

## THE TOMB OF IPI: 3D DOCUMENTATION IN A MIDDLE KINGDOM THEBAN NECROPOLIS (EGYPT, 2000 BCE)

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### Commission II

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### ABSTRACT:

Due to the multiplicity of tombs in the area and the work of early archaeologists in Deir el-Bahari, the necropolis resembles a Swiss cheese. In addition, most of these monuments and their remains (coffin fragments, human remains, subsidiary structures) were left unpublished. A century later, the major purpose of the Middle Kingdom Theban Project of University of Alcalá (MKTP-UAH) –led by the moudir (i.e. “director” in Arabic) Antonio Morales– is to document, understand, and publish all these monuments and findings left behind by previous expeditions. Such publications will shed light not only on the necropolis and owners of the monuments, but will also help to understand the beginning of the so-called Middle Kingdom, a golden age of the pharaonic period with a significant and impressive architecture. In fact, most of archaeologists take these tombs as patterns for this golden age, without taking into consideration that we do not know much about them.

### 1. INTRODUCTION

When the American archaeologist Herbert Winlock initiated his work in the 1920s in Deir el-Bahari (Figures 1 and 2) on behalf of the Metropolitan Museum of Art (MMA), he could not suspect that 100 years later these tombs and their findings would still retain scholarly attention. The main goal of the MMA mission was to reveal the deepest secrets of these mortuary monuments and search for aesthetically appealing objects. Western museums organized these missions to obtain Egyptian antiquities for their collections. For this, Winlock took an average of a month per tomb in order to achieve the maximum number of discoveries in a short period of time. However, in 1923 another MMA team discovered the main ramp of the mortuary temple of Hatshepsut, and therefore Winlock had to leave the necropolis and apply every effort to the royal monument (Carter, 1912; Maspero, 1889; Soliman, 2009; Winlock, 1914; 1915; 1923; 1924; 1947).

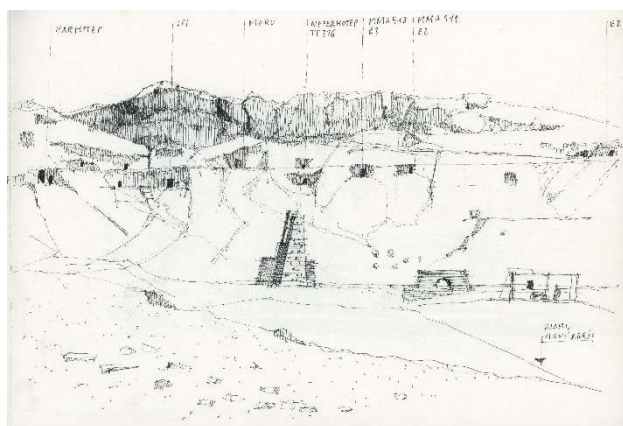


Figure 1. Design of Deir el-Bahari archaeological area.

One of the major targets of the Middle Kingdom Theban Project is the tomb built for the vizier Ipi (TT 315). This tomb was one of the greatest monuments in the area, standing 500 years before the construction of the temple of Hatshepsut. This official worked in the last years of the Eleventh Dynasty, under the last Mentuhoteps (2055-2005 BCE), and probably reached the

position of vizier by the beginning of the Middle Kingdom, under the rule of Amenemhat I (2005-1956 BCE).

The third and fourth season of the MKTP conducted under the auspices of the University of Alcalá extended from late March to the end of April, 2017 (Morales, 2017) and 2018 (Morales, 2018). The project aimed at cleaning the mortuary chambers of the tomb of Ipi (TT 315) and the nearby tomb of the royal treasurer Henenu (TT 313), as well as working on the outer courtyards of these two monuments, just in the areas where Winlock's expedition worked previously.

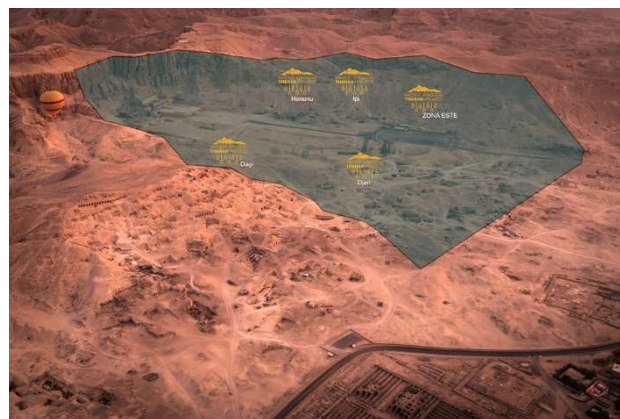


Figure 2. Aerial view of Deir el-Bahari

#### 1.1 The site

The tomb of Ipi (TT 315) is a large funerary complex, located in a sector of the necropolis where another dozens of funerary constructions of the same date were built. The courtyard of Ipi's tomb is ca. 100 m long and around 30 m wide. The inner section of the tomb consists on a horizontal corridor leading into the mountain some 20 m down to a rectangular room, which was the cultic chamber where the statue of the deceased received offerings mortuary rituals. Under the floor of this chamber there is a descending corridor with a steep slope of 30° that actually follows the descending geological strata for over 10 m, reaching the innermost chamber of the monument, the sarcophagus chamber (4.5 x 4 m), where the remains of Ipi's sarcophagus and

funerary equipment remained (Figures 3, 4, 10, 13, 14, 15 and 16).

Among the most important discoveries, this previous season the archaeologists of the team discovered a mummification deposit where all the embalming materials were stored in large jars containing natron bags, wrappings, textiles, shrouds, etc. This chamber (6.2 x 1.8 with irregular height between 0.7 m and 2.5 m) was already discovered in the 20s by Herbert Winlock. When he found it, he located 67 jars in the chamber and emptied some of the jars, but he thought the contents were irrelevant, threw them away and left the remaining jars there. Another area that has revealed interesting evidence has been the foundations of several structures in the western side of the complex, where remains of two walls and a couple of stone structures –perhaps subsidiary tombs– have been located.

Regarding the inner section, the structure suffered much pillage and robberies therein, including the removal of stone blocks to be used in other monuments. Ideally, these tombs would have been built with sandstone blocks for the floor and limestone for the walls, perhaps with incised hieroglyphs with the name and titles of the tomb owner. In addition, within the sarcophagus chamber, a remarkable feature is that the room was excavated to receive the sarcophagus under the floor of the chamber. In fact, the lid of the sarcophagus was the last block of the floor to be placed, sealing the coffin and the mummy within the sarcophagus under the floor.



Figure 3. View of Ipi's sarcophagus.

## 1.2 Historical Review

The triumph of king Mentuhotep II Nebhepetra at the end of the Eleventh Dynasty (ca. 2055 BCE) signified the emergence of a powerful Egyptian state built upon a culture of traditions and transformations centralized at Thebes. From the First Intermediate Period, the city witnessed the expansion of the Theban rulers toward the northern old power at Memphis and the unification of the country by Mentuhotep II. Because of this, Thebes became the focus of numerous transformations, among them the construction of the royal mortuary complex for Mentuhotep II in Deir el-Bahari and the building of private tombs for the powerful officials who contributed to the unification of the country and the construction of the Middle Kingdom era, the "classical period" in pharaonic history. In spite of the role of the new capital (Thebes), the royal and private tombs of the period have never been a priority in the study of the funerary monuments at Thebes. The Middle Kingdom Theban Project launched from the University of Alcalá aspires to contribute to a better knowledge of the reign of Mentuhotep II and the beginning of the Twelfth Dynasty by studying, analysing, protecting, and

publishing each of the tombs in the necropolis, including the tomb of Vizier Ipi (Bull, 1924).

The vizier Ipi was one of these "architects of the state" during the late years of the Mentuhotep family and the initiation of the Twelfth Dynasty, with king Amenemhat I at the head of the new moves. The vizier must have participated in some of the important political, social, and economic programs developed at this moment in the history of the dynasty, decisions that introduced Egypt into one of the golden ages of its history. The intellectual, cultural, and artistic production flourished, and individuals such as Ipi wanted to express their prestige, role, and impact on this new glorious period with the construction of a large funerary complex in the area where Mentuhotep II, "father of the unified country", built his funerary temple and tomb.

Ipi's tomb was located in the western part of the necropolis and is one of the largest complexes in the area. One of the most relevant characteristics of the Ipi tomb is the monumentality of the building, exposed to the rest of the necropolis in a vast scale. Unfortunately, the exposure to the tomb and the large scale of its components made it easy –in later periods of economic and social crisis– to plunder the tomb. Among the most interesting sections, the huge courtyard (approx. 80 x 40 m) and the tomb façade –excavated in the limestone rock– offered a monumental image of this complex and came to express the power and authority of Ipi by the beginning of the Twelfth Dynasty.

## 1.3 Graphic database

Antoine Babuty Desgodetz (Celis, 2006) began the technique of the correct lifting of ancient monuments and the enhancement of these buildings from the appearance of the publication in 1682 "*les edifices antiques de Rome, dessinés et mesurés tres exactement*".

In the research on heritage, an important studio tool to evaluate the temporal evolution of the Monument is the analysis of graphic documents (Echeverría, 2015), which allows us to add information to other studies. In the case of the Ipi's tomb, this information is not very abundant and has a testimonial nature given the low precision of it (Figures 4, 5, 6 and 8).

Underground surveying of cellars, caves, and architectural spaces is quite different from surveying on the surface. In this project, researchers deal with various challenges derived from the lack of light, temperature, and accessibility. Another problem in underground surveying is how to orientate the underground survey to the surface one.

For this purpose, our methodology integrates different geomatics techniques, including scanner laser for 3D modelling and classic topography, which helps to locate control points according to the reference frame of the Geodetic Network.

Therefore, we argue that our work recording underground survey data will bring into light an important part of the pharaonic heritage and the major issues recording data in the field.

Based on the necessity to study and document all these spaces, corridors, chambers and architectonic features, the MKTP will continue with underground surveying, laser 3D scanning, and the study of the tomb architecture. These methods will be combined with topographical techniques and photogrammetry.

## 2. METHODOLOGY

In this article, we shall proceed to explain all the process followed in this particular research conducted in the tomb of a Vizier called Ipi, located in the site of Deir el-Bahari (Luxor, Egypt). The façade of the tomb is, at this moment, in the process of rebuilding, so the results will be modified in real time, as Porcuna clearly





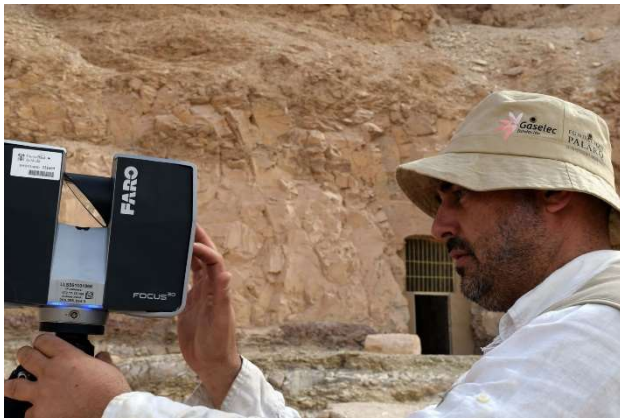


Figure 9. Configuring the laser options of the 3D scanner

In external positions, the high heat and intense luminosity required work in the first hours of the day, even before the sun came out, which forced the expedition to reach the area where the work had to be done before 6 AM. As soon as it started to heat up quickly, the scanner stopped working when it exceeded its working temperature range, which forced it to remain in stand-by to recover normal temperature. In addition, architects had to find a cool area where it could be left to recover working capacity. Another difficulty lies in the nature of the work surface itself, with large irregularities that forced at all times to adapt the tripod to the most appropriate situation for the operation of the scanner, which sometimes led us to use of the tripod without its support, using a flat platform to access low-rise camera points.

In the inner section of the tombs, the greatest complexity came from the irregularity of the walls, excavated in the living rock, with very acute angles in the whole height of the tunnel. This situation forced us to perform more positions than in normal situations in order to reduce the blind areas of the route and then proceed to achieve the most correct reconstruction of the final image.

LASER SCAN PARAMETER	FARO FOCUS 3D
CHOSEN OUTLINE	Outside from 40m Inside from 15 m
RESOLUTION AND QUALITY	Resolution: 1/6 Quality: 4x
SCAN RANGE	Vertical range: from -60° to 90° (variable) Horizontal range: from 0° to 360° (variable)
SENSORS	Use clinometer: activated Use compass: activated Use altimeter: activated
COLOR PARAMETERS	Weighted measuring to the center
ADVANCED CONFIGURATION	Clear contour: activated Clear sky: activated

Table 1. Laser scan parameter

Finally, in each of the inner positions, a detailed study of the artificial lighting of the area was made from portable light points that would allow obtaining the colour image of the interior. The scanner was adapted for the electrical connection of the battery charge (to support the long day of continuous work) and for situating a light under the scanner that would illuminate the whole scene without making reflections in the shot.



Figure 10. 360° view with scanner 3D. Sarcophagus chamber in Ipi's tomb.

After this step, the different scans were put together to reach the complete point cloud of the Ipi's funerary complex. In the subsequent processing of the information (with FARO's SCENE software), the major difficulties were in the process of connecting the various zones: that is the combination of the wells, the chambers and, especially, the outer with the inner sections of the monument (Figures 11, 12, 13 and 14).

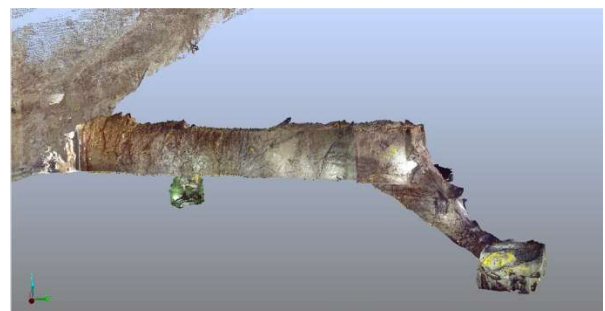


Figure 11. Lateral view of Ipi's mortuary complex. Scanner Faro focus 3D and SCENE software.



Figure 12. Outdoor view of Ipi's courtyard. Scanner Faro focus 3D and SCENE software.



### 3. PROSPECTIVE

In the near future, based on the Egyptian Ministry of Antiquities permissions, the MKTP aims at continuing each campaign with a more in-depth exploration of the tomb at those points where the excavation has not yet been completed, both inside and outside, and new data can be obtained. In addition, this work will make possible to compared the tomb of Ipi and Henenu with the rest of the existing tombs in this area of great archaeological interest, which will also allow to identify constructive patterns, historical features of the monument of Ipi and integrate it into the entire history of monuments construction in the necropolis.



Figure 13. Sarcophagus chamber. 3D model. Scanner Faro focus 3D and SCENE software.



Figure 14. Sarcophagus chamber. 3D model. Scanner Faro focus 3D and SCENE software.

From this initial work carried out with the Ipi's tomb's volume, it is intended to continue with a modelling of the spaces of the rest of the tombs (Henenu, Dagi, Djari...) in order to participate in models of augmented reality. In addition, it is also planned to insert the data obtained within the INSPIRE standards.

There are two main data specifications inside INSPIRE where cultural heritage data are site: Data Specification on Protected Sites, and the Data Specification on Area management / restriction / regulation zones and reporting units (Chías, 2015).

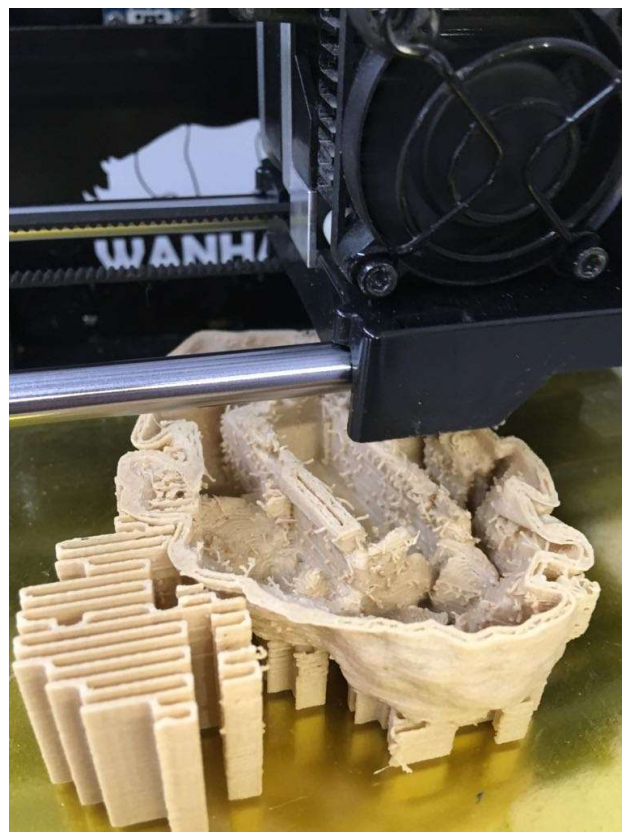


Figure 15. 3D Printing process of Ipi's sarcophagus chamber

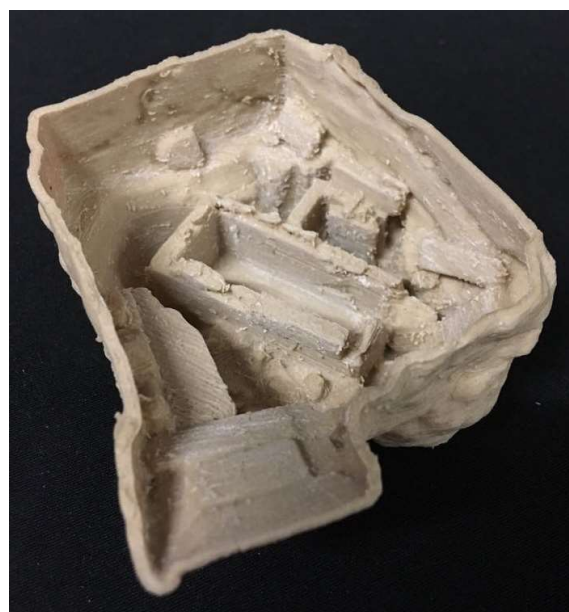


Figure 16. Indoor detail of sarcophagus chamber. 3D printing.

### 4. CONCLUSIONS

As observed above, although the project has graphic material from the tombs, for the first time we have obtained a representation –almost real– of its current state. This means a representation that is not flat but in 3D form to be used by researchers, mainly archaeologists, architects, and conservators, in their current work in the necropolis and in this tomb.



Figure 17. Last corridor of Ipi's tomb. 3D printing.

From the 3D model, we can obtain plans, cross sections, orthophotos, details of particular corridors, chambers, and shafts, and we can even make a 3D material construction as reliable as possible for museum and teaching uses (Figures 15, 16 and 17). On the other hand, through this data, a 3D recreation could be made and could be used for restoration work. Interestingly, the tomb of Ipi presents some characteristics that seem to indicate that a section of the tomb might have been built some centuries later, a matter that can be traced easily and studied more accurately through the representation in 3D of the various sections of the tomb. In this way, the expectations of the application of these techniques are answered with representations of the tomb that can be used for further research, teaching, and the dissemination of the archaeological results.

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#### REFERENCES

- Bull, L.S., 1924. A new vizier of the Eleventh Dynasty, *Journal of Egyptian Archaeology* 10, no. 1, pp. 15.
- Carter, H., 1912. *Five years' explorations at Thebes: a record of work done 1907-1911*. London: Frowde, pp. 22.
- Celis, F., 2006. Desgodetz y los orígenes del levantamiento moderno. *Revista Expresión Gráfica Arquitectónica* nº 11, Valencia, pp. 76.
- Chías, P. and Abad, T., 2015. Spatial Data Infrastructures and Spanish Cultural Heritage: the INSPIRE Framework applied to the Monastery of El Escorial. *Journal of Map & Geography Libraries*, 11(2), pp. 245-265.
- Echeverría, E., Celis, F., And Casa, F. da, 2015. Drawing as a research tool: reconstruction of the trip time of the urban image of Alcala de Henares. *Revista Expresión Gráfica Arquitectónica* nº 25, Valencia, pp. 180.

Goitia, A., 2010. Restituir, Redibujar, Aventurar. Estrategias para documentar tres puertas monumentales de Madrid. *Revista Expresión Gráfica Arquitectónica* nº15, Valencia, pp.74.

Maspero, G., 1889. Trois années de fouilles dans les tombeaux de Thèbes et de Memphis, in *Mémoires publiés par les membres de la Mission archéologique française au Caire* I. Paris, pp. 133-181.

Mesa, A. De, Regot, J., Núñez, M<sup>a</sup>. A. And Buill, F., 2007. Estrategias de modelado en la Sagrada Familia. *Revista Expresión Gráfica Arquitectónica* nº 12, Valencia, pp. 92.

Morales, A., Abd El-Hady, R., Accetta, K., Alarcón, S., Bardaji, T.; Celis, F.; Echevarría, E.; Falk, S.; Hussein, M.; Ikram, S.; Ortiz, J.; Osman, M.; Sáez, A.; Sánchez, R.; Serova, D.; Shared, H.; Yamamoto, K. and Zidan, E., 2017. The Middle Kingdom Theban Project: Preliminary report on the University of Alcalá Expedition to Deir el-Bahari, Third Season (2017). *Studien Zur Altägyptischen Kultur*. Bnad 46.

Morales, A., Abd El-Hady, R., Accetta, K., Arranz, M.; Bardaji, T.; Carrillo, M. F.; Celis, F.; Díaz, C.; Dorado, E.; Echeverría, E.; Falk, S.; Gracia, C.; Ikram, S.; Illana, S.; Kruck, E.; Luciañez, M.; Martínez, O.; Meza, D.; Mora, P.; Ortiz, J.; Osman, M.; Sánchez, R.; Serova, D.; Shared, H.; Spinelli, D.; Tarek, A. and Yamamoto, K. 2018. The Middle Kingdom Theban Project: Preliminary report on the University of Alcalá Expedition to Deir el-Bahari, Fourth Season (2017). *Studien Zur Altägyptischen Kultur*. Bnad 47.

Navarro, P, Herráez, J., Mora, Á., Barros, H. And Denia, J.L., 2011. Aplicaciones de la Tecnología de digitalización tridimensional por la coordinación de monumentos históricos del instituto nacional de arqueología e historia (INAH) en México DF. (2009 y 2010). *Revista Expresión Gráfica Arquitectónica* nº17, Valencia, pp.42.

Olmo, L., Castro, M., And López-Macia, M., 2012. La utilización del Scanner en el registro arqueológico: La experiencia de la Universidad de Alcalá. *Visual Archaeology Review*. Vol 3. Nº 5, pp 93-97.

Porcuna, D., Córdoba, R., Sanz Cabrera, R., And Montes Tubio, F. De P., 2016. Metodología para la reconstrucción virtual interactiva en modo videojuego del Patrimonio cultural. Aplicación al castillo medieval de Torreparedones (Baena). *Revista Expresión Gráfica Arquitectónica* nº28, Valencia, pp. 278.

Soliman, R., 2009. *Old and Middle Kingdom tombs*. London, Golden House Publications, pp. 126-128.

Winlock, H. E., 1914. Excavations at Thebes in 1912-13 by the Museum's Egyptian Expedition, *Bulletin of the Metropolitan Museum of Art*, 9, no. 1, Jan. 1914, pp. 18-19.,

Winlock, H. E., 1915. The Theban Necropolis in the Middle Kingdom, *American Journal of Semitic Languages and Literatures*, 32, pp. 1.

Winlock, H. E., 1924. The Egyptian Expedition MCMXXI-MCMXXII, *Bulletin of the Metropolitan Museum of Art* 17, no. 12, Part 2, pp. 32.

Winlock, H. E., 1923. The Egyptian Expedition 1922/1923, *Bulletin of the Metropolitan Museum of Art* 18, no. 12, Part 2, pp. 11-19.

Winlock, H. E., 1947, *The rise and fall of the Middle Kingdom in Thebes*. New York, Macmillan, pp. 44-67.