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DIGITAL TECHNOLOGIES IN
THE PROMOTION OF CULTURAL HERITAGE -
MACEDONIAN TYPE TOMBS

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Abstract: *The paper presents two "Macedonian-type tombs", on which, due to their inaccessibility, some of the new digital technologies used in archaeology have been implemented, in order to promote these archaeological objets that are physically inaccessible to the general public. The ultimate goal of these projects is to acquaint the general public with our rich cultural heritage.*

Due to unavailability of the two "Macedonian-type tombs", 3D models have been made for them, one of which is exhibited in the Archaeological Museum of the Faculty of Philosophy – Skopje, and the other in the House of Robev Family, as well as 3D reconstructions of the tombs have been made and they are published on the Youtube channel.

Key words: Macedonian-type tombs, Lychnid, Bonche, 3D reconstructions, 3D models

The development of the so-called "Macedonian-type" of tombs, begins after the second half of the 4th century BC when they are built as the eternal home for the aristocracy. Some of these tombs were decorated in a variety of ways, often with temple-like facades shaped in the Doric and Ionic styles, and the

interior walls were richly frescoed with plant motifs, scenes of battles, hunting, chariot races etc.[1] Probably in the last quared of the 4th century BC vaulted tombs appear.[2] The end of using and building this type of tombs is around the middle of the 2nd century BC and this was obviously connected with the weakening of the Macedonian aristocracy and the fall of Macedonia under the Roman Empire.

However, the appearence of the vault as an architectural element, its origin and dating, causes controversies and disagreements in scientific circles. According to certain researches, the vault in the "Macedonian-type" tombs actually has its own protogenic development in Macedonia.[3] But according to other researchers, the Macedonian military architects who followed King Alexander III of Macedonia in his campaign, noticed the vault as an architectural solution in the countries of the east. According to this theory, the vaulted tombs in these areas were most likely built after the death of Alexander III, after his military architects returned and passed on the art of vault building.[4] This chronological connection is used by the majority of researchers to determine the most famous tomb of this type, the so-called Philip's Tomb in Aigai,[5] as a tomb in which Philip III Arrhidaeus is buried. In support of this hypothesis is the analysis of S. Rotroff about the finds of ceramics in the tomb, which he dates according to the same indigenous movable material recorded in a closed context in Athens, and that is towards the end of the 4th century BC.[6] However, even decades after the discovery of this tomb, there is still scientific debates about its dating and affiliation.

So far, around 100 "Macedonian-type" tombs have been discovered in the Balkans and Asia Minor, including the tombs from Bonche and Lychnid.

The above-mentioned two tombs are located in the territory of today's Macedonia. One is located at the archaeological site of Pavla Chuka, between the villages of Podmol and Bonche – the northeastern part of Pelagonia,[7] while the other tomb, which is also the subject of processing in this paper, is the "Macedonian-type tomb found in Ohrid" – the ancient city of Lychnid.[8]

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[1] Miller S. G., 1982, 153-171.

[2] Miller S. G., 1993, 1-4.

[3] Hammond N. G. L., 1978, 331-350.; Fredricksmeyer, E. A., 1981, 330-334. Andronicos M., 1987, 1-16.

[4] Tomlinson R. A., 1977, 473-479.; Boyd T. D., 1978, 83-100.

[5] Andronicos M., 1976, 123- 130.; Andronicos M., 1977, 40- 72.; Andronicos M., 1980, 168-178.; Andronicos M., 1987, 1- 16.

[6] Rotroff S. I., 1997.; Gill W. J. D., 2008, 335-358; With several examples of dating according to found material.

[7] Jakimovski A., 2012, 165 – 180.; Jakimovski A., 2015, 27-42.; Jakimovski A., 2021, 123-136.

[8] Bitrakova Grozdanova V., Kuzman P. 1997, 23-25.; Битракова Грозданова В., Кузман П., 1998, 10.; Bitrakova Grozdanova V., 2021, 425-435.

The tomb on the archaeological site Pavla Chuka – Bonche, is a ruler's tomb which is one of the most beatufiul early antique buildings in ou territory and beyond. For the first time, it was brought into the archaeological science in 1936, when the chamber of the tomb was excavated. Research in 2007 revealed a hitherto unknown monumental wall, which in the form of a ring surrounded the tomb, as well as another object attached to the wall itself, which most likely represents Heroon. [9]

Subsequent research revealed the entire length of the circular wall that completely surrounds the other elements of the tomb, the vaulted corridor – the dromos, the antechamber and the chamber.[10] Some of the missing blocks were blown up by the local population in the past.

A few meters east of the entrance to the tumulus, a certain number of monolithic stone block were registered. Only two rows of stone blocks remain of this wall *in situ*. It is the only preserved wall that suggests that it is an object with an elongated rectangular shape, i.e. that it is Heroon.

A part of the access corridor to the interior of the tomb was also discovered. It was carved into the rock and in the form of a slightly inclined ramp descends to the entrance to the tumulus, i.e. to the begining of the vaulted corridor – dromos.

The dromos was constructed of monumental rectangular stone blocks, with lengths of 2 to 3 m. and up to about 0.60 m. in width and height. It is very well preserved, only a few blocks are missing. The length of the dromos is 11 m., while the height of its southern end (its beginning) is 3 m., and at the northern end, in front of the entrance to the antechamber, it is 3.20 m. high. The approach, i.e. the entrance from the open corridor to the vaulted dromos was closed (blocked) with stone blocks, identical in shape and construction to those of the outer circular wall and the dromos itself. In fact, the closed part of the tomb starts from that place.

The chamber and antechamber of the tomb were constructed of smaller standardized limestone blocks. This type of stone is rare in the wider area, so it is assumed that at that time it was considered a more valuable building material. The limestone blocks were very precisely cut, with dimensions of 0.50 m. in height and with a length between 0.60 and 0.90 m. The chamber and the antechamber were separated by a double door, which revealed a marble threshold with notable clamp openings. There is an almost identical marble block-threshold of this kind at the entrance of the vaulted dromos in the antechamber. At the bottom of the chamber, limestone blocks were recorded adhering to the walls of the chamber, placed in the form of the Cyrillic letter G (Г). According to the positioning, they most likely served as a bed or couch (κλίνη)

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[9] Jakimovski A., 2012, 165 – 180.; Jakimovski A., 2015, 27-42.

[10] The researches are within the framework of the project Archaeological researches of Staro Bonche carried out in the period from 2007 to 2022 under the leadership of A. Jakimovski.

where grave goods were placed. The highest preserved height of the walls of the chamber is 2 m. Unfortunately, the investigation of the interior of the tomb did not reveal any moving finds. There have not been discovered any architectural decorative elements, which such a monumental object mus have possessed. As a matter of fact, th e presence of decorative plastic has been registered in most analogous examples of this type of tombs.

During research, 10 graves were discovered among the scattered remains of the building (Heroon). Six burials are of the cist type of roughly made stone slabs, and four are free burials in the rocky terrain. The graves are, without exception, small in size, which indicates to us that they are burials of children. Due to the negative influence of the chemical properties of the earth, the osteological material in them is very rare. Their dating is based on the findings of coins, one of Julian II the Apostate found in 2009, minted between (361 - 363 AD),[11] and the second coin found during research in 2019 belongs to Theodosius I (379-395). According to these findings, the graves are dated to the second half of the 4th century and during the 5th century.[12] The placement of Grave 3 on a block removed from the circular wall of the tomb points to the conclusion that in ancient times, that is, in the 4th – 5th century, the tomb was already partially dismantled and probably looted. From the second half of the 4th century, the monumental building grew into a cult place where burials took place. With research in 2019 on the western part of the dromos of the tomb, burials with grave goods from the Middle Ages were discovered, which, according to analogies with identical objects, are dated to the late 10th and the first quarter of the 11th century.[13] In 2020, the burials from the Middle Ages were confirmed, and it can be concluded that this tomb as a cult space also existed at the beginning of the 11th century.

Since the representative tomb of the Pavla Chuka site was looted in the distant past, no movable finds were discovered in its interior. In the absence of relevant movable findings, we can rely primarily on establishing analogical comparisons with similar tombs in the ratio of architectural concepts and construction style. According to analogies with those found so far, the tomb of Pavla Chuka is dated to the last quarter of the 4th century BC.[14]

The second tomb is located in the old part of today's Ohrid, ancient city of Lychnid, right above the ancient.[15] The tomb was known to the local population already in the first decades of the twentieth century.[16] In the 50s of the 20th

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[11] Sutherland J. W. E., 1981, 423, No.228.

[12] Јакимовски А., Темелкоски Д., 2019, 71.

[13] Јакимовски А., Телкоски Д., 2019, 63-75.

[14] A. Jakimovski 2009, http://www.mav.mk/article.php?lang=en&article=20.; Jakimovski A., 2012, 165 – 180.; Jakimovski A., 2015, 27-42. A dating presented in 2007 for the tomb from Staro Bonche corresponds to a tomb from Amphipolis in 2012 (with which it is most similar), also dated to the last quarter of the 4th century. Analogies to the tomb of Pavla Chuka can be found in several famous tombs.

[15] В. Битракова Грозданова, 1986, 257., П. Кузман, 1996, 258.

[16] The tomb was probably used as a hiding place during the First World War. On the southwest side of the chamber there are traces of human destruction on the floor and wall.

century V. Lahtov has opened the tomb in order to protect it, and installs an iron door, which is still standing today. Later, in 1984 V. Malenko carried out archaeological excavation in the antechamber. The first detailed analysis of the tomb was carried out in 1996 by the National Institution for Protection of Monuments of Culture and Museum – Ohrid.[17]

The tomb consists of a dromos, an antechamber and a chamber.[18] The entrance to the dromos is through five stairs with a width of 1 m. The dromos has dimensions of 2.30 x 0.83 m., the antechamber has dimensions of 1.65 x 2.8 m., and the chamber has dimensions of 3.95 xx 3.10 m, where there are traces of beds (κλίνη) where the deceased were laid.[19] It is assumed that the tomb was robbed in antiquity, but there is no concrete evidence for that either.

The tomb was built of massive carved limestone blocks. The floor of the tomb is made of hydrostatic mortar, which is best preserved in the chamber, and in the antechamber, unfortunately, does not exist at all. The wall decoration that is present in the antechamber and the chamber is made in several colors, of which the Pompeian-red color dominates, which is complemented by stucco decoration.

The north-western wall of the chamber has a plinth that is 0.10 m. high and orthostats 1.24 m. high made of stucco that imitates marble slabs. The free zone above the orthostats with dimensions 1.0 m. is filled with Pompeian-red color, while the upper parts of the wall were probably painted with white color which does not exist anymore. On the other side, that is, the entrance from the antechamber to the chamber, there are orthostatas with a height of 1.27 m, which is identical to those in the chamber, and the free zone which is filled with Pompeian-red color, has the same height, while the upper part where there are no evidences of painting has a height of 0.4 m.

Since no movable material has been found in this tomb either, and the period of construction cannot be reliably determined, the dating is based on alaogies with "Macedonian-type" tombs, that is, the dating based on the architecture and decoration.[20] The dating of the tomb in Lychnid is probably the end of 3rd century BC.[21]

The first presented tomb from Bonche was excavated in the period from 2007 to 2022, within which modern digital topographical methods were made,

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While, at the very entrance above the antechamber, the destruction of the vaulted roof is visible, which was definitely caused by a human factor. According to the old local citizens, even during the Second World War, this tomb was used by the Bulgarian soldiers as a hiding place, and this is proven by the inscriptions on the southwest wall of the chamber.

[17] Bitrakova Grozdanova V., Kuzman P., 1998, 10.

[18] Bitrakova Grozdanova V., 2021, 425-427.

[19] There are assumptions that perhaps Aeropos was buried in this tomb, who according to ancient written sources is represented as the ruler of Lychnid in the 3rd century BC. See in: Kuzman P., 2010, 58 -59; Блажевска С., 2013., Битракова Грозданова В., 2017, 114.

[20] Битракова Грозданова В., Кузман П., Скопје 2017, 113 - 114.

[21] Битракова Грозданова В., 2017, 112.

primarily due to the inaccessibility of thi tomb,[22] which is extremely significant and one of the most beautiful early antique objects in our country, with the aim of showing and bringing the scientific and general public closer to this object. For this purpose, during the archaeological excavations of this tomb, modern geomatic and architectural methods were applied in the preparation of the photo-technical documentation.

Fist, tachymetric polar recording of the terrain near the tomb was performed using a geodetic instrument – Total station, wit which the values of the placed markers for aerial photogrammetric recording were takne. The obtained values were followed by the aerial photogrammetric recording of the tomb with the help of a drone. The obtained aerial photogrammetry images were software processed with Agisoft Metashape photogrammetry computer program, where it was obtained a real virtual 3D model of the outer part of the tomb. Thanks to the results of the aerial photogrammetric recording with the help of computer software for technical drawing AutoCAD, thetechnical plans of the outer part of the tomb was prepared. The interior part where the floor survey was carried out was also drawn in the technical drawing software Auto-CAD.

The expert team, thanks to the field technical documentation, supplemented with the previous knowledge, finally made decisions in which direction to move the preparation of the ideal 3D virtual reconstruction of the tomb in Bonche.

Virtual reconstruction of the tomb from Bonche was created in computer software AutoCAD 3D, where a short film (animation) was made and published on Youtube.[23] The main goal in creating a virtual reconstruction of the tomb was to promote and familiarize the experts and the general public with this hard accessible archaeological site. A Styrofoam model of the tomb is made, and today is exhibited in the Archaeological Museum at the Faculty of Philosophy.

Due to inaccessibility of the second tomb from Ohrid (ancient Lychnid), as it is located on private property and access to the tomb is impossible for visitors, it was a challenge to find suitable solution to show it to the general public. For this purpose, in 2021, the project "Virtual reconstruction and model of a tomb of Macedonian type in Ohrid" was implemented".[24]

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[22] It is located in one of the most uninhabited areas in Europe, in the immediate vicinity of Mariovo - Prilepsko, to which no road leads.

[23] https://www.youtube.com/watch?v=2-o5801HPBY&t=48s

[24] The project was implemented in 2021 by a group of archaeologists, students, civil engineers, who, with the support of the Ministry of Culture, implemented the project "Virtual reconstruction and model of a Macedonian-type tomb in Ohrid". The bearer of this project was the Association for Protection and Sustainable Development of the Environment REGIONAL GREEN CENTER OHRID, in cooperation with the National Institute for Protection of Monuments of Culture and Museum - Ohrid. The head of the project was Ivan Malezanov.

For start, a floor survey was carried out in the tomb. In addition to the survey, photo documentation as well as individual modest terrestrial-photogrammetric recordings of certain details suc as part of a wall with frescoes, stone plastic, stone blocks etc. was carried out.

It was necessary for the team to refrain from detailed photogrammetric recording due to the potentially negative impact of artificial lighting on primarly the frescoes and other parts of the tomb. In addition to lighting, the lights themselves heated up and increased the temperature in the tomb after longer operation. Also, the expert team, with their very presence inside the tomb, increased the temperature. The humidity of the air was measured and constantly varied depending on the numbere of people inside and the activities taking place.[25]

Afther the field documentation of the tomb, technical processing of the data followed. From the floor survey, plans were prepared using AutoCAD technical drawing software, and the individual photogrammetric recordings were processed in Agisoft Metashape computer software for photogrammetry, which gave us a 3D view of certain parts (wall with frescoes, stone plastic, stone blocks etc.) from the tomb.

The next stage was the creation of an ideal 3D virtual reconstruction of the tomb. Thanks to the results of the field technical and photo documentation, supported by the data from the previous researches, a final conclusion was made on how to create the conceptual 3D cirtual reconstruction of the tomb.

The 3D virtual model of the tomb was created in computer software AutoCAD 3D, after its final creation, a short film (animation) was created and published on Youtube[26] in order to present and promote the tomb to general public.The Institute for the History of Art and Archaeology at the Faculty of Philosophy in Skopje also produced a model of the final 3D reconstruction of the tomb with the help of a 3D printer. The team included an expert artist who performed manual artistic painting of the 3D model. The final model of the ideal reconstruction of "Macedonian-type" tomb from Lychnid was handed over to the Musum building "Robev Family House" in Ohrid, where it is exhibited.

Also in front of the site itself, on the supporting wall above the ancient theater, there is an information board that contains basic information about the tomb and a QR Code for free access to the virtual reconstruction.

The detailed technical documentation, the virtual reconstruction and the model of "Macedonian-type" tomb that is exhibited today in the Museum building "Robev Family House" is one of the ways in which the visitor can experience what he cannot physically visit.The idea is to promote archaeological sites that are physically inaccessible to the general public, in order to get to know the cultural heritage in the Ohrid region.

[25] https://www.youtube.com/watch?v=AhdNDL9VN28&t=15s
[26] https://www.youtube.com/watch?v=9b_IukLdhfc&t=8s

For many years, the two presented tombs, although they represent a rarity in the territory of today's Macedonia, were left in oblivion. The whole idea of creating the virtual reconstruction and 3D model of the tombs is to promote the two archaeological sites, making them accessible to the general public.

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Fig. 1 - The tomb on the archaeological site Pavla Chuka – Bonche
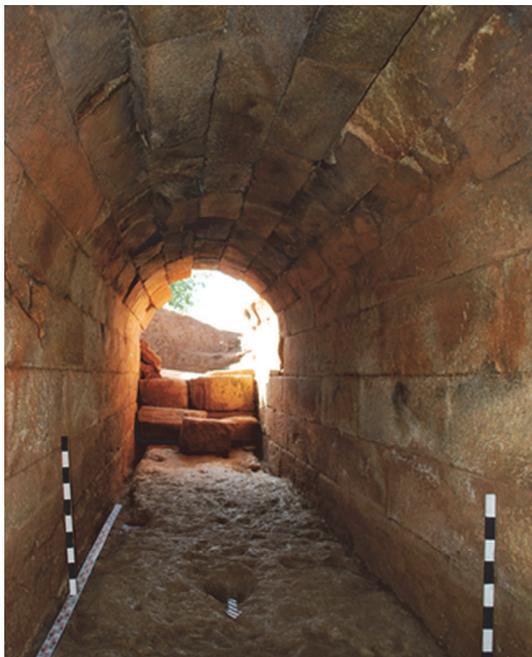
Fig. 2 - The vaulted corridor - the dromos - Pavla Chuka – Bonche
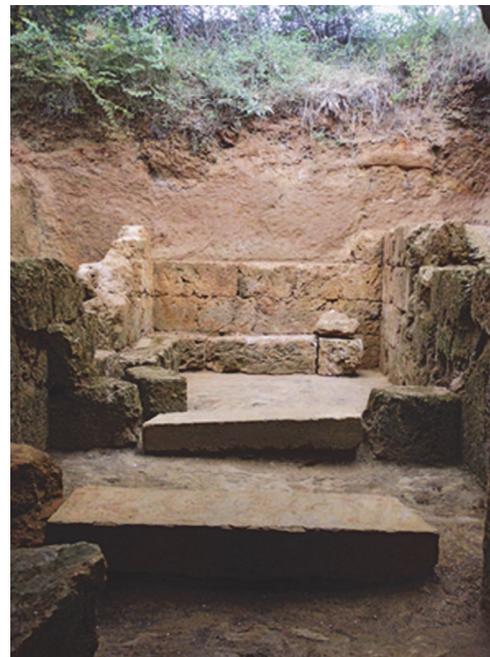
Fig. 3 - The antechamber and the chamber - Pavla Chuka – Bonche

Fig. 4 - The antechamber and the chamber - Pavla Chuka – Bonche

Fig. 5 - Virtual reconstruction of the chamber - Pavla Chuka – Bonche

Fig. 6 - Model exhibited in the Archaeological Museum at the Faculty of
Philosophy in Skopje

Fig. 7 - The dromos of the tomb from Lychnid

Fig. 8 - Antechamber and chamber of the tomb from Lychnid

Fig. 9 - The chamber of the tomb from Lychnid

Fig. 10 - Virtual reconstruction of the tomb from Lychnid

Fig. 11 - Model of the tomb from Lychnid exhibited in Museum house of Robev family - Ohrid
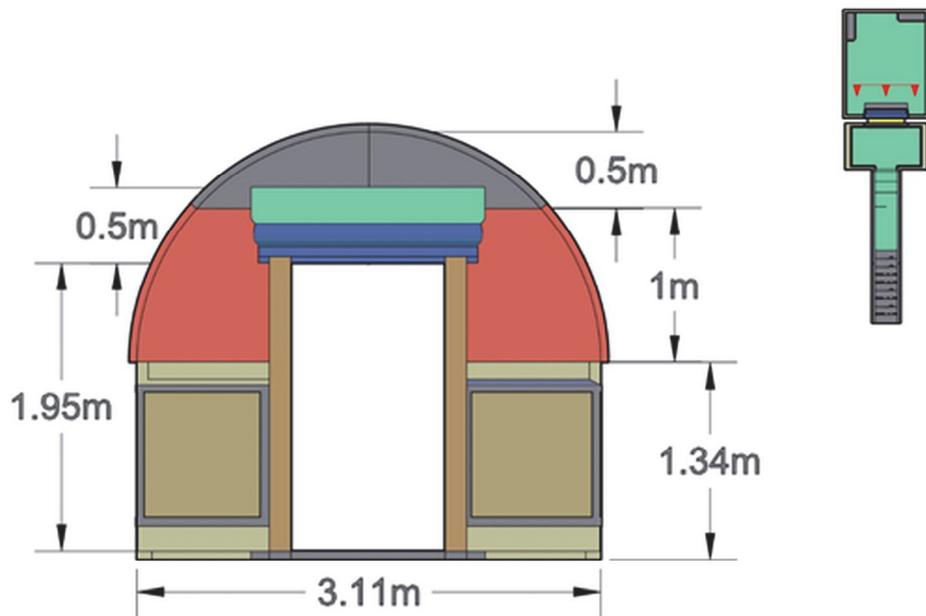
**Fig. 12** - Graphical representation of the exit of the chamber (elaborated by K. Denkovski, 2021)
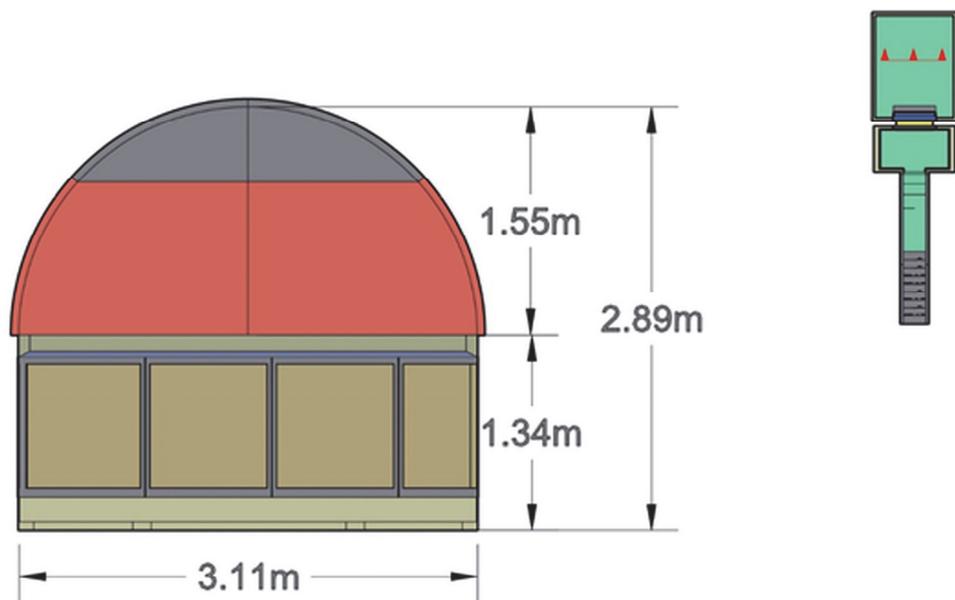
Fig. 13 - Graphical representation of the north-east wall of the chamber (elaborated by K. Denkovski, 2021)
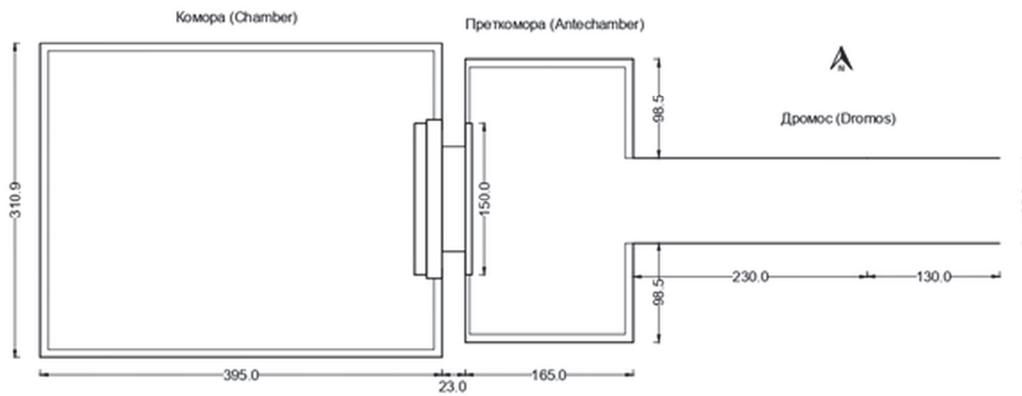
**Fig. 14** - Base of the tomb from Lychnid
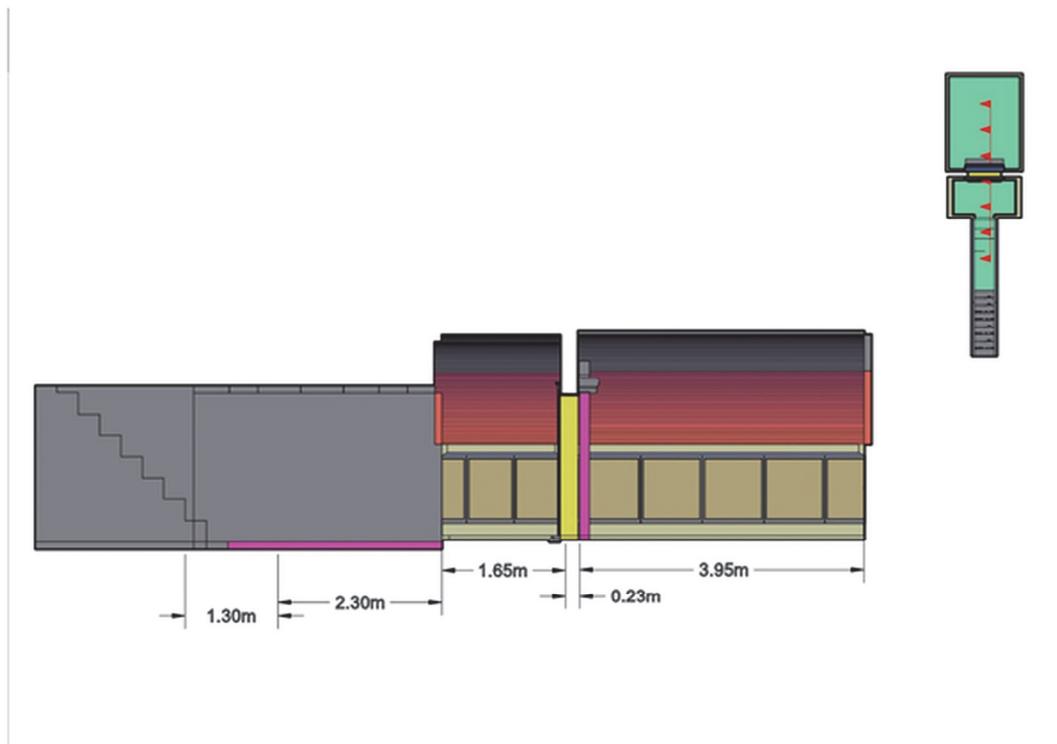
Fig. 15 - Graphical representation of the cross secion of the tomb (elaborated bv K. Denkovski, 2021)