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ABSTRACT

A Digital Reference Collection for Undecorated Roof Terracotta from Olympia

Annalize Rheeder

As part of the Digital Roof Project's ongoing work in Olympia, a digital reference collection is being compiled for undecorated roof terracottas, which includes a wide variety of data, including 3D and 2D shapes and documentation on the fabric. A novel approach is the addition of a chronological framework based on the decorated architectural terracottas.

KEYWORDS
3D Documentation, Architecture, Chronology, Digital Documentation, Roof Tiles

ANNALIZE RHEEDER

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Introduction

1 One of the most pressing concerns in current scholarship regarding undecorated roof tiles is the lack of comprehensive datable reference collections. In the absence of additional sources, most material in Greece can only be classified according to general time periods, such as ›Classical‹ or ›Roman‹. In the case of Olympia, the Digital Roofs project is exploring a novel source of information, namely the extensive collection of decorated architectural terracottas for which well-established and detailed typologies already exist. According to our hypothesis, the roof tile profiles preserved as part of the decorated elements are similar to those of the undecorated elements from the same roof. These elements thus provide a datable framework from which a digital reference collection can be constructed. In order to test our hypothesis, a small collection of roofs for which both the decorated and undecorated elements are already known serve as a control. To demonstrate how the proposed digital framework could function, a tile recently excavated from the Gymnasium by the Ephorate of Antiquities of Illia under the direction of Erofili-Irida Kollia will be used. Friederike Fless has been investigating this assemblage since 2022, while the decorated architectural terracottas spread across collections at the Antikensammlung in Berlin and the Archaeological Museum in Olympia have been documented since 2021.

2 There is a degree of standardisation in the overall form and size of undecorated roof tiles starting in the Classical period onwards. One long-held perception is thus that there is little to differentiate tiles belonging to the same period and region further into more detailed categories. In addition, roof tiles require a lot of resources to study. In terms of volume and weight, they might be one of the most prevalent archaeological finds and thus require a lot of time, skilled labour, and space to process, document, and store. Due to these factors, the majority of publications would include only one or two reconstrued or well-preserved tiles as representative samples of an entire assemblage. Pioneering studies conducted on isolated cases in Italy, the UK, and Jordan have demonstrated that roof tiles from the same period show additional chronological

development in their overall size, in the profile of raised borders, as well as in the type and form of interlocking features[1]. These studies herald a shift in how archaeologists perceive undecorated roof terracottas. While there is a growing recognition of the scientific value of the material, further action is still hampered by a lack of datable typologies, documentation standards, and resources. This creates challenges for investigating material, especially those from secondary contexts such as shipwrecks and surveys[2].

3 In light of these challenges, the Digital Roofs Project led by Friederike Fless has developed extensive workflows and methods that utilise a variety of digital and technological tools[3]. These have been field-tested and adapted in collaboration with various colleagues and specialists and have been applied to material from Kalapodi, Vulci, Pompeii, Pergamon, and the Kerameikos in Athens.

Traditional Methods Used for Dating Roof Tiles

4 Buildings with terracotta roofs first appeared in Olympia in the 7th century BC and it remained an important building material until late antiquity. Within the intervening centuries, roofs were repaired, expanded, demolished, and re-used. While the rubble was often used as infill, roof terracottas were also recycled as a building material for the construction of different features, including floors, walls, or water channels. For example, in a recent 2017 excavation, Reinhard Senff found a piece of a decorated sima used in the construction of a kiln[4]. Roof terracottas are thus largely found in secondary contexts. In the rare cases where a collapsed roof is excavated, such as at the Gymnasium, the archaeological context dates the period of collapse and not when the roof had been constructed. Since terracotta tiles can be in use for decades, sometimes even centuries, the archaeological find context is not very helpful for determining the date of production.

5 One of the more reliable ways of dating is by identifying the building or building phase to which a specific object belongs. The building's known history of construction and repair thus provides a datable reference. The most prevalent method for dating decorated architectural terracottas is based on art-historical analysis of the decoration motifs and profiles. The 1995 publication by Joachim Heiden on the Architectural terracottas from Olympia is an important example of this method[5]. Heiden was able to organise the material in 67 roofs, and in many instances, he could identify not only the associated buildings but also different phases of repair.

6 When it comes to the undecorated roof tiles, the situation is considerably more difficult. While Heiden did document a small number of roof tiles that are clearly identified with specific roofs, the majority of the material is still unpublished and unassigned. In the handful of isolated case studies where researchers were able to create a more detailed datable typology already mentioned, the typologies relied on additional sources to date the objects, such as tile stamps or the occupation history of a site. Thus, while these studies demonstrate the potential for creating typologies out of what was previously considered to be uniform assemblages, they also confirm the need for an additional datable reference to use as a starting point for a new typology. In this regard, the archaeological context of Olympia is not very suitable, and while there are a number of

1 Conti 2018; Hamari 2019; Mills 2013; Warry 2006; Shepard 2006.
2 Lang – Pantelidis 2020, 9; Royal 2012.
3 Fless – Rheeder 2021; Fless – Rheeder 2023.
4 Senff 2017.
5 Heiden 1995.

Fig. 1: Composite drawing of OLY-DE-04R394-OF24-5103 created from a 3D scan

1

tile stamps known, these are found only on selected tile types from a limited time span. For this reason, new sources of datable information had to be identified and tested.

New Tools and Methods

7 One of the main aims of the Digital Roofs project is to explore new methods for documenting roof terracottas that are not only faster but also increase the quality of information available for specialist study. New workflows and methods that incorporate the use of various instruments and other digital tools have been developed. For the documentation of the fabric, the handheld digital microscope (Dinolight Model AM7915MZTL) offers considerable advantages. It is used both to observe the fabric in greater detail and to capture high-resolution images of the magnified views for later study and publication. The colour of the clay, as well as any coating layers, is recorded using a wireless colourimeter (ColourPin II).

8 The form can be documented using two different methods: a handheld 3D scanner (Creaform GOscanSpark) or an extra large version of the Laser Aided Profiler. Traditional methods required both skilled personnel and a considerable time in order to produce scaled hand drawings. Due to the cost of both producing the drawings and publishing images in print, most publications could only publish selected objects. In the case of decorated architectural terracottas, these would be limited to a profile section and frontal view of the main decorative element of key pieces. Therefore, we introduced the handheld 3D scanner to our workflow that produces a high-resolution scalable 3D model of an object. The 3D model captures the entire object, which makes it possible to view all sides, and multiple sections can be extracted through any feature of the tile. The 3D models can be made available online through the DAI's Arachne portal. For printed publications as well as catalogues, unified scaled 2D images composed of orthogonal views and different sections can be generated from the 3D models (Fig. 1).

2

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Fig. 2: Pan tile from the Gymnasium excavations 2013–2015 captured using the XL LAP (documented 2022)

Fig. 3: Reconstruction of connection between pan tile (OLY-DE-03W128ab-OF24-3728) and sima tile (OLY-DE-03W002-OF24-3701) from roof 37; the back of the sima tile is reconstructed digitally

9 The laser aided-profiler (LAP) was first developed by Peter Demján and Vladimir Držík for the documentation of ceramics[6]. Using a combination of two lasers and cameras, a computer-aided profile drawing and coloured photographs are captured and combined into an image that conforms to established conventions for ceramic documentation. A skilled operator can document hundreds of objects per day, and the images are ready for publication without any significant additional post-production required. The conventional LAP can capture profiles of 250 × 100 mm, which is too small for the majority of tile fragments. For this reason, the LAP team, in consultation with the Digital Roofs projects, developed an extra large (XL LAP) version that uses four lasers and can capture profiles of 60 × 30 cm. This instrument was deployed for the first time in 2022 in Kalapodi during a field campaign in collaboration with Annika Busching and has subsequently been used in Olympia and the Kerameikos. The XL LAP creates profile sections through objects with the aid of lasers and can also capture photographs from the top and bottom of tiles, which are then combined into one scaled drawing (Fig. 2). Compared to the 3D scanner, the XL LAP is substantially faster both in the field and in post-production but it captures less information. It is, therefore, more suited for processing large volumes of simpler objects, such as undecorated roof tiles, while the 3D scanner is better suited for documenting more complex shapes, in this case, decorated architectural terracottas.

Creating a Chronological Reference for Olympia

10 A significant advantage of the 3D scanner is that it captures the object in its entirety. Unlike traditional drawings, the undecorated components to the back are therefore documented as well. Specific types of architectural terracottas consist of a decorative element combined with a tile component, which, in theory, should be similar to the undecorated tiles belonging to the same roof. The different roof elements had to fit together in order to form a functioning roof, where the stability and waterproofing depended on a system of interlocking and overlapping elements. For example, pan tiles have either a notch or rabbet on the underside in order to fit over the underlying tile and hold the tile in place. An example is shown in Fig. 3 where a pan tile with two notches on the underside fit over the raised borders on the tile portion of a sima tile below.

6 Demján et al. 2023.

4

Fig. 4: Raised border profiles found on pan and sima tiles from Western Greek roofs from Olympia

11 In theory, then the roof tile parts of architectural terracottas should have the same interlocking features, such as raised borders, notches, and rabbets, as the undecorated roof tiles from the same roof. Furthermore, if the undecorated and decorated elements were produced at the same time by the same craftsmen, it can also be expected that they would make use of the same clay fabric and show similarities in terms of production techniques. Using the methods developed by the Digital Roofs Project, the roof tile profiles, fabric, and production techniques can be documented and, importantly, dated according to Heiden's typology. This then forms the basis by which the existing collection of architectural terracottas can be used as a datable reference for the undecorated roof tiles from Olympia.

12 The whole premise, however, is based on the assumption that the roof tile portions of decorated elements are similar to those of regular undecorated roof tiles from the same roof. The first step, therefore, is to investigate the exact relationship between specific features found on both. As already mentioned, a small number of the 67 roofs identified by Heiden include regular roof tiles. Depending on the state of preservation, these examples serve as a control group. Some of the best-preserved are associated with the Western Greek roofs from the archaic treasuries. In Fig. 4, the raised borders from regular pan tiles are shown next to the raised borders found on sima pieces from the same roofs. The example includes roof 37 from the treasury of Syracuse, roof 41 from the treasury of Gela, and roof 42, which, according to Heiden, might be attributed to the treasury of Selinunt. Roof 37 is the earliest and, together with roof 41, is dated to the middle of the 6th century BC, while roof 42 is later, at earliest the

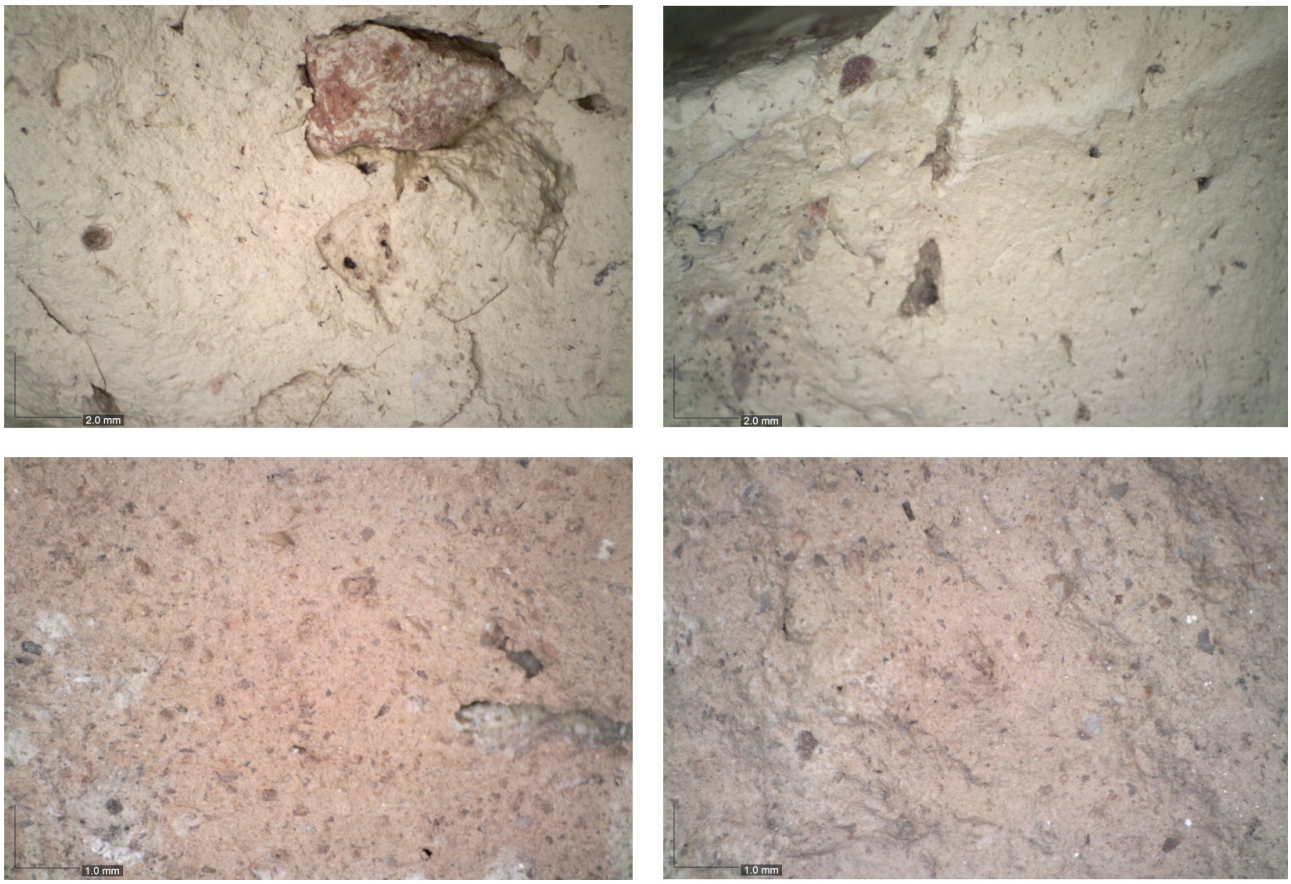

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Fig. 5: Microscope photographs of clay fabric. From top left: roof 37 pan tile OLY-DE-03W108; roof 37 sima tile OLY-DE-03W011-OF24-3708; bottom row: roof 42 pan tile OLY-DE-09W051-OF24-4211; roof 42 sima tile OLY-DE-09W019 (documented 2023)

beginning of the 5th century[7]. On roof 37, the raised border from the pan tile is almost identical to the one on the lateral sima. On roof 41, the raised borders are similar in terms of the overall shape, but the dimensions vary. On the pan tile, the raised border is 3 cm high and 8 cm wide, while on the lateral sima, the border is the same height but is 6 cm wide. On the raking sima, the height between the raised border and the top of the tile is roughly the same, but it is 7 cm wide. The most important relationship is between the lateral sima and pan tile, as the first row of pan tiles had to fit on top of the sima tiles (see Fig. 3). The raised border on the sima could, therefore, not be substantially larger than the corresponding notch on the underside of the pan tile, but if it's a bit smaller, it is still functional. The border on the raking sima is less critical since it is not physically interlocking with regular pan tiles, but it should still fit underneath a cover tile. The cover tiles from roof 41 measure roughly 21 cm on the inside, so as long as the raised border is less than half that measurement, the elements would still fit. Roof 42 is an exception for Olympia because the lateral sima pieces do not have a discernable raised border. This situation is not found on any of the other roofs. While there is a slight curve in the top surface of the backing tile, this does not constitute a recognisable raised border. The back portion of these sima tiles is not preserved to the full extent, and as such, it is not possible to say exactly how they connected with the pan tiles. These three examples demonstrate that, in most cases, the raised border on the pan tiles and sima tiles from the same roof can be expected to be similar. Where variations in size occur, these fall within definable parameters linked to the interlocking system used, but the profile of the raised borders retains the same features. But as roof 37 demonstrates, exceptions to the rule do occur, and it is therefore important to evaluate each case within its wider context.

7 Heiden 1995.

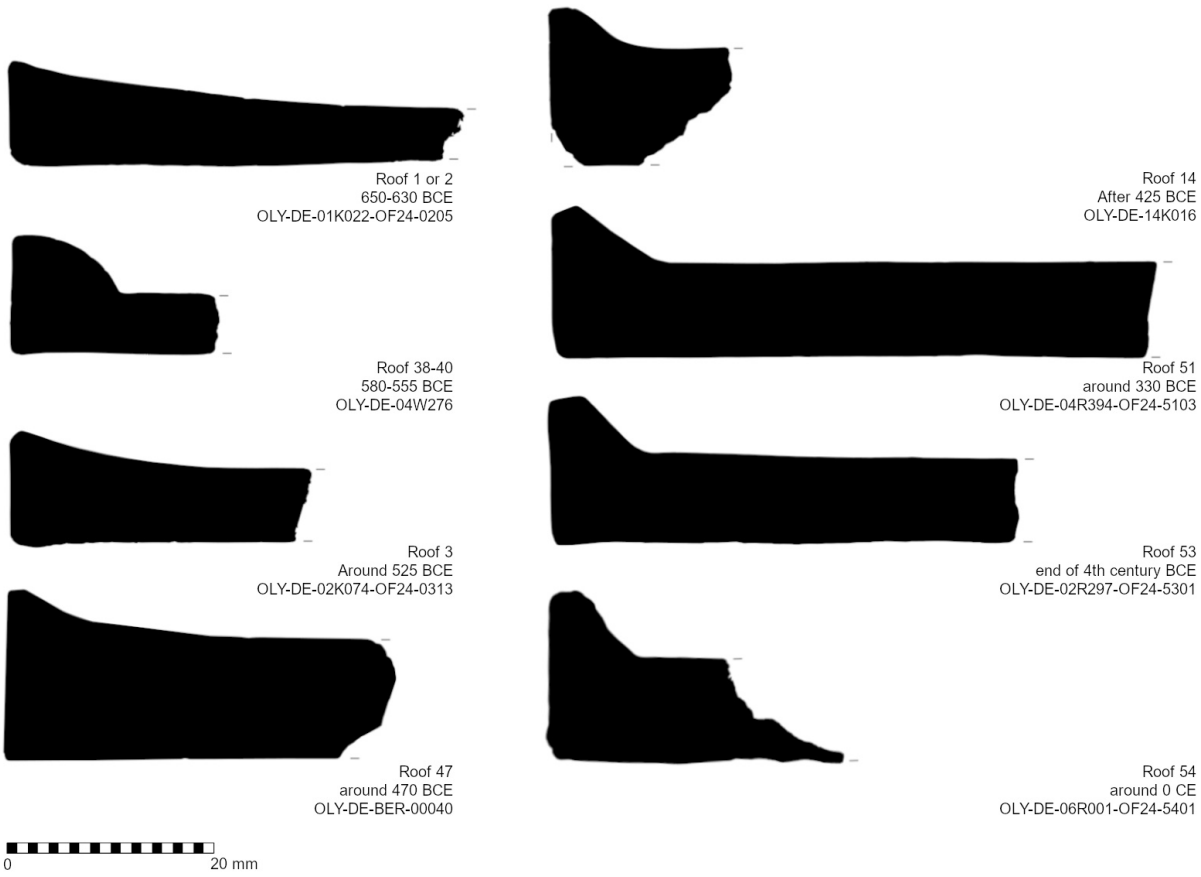

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Fig. 6: Raised border profiles preserved on lateral sima fragments from Olympia dated according to Heiden 1995

13 A visual analysis of the fabric of these elements indicates strong similarities. As seen under the digital microscope (Fig. 5), the clay texture and the type and density of the inclusions are similar for pan and sima tiles from the same roofs.

14 The material from Olympia, therefore, supports the theory that the tile portion of decorated elements corresponds to those of undecorated tiles from the same roof. This has a number of implications for the study of undecorated tiles. In cases where there are no known undecorated tiles associated with a roof, the parts preserved on the architectural terracottas provide an indication of their form and fabric. By collecting the available profiles preserved within the collection of architectural terracottas at Olympia, it is possible to create a reference collection that includes tiles from different types of roofs and time periods. This collection illustrates the development of specific features and provides a clearer indication of the time frame in which they were in use. In Fig. 6, the raised borders from different time periods are shown. The size and shape of the profiles in relation to the main tile show variation, which is restricted to specific time periods. For example, the Western Greek roofs from the middle of the 6th century have a large raised border with an almost semi-circular profile, while the raised borders from around 330 BC have a narrow fillet at the top that slants outwards followed by a diagonal profile at almost 45 degrees. On later tiles, the top fillet becomes wider and less slanted, and the diagonal portion becomes steeper until the raised border becomes almost rectangular.

15 Since the reference collection relies heavily on the tile portions preserved as part of decorated elements, there is a limit to the type of information available. For example, the interlocking features that occur on the front of a roof tile are normally not preserved in architectural terracottas. And since the material is from museum collections, visual observation of the fabric is limited to clean existing breaks. The state of

preservation of the objects also influences the availability of appropriate roof tile sections. The use of decorated elements decreased significantly after the 1st century AD, which means that material from later periods is under-represented. The reference collection is, therefore, not a complete substitute for a comprehensive catalogue of undecorated roof tiles from Olympia. However, since such a catalogue is not available, the reference collection provides a first step for the identification of undecorated tiles by providing standardised data on a range of features that can be dated with greater specificity that extends beyond generalised time periods. In order to demonstrate how this reference could aid in the study of undecorated tiles from the region, especially those that come from a secondary context, a case study will be used.

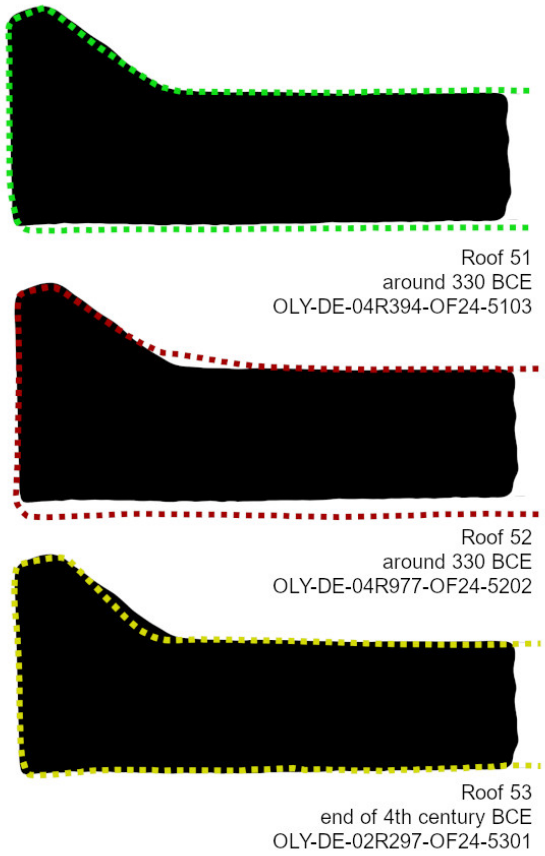

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Fig. 7: Raised border profiles from three different sima pieces (dotted lines) compared to OLY-GYM-2013-2015-0001

A Case Study

16 The excavation by the Ephorate of Antiquities of Illia on the Gymnasium has found a large number of roof tiles in different find contexts. A number of these are secondary contexts in which roof tiles are re-used as a building material in various ways, including the construction of earthen walls. In 2022, Friederike Fless investigated one such context, which included a wide variety of tile fragments, including OLY-GYM-2013-2015-0001 (see Fig. 2). The fragment represents only around 10 % of the original tile, including a portion of the raised border. The profile has a characteristic top edge that slants outwards while the inside face of the border is a diagonal line at close to 45°. This profile is seen on a number of roofs from the late classical and early Hellenistic period in the reference collection.

17 There are different methods that can be used for analysing multi-variate and geometric data, including morphometric shape analysis[8]. For the purposes of this demonstration, the geometric data is compared visually by overlaying different profiles on top of each other. The tile is compared to profiles from roofs 51, 52, and 53 (Fig. 7). Roof 51 is associated with the Leonidaion, which had a long occupation history with many different building phases. The first phase of roof tiles is dated to around 330 BC, with up to five subsequent repair phases known[9]. The building associated with roof 52 is currently not known, but the roof is dated to the same period as the first phase of roof 51, and it has one repair phase. The building associated with roof 53 is also uncertain, but the original sima series can be dated to the end of the 4th century BC, with one subsequent repair phase[10]. All the profiles used in this example are associated with the original roofs, not a repair phase. Based on a visual comparison of the profiles, the tile from the gymnasium excavation most closely resembles the profile associated with roof 51. The tile from roof 52 is thicker, and the raised border profile is wider. The raised border from roof 53 is slightly narrower.

8 Demján u. a. 2023.
9 Heiden 1995, 140.
10 Heiden 1995, 145.

8

Fig. 8: Microscope photographs taken at 20 times magnification; From top left OLY-DE-2013-2015-00001 from the gymnasium excavation; OLY-DE-04R395-OF24-5104 Roof 51; OLY-DE-04R005-OF24-5206 from roof 52; OLY-DE-02R298-OF24-5302 Roof 53

18 The microscope photographs taken at 20× magnification for fabrics associated with each of the relevant groups are shown in Fig 8. It should be noted that the observations on the gymnasium tile were made on a fresh break, while the others are all on existing breaks, which slightly influenced the appearance of the clay texture and the saturation of colours. A visual comparison shows that there are similarities in the fabrics of the gymnasium tile and that of roofs 51 and 52 in terms of the shape, size and distribution of the inclusions. In this specific instance, the colours of the temper grains are deceptive. Close observation of the grains in roof 52 reveals that this particular temper discolours to black at the surface while the core remains a deep reddish ochre – thus, the higher percentage of black grains for roof 51 is not as relevant for this discussion. It is not common for temper grains to have such dramatic colour differences. Instead, it appears to be a characteristic of this particular type only. The difference between the fabric of the gymnasium tile and that of roof 51 and 52 appears slight when compared to that of roof 53. The clay texture and colour, as well as the density, sorting and type of temper grains, are different.

19 By visually comparing tile found during the Gymnasium excavations against objects associated with roofs 51, 52, and 53, it is apparent that the gymnasium tile has strong similarities with that of roofs 51 and 52, and less so with roof 53. This raises the possibility that the objects might have originally belonged to either roof 51 or 52. But even if the specific roof cannot be determined, by comparing the tile to the material in the reference collection, the period in which it had been produced becomes clearer. It is most closely related to material dated to around 330 BC, and as such, it is likely that it was produced during this period.

Conclusion

20 The study of undecorated roof tiles from Greece is currently limited by a lack of comprehensive reference collections. As such, it is not possible to date material from secondary find contexts beyond assigning very broad time periods such as ›Hellenistic‹ or ›Roman‹. Work conducted on the collection of well-published decorated architectural terracottas has shown that there is a strong correlation between the roof tile profile and the fabric of undecorated tiles and decorated architectural terracotta pieces belonging to the same roof. This makes it possible to use the architectural terracottas as a reference for classifying undecorated tiles found in Olympia. By using a tile fragment found during excavations at the Gymnasium, we demonstrate how the digital reference collection can aid the study of undecorated roof tiles from Olympia by providing a framework for classifying and even dating material.

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21 We are grateful to Philip Bes for first introducing us to the use of portable microscopes for fabric recording and for his advice and encouragement. We would also like to thank Stephan Zink for sharing his experience with using the DinoLight and introducing us to the ColourPin. We would like to thank Moritz Taschner from the Staatliche Museen zu Berlin as well as his colleagues Oliver Vollert and Jörg Kleemann for making our work in the Antikensammlung possible. Finally, we would like to express our gratitude to the director of the Ephorate of Antiquities of Ilia, Erofili-Irida Kollia, as well as the DAI's previous director of excavations at Olympia, Reinhard Senff, and his successor, Oliver Pilz.

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ZUSAMMENFASSUNG

Eine digitale Referenzsammlung für undekorierte Dachterrakotten aus Olympia

Annalize Rheeder

Im Zuge der laufenden Arbeiten des Digital Roof Project in Olympia wird eine digitale Referenzsammlung der undekorierten Dachterrakotten erstellt. Sie umfasst ein breites Spektrum an Daten, unter anderem 3D- und 2D-Shapes und eine Dokumentation des Materials. Ein neuartiger Ansatz kombiniert diese Daten mit einem chronologischen Datierungsgerüst, das auf dekorierten architektonischen Terrakotten basiert.

SCHLAGWÖRTER

3D Dokumentation, Architektur, Chronologie, Dachziegel, Digitale Dokumentation

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