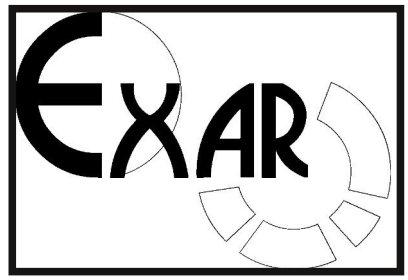
EXPERIMENTELLE ARCHÄOLOGIE IN EUROPA
Jahrbuch 2017
Heft 16

Herausgegeben von Gunter Schöbel
und der Europäischen Vereinigung zur
Förderung der Experimentellen
Archäologie / European Association for
the advancement of archaeology by
experiment e.V.

in Zusammenarbeit mit dem
Pfahlbaumuseum Unteruhldingen,
Strandpromenade 6,
88690 Unteruhldingen-Mühlhofen,
Deutschland



EXPERIMENTELLE ARCHÄOLOGIE IN EUROPA

JAHRBUCH 2017

Festschrift für Mamoun Fansa zum 70. Geburtstag

Unteruhldingen 2017

Gedruckt mit Mitteln der Europäischen Vereinigung zur Förderung der Experimentellen Archäologie / European Association for the advancement of archaeology by experiment e.V.

Redaktion:	Ulrike Weller, Thomas Lessig-Weller, Erica Hanning
Textverarbeitung und Layout:	Ulrike Weller, Thomas Lessig-Weller
Bildbearbeitung:	Ulrike Weller, Thomas Lessig-Weller
Umschlaggestaltung:	Thomas Lessig-Weller, Ulrike Weller

Umschlagbilder:

Bibliographische Information der Deutschen Bibliothek

Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie, detaillierte bibliographische Daten sind im Internet abrufbar unter: http:\\dnb.dbb.de

ISBN

Gedruckt bei: Beltz Bad Langensalza GmbH, 99947 Bad Langensalza, Deutschland

Inhalt

Experiment und Versuch

Rekonstruierende Archäologie

Vermittlung und Theorie

Jahresbericht und Autorenrichtlinien

Experimentelle Archäologie in Europa 16 – Jahrbuch 2017, S. 208-216
Kategorie: Vermittlung und Theorie

The Sarcophagi Garden in Ephesus.

Condition survey of 21 sarcophagi and conservation of the "Amazon Battle" sarcophagus

Barbara Rankl

Zusammenfassung – Der Sarkophaggarten von Ephesos. Bestands- und Zustandsanalyse von 21 Sarkophagen sowie Konservierung und Restaurierung des Amazonenschlachtensarkophags. *Der erste Teil des Beitrags beschäftigt sich mit der konservatorischen Bestands- und Zustandsaufnahme aller Objekte im Sarkophaggarten in Ephesos (Türkei) und der Auswertung im Rahmen einer Bestands- und Zustandsanalyse.*

Im Zentrum des Artikels steht der fragmentierte Corpus des Amazonenschlachtensarkophags aus der Hafennekropole Ephesos', datiert um 190 n. Chr. Dieses, in den 1930er Jahren geborgene Objekt, wurde gemeinsam mit 20 anderen Steinsärgen im Sarkophaggarten, im archäologischen Park Ephesos präsentiert. Der Sarkophag wurde aus pentelischem Marmor gefertigt und zeigt eine Amazonomachieszene in Form eines Reliefs auf allen Seiten des Sargkastens.

Des Weiteren wird die komplexe Fragestellung der Gefügeschädigung des Amazonensarkophags, verursacht durch Bewitterung und mikrobiellen Bewuchs, mithilfe materialwissenschaftlicher Untersuchungen geklärt. Die modellhafte Restaurierung dieses stark geschädigten Objekts wurde unter Verwendung von innovativen Methoden im Jahr 2015 im Rahmen der Diplomarbeit der Autorin durchgeführt und wird ebenfalls kurz vorgestellt. Abschließend werden Möglichkeiten und auch Herausforderungen, den Erhalt dieser Objekte im Sarkophaggarten betreffend, angedacht.

Schlagworte: Restaurierung, Marmor, Festigung, Präsentation, Steinsarg, Bearbeitungsspuren
Keywords: Conservation, marble, consolidation, presentation, stone coffin, tool-marks

Introduction

The following paper summarises a diploma thesis at the Institute for Conservation, University of applied Arts Vienna, finalised in 2016 and featuring the investigation and conservation of sarcophagi in Ephesus. This diploma project was a result from the cooperation between the Institute for Conservation (Head of Institute: o. Univ.-Prof. Mag. art. Dr. phil. Gabriela Krist) and the Austrian Archaeological Institute.

The first main emphasis of this paper is

Fig. 1: Sarcophagi Garden in Ephesus, overall view. – Sarkophaggarten in Ephesos, Gesamtansicht.

the technological condition survey of all objects in the Sarcophagi Garden in Ephesus/Turkey. This first chapter also includes a technological and condition analysis.
The second focus is the chest of the so-called "Amazon Battle" sarcophagus dated around 190 AD, from the harbor necropolis in Ephesus. It was excavated in the 1930s and is presented together with 20 other stone coffins in the Sarcophagi Garden on Ephesus' archaeological site in Turkey. The object is carved out of pentelic marble with an amazonomachy frieze on all four sides.
The poor condition of this valuable object required conservation, which was undertaken by the Institute of Conservation. This included not only the practical work, but also scientific analysis of the deterioration caused by weathering and biological colonization.
Gathering all the necessary data, taking samples and the conservation of the "Amazon Battle" sarcophagus took place in Ephesus in the context of three campaigns that lasted a total of 3 months. The scientific investigations and the evaluation of the data for the technological and condition analysis were undertaken in Austria.

The Sarcophagi Garden

The presentation of 21 stone coffins is located in an area of the archeological park Ephesus (*Fig. 1*). This recent grouping was assembled in the last 10 years. The exhibition is open to the public and is located north of the famous Harbor Street. It can be noted that this collection is no ensemble: the fact that all objects are sarcophagi and come from Ephesus is their only link. In addition, there is no connection between the sarcophagi and the site or its surroundings.

Technological and condition analysis

An inventory and condition survey of the 21 stone coffins in the Sarcophagi Garden was made, using a standard form, which was designed to enable a qualitative and quantitative analysis. Samples could not be taken from all objects. It was decided to use non-destructive examination methods for the survey in general.
This complex is comprised of several sarcophagi types. Proposals for a possible classification in groups of objects can be as follows: 7 of the 21 objects belong to the group of garland sarcophagi (*Fig. 2*), a type decorated with garlands, which is a typical design in Asia Minor (Koch, Sich-

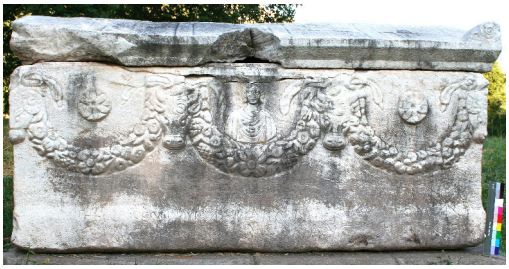


Fig. 2: Garland sarcophagus, Sarcophagi Garden. – Girlandensarkophag, Sarkophaggarten.

Fig 3: Unfinished garland sarcophagus, Sarcophagi Garden. – Girlanden-Halbfabrikat, Sarkophaggarten.

TERMANN 1982, 499-500). The largest group are the 11 unfinished garland sarcophagi (*Fig. 3*). These products are in a quarry state and illustrate an intermediate stage in the manufacture of a completed sarcophagus (KOCH, SICHTERMANN 1982, 499-500). The decorations were left in an embossed state, meaning they were left standing proud but only roughed out. Apart from the main groups now featured, there is also a frieze sarcophagus, known as the "Amazon Battle" sarcophagus, which is described in more detail later. Other exceptions include a sarcophagus, which has both figural representations and garlands, and a coffin which was left plain and undecorated.

All coffins are made of white crystalline marble. Some have inclusions of graphite, dolomite, mica and ferrous minerals. In determining the provenance of white marbles one has to rely on analytical data and results, as they are visually difficult to distinguish (LAUBENBERGER, PROCHASKA 2011, 54). However, typological features provide clues to the origin of the marble types in the Sarcophagi Garden. Thus it can be assumed that most are locally quarried and carved. The "Amazon Battle" sarcophagus is an exception.

The local marble extraction, craftsmanship and export of this stone were of great importance for the Ephesian economy. Marble deposits in the region around Ephesus provide this rock (PROCHASKA, GRILLO 2012, 584). Two groups of marbles from Ephesus area quarries are known: Ephesus I and Ephesus II. However, other varieties have also been found. In the region around Ephesus at least 40 ancient quarries have been identified (PROCHASKA, GRILLO 2012, 585).

Other materials of anthropogenic origin, which are part of the object inventory, were spotted during the survey. Metal brackets are among the most frequently occurring remains. Joint mortar residues for closing the lid and the corpus can also be observed. The aim of this sealing was to prevent the smell of the corpses from escaping into the air (KNIBBE, LANGMANN 1993, 23). The mortars have different compositions; some are partially superimposed and are therefore an indication that the sarcophagus had been closed more than once, for example reused for another burial. The objects of the Sarcophagi Garden were examined by UV light. Residues of the original polychromy were found on two objects. However, it can be possible that several others were coloured.

The most frequently found tool marks are moil chisel tracks. The impressive diversity of this instrument can be observed on the surfaces of the sarcophagi. Further tool marks go back to a processing with the tooth chisel. Especially on the exterior of the objects, flat chisel tracks were detected in the completed reliefs of the sarcophagi. In terms of tool marks the

Fig. 4: Secondary side of a garland sarcophagus, decorations are partially unfinished. – Nebenseite eines Girlandensarkophags, zur Hälfte ausgearbeitete Girlande.

"Amazon Battle" sarcophagus is an exception as drilling and rasp marks were discovered.
It is particularly interesting to observe that some sarcophagi illustrate different stages of completion in their decorations. Coffins have often been placed inside tombs or mausoleums and stood in niches or on a wall. Hence it was not necessary to fully finish all the sides. *Figure 4* shows such secondary sides.
Within the scope of the condition survey, damages to the individual objects were detected, based on the "Illustrated Glossary on stone deterioration patterns" by ICOMOS-ISCS (ICOMOS 2010). The most common damage types are material loss, detachment, biological colonization and cracks.
The deterioration is largely due to two causes: the first is climate-related, brought about by extreme heating of the marble surface in arid months, with resulting damages such as scaling and sugaring. During the humid months, the objects are exposed to heavy rainfall. Due to the wide humidity range and mild temperatures, even in winter, this climate forms a good basis for the attack by microorganisms.
The second cause of damage is anthropogenic, because some visitors of the archaeological park climb onto the sarcophagi or climb into their interiors. This cannot be considered only as a lack of respect for this cultural heritage, but also of actual damage to the objects.
Within the scope of the condition survey, each coffin was assigned a condition category. The categories can be described as follows:
Good condition: The condition is stable and there is no intrinsic substance hazard.
Average condition: The condition is still stable, though the item is damaged. Treatments are recommended.
Poor condition: The condition is unstable. Serious damage is observed, associated with loss of substance. There is an urgent need for conservation treatments.
Out of the 21 objects, four are in good, nine in average and eight in poor condition. This rating shows clearly the need for conservation work within this complex, because just four out of 21 objects do not require treatment.

The "Amazon Battle" sarcophagus

This fragmented corpus has ornaments in the base area and a figural frieze on all four sides (*Fig. 5*). The relief shows scenes of fighting between Amazons and Greeks. The sarcophagus was made around 190 AD, is of Greek origin and its production can clearly be assigned to Attic workshops (Rudolf 1989, 33-38). This means that the object is an imported marble sarcophagus and very rare among the collection of sarcophagi on site. The coffin was brought immediately after its excavation in the 1930s to the Ephesus Museum

Fig. 5: "Amazon Battle" sarcophagus, front side, condition after treatment. – Amazonenschlachtensarkophag, Vorderseite, nach Restaurierung.

near the archaeological park (RUDOLF 1989, 33-38). After a long stay inside, it was transported to the museum's open-air depot, and subsequently placed in the Sarcophagi Garden where it has been on display for about 10 years together with the 20 other objects there.

Technological inventory

For determining the provenience of the "Amazon Battle" sarcophagus' marble variety, a sample was taken and chemical analysis of inclusion fluids carried out by Ao. Univ.-Prof. Dr. phil. Walter Prochaska (Montanuniversität Leoben, Geology and Economic Geology). The results of this study indicated a clearly identifiable origin, the Pentelikon quarry located northeast of Athens.
For further scientific investigations, which where supervised by ao. Univ.-Prof. Dr. phil. Johannes Weber (University of applied Arts Vienna, Institute of Art and Technology), additional samples were taken to clarify the inventory and condition of the object. First the samples were examined under a stereomicroscope and a scanning electron microscope. Then thin sections were prepared, which were viewed under a polarizing microscope as well as a scanning electron microscope.

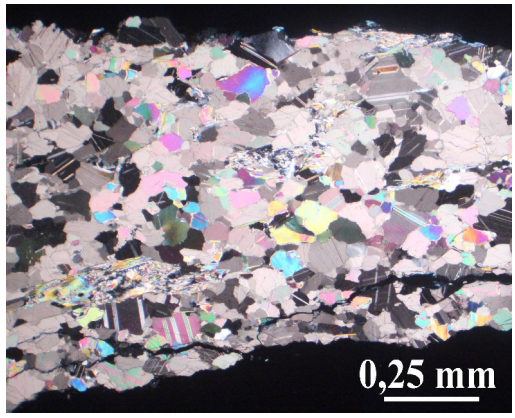


Fig. 6: Calcite structure, thin section, polarising microscope. – Kalzitgefüge, Dünnschliff, Polarisationsmikroskop.

In addition, in situ investigations by X-ray fluorescence spectroscopy (XRF) were carried out. The measurements were carried out by the Austrian Archaeological Institute.
The structural characteristics of the samples taken are consistent with the general characteristics of Pentelic marble (*Fig. 6*). On the back-side of the object, layers were found, which could be identified as mica, more precisely as Muscovite and Serizite (*Fig. 7*). Inclusions of other minerals were also detected.
In summary, the block of stone that was used for carving this coffin is very inho-

Fig. 7: Inventory mapping, back side, mica layers (purple). – Bestandskartierung, Rückseite, Glimmerlagen (lila).

mogeneous and does not correspond to the usual quality of Pentelic marble, especially at the rear.

Condition before conservation

The condition analysis of the Sarcophagi Garden revealed that the “Amazon Battle” sarcophagus has the poorest condition of all 21 sarcophagi and it was decided that the object will be used for a model conservation treatment by the Institute for Conservation.
The detection of all types of damage, the evaluation of microscopic and microbiological investigations, as well as the in situ measurements, such as ultrasound measurements are documented in the condition analysis of this object (*Fig. 8*): The stone coffin is in a poor condition, as distinct types of damage are noted and these are coupled with acute loss of substance. The matter is urgent and immediate conservation measures are needed to reduce and stop the loss of surface.
One of the main damages is delamination. Special decay mechanisms of sericite lead to considerable loss of substance in the mica layers (*Fig. 9*). Scaling is also a main source of damage. The surface is covered with scales. An important result

Fig. 8: Condition before conservation, detail of right side of sarcophagus, damages visible are delamination, scaling, sugaring and biological colonization. – Zustand vor Restaurierung, Detail von rechter Seite des Sarkophags, Schadensbilder sichtbar: Schichtspaltung, Schalenbildung, Zuckerkorrosion, biogene Besiedelung.

of the investigation was that this scaling is not related to the mica minerals in the structure, but only in the calcite structure near the surface. Sugaring, a typical kind of damage to marble, can also be observed on the sarcophagus. The microflora on the object comprises of a complex community of lichens, bacteria, algae and

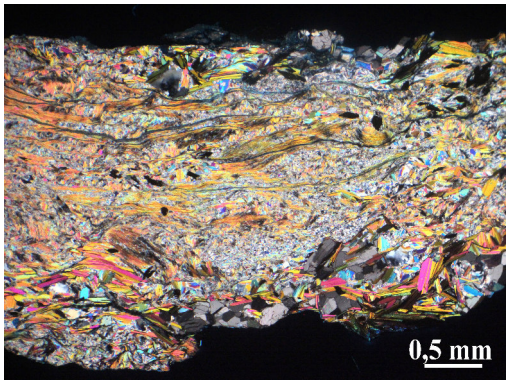


Fig. 9: Calcite and mica structure, damage of delamination due to cracking in mica layers, thin section, polarising microscope. – Kalzit- und Glimmergefüge, Schaden der Schichtspaltung aufgrund von Spaltrissen im Glimmergefüge, Dünnschliff, Polarisationsmikroskop.

Fig. 10: Consolidation with nanolime. – Festigung mit Nanokalk.

black fungi. In this case, the microorganisms act as catalyst and drive the structural damage ahead by their growth.
Both lime and gypsum crusts can be detected on the stone surface. The lime crusts have a protective function. In contrast, the gypsum crusts can be harmful for the object.
The distinction between two different crusts is the result of the condition survey and the scientific investigations of samples taken from the deposits. The investigations dealing with the crusts were supervised by VL Dipl.-Ing. Dr. rer. nat. Tatjana Bayerova (University of applied Arts Vienna, Institute of Conservation).
These were examined under a light microscope and a scanning electron microscope. In addition, fragments of the samples were subjected to Fourier Transform InfraRed (FTIR), XRF and X-ray diffraction (XRD).
Due to the frequent occurrence of oxalates in the deposits on ancient objects in the Mediterranean, they were also a search focus in the investigations. The origin of these oxalates is controversial. One hypothesis assumes that the oxalates originate from the degradation of organic substances. These could be the remains of polychromy or a “protective coating” (Lazzarini, Salvadori 1989, 20-26), which was already been applied in ancient times (Martin-Gil et al. 1999, 58-62; Maravelaki-Kalaitzaki 2005, 187-198). The results of the examinations of the deposits on the sarcophagus revealed that the samples show no oxalates. But of course, an occurrence of oxalates in other areas of the deposits on the object cannot be excluded.

Conservation treatments

The object had to be removed for the conservation procedures and transported to a workshop. After cleaning and the removal of various deposits, the biocide treatment could be carried out. It was necessary to find differentiated approaches for the interior and the exterior. The lichens could be partially removed with potassium hypochlorite, a new agent in its use for conservation.
The most complex task was the consolidation of the weakened structure of the stone. As already distinct in the condition analysis, there is on the one hand the delamination in the mica structure, and on the other hand, the sugaring and scaling

in the calcite structure. For a successful consolidation, those areas had to be treated differently. For the calcite structure, nanolime was used. This is a consolidation medium which is highly compatible with carbonate substrates (*Fig. 10*). For the mica layers a different consolidate was used: a stone strengthener based on silicic ester, which is highly compatible with silicate substrates.
Using micro-pointing procedures, the three types of damage – scaling, sugaring and delamination – were stabilized and closed as part of the same action.

Conclusions

The two significant causes of damage occurring in the Sarcophagi Garden have been discussed in the condition analysis and are on the one hand climate-based, and on the other hand anthropogenic. In order to protect the objects from future damage an optimal solution would be the building of a roof construction and a barrier. Another recommendation is to dismantle the objects and to create a better placement.
These options are, from a conservation point of view, very good solutions, however, very difficult to argue, if one includes the entire archaeological park and its preservation in the considerations. These issues require an interdisciplinary discourse to which the conservation science can contribute.
However, even small treatments can already help the objects to make them more resistant to weathering in the future: some interiors of the sarcophagi collect rainwater after heavy rainfalls, due to missing or damaged lids. To reduce weather-related damage those objects should be closed so that rainwater cannot penetrate into the interior. Some of the objects have no base. In order to prevent the risk of rising moisture, building a base can help deflect moisture.
In the case of the “Amazon Battle” sarcophagus it was possible to achieve, giving this valuable object a new, from a conservation point of view, better site inside the gallery of the Ephesus-Museum near the archeological park.
For the future, it would be desirable to conserve those objects of the Sarcophagi Garden, which are in poor and average condition. Additionally, an evaluation of the conservation of the “Amazon Battle” sarcophagus would be of most advantageous for further conservation projects in Ephesus.

Acknowledgements

The author would like to thank o. Univ.-Prof. Mag. art. Dr. phil. Gabriela Krist (University of applied Arts Vienna, Institute for Conservation) for supervising the diploma thesis and the Austrian Archaeological Institute (especially Director of the OeAI and Excavation Director, Ephesos Priv.-Doz. Mag. Dr. Sabine Ladstätter) and the Ephesus-Museum Selçuk (especially Director Cengiz Topal) for making the sarcophagus available, and the good collaboration and support during the whole project.
Further thanks to ao. Univ.-Prof. Dr. phil. Johannes Weber and VL Dipl.-Ing. Dr. rer. nat. Tatjana Bayerova for supervising the scientific analysis. Special thanks to Mag.art. Marija Milchin for the conservational co-supervision of the diploma thesis.

Literatur

ICOMOS (ed.) 2010: Illustrierter Glossar der Verwitterungsformen von Naturstein. Petersburg 2010.
Koch, G., Sichtermann, H. 1982: Römische Sarkophage. München 1982.
Knibbe, D., Langmann, G. 1993: Via Sacra Ephesiaca I. Wien 1993.
Laubenberger, M., Prochaska, W. 2011:

Untersuchungen zur Marmorprovenienz von zwei Porträtköpfen aus Ephesos im Kunsthistorischen Museum in Wien. Technologische Studien 8, 2011, 43-64.

Lazzarini, L., Salvadori, O. 1989: A reassessment of the formation of patina called scialbatura. Studies in Conservation 34, 1989, 20-26.

Maravelaki-Kalaitzaki, P.-N. 2005: Black crusts and patinas on pentelic marble from the Parthenon and Erechtheum (Acropolis, Athens): characterization and origin. Analytica Chimica Acta 532, 2005, 187-198.

Martin-Gil, J., et al. 1999: Ancient pastes for stone protection against enviromental agents. Studies in Conservation 44, 1999, 58-62.

Prochaska, W., Grillo, S.-M. 2012: The marble quarries of the metropolis of ephesos and some examples of the use for marbles in ephesian architecture and sculptering. In: A. Gutiérrez Garcia-M. et al. (ed.), Interdisciplinary Studies on Ancient Stone. Tarragona 2012, 584-591.

Rudolf, E. 1989: Attische Sarkophage aus Ephesos. Wien 1989.

Picture credits
Fig. 1-5, 7-8, 10: Mag. Barbara Rankl, Universität für angewandte Kunst Wien
Fig. 6, 9: ao. Univ.-Prof. Dr. phil. Johannes Weber, Universität für angewandte Kunst Wien

Author
Mag. Barbara Rankl
Restaurierung und Konservierung von Stein und mineralischen Werkstoffen
ranklbarbara@gmail.com