The restoration and the anastylosis of the Macedonian tomb of "Macridy Bey" near Thessaloniki

Restauro e anastilosi della tomba macedone detta "di Macrid Bey" presso Salonicco

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La tomba a due camere, datata tra il IV-III secolo a.C., è la più importante della necropoli di Derveni, posta in un punto strategico lungo la via Egnatia, poco a nord di Salonicco. Prende nome dall'archeologo greco-ottomano Theodoros Macridy Bey (1872-1940), assistente direttore del Museo imperiale ottomano di Istanbul, che la scoprì nel 1910.

La tomba e il dromos antico di accesso erano coperti da un tumulo artificiale, in parte conservato, coperto dalla vegetazione. La sua architettura è di rilevanza monumentale. La facciata è marcata da semicolonne ioniche, su base attica e crepidoma, concluse da un timpano. Un breve vestibolo introduce alla camera sepolcrale attraverso un grande portale in marmo: di marmo erano anche i battenti della porta, che Macridy Bey smontò e trasportò a Istanbul, dove sono ancora oggi visibili. La struttura è in blocchi di tenera pietra locale, montati a secco. Ulteriori indagini archeologiche sono state svolte nel 1993-95. La tomba era in pessimo stato di conservazione, a causa del crollo della facciata, mentre la volta del vestibolo era in pericolo di collasso. Durante lo scavo, fu in gran parte rimosso il tumulo, ancora ben conservato, per poter intervenire sulle volte, ma purtroppo il restauro non fu iniziato. Il monumento venne quindi abbandonato, con ulteriori danni alla struttura e ai materiali.

Si è reso quindi necessario un nuovo intervento per l'anastilosi, il consolidamento e la protezione della struttura, insieme alla sistemazione dei dintorni del monumento, approntato nel 2008 e realizzato tra il 2012 e il 2014 dal personale dell'Eforato dell'Antichità della regione di Salonicco, coordinato dagli autori del saggio, architetti e ingegneri.

Il progetto ha puntato alla protezione del tumulo della tomba e del dromos con una nuova protezione di basso impatto ambientale e formale, per non aggravare la situazione creata dagli scavi del 1993-95. Si è inoltre reso necessario proteggere il tumulo rimanente con teli di geotessuto e assicurare la regolazione delle acque. Per quanto riguarda la tomba, sono state rimesse in sesto le volte nel vestibolo senza smontare le strutture. Il rispetto della concezione statica originaria ha spinto i progettisti ad evitare il consolidamento e il riempimento delle lacune con malta, per non alterare la costruzione interamente a secco. Per la stessa ragione, i blocchi esistenti allo stato frammentario sono stati consolidati con l'inserimento di barre in acciaio inox.

Per quanto riguarda la facciata, si è scelta la strada dell'anastilosi, con la ricostruzione di alcune parti dell'ordine. Il muro ricostituito è assicurato ad una trave di acciaio inox collegata a meccanismi di dissipazione di energia appositamente studiati. La pulitura e il consolidamento delle superfici hanno infine restituito un brano di notevole estensione di pellicola pittorica, rivelando un inedito contesto cromatico.

L'eliminazione del tumulo ha reso necessario proteggere la tomba con una nuova copertura di basso impatto ambientale, ma non priva di identità formale e capace di fornire nuovi punti di vista sull'opera. Il monumento ha riconquistato quindi la sua 'internità' senza giungere alla ricomposizione del tumulo, tecnicamente improponibile.

Un elemento caratterizzante è quello relativo alla percezione della tomba e del contesto, fortemente alterata dallo scavo del 1993-95. È stato quindi restituito l'accesso antico dei visitatori, costruendo un ponte pedonale accessibile dalla via Egnatia. La considerazione dei valori percettivi del monumento viene anche dalle nuove piantumazioni, necessarie per riconnettere la tomba al suo contesto e proteggere il tumulo esistente, e dal controllo della illuminazione, che segna con discrezione l'accesso alla visita.

1 / Prefecture of Thessaloniki, district of Derveni.

1. Introduction

The two-chambered tomb of "Macridy Bey" (late 4th-early 3rd c. B.C.), known to the scholarly community since the early 20th century, is the most important tomb in the necropolis of Derveni[1], a narrow, strategically-important passage connecting the head of the Thermaic Gulf with the plain of Langadas and the Koronia and Volvi lakes (fig. 1). The region with the passage and tombs[2] belonged to the vital territory (*chora*) of ancient Lete[3], one of the most important cities at north of Chalkidiki.

The tomb and ancient *dromos* leading to it were covered by an artificial tumulus, most of which remains preserved (fig. 2).

The tomb was discovered in 1910 by the Greek Ottoman archaeologist Theodore Macridy Bey (1872-1940), assistant director of the Ottoman Imperial Museum of Constantinople and subsequent director of the Benaki Museum (1931). According to the excavator, the tomb, which was found looted, was constructed for the burial of a single prominent individual[4].

Archaeological investigation was resumed during the 1990s by the Ministry of Culture and Sports under the supervision of archaeologist K. Tzanavari[5]. The tomb was in a very poor state of preservation and its antechamber vault was in imminent danger of collapse. Following the 1995 excavation and taking of rudimentary protective measures, work was halted.

The project for the protection, reconstruction, restoration, and conservation of the structure and that for configuring the monument's surroundings were prepared in 2008 and between 2012 and 2014. Project implementation began in 2012 with NSRF 2007-2013[6] funding and was completed in 2015. The project's budget was €1.200,200 and was carried out by the Ephorate of Antiquities of Thessaloniki Region's own personnel.

2. The architecture of the tomb

The tomb is set off-center on the west side of the tumulus and belongs to the two-chambered type of Macedonian tomb[7] (fig. 3). The antechamber and burial chamber, which have different dimensions (fig. 4), are built of brown or grey limestone ashlar of varying sizes[8].

[1] "The discovery in 1962 of unlooted cist graves at Derveni containing rich grave offerings of gold, silver, bronze, iron, ivory, alabaster, glass and clay was an event of considerable archaeological significance in Macedonia" in Π. Θεμελης, Ι. Τουρατσογλου, Οι τάφοι του Δερβενίου, in "Δημοσιεύματα του Αρχαιολογικού Δελτίου", 59, 1997, p. 192; B. Barr-Sharrar, *The Derveni Krater: Masterpiece of Classical Greek Metalwork*, Princeton 2008; G. Betegh, *The Derveni Papyrus*, Cambridge 2004.

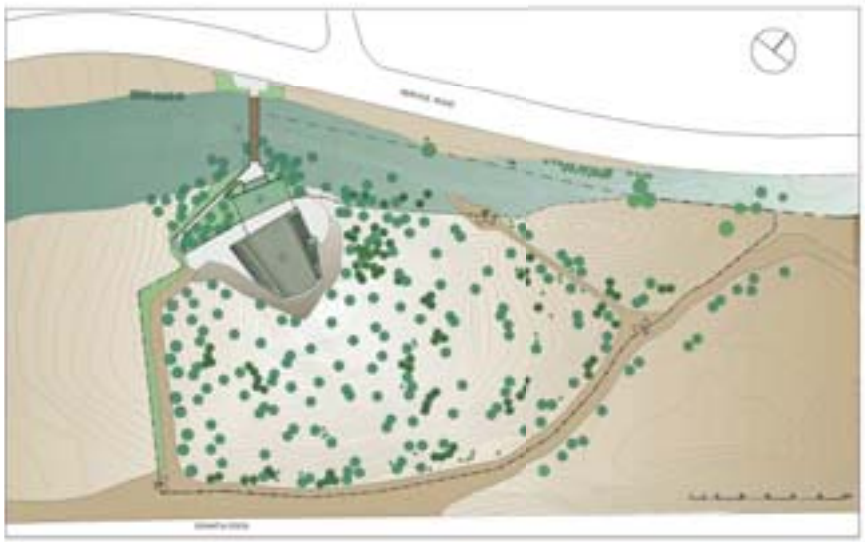
[2] In addition to the tomb of Macridy Bey, a total of 11 other tombs have been excavated along a length of 1500 meters: seven cist graves, one pit grave, two Macedonian tombs (one single-chambered, the other double-chambered), and a carved single-chamber vaulted tomb.

[3] There is a fairly extensive bibliography relating to the Archaic, "Thracian", and later, "Macedonian" phases of the history of Lete, the gold mines along the river Echedoros, the striking of its earliest coins with a Silenos or Centaur abducting a Nymph, the topography, the sanctuaries, and the finds. The testimony of Stephanos of Byzantium (Ethnika 413, 19-22, s.v. Lete) is as follows: "Lete, a Macedonian city, after the sanctuary of Leto founded nearby, as Thagenes states in his Makedonika. The ethnic name is Letaios; this is the appellation of Nearchos of Lete (Letaios), the most distinguished of the warriors who accompanied Alexander the Great". "The presence of Thearodokos Menandros, son of Lysandros of Lete at the Nemean games of 323 BC is evidence that the city reached its apogee in the last quarter of the 4th century BC - that is, during the period when the tombs at Derveni were in use." Π. Θεμελης, Ι. Τουρατσογλου, Οι τάφοι του Δερβενίου, in " ημοσιεύματα του Αρχαιολογικού Δελτίου", 59, 1997, pp. 192-193. Bibliography and further reading: K. Tzanabarh, Δερβένι, μια νεκρόπολη της αρχαίας Λητής, in Π. Αδαμ–Βελενη (ed.), Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη, 10 , Θεσσαλονίκη 1996, pp. 461-476, K. Tzanabarh, Λητή, πόλις Μυγδονική, in"Μακεδονικά", 39, 2010-2012, pp. 83-98.

[4] Th. Macridy, *Un tumulus Macédonien à Langaza*, in «Jahrbuch Archaologisches Institut des Deutschen Reichs", XXVI, 1911, p. 214.

[5] K. Tzanabarh, Ο μακεδονικός τάφος του Δερβενίου. Επαναπροσδιορισμός της ταυτότητας ενός παλιού ευρήματος, in Π. Αδαμ – Βελενη (ed.), Μύρτος. Μελέτες στη μνήμη Ιουλίας Βοκοτοπούλου, Θεσσαλονίκη 2000, pp. 593-617.

2/ Macedonian tomb of "Macridy Bey", the archaeological site post-intervention (2015).



3/ Macedonian tomb of "Macridy Bey", site plan, post - intervention.

The burial chamber (4.07 x 5.08 m.) is vaulted. The walls are 3.35 m. in height and built of dressed stone blocks approximately 1.00 m. in length, 0.60 in thickness, and with a height ranging from 0.35 to 0.40 m. The blocks are set in nine courses. The ninth course, on which the burial chamber vault rests, has a height of 0.40 m. and projects from the course below it by about 2.5 cm. In the partition wall between the burial chamber and antechamber there is a trapezoidal-shaped doorway (height 3.00 m.) with Doric marble doorframe (fig.5)[9]. Above the lintel in the tenth course, there was a stone block measuring 3.10 m. (length) x 0.60 m. (width) x 0.40 (height) which functioned as a relieving beam for the lintel[10]. The tympanum of the arch formed in the upper part of the wall consisted of six courses extending on either side of the vault.

The thickness of the partition wall up to the springing of the vaults was 0.60 m, while that of the stone blocks of the tympanum fluctuated between 0.35 and 0.48 m.

The burial chamber floor[11] (fig. 4) consists of stone blocks of various dimensions (average height: 0.27 m.). The monolithic marble threshold carries a molding on its west face. The double-leaf door of the main chamber, today on exhibit in the archaeological Museum of Constantinople, was also of marble[12]. Below, the leaves of the doors carried near their point of contact two small bronze wheels which rolled along two quadrangular metal rails

[6] National Strategic Reference Framework (NSRF) 2007-2013.

[7] Macedonian tombs constitute a special category of underground chambered structures found chiefly in Macedonia. Plato in his *Laws* gives the earliest and possibly most exact description of what is called a 'Macedonian tomb'. He describes the tomb of the euthynai, that is of the divinely-appointed masters of the leaders: "Their tomb shall be constructed underground, in the form of an oblong vault of spongy stone, as long-lasting as possible, and fitted with couches of stone set side by side; in this when they have laid him who is gone to his rest, they shall make a mound in a circle round it and plant thereon a grove of trees, save only at one extremity, so that at that point the tomb may for all time admit of enlargement, in case there be need of additional mounds for the buried…"Plato, *Laws*, 947d-947e (http://perseus. uchicago.edu).

[8] I. Papayianni et al., *Analysis of the building materials from the Macedonian tomb of "Macridy Bey" at Derveni. Evaluation of results. Determination and monitoring of technical characteristics of intervention materials (mortars, grouts, natural stone, new unfired bricks, and others) for the restoration and conservation of the monument and technical support for their application*, Thessaloniki 2008, (unpublished paper, in Greek).

[9] The threshold, the two end sections of the lintel and the north orthostate, which displays diminution (μείωσις) of its width along its height, were preserved in situ.

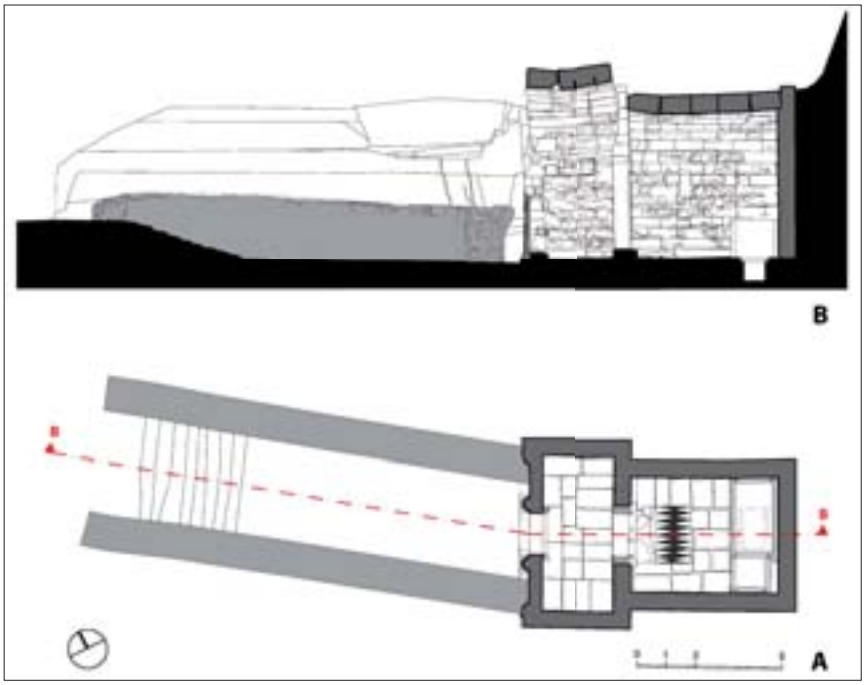
[10] The ends of the beam were preserved in situ. Its remaining sections were found in 2008 among scattered stone blocks.

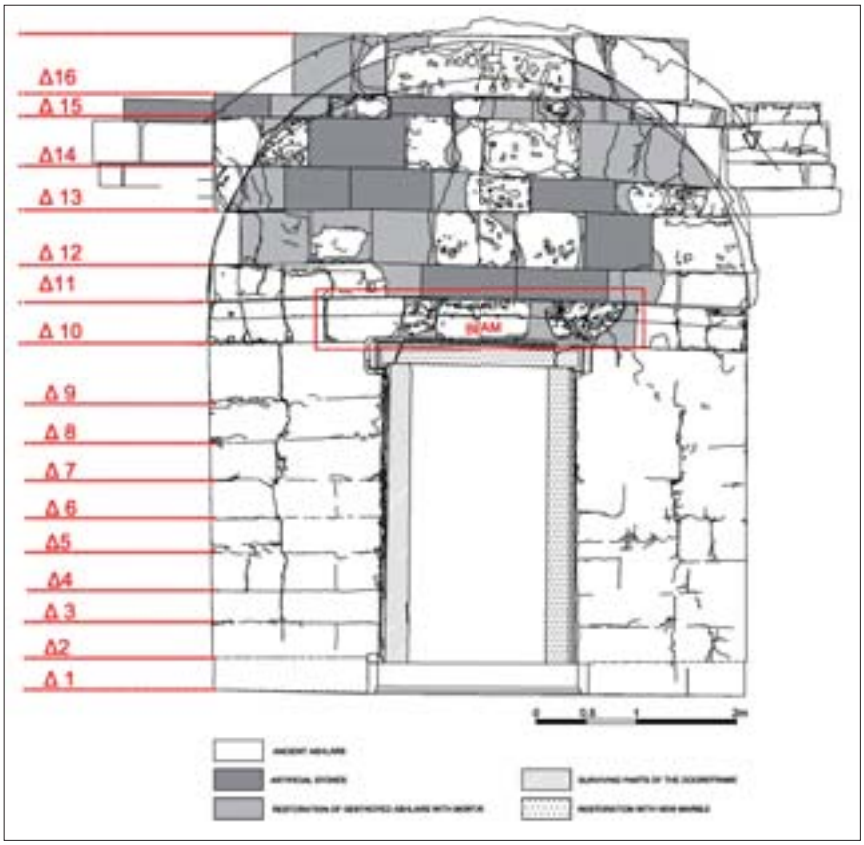
[11] A significant section of the floor is no longer preserved in situ.

[12] Th. Macridy, *op. cit.*, p. 198.

4/ Macedonian tomb of "Macridy Bey" and dromos, plan (A), section B-B (B).

5/ Macedonian tomb of "Macridy Bey", the burial chamber west wall.



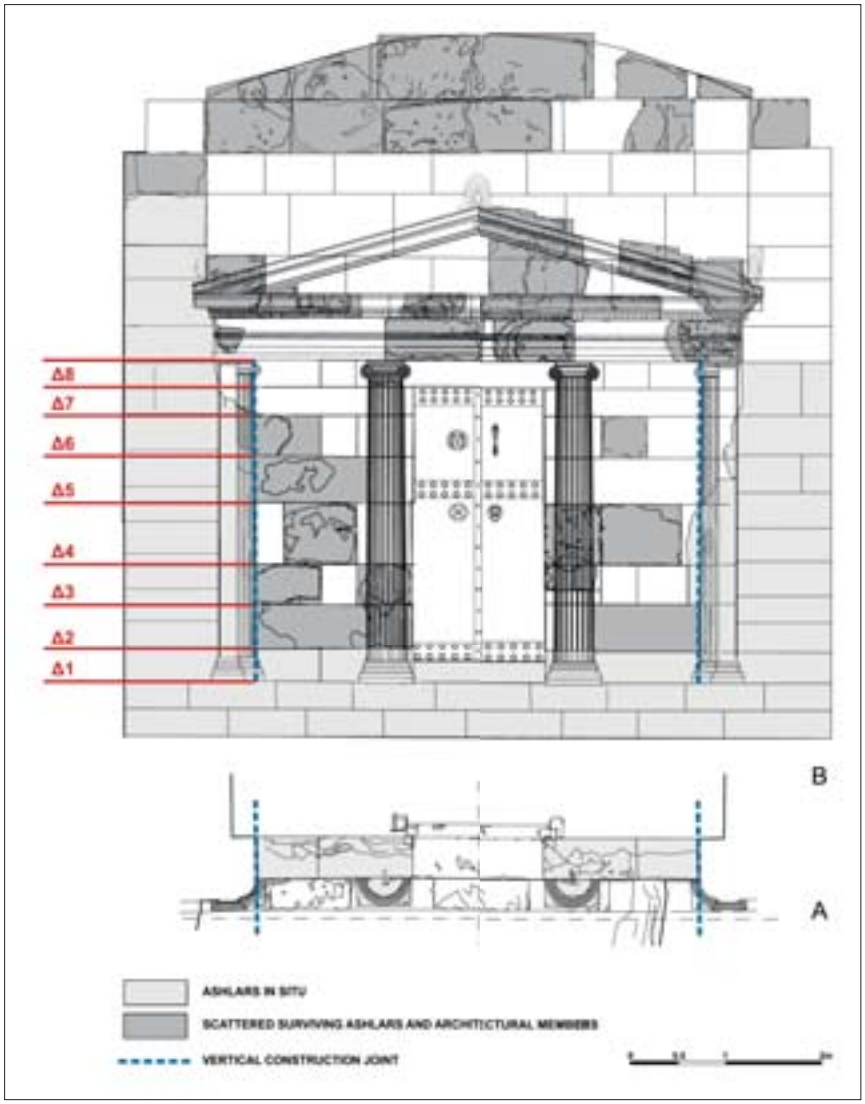


when the doors opened and closed. The rails themselves were mounted on the threshold and on two stones set in front of it.

On the east side of the burial chamber there is a marble burial construction (height 1.32 m.) resting on the ground (fig. 6). On its interior, the construction is divided into two spaces of unequal size, a sarcophagus and a container (fig. 4, plan). Beneath the sarcophagus floor is a cist grave of porous stone coated in mortar (fig. 4, section). An oak *larnax* (cinerary urn) was set inside the tomb[13]. The cist grave was covered with porous stone slabs which formed the floor of the sarcophagus. The container and

[13] Ivi, p. 212.

6/ Macedonian tomb of "Macridy Bey", the marble burial construction (the sarcophagus and the container) after the conservation work and lighting.



7/ Macedonian tomb of "Macridy Bey", study of the antechamber west wall, plan (A), façade (B).

8/ Macedonian tomb of "Macridy Bey", graphical reconstruction of the antechamber west wall.

sarcophagus were covered by marble slabs (thickness 0.16 m.)[14]. Beneath the marble slabs was a second cover made of cypress planks[15].

The antechamber's interior dimensions are 5.40 x 2.60m. The walls consist of ten (10) courses; their height ranging between 0.33 to 0.55m[16] (fig. 4, section). The chamber is covered by a vault resting on the tenth course. The ashlar blocks of this course carried on their upper section a band 0.17m in width and projecting by 0.02m. The antechamber floor consists of various-sized stone blocks which were plastered [17] (fig. 4, plan).

The tomb's façade, which collapsed in antiquity[18] was configured in the Ionic order[19] (fig. 7). The wall of the façade had a variable width between 0.60 and 0.45m, and its upper terminus was curved. There were two semi-columns in the center of the wall to either side of the entrance, and at the ends of the façade wall there were two quarter-columns with inherent pilasters supporting an entablature and pediment. The entablature consisted of a tri-band, stepped architrave, molding, frieze, and dentil cornice. The semi-columns' bases were of Attic type with inherent plinth, resting on a two-step crepidoma. The surviving column drums have a height of 0.15 m. to 0.67 m., a mean diameter of 0.44 m., and carry eleven flutes (width 0.044 m.) semicircular in section, as well as twelve vertical bands (width 0.014 m.). The drums were connected with the stone blocks, which were of the same height as the drums, with metal clamps.

The blocks carrying the quarter-columns were not connected to the adjacent stone blocks, with the result that from the second to eighth course there is a vertical construction joint. The wall of the façade was connected to the transverse walls of the antechamber at the height of the architrave. The latter rested in two notches found in the corresponding blocks of the transverse walls.

[14] The sarcophagus was covered by three marble slabs, and a single marble slab covered the container. The slabs covering the sarcophagus carried the incised letters A, B, Γ, which served for their installation on site. *Ivi*, p. 212.

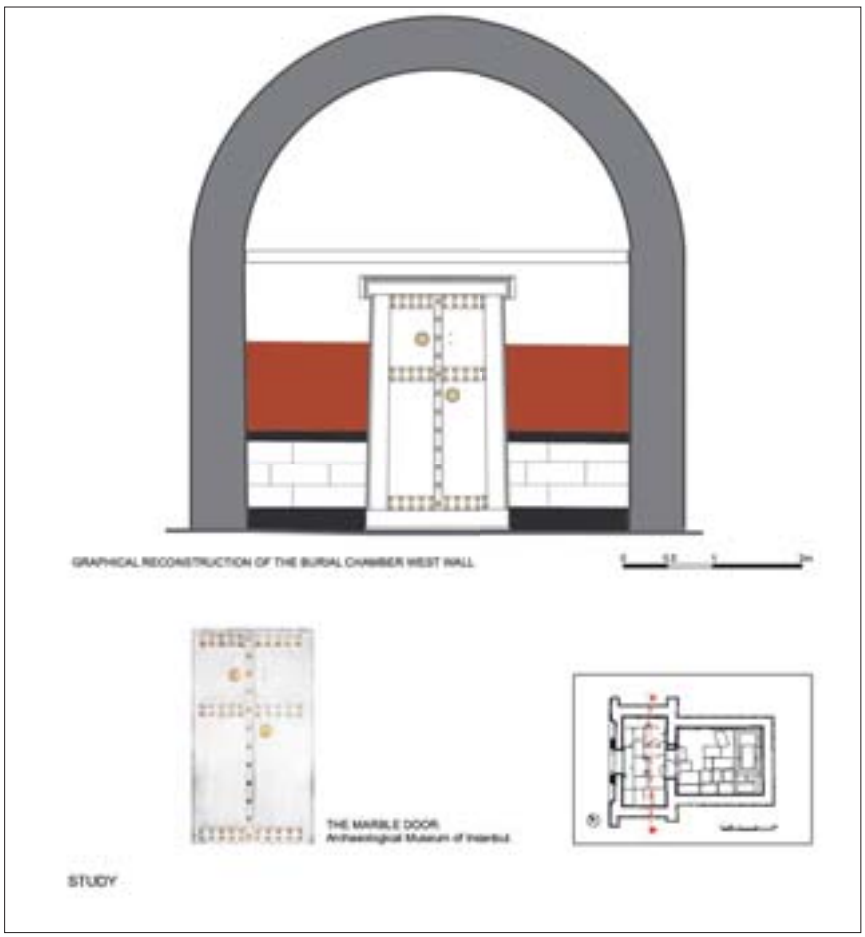
[15] *Ivi*, p. 213, fig. 26.

[16] This description refers to the surviving walls.

[17] The floor is preserved intact.

[18] *Ivi*, pp. 195, 198, fig. 11, p. 201, fig. 12, p. 203. In the initial excavation of 1910, the following remained preserved: the threshold of the entrance door and two bases for the Ionic semi-columns on either side of it; the first wall course (north and south of the entrance), and an ashlar block from the second course in the north part of the façade. At higher positions on the north and south parts of the wall, there can be made out quarter-column drums, while from the springing of the antechamber vault and upward the ashlar blocks which demarcated the north and south ends of the façade are preserved.

[19] The proposal for the reconstruction of the original form of the façade of the tomb and the partition wall (the east wall of the antechamber) was based on a detailed architectural drawing and study of the building as well as on the recording and identification of the position of the scattered architectural members and ashlar blocks found during the excavation.



9/ Macedonian tomb of "Macridy Bey", graphical reconstruction of the burial chamber west wall.

The entrance to the antechamber was in the central space between the columns. The double-leaf entrance door was wooden and decorated with bronze elements which were found in the 1910 excavation[20] (fig. 8). On the exterior, the wooden door was protected by earth pressure, and five rows of stone blocks (ashlars) sealed the opening[21].

3. The decoration of the building

The front of the tomb was painted. During the 1910 excavations, traces of red and blue were found on the column capitals, the epistyle and the cornice, while a bright yellow color surrounded by violet was discovered on the drum of the pediment[22]. The semi-columns, quarter-columns, pilasters, and blocks of the façade were coated with a white mortar which remains preserved[23] (fig. 8).

The walls of the burial chamber were coated in white mortar, while those of the antechamber were painted. Fragments surviving *in situ* show that there were five zones alternately painted (from the base of the wall to its crown) black, white, black, red, and white (figs. 9-10). On the antechamber's east wall, iron nails (thickness 0.008 m.) were found which the excavator suggested had been intended for suspending weapons or other burial gifts[24].

The stone floor blocks were coated in white plaster. On the upper surface of the blocks in the burial chamber in front of the entrance (fig. 4, plan) there was painted decoration (2.06 x 1.39 m.), depicting rhombuses alternately painted in black, yellow, and red (no longer surviving)[25].

The *dromos* (road) leading to the tomb had a length of 14.70 m., with nine (9) steps on its west side cut into bedrock (fig. 4). At its beginning it

[20] *Ivi*, pp. 200-204, figs. 8, 14, 16, 17.
[21] Some of the blocks were identified during the recording of scattered architectural members and ashlars.
[22] *Ivi,* p. 200.When the 2008 study was conducted, minimal traces of red survived on the column capital.
[23] Laboratory analyses of the coatings and coloring agents was carried out by Dr. Svetlana Vivdenko, chemist.
[24] *Ivi,* p. 204.
[25] *Ivi,* p. 211.

10/ Macedonian tomb of "Macridy Bey", the antechamber's west wall after structural restoration and anastylosis.

11/ Macedonian tomb of "Macridy Bey", the archaeological site in 1995.

12/ Macedonian tomb of "Macridy Bey", the slope of the tumulus on the south side of the dromos.

had a width of 3.50 m. and at its end (the tomb façade) a width of 3.05 m. The walls of the *dromos* (height 2.00 m.) were of unbaked bricks covered in clay mortar[26]. The *dromos* was paved in clay earth and gravel.

The building was covered by a tumulus (minimum diameter 75 m., height 19 m.)[27]. Technical soil investigation of the tumulus in 1996[28] revealed that it was constructed of a fill implemented with horizontal stratification – packing of successive layers (max. thickness of largest layer = 0.50 m.) consisting of soil of different compositions (fig. 11). Specifically, layers were primarily of clayey sand to gravel, with intervening, thinner clay strata. All fill materials came from the surrounding area.

4. State of preservation of the monument

Even when the monument first came to light in 1910, the tomb was in very poor condition. As the excavator Theodore Macridy noted, the building was leaning to the northwest, the west wall of the burial chamber was severely cracked, and the façade wall had collapsed, destroying the south leaf of the double marble door to the main chamber. After excavation, the tomb was abandoned and gradually re-covered due to erosion of the tumulus so that only its top remained visible by the 1990s. Excavation resumed 82 years later (1993), once more revealing the interior of the structure as well as a part of the ancient *dromos* to a length of 4.60 m. from the façade and to a depth of 6 m. from the extrados of the antechamber vault. To uncover the *dromos*, the earth of the tumulus was empirically removed, which resulted in the creation on either side of the *dromos* of nearly vertical slopes which over time were eroded by rainwater (fig. 12). This later excavation covered a much more extensive area, leading to the removal of about one-third of the tumulus down to the springing of the antechamber's vault. The resulting vertical excavation face had a maximum height in excess of 12 m., which decreased in the ensuing period as a result of surface erosion from rainfall[29] (fig. 11). The erosion products were accumulated at the toe of the excavation face, forming an inclined surface (height 4 m.); in the higher part of the excavation face, undercuts were created (fig. 2). During the removal of the tomb's fill, lost architectural members[30] and ashlars from the building's façade and the west wall (face) of the burial chamber were recovered[31].

During this same period, some of the façade's ashlars remaining in situ were disassembled and removed from their positions for safety reasons. Following the second excavation, and after taking basic protective measures to shore up the antechamber vault and install makeshift protective coverings, work on the tomb was suspended (fig. 11). In succeeding years, due to the inadequate protection of the building and surrounding soil from rainwater, the monument suffered new damage which exacerbated its already-compromised state of preservation[32].

5. The state of preservation of the tomb

The building had been heavily deformed on the west[33], which had resulted in the cracking and spalling of many ashlars. Moreover, its walls had shortened in consequence of localized failures in the resting surfaces and the strong compressive load, while its perimeter walls had bent inward (deflection 0.02 - 0.05 m.) due to the lateral thrust of the surrounding soil (fig. 12-14).

[26] Its walls are of unbaked bricks measuring 15 x 22 x 10 cm to 37 x 22 x 10 cm.

[27] The artificial mound formed atop the tomb of the deceased, inextricably bound with burial practices throughout the world, became a landmark in the area where it was constructed, preserving alive the memory of the deceased and transferring down to the present its actual and semiological essence.

[28] N. Hatzigogos, S. Tsotsos, *Geotechnical issues related to the artificial tumulus and construction materials of the Macedonian tomb "Macridy Bey" in Derveni*, Thessaloniki 2008 (unpublished paper in Greek).

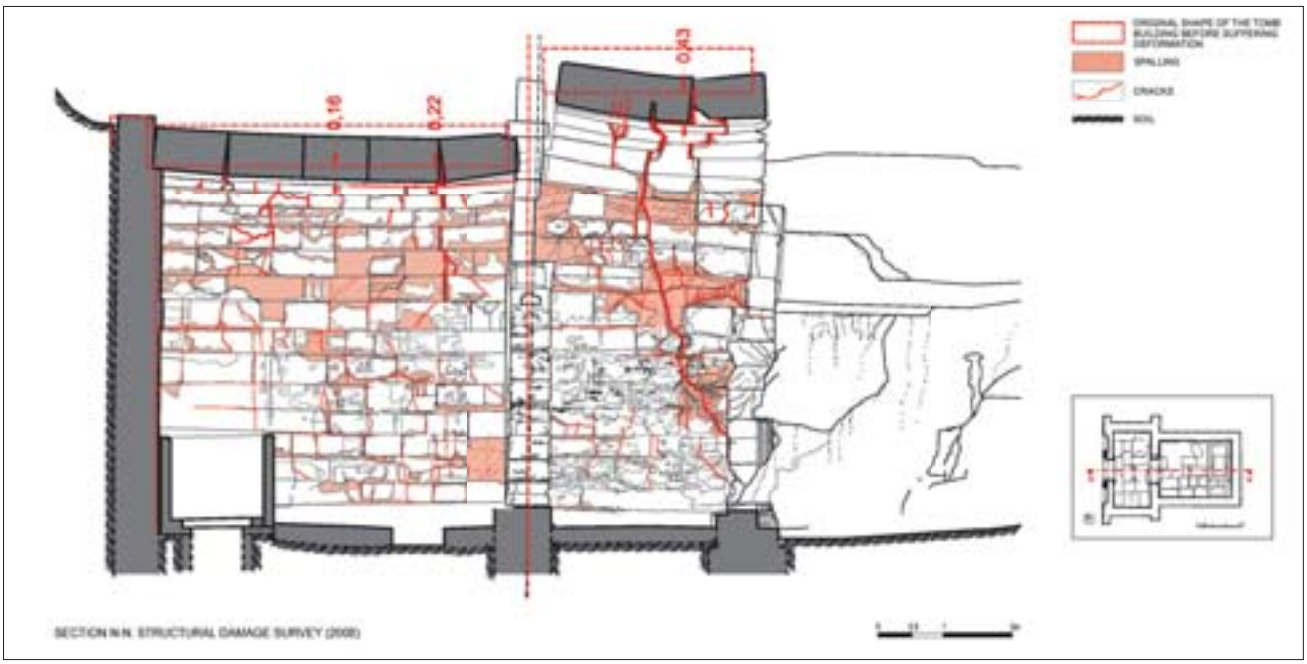
[29] In accordance with the thinking of the period, the intervention was done to reduce the weight on the building's vaults and to study the stratigraphy of the tumulus.

[30] These included sections and fragments of the epistyle, entablature, pediment, drums of semi-columns, and a column capital.

[31] In all, 150 architectural members and ashlar blocks were architecturally surveyed, drawn, and identified. Around 50 of these ones were repositioned on the building.

[32] An automated digital deformation monitoring system was installed in order to reveal this new type of damage.

[33] This is a detrusion-like deformation, caused by the lateral (radial) expansion of the tomb. The deformation is progressive, and the overall monument's deviation from the vertical is 7 cm at the east wall, 14 cm at the partition wall, and about 40 cm at the façade.



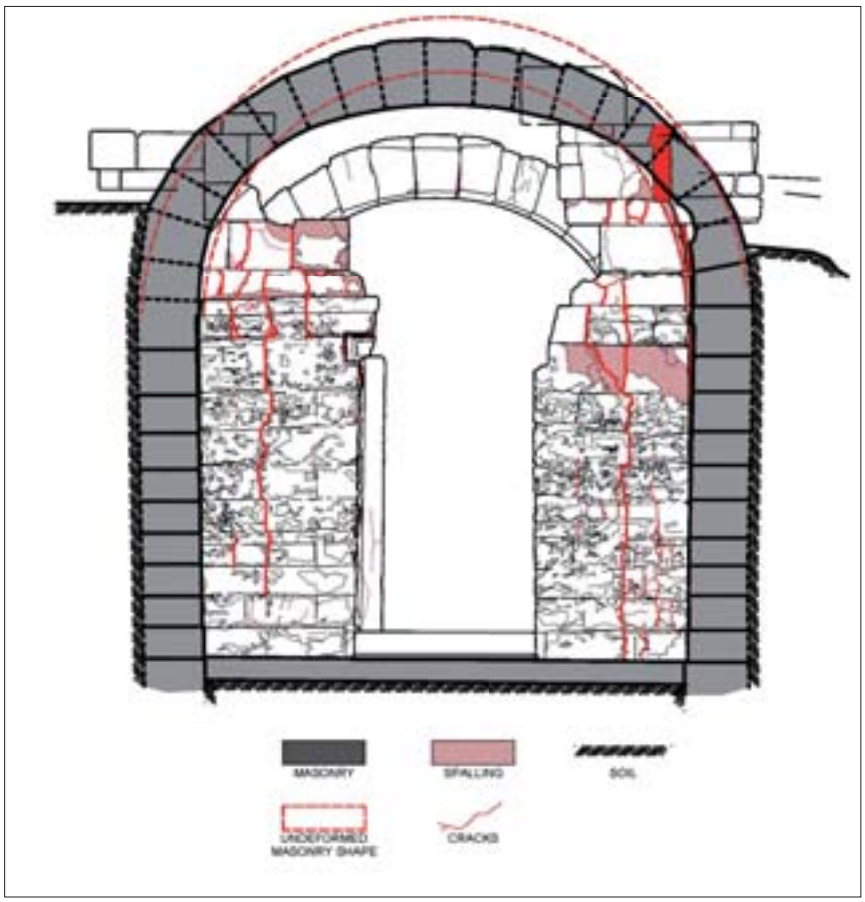
13/ Macedonian tomb of "Macridy Bey", longitudinal section, structural damage, survey 2008.

14/ Macedonian tomb of "Macridy Bey", state of conservation.

The greatest deformation was observed in the building's vaults, chiefly that of the antechamber, which was already on the verge of collapse (fig. 15). Specifically, the burial chamber's vault had decreased in height by 0.22 m, and that of the antechamber by 0.43 m. As a consequence, a dense web of cracks (width up to 0.10 m) pervaded the vaults. In 2011 before the start of work, the antechamber vault exceeded the limits of stability, and rested permanently on the scaffolding used to shore it up (fig. 14).

Significant deterioration was also observed in the partition wall, which despite severe damage - most notably, to its upper section (*tympanum*) - had been found upright in 1910. In 1995 the central section of the *tympanum* was found fallen, and only the north orthostate, north end of the lintel, threshold, ends of the overlying beam and a limited number of blocks (which had been shored up in makeshift fashion in the 1990s) were preserved *in situ* (fig. 15).

In addition, the foundation of the wall had suffered differential subsidence, the ashlars were cracked, and the wall itself had shortened due



15/ Macedonian tomb of "Macridy Bey", section, structural damage, survey 2008.

16/ Macedonian tomb of "Macridy Bey", antechamber's east wall façade before anastylosis.

to the powerful compression, resulting in an overall difference in height of 0.06 m at lintel level.

The most extensive damage was observed on the wall of the tomb's façade, the central part of which had already collapsed in antiquity; only the architectural members and stone blocks of its first course survived *in situ*, but in very poor condition (fig. 16). Overwhelming fractures and deformation were observed in the south quarter-column (surviving height: 2.00 m), in contrast to the surviving section of the north one (height 2.80 m), which despite severe cracking did not present significant deformation. Damage and breakage due to the wall's tilting were also noted in the first course of blocks as well as in scattered blocks and architectural members from the façade. The threshold and bases of the two semi-columns were in relatively good condition. The blocks in the burial chamber, the marble sarcophagus, and the colored plaster which had adorned the monument's walls and vaults had also suffered extensive damage. The damage observed on the stone blocks included cracks, peeling, fractures and deposits. The sarcophagus had similar problems (fractures in its cover slabs, cracks, deposits), while damage to the colored plaster involved detachment from the substrate and partial destruction, loss or peeling of the colored surface, mechanical damage, graffiti, etc.

6. Assessment

Assessment of the condition of the monument and investigation into the mechanisms that caused the observed damage formed the main body of the study for its conservation and structural restoration[34]. The

[34] A. Papasotiriou *et al.*, *Damage assessment to the Macedonian "tomb of MacridyBey" at Derveni,* Conference Proceedings, 8th International Symposium on the Conservation of the Monuments in the Mediterranean Basin, Patra 2010.

structural assessment showed that the tomb's strength was *ab initio* significantly inferior to the load of the overlying soil. As a result, the subsidence of the tumulus soil during its compaction under self weight was directly imposed on the burial building as a displacement load, causing deformation far beyond the yielding point of the vaults and many of the walls. As the compaction of the tumulus advanced, the soil gradually acquired enough bearing capacity to be self supported, and further deformation of the tomb ceased. The equilibrium which had developed between the tomb and earth loads was sufficiently stable, and led to a long period of quiescence during which the tumulus functioned as a protective cover for the tomb.

In the wake of the removal of the tumulus in 1995, this equilibrium was disturbed, and a complex new damage-causing mechanism was activated due to the exposure of the monument and the earth around it to environmental conditions. By virtue of the marked presence of expansive clay minerals, the soil began to experience periodic expansion and contraction due to seasonal variations in ground moisture. This phenomenon, in combination with the horizontal thrusts of the vaults and their insufficient lateral support after the removal of the tumulus led to the additional deformation of the upper part of the building, causing the antechamber vault to become unstable[35]. The vault exceeded its stability limit in 2011, one year before work began, and rested permanently on the underlying scaffolding used to shore it up.

7. The aims and objectives of the restoration project

The aim of the project was to study, protect, preserve and make available to the public the burial complex (tumulus, tomb, and ancient *dromos*) of "Macridy Bey", an outstanding example of Macedonian funerary architecture and burial customs. The primary objective of the study was to protect the tumulus, tomb, and ancient *dromos* from weather conditions[36], to remediate the building's dilapidated state and consolidate it *in situ* without disassembling its structural elements (vaults, walls), and to enhance the architecture of the tomb by restoring its destroyed faces and conserving its interior decoration and the marble sarcophagus.

The project relied on historical and technical research carried out during preparation of the study and the project itself by scientists from different fields and by specialized laboratories[37].

Historical research included the study of the means of construction of the building and ancient *dromos*, the drawing and identification of architectural members and blocks originating from the collapsing walls, and studying the monument in comparison to other "Macedonian tombs".

Technical research involved the archaeometric study of the construction materials of the tumulus[38] and tomb, determining and monitoring the technical characteristics of materials used for the project (mortars, grouts, artificial stone, mud-bricks)[39], and establishing the parameters for protecting the tomb from humidity[40] and the tumulus from erosion[41].

The work was carried out in accordance with the approved studies in four stages. The first stage included the installation of protective shelters over the building and ancient *dromos*, and the protection of the vertical excavation face of the tumulus from erosion caused by rainwater. The second involved the structural restoration of the building; the third, the restoration of the collapsed walls and conservation of the decoration and ashlars, and the fourth, the landscaping of the surrounding area,

[35] During the first two years of deformation monitoring (2009-2010), a maximum annual deformation to the antechamber vault of about 15 mm was recorded, while annual residual deformation surpassed 10 mm.

[36] Installation of shelters was considered necessary to limit the variation in soil moisture and consequently to reduce the annual deformation of the tomb to acceptable levels.

[37] Within the framework of the project, a further 18 studies and technical research on specialized subjects involving the protection and restoration of the entire burial complex (tumulus, tomb, dromos) were carried out.

[38] N. Hatzigogos, S. Tsotsos, *Geotechnical issues relating to the tumulus and construction materials of the Macedonian tomb "Macridy Bey" at Derveni, Thessaloniki. Estimates of the load on the tomb by the tumulus over time*, Thessaloniki 2008 (unpublished paper in Greek).

[39] I. Papayianni *et al.*, *Analysis of the building materials from the Macedonian tomb of "Macridy Bey" at Derveni. Evaluation of results. Determination and monitoring of technical characteristics of intervention materials (mortars, grouts, natural stone, new unfired bricks, and others) for the restoration and conservation of the monument and technical support for their application*, Thessaloniki 2008 (unpublished paper in Greek).

[40] D. Aravantinos *et al., Determination of the parameters for protection of the Macedonian tomb at Derveni from moisture during the monument's restoration, conservation, and enhancement*, Thessaloniki 2008 (unpublished paper in Greek).

[41] N. Naskos, *Technical soil research – study and measurements of shifts on the excavation slopes of the tumulus and building of the Macedonian Tomb "Macridy Bey" at Derveni, Thessaloniki*, Thessaloniki 1997 (unpublished paper in Greek).

[42] To ensure appropriate microclimatic conditions inside the shelters to protect the tomb and dromos, technical research was carried out to determine the parameters for protecting the monument from humidity during and after completion of restoration work. The first stage of research involved assessment of the architectural study for the shelters installed to protect the monument from climatic conditions. The aim of the second stage was to determine the impact of the new construction on temperature and humidity conditions inside the monument. The third and final stage included an assessment-evaluation of the data from eighteen months' recording and processing microclimatic conditions inside the monument following the shelters' installation and proposals for new measures to improve them.

[43] In the case of the tomb of Macridy Bey, installation of protective shelters of the open type instead of the closed shell normally chosen in Greece for burial monuments of this period (Ι. Δημακοπουλος, Κελύφη προστασίας εν είδει τύμβου, ΤΑΠΑ, Αθήνα 1995) was deemed most appropriate, not only for protecting the building but above all for preser-ving the tumulus as an integral part of the monumental complex.

illumination, and highlighting of the monument through the use of new technologies such as a website, three-D digital representations, and video.

8. The protection of the tomb and dromos from weather condition: the shelters

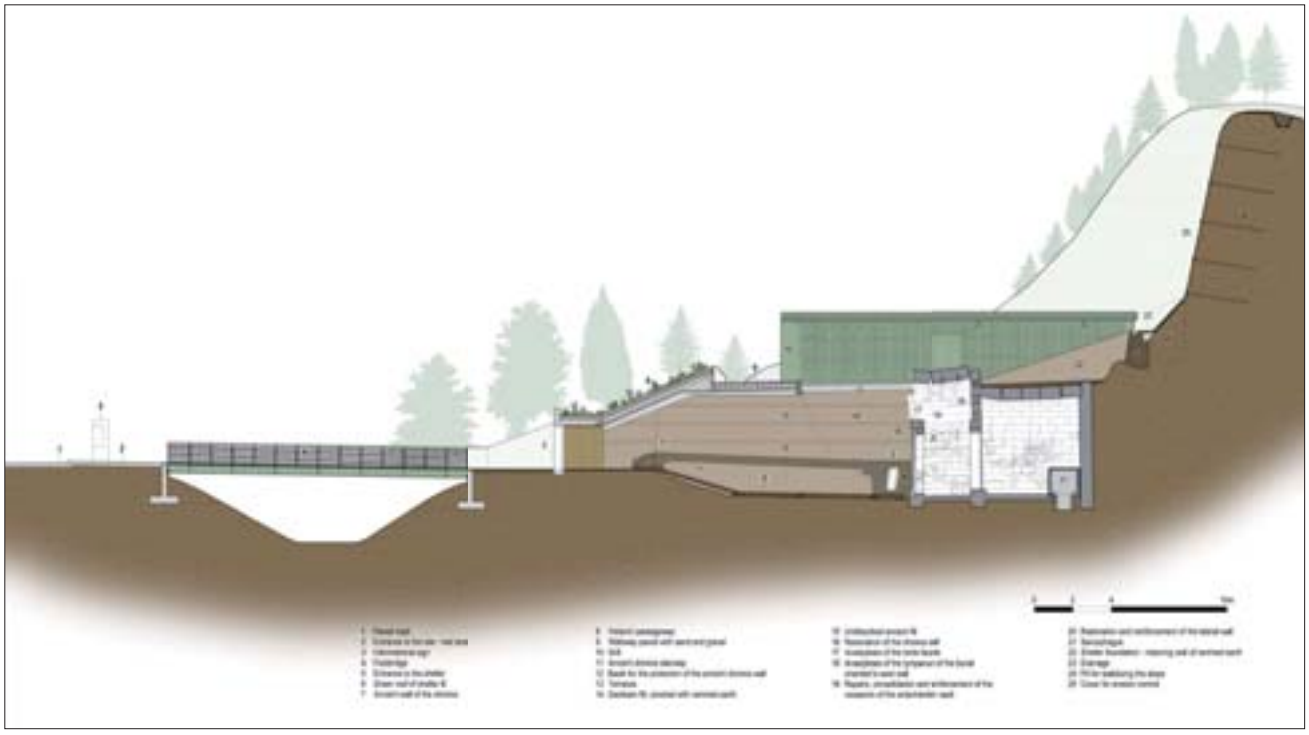
To guarantee the physical integrity of the monument (tomb, tumulus, and *dromos*), and in particular to remove the causes which led to the structure's complex pathology, it was considered imperative to provide it with a protective covering which, in combination with the waterproofing of the surrounding ground, would ensure the appropriate microclimatic conditions for its hygrothermal (moisture/temperature) protection[42] (figs. 2-3).

The tomb was housed in two independent steel structures – shelter A and shelter B – having a total surface area of 451m^2, deployed at different levels with a shallow foundation around their perimeter[43] (fig. 17). Shelter A covers the tomb and excavation around it, and shelter B covers the access road to the tomb. The shelters were built at the level of the earth of the tumulus created during excavation in the 1990s.

The architectural design of shelter A was determined by the choices in the

17/ Macedonian tomb of "Macridy Bey", longitudinal section, post - intervention.

18/ Macedonian tomb of "Macridy Bey", protection of tomb and dromos, the shelters.



19/ Macedonian tomb of "Macridy Bey", protection of the tomb and dromos with new shelters.

20/ Macedonian tomb of "Macridy Bey", shelter rammed earth foundation.

study, namely: its form was to be such as not to compete with the monument, and to be integrated into the landscape as shaped by the 1990s excavation without disturbing it. These choices led to the designing of a shelter that was trapezoidal in both plan and cross section (figs. 1,18). The shelter's plan was adapted to the perimeter of the toe of the mound's vertical excavation face, while its trapezoidal section recalls the outline of the face of the mound's excavated section on which the shelter is projected. The shelter's main western face is perforated, thus permitting the monument to be viewed from the level of the upper story. The north and south faces are configured with frames of metal blinds enclosed by sections of sheet metal[44] (fig. 19). The entrance, located on its north face, is configured as a covered antechamber which projects from the face and leads to the level of the vault of the building (fig. 18).

Rainwater is collected via a network of hidden gutters and removed via a peripheral underground drainage system, ending up in a natural trench west of the tumulus. In parallel, to waterproof the ground over a zone extending 2.50 m. around the shelter, a complex drainage system was installed at the level of the excavation of the tumulus. It incorporated adequate piping, as well as an HDPE membrane succeeded by layers of various soil materials.

All the bearing and non-bearing elements of shelter A are bolted together and of relatively small size. Their connections have been suitably studied to allow easy disassembling and removal of the shelter in future.

To avoid disturbing the stratigraphy of the tumulus, the shelter has a shallow foundation. It consists of two strip footings constructed along the shelter's north and south sides, resting at the level of excavation of the tumulus during the 1990s. The foundation of the east side is different. There, to avoid constructing a reinforced concrete wall, a special geo-construction (reinforced and stabilized fill) was employed as a sort of gravity-retaining wall on which the shelter's bearing organism was set (fig. 20).

Situated west of shelter A, shelter B west covers the ancient *dromos* providing access to the funerary building. The goal of the study was to create the sense inside the shelter of a closed burial monument, while on the exterior the construction is part of the archaeological landscape, which in this case is the tumulus.

Shelter B is undercut and consists of one level and one inclined section with a surface area of 134 m^2 (fig. 3). Its level section was designed to be walkable, thus allowing visitors to circulate at the level of shelter A and view the monument from its west main face. The goal of the morphological design of the inclined section was to restore the original form of the slope of the tumulus. Towards this end, it was designed with a pronounced slope of 46%.

[44] The choice of solutions for the design of the facades aimed to provide continuous controlled ventilation to the sheltered area, protecting it from becoming overheated and from greater relative humidity, factors which damage the structural elements and decoration of the building.

21/ Macedonian tomb of "Macridy Bey", the slope of the tumulus on the south side of the dromos post - intervention.

22/ Macedonian tomb of "Macridy Bey", post - intervention.

23/ Macedonian tomb of "Macridy Bey", longitudinal section, structural restoration of the antechamber side walls, structural reinforcement.

For reasons of thermal insulation and integration into the natural environment, the shelter's roof was planted with low-intensity growth of a spreading type similar to that which grows in the natural environment (fig. 19).

The entrance to shelter B on its west side is configured as an antechamber with rectangular ground plan (fig. 2). The roof of the antechamber comprises a continuation of the inclined section of the shelter, and is also planted. The entrance door occupies the greater part of the façade and is perforated to permit air to circulate freely and offer a view of the monument at night.

9. The protection of the tumulus

Protecting the vertical face of the tumulus from erosion and improving its stability were achieved by covering its surface with a geo-synthetic mesh (fig. 19) which was stabilized with wire ropes and bonded anchors (soil nailing)[45]. At the toe of the vertical face of the excavation, the accumulated erosion deposits were covered with a layer of stabilized earth, and they are used as a counterweight, reinforcing the stability of the excavation face (fig. 2).

The restoration of the slopes[46] on either side of the *dromos* was accomplished in the form of terraces in order to resemble the slopes created during recent excavation research (conducted in 2013). Due to deterioration of the exposed soil (fig. 12), the weakening of its bearing capacity, and the risk of damage to the walls of the *dromos*, the terraces were built using geofoam and subsequently covered by reinforced earth of a color and hue similar to that of the earth of the tumulus[47] (figs. 21-22).

10. The structural restoration and anastylosi of the building: the guidelines

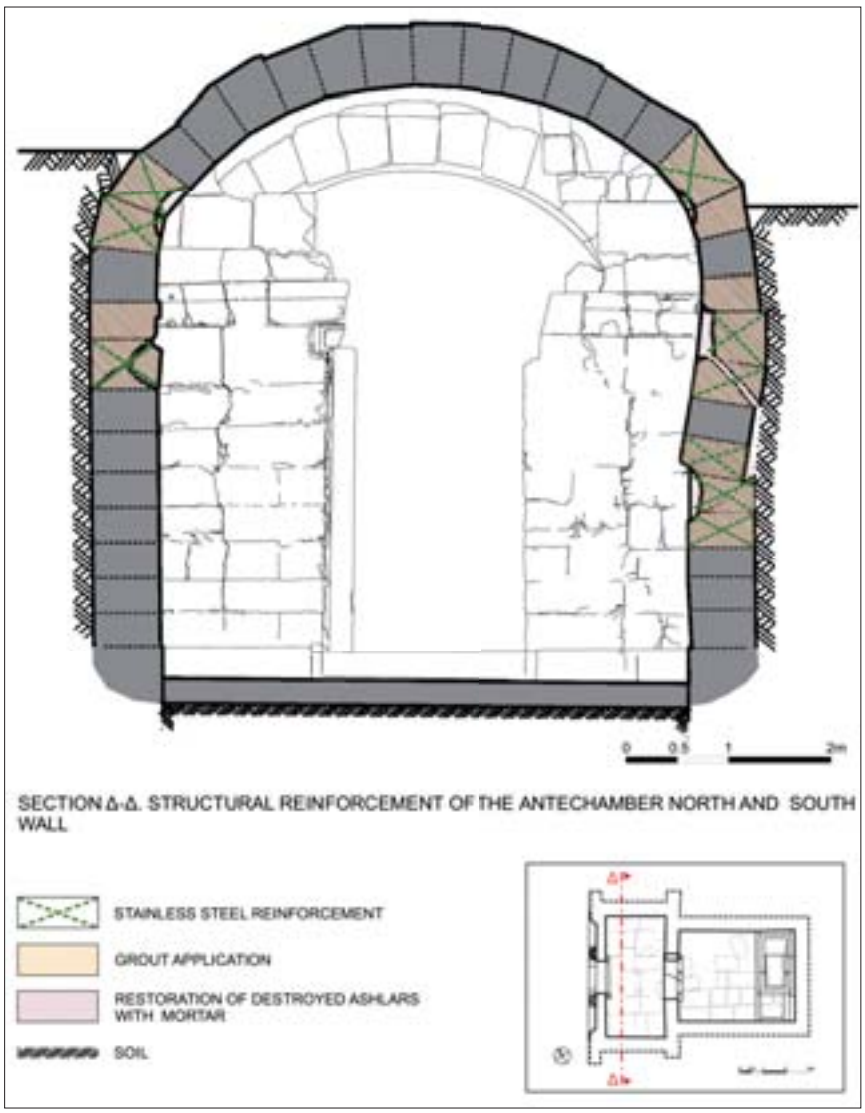
The goal of the intervention was for the monument to regain in an optimal manner all the historical and aesthetic values it once possessed so that it could be incorporated into contemporary culture.

The basic theoretical principle informing the intervention was the preservation of the tomb in its authentic, modern-day form, given that the deformations of the building and damage to its building materials are

[45] N. Naskos, *Design of the protective measures for the excavation slope of the tumulus of Macridy Bey*, Thessaloniki 2015 (unpublished paper in Greek).

[46] They were formed due to the 1995 excavation.

[47] Study by Dr. N. Hatzigogos, technical geologist.



24/ Macedonian tomb of "Macridy Bey", section, structural restoration of the antechamber side walls, structural reinforcement.

25/ Macedonian tomb of "Macridy Bey", the antechamber vault after the structural restoration.

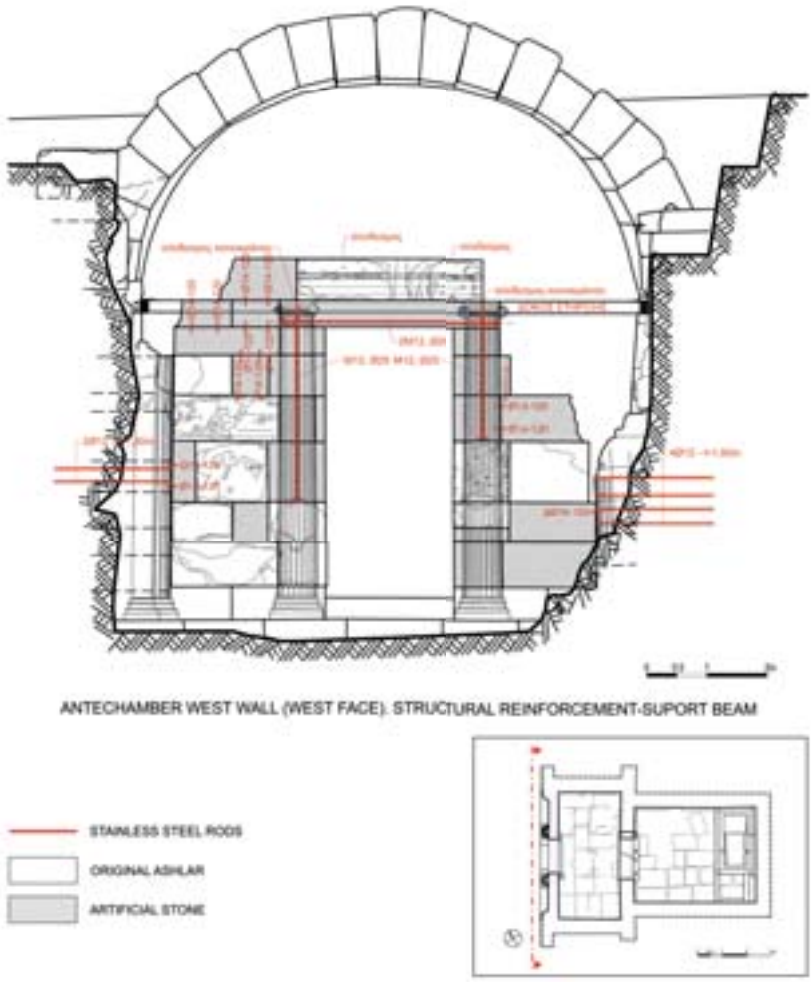
26/ Macedonian tomb of "Macridy Bey", the antechamber vault and south wall, structural restoration with compatible mortar.

witnesses to the timelessness of the monument, which is itself a bearer of the historical process.

The intervention is reversible and was implemented in accordance with international principals for the reconstruction of ancient monuments, specifically the Charter of Venice, and with the two main choices of the study, which were (a) preservation during intervention of the original dry construction system, and (b) limitation of interventions to only those absolutely necessary.

27/ Macedonian tomb of "Macridy Bey", anastylosis of antechamber west wall (façade), structural reinforcement, support beam.

28/ Macedonian tomb of "Macridy Bey", anastylosis of the antechamber east wall, structural reinforcement of the tympanum.



Interventions fall into two categories: the structural restoration of the antechamber vault and the restoration of its destroyed walls. During the restoration of the building, the original function of the structural elements and the autonomy of the ashlars and architectural members were preserved, while interventions to provide static reinforcement were almost entirely confined to new ashlars. The restoration of the partition wall's tympanum and the building's façade was deemed necessary to reinstate and utilize the dispersed ancient building materials found during excavation[48], to render the architectural form of the structure comprehensible, and to enhance the monument's educational influence and value.

11. The structural restoration of the building

The goal of the intervention was to restore the stability and structural integrity of the tomb in its deformed state, without altering its dry construction. The basic choice of the study was to remediate the building's dilapidated state, above all its vault and antechamber, without dismantling it[49]. For this purpose, a complex technique of stitching and grouting the cracked voussoirs[50] and ashlars of the antechamber's long walls *in situ*[51] was studied and implemented, using a specially-developed injection grout[52] which allowed for their structural separation even after intervention (figs. 23-24). The cracks in the voussoirs as well as the enlargements of the contact joints between courses in the gaps in the joints of the vaults were not filled with mortar in order to avoid altering the structure's dry construction method and modifying the image of the monument as it had been preserved down through time[53] (fig. 25). Interventions to the ashlars of the antechamber walls were limited solely to those positions where the type of damage threatened the stability of the construction, that is, to the crowning (upper edges) of the long walls. The restoration of the destroyed surfaces of the ashlars was done with a specially-designed compatible mortar of similar color and shade, and in accordance with the geometry of the deformed form of each individual ashlar (fig. 26).

12. The anastylosi(s) of the collapsed walls

The extent of intervention to the tomb's façade was determined by the deformation at the ends of the wall. Deformation increased significantly starting from a height of 3 m. (figs. 13, 15). For this reason, only the central section of the wall (to the height of the architrave), which did not deviate from its vertical, was restored.[54] More specifically, the two semi-columns and the north part of the wall between the semi-column and the quarter-column together with the central section of the architrave were reconstructed. The corresponding south section of the wall was partially reconstructed due to the large deformation the quarter-column had suffered. The wall was built in accordance with the original construction system by integrating the surviving ancient ashlars and architectural members, and with new porous (limestone) ashlars at the locations of missing material (fig. 28).

To avoid the risk of the wall's tilting[55], a stainless steel beam was incorporate in the rebuilt ashlars of the eighth course to provide lateral support (figs. 21-22, 29). The beam transfers the loads from the façade to the lateral walls of the antechamber at the height of the tenth course. At this height there are carved notches by which the architrave was connected to the side walls. The beam is supported with bonded anchors embedded in

[48] The detailed study and identification of the greater part of this building material provided an opportunity to restore it without altering its authenticity. The extent of the restoration was in each case determined by the proportion of ancient to new material on the one hand, and on the other by the limitations imposed by the monument's deformation with respect to the repositioning of ashlars.

[49] Reassembling the antechamber vault would have led to a significant loss of authentic building material due to fragmentation and the spalling of its ashlars.

[50] Stitching was implemented with patterned stainless steel rebar, installed in drilled holes and bonded with compatible grout of special composition. Monitoring the spread of the grout on each stone was achieved by carrying out the grout injections in stages, in combination with the use of grouts of different degrees of injectability. Each stone had its own injection program, which accurately predicted the type and amount of grout to be applied in each area. Before, during, and after the injections, endoscopic observation was done to identify the inner structure and pathology of the stones, as well as for a final monitoring of the fill percentages of gaps.

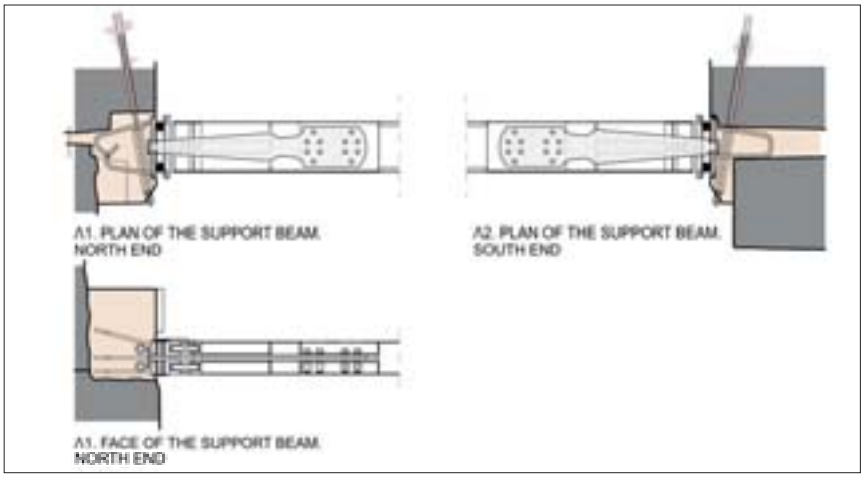
[51] Reconstruction of the vault and south antechamber wall included grouting, stitching, and patching36 ashlars.

[52] The pozzolanic grout was of high bond strength, relatively high compressive strength, and negligible drying shrinkage.

[53] To monitor the effectiveness of the intervention, a trial load on the vault was conducted. The trial included the gradual application of a test load on the vault and the simultaneous recording of the monument's response, with measurements of deformations in pre-selected locations. This trial confirmed that after the intervention the vault displayed the structural behavior which the study had anticipated.

[54] The repositioning of the surviving parts of the entablature of the pediment proved impossible due to the pronounced deformation of the building at this height. The architectural members and ashlars from the façade that it was not possible to reinstate on the monument due to the building's deformation were conserved, reassembled, and are displayed inside Shelter A.

[55] The central section of the wall, which had collapsed from the time of its construction, was separated from the rest of the wall by two vertical construction joints (N. Naskos, *op. cit.*, p. 4). Due to the presence of these joints, during anastylosis, the section of the wall that was reconstructed remained structurally independent. As a result it does not have sufficient stability, and is prone to rocking.



29/ Macedonian tomb of "Macridy Bey", anastylosis of the antechamber west wall (façade), lateral support beam, detailed drawing.

the ashlars of the side walls, which were restored with mortar. To control the load exerted by the beam on the lateral walls, an energy-absorbing mechanism, designed according to capacity criteria, was incorporated into the beam ends. The effectiveness of this design was confirmed by laboratory and *in situ* strength tests.

The anastylosis of the partition wall was carried out in accordance with ancient building techniques and included the rebuilding of the destroyed parts of its doorframe and overlying beam and recovery of the destroyed courses of the tympanum (fig. 5, 10). The destroyed central section of the lintel was reconstructed in the structure's deformed state with white marble from the same source as the ancient stone[56]. Because the surviving end sections of the lintel were at different levels, the doorpost was not reconstructed to its original height; rather, its upper end reflected a typical form of breakage (fig. 10).

The restoration of the destroyed courses of the tympanum was done by repositioning scattered surviving ashlars and completing missing ones with new ones of artificial stone. Due to its poor state of preservation and the diminished bearing capacity of the doorposts and lintel, which did not permit the imposition of additional loads, the drum was reinforced with stainless steel beams, by which its central section was suspended from the upper wall courses[57] (fig. 29). Conservation of scattered and *in situ* blocks and architectural members included cleaning, stitching fragments which had become detached with stainless steel rods, and repairing the destroyed sections with artificial stone (compatible mortar).

Conservation of the colored plaster involved the removal of deposits, consolidation of loose painted surfaces, consolidation around the periphery with compatible mortar, and consolidation of loose sections of the wall using compatible materials (fig. 10). Conservation of the sarcophagus involved cleaning, stapling the cover slabs' fragments with stainless steel dowels, consolidating small fragments, and conserving the painted plaster on its interior.

13. Enhancement and presentation of the Macridy Bey burial complex to the public

The tomb of "Macridy Bey" is situated in a wooded area of 2.2 hectares. On the east, this expanse borders the main road linking Liti (ancient Lete) with Thessaloniki (Via Egnatia); on the west it borders a ditch running parallel to a service road of the Via Egnatia, and on the north and south it borders private properties. Prior to the intervention, due to the

[56] The marble was dressed using ancient techniques, in agreement with tool traces found on the authentic marble architectural members.

[57] Intervention was exclusively confined to ashlars made of artificial stone and is reversible.

configuration of the land and the ditch on its west access to the monument was via the neighboring property on the south. The Via Egnatia runs parallel to the cemetery, which borders the newly-built settlement of Anthoupolis on the west, and the largest environmental park in northern Greece on the east. A number of major Greek manufacturers and transporters of cement and lime products are located in the site's immediate vicinity.

Although it was exposed to challenging environmental conditions, to this day the tumulus of Macridy Bey forms a distinctive natural landmark, mainly due to its monumental dimensions, although its semiological value has been lost to the general public. For this reason, it was important not only to restore and enhance the monument and make it accessible to the public, but also to restore the Cultural Landscape[58]. The principles which were taken into account in accordance with the international legal framework for archaeological heritage are summarized below: a) the historic site is not a single or solitary monument but a material and conceptual body within a wider spatial and cultural landscape. Thus, the environment must be taken into account and contribute to the monument's enhancement; b) the historic site should be regarded as a cultural entity so that its authentic and dynamic presence is not lost; c) the monument should not be seen simply as romantic ruins that turn it into a picturesque space with limited potential as a result of its current fragmentary form.

Enhancement of the archaeological site constitutes a set of actions guaranteeing above all its protection, and secondly, highlighting the unique elements of its appearance. As a whole, the monument and site offer visitors an experience of classical antiquity as well as a didactic and even aesthetic experience, ensuring in future the possibility for a developmental perspective integrated into the context of local society, as well as for future incorporation of the remaining monuments in the necropolis into the overall cultural landscape[59] (fig. 30).

Enhancement work on the burial complex included: the development and improvement of the surrounding environment included the designing of the entrance to the archaeological site and access to the monument, reproducing ancient visitors' perception of the site, an illumination system to spotlight the monument, installation of visitor signage, setting up the website (macedoniantombmacridybey.culture.gr), and producing a short documentary film about the monument to increase public awareness and interest.

In accordance with the approved study, access to the tomb is provided by the Egnatia service road via a metal footbridge with a wooden deck[60] leading to the terraced area of the tomb created by the 1993 excavation,

30/ Macedonian tomb of "Macridy Bey", the entrance of the archaeological site.

31/ Macedonian tomb of "Macridy Bey", lighting enhancement.

[58] Cultural Landscapes represent the combined works of nature and of man and are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. (UNESCO/ICOMOS Expert Group, World Heritage Convention Operation Guidelines, February 1995).

[59] J. Mc Glade, *Archaeology and the evolution of cultural landscapes: Towards an interdisciplinary research agenda*, in P. J. Ucko, R. Layton (eds.), *The Archaeology and Anthropology of Landscape: Shaping your Landscape*, London 1999, pp. 458-82; W. T. Alderson, S. Payne Low, *Interpretation of Historic Sites*, Lanham (Maryland) 1985; G. Chitty, D. Baker, *Managing Historic Sites and Buildings: Reconciling Presentation and Preservation*, Howe 1999.

[60] The route of the footbridge was dictated by the property boundary of the neighboring piece of land on the south, and its width was governed by an existing grove of trees. The footbridge is 16 m long and 2.20 m wide.

where the entrance to the shelter (B) covering the ancient *dromos* is situated. From the entrance, visitors arrive at the façade of the tomb monument via an elevated metal walkway with wooden flooring that is under-lighted at night[61]. During the day the façade is lit from above, through the perforated face of the above-ground shelter. The walk way follows the route and conformation of the ancient *dromos*, including a small staircase set exactly over the site of the ancient one.

14. Illumination of the monument

The nighttime lighting of the monument which was implemented had the following goals: spotlighting the facades of the antechamber and burial chamber, providing visual contrasts (brightness, color, texture) between the different surfaces of the building's walls and floors, avoiding or lessening visual interference such as glare,[62] reduced luminosity from interference of various types, etc., full reversibility of interventions (placement of lighting elements and accessory electrical equipment) throughout the archaeological site, respect for the monument, safety of installations (minimizing outages and fire risks, providing electrical protection), and long-term uninterrupted functioning through energy conservation in accordance with sustainable growth demands (fig. 31).

To illuminate the site, it was decided to use high-quality white light, for the most part implemented with high-yield light/color new technology lamps (LED and/or metal halide)[63]. In addition, interior lighting was foreseen in case of emergency, as was security lighting on the footbridge, with small recessed spotlights set in the wooden deck.

The choice of lighting fixtures and electronic means to control them aimed at providing a range of luminescence that would function in a balancing fashion in relation to constantly-changing lighting conditions throughout the day, but which can also be adapted to an occasional evening tour, guided by artificial light[64].

15. Plantings

For the post-excavation re-connection of the archaeological site with its natural environment, it was considered necessary to plant selected locations. The proposal implemented was the complex result of investigation and assessment of contemporary conditions, ancient and historical evidence, and the sought-after condition of the landscape, with an emphasis on the management of native flora, which sometimes had to be fought against, limited in terms of expansion, or supported in terms of natural rebirth[65] (figs. 2-3).

Plantings had a functional, ornamental or occasionally, protective character[66]. To integrate it into the natural environment, the inclined roof of the protective shelter of the ancient *dromos* was planted with low-requirement, spreading plants similar to the native flora (fig. 19). Planting was extended on either side of the roof of shelter B with the goal of fully incorporating it into the environment while simultaneously protecting the slopes of the tumulus from erosion.

Ornamental plantings were confined to the entrance to the archaeological site and the designated southern perimeter of the visitors' area, and had the character of reinforcing existing vegetation. Mixtures of shrubs and herbaceous native species were employed in all cases.

[61] This walkway is a morphological extension of the footbridge.

[62] K. Narisada, D. Schreuder, *Light Pollution Handbook*, in "Astrophysics and Space Science Library", Berlin 2004, vol. 322.

[63] The lighting study was done by Konstantinos Danis (MSc), Electrical and Computer Engineer, in collaboration with the architects-engineers overseeing the project.

[64] J. King (ed.), *External Lighting for Historic Buildings*, in "English Heritage Annual Report & Accounts", 2007.

[65] M. Trotter, M., B. Mcculloch, *Impact of a planting programme on historic and archaeological sites of Quail Island*, Lyttelton Harbour, Wellington, (New Zeland) 1999.

[66] The study for the planting of the site was done by landscape architects Dr. K. Tamoutseli, and Dr. F. Iliopoulou.