is written along the fibres: see *supra*, n. 13. The attribute "perfibral" (as well as "transfibral") is defined in each XML file taxonomy: / TEI / teiHeader / encodingDesc / classDecl / taxonomy / category xml:id="perfibral". See Uggetti 2022a, pp. 330–331; Chaufray, Uggetti in press.

19. In order to pinpoint the first hand identified in a Demotic document: / TEI / text / body / div type="edition" / div n="1" type="textpart" subtype="fragment" / div n="r" type="textpart" ana="#perfibral" xml:id="FILENAME-recto" / div type="textpart" subtype="column" corresp="#FILENAME-1" xml:lang="egy-egyd" / ab / handShift new="m1". See Chaufray, Uggetti in press.

20. Usually its distance from the right edge of the fragment is indicated: / TEI / teiHeader / fileDesc / sourceDesc / msDesc / msPart / physDesc / objectDesc / supportDesc / support / rs type="kollesis" n="1" / measure unit="cm". See Uggetti 2022a, p. 331; Chaufray, Uggetti in press.

21. Chaufray, Uggetti in press.

between spellings in ancient and modern languages and supply links to the Trismegistos database (www.trismegistos.org). Whenever possible, family relationships and functions are indicated for each person, in particular for scribes and witnesses.

Scholars shall be able to search for papyri by inventory or publication number and to interrogate the database in XML format via a user-friendly interface on the GESHAEM website. First, the description of the support will be shown, then the prosopographical and the geographical lists of the elements named in each document. Transliteration and translation of the text will follow on two columns, side by side: by clicking on two buttons, it will be possible to highlight either the persons (PER) or the places mentioned (GEO), then by hovering over these names their transcription in Latin characters, their link to Trismegistos and, for individuals, eventually their role, will appear. Both the infrared and the colour photos will be available and might be enlarged. A button will make the XML source file directly accessible.

Concerning the scientific outcomes of GESHAEM, what was supposed to be a breastplate has provided one of the first Greek texts.[22] The restoration images indicate the precise position of the six fragments forming the document now inventoried as Inv. Sorb. 2855 and show that, in order to be reused in the funerary workshop, it was cut into pieces, which were then put in separate layers of the *cartonnage*, turned following different orientations or flipped. After extraction, they have been stretched out, flattened and repaired with small strips of Japanese paper[23] covered on one side with methylcellulose.[24] Once reassembled, the papyrus has been stored in a non-acidic blotting paper folder.

The infrared photographs allow the recognition of the main elements of a petition to an official. A fragment preserves its original upper right corner, where *par' Apollôniou* can be read, which is the name of the petitioner. At the top of another fragment, the remaining letters invite the restoration *adikoumai hypo*, used to present the circumstances which prompted the plea. In the middle of a third fragment, the verb usually employed to introduce the request, *axiô oun*, is clearly readable. Finally, the last line contains the faint but still recognisable traces of the farewell, *eutuchei*.

The official at issue is Philonautês, as could be seen from the address on the verso. The beginning of his name is partially readable also on the recto and is followed by his title: *toparchês*. So, up to now, Inv. Sorb. 2855 is the only attestation of this toparch, otherwise completely unknown. Hopefully, Jouguet collection's papyri will unveil many other interesting elements about the administration of Ptolemaic Fayyum: all the results will be published on the website geshaem.huma-num.fr.

22. Uggetti 2022a, pp. 331–332; Uggetti 2022b, pp. 991–993 and 995–1000.
23. Gampi, 12 g/m², pH 7.3.
24. Tylose MH 300 P.

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