

Masonry Construction in Olympia, Greece, during the Roman Imperial Period – Mapping, Classification and Dating

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INTRODUCTION

The formation of the Province of Achaëa in 27 B.C. by Emperor Augustus led to economic change and subsequent urban growth in Athens, Sparta, Corinth and Patrae, and also in Elis, Argos and Tegea. The Greek motherland saw an economic revival, despite certain restrictions, that resulted in the development of new urban living. An important contributory factor in this economic revival was the perception of Greece as a huge “open air museum” to travellers from around the Mediterranean. The major sanctuaries benefited most from this perception, including Olympia, and attracted large numbers of visitors that resulted in considerable construction activity particularly during the imperial period. (Bechert 1999) This resulted in the addition of a large number of baths and guest houses that provided comfortable accommodation for travellers. The Romanisation of Greece led in Olympia to the introduction of new construction techniques and materials. This is particularly evident in the construction of baths in the 1st century B.C. that not only resulted in changes in the use of traditional building materials but also heating systems.



Figure 1. Olympia, South-West Baths. General view

The South-West Baths in Olympia were part of the extensive imperial construction activities during the 1st century A.D. and were studied as part of the “*Olympia in the Roman Imperial Period and in Late Antiquity*” research project led by Prof. U. Sinn. The documentation and analysis of brickwork represents an important dating indicator: using this technique four construction phases could be defined: The first one consists of a well constructed *opus mixtum*, i. e. a *reticulatum* (7.4 cm side length) of local limestone, combined with a *testaceum*, for which no similar quality is documented in Olympia nor in its surrounding areas. (Medri 1995 (2001)) Stratigraphic evidence involving ceramics, glass, lamps and tools allow this construction phase to be dated to the Neronic period. (Martin 1995 (2001)).

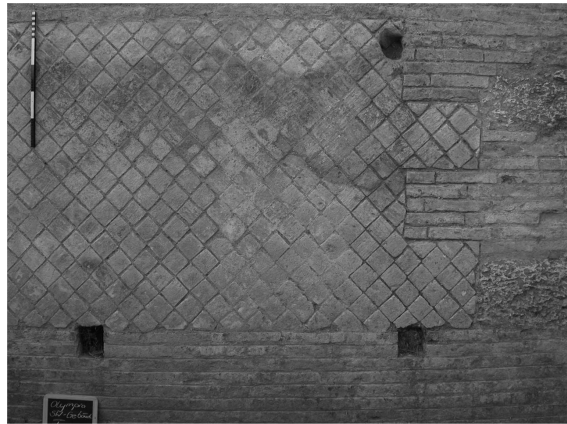


Figure 2. Olympia, South-West Baths, phase 1

Other construction phases (the central part of the building, the service sections and the latrine) have been dated to the end of the 1st century AD and consist of a simple *opus testaceum*.



Figure 3. Olympia, South-West Baths, phase 2 (Haseley)

While the above is relatively easy to classify, the dating and categorisation of masonry types in the courtyard is more difficult due to the large variations in construction techniques. The northern flight of rooms consists of *opus spicatum* and can be dated to the second construction period. The bond consists of fieldstones, which are framed by bricks in a rhomboid fashion whereby corners and the inner faces of doors are made of *testaceum*. Other masonry belonging to this construction phase includes an *opus incertum*, which is only used sporadically within the walls. A peculiarity is the use of different types of masonry in the opposite faces of a wall: on one side, an *opus spicatum* (see **fig. 3**) may be seen, while the opposite side consists of an *opus testaceum*. Mortar analysis allowed dating to the second phase (the third phase is characterized by highly sandy mortars, while mortars in the second phase consist of very hard mortars with high lime content).



Figure 4. Olympia, South-West Baths. Phase 2, *opus spicatum*

The third construction phase probably occurs after a destructive earthquake at the beginning of the 3rd century A.D. since brickwork in this period has a layer of debris which lay at the bottom of the latrine space and had shifted at its margins towards the lateral part of the latrine canals (Martin 1996).

The abandonment of the building is followed by a period of dismantling, which not only led to the removal of a large part of the interior decoration but also to the pillage of walls in the northern section of the building. Later restoration again used different types of masonry. This includes irregular masonry, consisting largely of spoils of recycled material such as bricks, fieldstones and marble fragments. There is also a wall section consisting of highly irregular *testaceum*, distinguished by its broad joints and narrow bricks as well as mortar with a very high sand fraction.

Bricks in modern research are an important tool in dating. Joints become increasingly thicker over the centuries while bricks become thinner. (Studies on masonry techniques are mostly focussed on Italy. Valuable references for the interpretation of building techniques and masonry are available

from (Lugli 1957; Aupert 1990; Medri 1995 (2001)). An assessment will be made of whether this methodology is applicable to the South-West Bath as well as to the other buildings in Olympia and whether a chronology can be developed. The study intends to reveal when brick production stopped and was replaced by the use of recycled materials. Furthermore, it will investigate whether the high-quality *opus reticulatum mixtum* from the first construction phase is the result of the use of work groups from Rome and whether brickwork of similar quality is found in Olympia. In addition, a classification and appreciation of the masonry of the peristyle court will be undertaken.



Figure 5. Olympia, South-West Baths, phase 3

THE SITUATION IN OLYMPIA

Olympia's public infrastructure includes a large number of buildings which were erected during the imperial period. They are characterised by a number of different construction materials and techniques. This paper focuses on these differences and in particular on the use of *opus testaceum* as a way of making comparisons. Aupert asserts that pure *opus vittatum* is non-existent, but is applied in Olympia as a mixed type. *Opus reticulatum* as well as *opus spicatum* are found in Olympia in a few buildings.

In order to allow comparisons to be made between masonry types, it was necessary to develop and define relevant parameters. These have been developed originally for *opus testaceum*, but are likewise applicable to combined masonry. From the original ten criteria developed by Lugli (p. 583), only five were considered applicable by Aupert. For example, the quality and colouring of bricks are too heavily dependent on local conditions to be useful to base regional comparison on them. However, my work at Olympia suggests that such comparisons are possible.

This paper makes use of the following parameters:

Picture	Presentation of the overall situation Presentation of a detail
Plan	Location in the map
Overall impression	Uniform or variation of colour, brick size etc.
Brick	Dimension, surface (rough or smooth), entire or split (triangular or halved)
Joints	Height of joints, condition, joint-marks
Type of masonry	
10-layer-module	
Putlog holes	
Type of use	
Dating	

Only those buildings whose construction phases could be dated reasonably accurately were analysed. All other identified masonry sections were identified but excluded from the present analysis. This paper considers the following buildings:

Table 1: Comparative overview of masonry types of selected buildings in Olympia

	Building	Function	Period	Masonry	Bricks of uniform production
1.	South-West Bath	Bath	1. century A.D.	Testaceum, Reticulatum, Spicatum, Incertum	yes
2.	Kladeos Bath	Bath	early 2. century A.D.	Testaceum	yes
3.	Leonidaion (restoration phase)	Guest house	early 2. century A.D.	Testaceum Vittatum, Reticulatum	yes
4.	South-West Gate	Festive Gate	2. century A.D.	Testaceum	yes
5.	North Building	Bath / Dining pavilion	1. and 2. century A.D.	Testaceum (reused material)	partly

	Building	Function	Period	Masonry	Bricks of uniform production
6.	East Bath / Oktogon	Bath	early 3. century A.D.	Testaceum	yes, but not in the courtyard
7.	Nymphaeum of Herodes Atticus	Nymphaeum	2. century A.D.	Testaceum, quasi Vittatum (reused material)	partly
8.	North Aqueduct	Aqueduct	2. century A.D.	Testaceum	yes
9.	Pheidias workshop (not completed)	Unknown	2./3.century A.D.	Testaceum	yes
10.	Roman Guest houses	Guest house	3. century A.D.	Quasi Vittatum, spicatum, Reused material- rubble stone	no
11.	South Bath	Bath	3. century A.D.	Testaceum, Reused material- Brick	no
12.	Leonidaion Bath	Bath	early 4. century A.D.	Testaceum, Reused material	no

Making use of the parameters outlined above, the following analysis can be developed.

Greek Hypocaust-Bath

Overall impression

The so-called Greek Hypocaust-Bath led to changes in bathing. The walls are based not on roman brick formats, but on the larger, Hellenistic ones. They give an overall uniform impression. Apart from the use of brick of large formats, there are wall sections constructed entirely with broken spoils of tiles.

Bricks

Height 7.5cm, width: 45-46cm partly 65.5cm, Imprints of straw on the surface, use of entire bricks

Joints

1.0-1.2cm, no joint-marks

Type of masonry

opus testaceum

10-layer-module

75.5cm

Putlog holes

?

Use

Bath

Dating

Ladstätter dates the construction of the hypocaust-bath to a phase of reconstruction that started in approximately 40 B.C.

Kladeos Bath**Overall impression**

The complex of the Kladeos Bath is formed as a uniform block without courtyards and exterior sections and is built in uniform masonry. There are slight variations in the brick-height indicators. Nonetheless the masonry carefully built and is comparable to that of the South-West Bath.

Brick

Frigidarium - height 4.0-4.5cm, bricks consistently broken into half in mid-section

Outer wall Tepidarium – Height 3.5-3.7cm

Joints

Frigidarium – 3.0cm, solid mortar, joint-marks in lower section

Outer wall Tepidarium – 3.0cm, very slight joint-marks in lower section

Type of masonry

opus testaceum

10-layer-module

Frigidarium - 69-73cm

Outer wall Tepidarium - 65-67cm

Putlog holes

1 layer, closed, distance 1.00m

Type of use

Bath

Dating

The Kladeos Bath was built around 100 A. D. and is one of the smallest baths of the sanctuary.

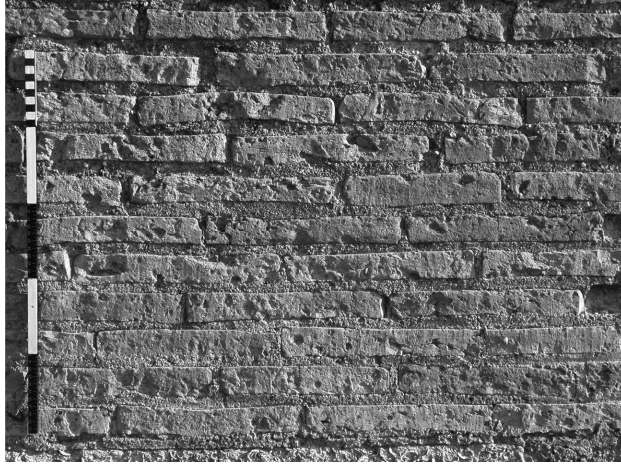


Figure 6. Olympia, Leonidaion, *testaceum* of the dividing walls

Leonidaion

Overall impression

The study refers to the renovation phase during the 2nd Century A. D., whereby two sections can be distinguished: the outer and divisional walls as well as the central water basin. The masonry of the dividing walls is relatively good work in *opus testaceum*, which is apparently the result of uniform brick production. This masonry is among the few examples of breaking bricks into triangular sections in Olympia, as this was not a local tradition.

The masonry sections adjoining the decorative basin were carried out in different techniques and quality. The wall of the outer ring consists of a mixed masonry of blocks of *muschelkalk* and brick layers (*opus vittatum*). These alternate in bands, each of which are four layers thick. The interior wall uses these materials more irregularly. The relatively large areas of *opus testaceum* give a more irregular impression than that of the divisional walls. In a smaller section of the outer ring, *opus reticulatum* was used.

The outer wall of the inner ring consists of triangular bricks, whereby the breaking of the bricks does not necessarily follow the markings on them. The courses are less carefully worked than in the outer ring. In some areas bricks are mixed with blocks of *muschelkalk* of highly variable sizes. The inner wall consists of a uniform *opus testaceum*, which

contains hardly any triangular bricks (approximately 10). The breaking of bricks followed here the typical pattern of Olympia, i.e. along the middle section.

Bricks

Outer and divisional walls: height 3.5-4.0cm, triangular bricks;

Basin – outer ring: height 4-4.5cm (*Vittatum* 9-11cm, *Reticulat* 7-8cm, irregular), triangular bricks

Basin – Inner ring: 4.0cm, half bricks

Joints

Outer and divisional walls: 1.5cm, joint-marks slightly towards bottom part, solid mortar.

Basin – Outer ring - 1.5-2.0cm, Joint-marks slightly towards bottom part

Basin – Inner ring – 2.0cm, Joint-marks slightly towards bottom part

Type of masonry

Mostly *opus testaceum*, but also some *opus vittatum*, *opus reticulatum*

10-layer-module

Divisional and outer walls – 53.5-54.7cm

Basin – Outer ring – 55.5-56cm

Basin – Inner ring – 59-60cm

Type of use

Guest house

Dating

The small remaining sections of the brick masonry belong to a restoration phase of the first half of the 2nd Century A. D..

North Bath

Overall impression

This building represents a bath and dining pavilion, which served continuously for the long period between the 7. Century B. C. to the 5. Century A. D. to feed the visitors of the sanctuary. (Sinn, Leybold et al. 2003) The masonry of the complex has a very irregular appearance, which almost certainly represents different phases. To a large extent bricks of large formats from predecessor buildings were re-used (Hellenistic Bath). In some smaller sections uniform masonry is present. Several sections can be identified which document at the same time the irregularity of the complex. Two phases (sections) were thus far dated by the excavator, which include bricks in the former peristyl (attributed to the Neronian

period). The basin, is dated jointly with a substantial extension of the building is dated into the late 2nd Century A. D.

Brick

Peristyl section – masonry a (Neronian) – Height 4.5 cm, half-bricks

Peristyl section – masonry b – Height 3.5cm, dominant brick size 20.5 x 21, 21 x 21, uniform formats, partly other, very large formats; tile use.

Bath section – masonry c – Height 6.5-7cm (Width 46-47cm)

Bath section – masonry d – Height 3.5-4.0 (Width 28.5cm)

Joints

Peristyl section – masonry a (Neronian) – Height 2.2 - 2.5cm, simple or double joint-marks, mortar very solid

Peristyl section – masonry b – Height 2.5cm, double joint-marks, smooth joint surface

Bath section – masonry c – Height 2-2.5cm

Bath section – masonry d – Height 3.5-4.0cm

Type of masonry

Neronian – *opus testaceum*, a uniform brick format as far as can be testified based on their small number

10-layer-module

Peristyl section – masonry a (Neronian) – cannot be determined

Peristyl section – masonry b – cannot be determined

Bath section – masonry c – 94cm

Bath section – masonry d – 70cm

Type of use

Bath, dining pavilion

Dating

The section of the North Bath evolved over the centuries. The present visible sections belong in two construction phases: a Neronian, which has not yet been finally documented and which was integrated into the later water basin. The second construction phase refers to the water basin and part of the adjoining rooms.

Brick pillar belonging to the Aqueduct

Overall impression

The remainder of the Aqueduct from Herodes Atticus consists of uniform brick masonry. The bricks were broken in half according to the local custom.

Brick

Height 4.0cm, Widths 27.0cm, in exceptional cases 24.0cm, bricks broken in mid-section, no surface marking visible.

Joints

2.8-3.0cm, Joint-marks in lower section

Type of masonry

opus testaceum

10-layer-module

71cm

Type of use Aqueduct**Dating**

Mid- 2. Century A. D.

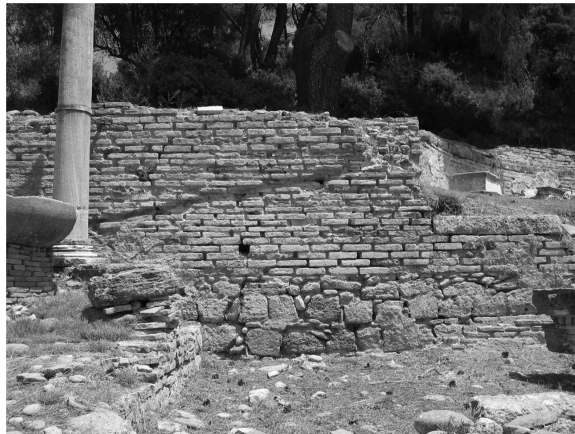


Figure 7. Olympia, Nymphaeum, Lower Basin

Nymphaeum of Herodes Atticus**Overall impression**

The nymphaeum consists of two basins, an upper one in a semi-circular shape and a lower one of oblong shape. The upper basin is set in a framework of niche architecture. The nymphaeum is mostly built in *opus testaceum* in high quality workmanship; the lower

basin section is remarkable for its higher prevalence of bricks of large formats. The wall between the two basins consists (in contrast to the remainder of the complex) of quasi *opus vittatum*

Brick

Lower basin - Height 4.0/6.5cm, Width 27.0/31.0cm, in exceptional cases 24.0cm, bricks broken in mid-section, no surface markings recognizable

Upper basin – Height 4.7-5.0cm, Width 28.5cm

Joints

Lower basin - 1.6-2.2cm, Joint-marks in lower section

Upper basin – 2.5-3.0cm

Type of masonry

opus testaceum, partly *quasi vittatum*

10-layer-module

78.5-94

Type of use

Nymphaeum

Dating

152 A.D.



Figure 8. Olympia, Roman Guest Houses, *quasi spicatum*

Roman Guest Houses

Overall impression

The complex of the roman guest houses (I and II) lies to the south of the Kladeos Bath. The Guest House I was built around 170 A. D. and renovated during the construction of House II in approximately 220 A. D.. The entire complex consists of a quasi-*opus vittatum*, with the only exception being the remains of one wall (Room I.3) erected in a rather badly built *opus testaceum*. The corners are partly reinforced by poros blocks.

Brick

Room I.3 - Height – 3.5-4.0cm, Width 28-29cm, half-bricks

Joints

Room I.3 - 2.0-2.5cm, smooth joint-marks, mortar with high sand content

Type of masonry

Room I.3 *opus testaceum*, otherwise quasi *opus vittatum* (fieldstone, tiles)

10-layer-module

68cm

Type of use

Guest house

Dating

approx. 220 - 230 A.D. ((Mallwitz and Schiering 1964) S. 109)

Workshop of Pheidias

Overall impression

The workshop of Pheidias has a dimension of approximately 15 x 32 m and consists of masonry of different construction and use phases. The brick masonry visible today belongs to a second construction phase, which was never completed. It consists of a two-layered brick masonry with an inner core of *caementicium*. This was identified as two phases: the first phase reached up to the 14th layer of smaller brick formats (28-30cm) and the second, upper layer (cf. Olympia II, 99). According to Mallwitz, both layers belong to one construction period and are to be interpreted as working phases. He claims this is as the result of the horizontal end after bricks from one source running out. The second phase is interpreted as representing bricks delivered by a different brickyard. However,

closer inspection reveals that that different joint-marks appear simultaneously with the new phase. It appears likely that some time went by between the two phases. The section is approx. 96 cm high above the *orthostates*. The second phase of the brick masonry begins with the 15th layer and is set off towards the inside by approx. 2 cm.



Figure 9. Olympia, Workshop of Pheidias

Brick

1. layer – Height 3.2, 3.5, 4.0cm, Width 29.5cm, partly 30.5cm
2. layer – Height 4.2cm, Width 42.0 (approx. 86 % of bricks), yellow and red bricks, broken in half

Joints

1. layer – 3.5, joint-marks highly variable
2. layer – 2.0-2.5, double joint-marks in upper and lower section, smooth in mid-section, irregular joint system

Type of masonry

opus testaceum, up to 50 cm high bands of *incertum* of fieldstone and small remainders of blocks (reused material)

10-layer-module

1. layer - 67.2cm
2. layer – 71-72.2cm

Type of use

eventually residential

Dating: Mallwitz dates this masonry at the beginning of the 3. Century A.D., following an earthquake.

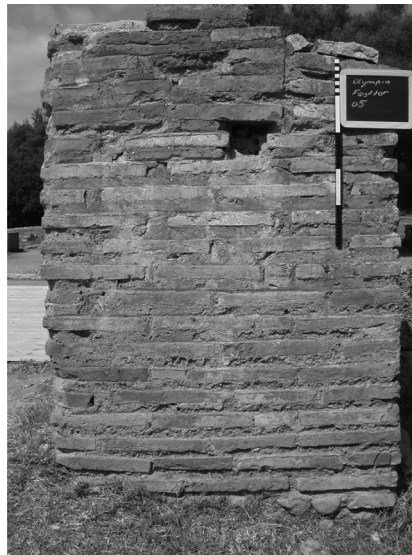


Figure 10. Olympia, South-West Gate

South-West Gate

Overall impression

The festive gate is located in the immediate vicinity of the South Bath and demonstrates a uniform masonry.

Brick

Height 3.5cm, Width 29.5 -30.5 cm, consisting of half-bricks; no finger marks visible on the surface.

Joints

3.0cm, but also up to 3.3cm, joint widths with some variation with joint-marks towards the lower side. Tendency towards wider joints in the lower section of the masonry.

Type of masonry

opus testaceum

10-layer-module

68.5 bis 70.5cm

Type of use

Festive gate

Dating

2. Century A.D.



Figure 11. Olympia, Nero-House, south-east corne

House of Nero**Overall impression**

The courtyard of the so-called *octagon* in the southeast of the sanctuary contains masonry of different phases, including remainders of masonry from the period of Nero. Large sections of the so-called Nero-house were demolished during the construction of the East Bath, resulting in scant evidence for the present period. In the south-east corner of the caldarium-basin (see fig. 9), remainders of *opus mixtum* were identified (even though Maura Medri could not address it in her publication, as the remaining parts were inaccessible). The type of joints does not coincide with the one identified in the South-West building from the same period. The quality of work of the *reticulat* is not particularly accurate. The triangular bricks and joints of the *testaceum* are in comparison to the South-West building relatively high and not properly developed. Likewise the building contains a mixture of masonry. Apart from the *opus mixtum*, the building contains other mixed types of quasi *opus vittatum*.

Brick

Height 3.0-3.5cm, largely based on tiles. Reticulat 8.5 x 9 or 8 x 9.8 (limestone)

Joints

1.3-2.0cm, joint-marks with a smooth surface with a little kerb in the lower part

Type of masonry

opus mixtum, quasi *opus vittatum*

10-layer-module

58.4cm

Putlog holes**Type of use**

residential

Dating

The so-called Nero-house is reported by Mallwitz to have been completed in the summer of 67 A. D., with the postponement of the Olympic Games by two years.

East Bath (Octagon)**Overall impression**

The construction of the East Bath with the so-called *octogon* and the so-called Little Bath required the removal of large parts of the previous construction of the Nero-house. This and the subsequent building of an early Christian building rendered the site rather difficult to understand. Based on the construction techniques of the complex, it can be subdivided into three sections: the so-called section of the *octogon*, the section of the so-called Small Bath and the courtyard between these two. The section of the *octogon* is built in rather uniform *opus testaceum*. The bricks are uniformly broken in half and occasionally bands of *opus incertum* of different height are found. The section of the Small Bath is likewise built in *opus testaceum*, the thickness of brick and joint layers are variable between the sections and also in comparison to the *octogon*. Bands of *opus incertum* can occasionally be found in the masonry. The building located between both baths is constructed throughout in *opus mixtum*. In contrast to them it is built largely out of reused material, exactly as the *reticulat* from the previous Neronian Phase, which is used in the *opus mixtum*. The corners are constructed as usual in brick masonry.

Brick

so-called. Octogon – Height 3.5-3.7cm, width 29-29.5cm, half-bricks

So-called. Small Bath – Height 3.0-3.2cm, width 28-29cm, half-bricks

Courtyard – Height 4.0-4.4cm, half-bricks and triangular bricks (reused material)

Joints

So-called Octogon – 2.7-3.0cm (central room 2.3-2.5cm), solid mortar, joint-marks slightly towards the bottom

So-called Small Bath – 3.4-3.6cm (2.3-2.6cm) slight joint-marks towards the lower joint section or in parts slightly towards the inner side.

Courtyard – 1.5-2.0cm, joint-marks towards the lower side,

Type of masonry

So-called. Octogon – *opus testaceum* with *incertum*-bands

So-called Small Bath - *opus testaceum* with *incertum*-bands

Courtyard - *opus mixtum*, *opus incertum*

10-layer-module

So-called. Octogon – 75.1cm (Central room 64.5cm)

So-called Small Bath – 66.3, 71.2, 73.5

Courtyard – ca. 65cm

Putlog holes

1 layer, 1.06m, closed

Type of use

bath

Dating

The area of the East Bath is dated into the late 2nd or early 3rd Century A.D..(Mallwitz and Herrmann 1999)



Figure 12. Olympia, South Bath, *Caldarium*

South Bath

Overall impression

Based on the different types of masonry consisting completely of reused material (bricks and tiles), the complex can be divided into three large sections: the main building, the court area and the annexed latrine. The main building was covered by a barrel vault and based on bricks of different formats. The dominant format is, however, of a large format, which might have been taken from a predecessor building. The brick surface carries finger markings in form of a cross, indicating that these bricks are not reused material from the so-called Greek Hypocaust-Bath or from the Hellenistic Bath in the north of the sanctuary. Furthermore, the use of various brick formats indicate that material from several buildings was available during construction. The corners of the main building are reinforced not only with *testaceum* but occasionally also with blocks of *muschelkalk*. Just the section of the *piscina* represents brickwork which might be derived from a building with similarly homogenous appearance. On a number of occasions, the main building contains bands of a type of *opus spicatum*. The masonry is irregular and the execution is not very thorough, which indicates the overall declining technical abilities of the period. The courtyard area stands in contrast to the main building and is built mainly from rubble stone with little use of bricks. The latrine is based on *opus testaceum* and in sections *opus incertum*, whose bricks (frequently tiles) are reused.

Brick

large brick formats, height 4.5-5.5cm, 17 cm width; *Piscina*: height 3-3.5cm, width 28cm, Latrine: height 2.7-3.0cm, width 28.5cm

Joints

2.5-3.0cm, smooth joints

Type of masonry

opus mixtum, in sections *testaceum*

10-layer-module

Main building 83-84.5; *Piscina* 64.5-67.5; Latrine ca.73cm, dependig on the type of reused brick

Type of use

Bath

Dating

The South Bath belongs, according to Mallwitz, to a restoration of the sanctuary during the reign of Dioclitian (286-305).

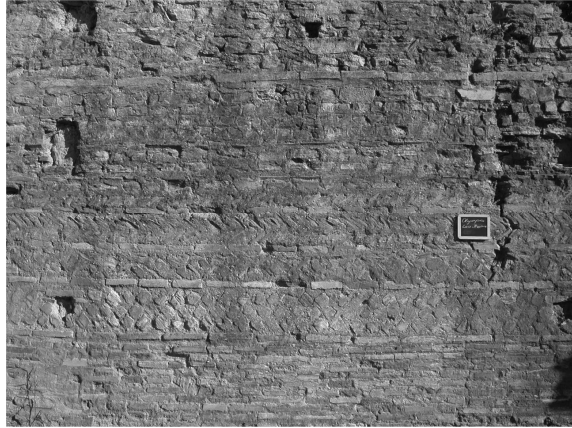


Figure 13. Olympia, Leonidaion Bath

Leonidaion Bath

Overall impression

The complex consists of a bath section and a courtyard, from which hardly any evidence has survived to the present day. The bath section has a large number of masonry techniques, which are worked much more carefully compared to the South Bath.

Brick

Brick Height- 3.5-5.0cm (Reticulat tesserae – 8x8cm, 7x8cm)

Joints

2.5-3.5cm (Reticulat1.7-2.5cm)

Type of masonry

opus testaceum, quasi opus reticulatum, quasi opus spicatum

10-layer-module

60-61cm, 74.5-76.5cm,

Type of use

Bath

Dating

3. Century A.D.

INTERPREATION AND CONCLUSIONS

Secular buildings are among the most common remains from the Roman imperial period in Olympia. Compared to Rome and Italy in general, there is a large variation in the use of materials and in consequence the variation of masonry types and techniques. This is in part a phenomenon of the eastern regions, which are distinguished from Rome by numerous local traditions. The masonry ranges from extremely high brick quality within a masonry of similarly high standard to roughly hewn stone laid in a slovenly manner. Generally, the masonry of Olympia consists of two outer faces and an inner section of *opus caementicium*. The following types of masonry are found:

1. *opus testaceum*
2. *opus mixtum*
3. *quasi opus vittatum*
4. *quasi opus spicatum*
5. *quasi opus incertum*

Since the 2nd Century A.D., *opus testaceum* is frequently combined with narrow bands of *opus incertum* (Octogon, Pheideas workshop, South Bath).

Brick formats

The bricks of Olympia are variable in size and form, with an average width of 29 cm. They are generally coarse and square. According to the local tradition they are generally only broken into two pieces in midsection. This technique is less efficient as it does not allow the use of the optimum length resulting from a diagonal cut of the brick. It does however ensure a good corner formation. Even the bricks from the Pheidias workshop, which are 43 cm large (equivalent to *sequipedalis*) are not cut into triangular bricks. Bricks from Olympia are rather thick compared to those in Italy.

Height of bricks and joints

In Olympia there is no tendency for the thickness of bricks to decline, while at the same time the thickness of joints increases. The South-West building provides a good example for this effect throughout its first three building phases. The bricks from the second phase (4.75 cm) are here considerably thicker than those of precursor buildings from the Neronian period (3.6 cm) while those of the third phase have a tendency towards 3.0 cm. It also confirms the tendency of increasing thickness of joints and a decline in mortar quality. Almost certainly economizing on the use of materials played an important part in this, as was suggested by Aupert. This is in contrast to those

buildings which were probably erected by Italian work groups. In this case the bricks and joints are extremely narrow and built with high precision compared to the standards of Olympia.

Chronology

The construction of the South West Bath in the 1st Century A.D. in *opus testaceum* coincides with changes in construction methods insofar as bricks are increasingly used and their appearance changes. Red-coloured, rectangular and homogenously large bricks are used. The first phase is made of a carefully laid *opus mixtum* based on triangular bricks. This method of economizing the use of bricks was contrary to local tradition. Usually, the method of reducing the use of bricks was to break them into pieces of unequal size. The use of triangular bricks is only documented from two buildings other than the South West Bath: the Leonidaion and the so-called Nero-House, which coincides at the same time with the use of *reticulat* in all three buildings. Its quantity as well as quality are very different. In the South West Bath it belongs to an incomplete construction phase, but exists throughout all wall sections. It does not appear in such large quantities in the Leonidaion nor the Nero-House. The *reticulat* in the Nero-House, although traditionally dated to the Neronian period, is of a much lesser quality and a reassessment of its dating would be desirable. The high standard of the *reticulat* of the South-West Bath clearly indicates workgroups with training in Italy rather than adoption of this technique by local workgroups.

Adjustments are already observable starting with the second construction phase. The bricks are only partly broken into triangular bricks, while the majority are just broken in half, which indicates local workgroups. Furthermore, the section of the peristyl is built with a mixture of fieldstone and rubble stone. The use of rubble as a filling material was much cheaper than the construction of *reticulat*, particular since the typical material for *reticulat* - tuff (which is also easy to cut) - was not locally available. The use of different masonry types (*testaceum* and mixed masonry) followed a certain pattern: where the construction requirement arose (vaults and technical sections) *opus testaceum* was applied and in less critical situations a simple mixed masonry type (light roofing and residential sections of the building) was used. It was irrelevant whether the bricks used for the *testaceum* were derived from a homogenous production line (Kladeos Bath, South-West Bath, Octagon) or whether the bricks were reused (South Bath, North Bath). The use of different masonry types within a building complex contributes to different degrees of degradation that are still present. The sections of *testaceum* are much better preserved than those carried out in the simple quasi *spicatum* technique.

Starting with the Kladeos Bath, the use of brick masonry became the standard in Olympia and it was used within the entire building complex. The restoration of the Leonidaion is also mostly based on bricks. In the section of the basin other masonry (*quasi vittatum*) is used. The Leonidaion as a guest house for visitors of high status and civil servants is an example of the Hadrianic period (Specht 1996), where the walls are erected based on bricks broken into triangular pieces (which was

typical of brick masonry in Rome). The quality of workmanship is in addition considerably higher than of local workgroups. For these reasons it is reasonable to assume the direct transfer of this building technique from Italy.

The later buildings such as South-West Gate, North Building and Nymphaeum of Herodes Atticus continued to be erected in *opus testaceum*. None of these buildings employs triangular bricks. The North Building demonstrates irregularities through its increasing use of different recycled brick material. This is explicable in that it was erected directly over the site of a Hellenistic building, offering direct access to such material. This latter effect clearly demonstrates the difficulty of developing a chronology of Roman buildings – particularly in the case of baths which were frequently remodelled and adjusted in later periods. Also they were subject to conversion work (public as well as private) because of their good quality construction and general robustness.

The Nymphaeum of Herodes Atticus employs increasingly large brick formats in the lower sections of the basin, but these are rapidly substituted in the upper sections with bricks of local production. However the lower basin section is carried out in a *quasi vittatum*.

The area of the East Baths, with the so-called Small Bath and the so-called Octagon are erected in *opus testaceum*. Both buildings show bands of mixed *incertum*. The walls of the Octagon are based on homogenous brick production which is partly contain bands of *incertum*. The so-called Small Bath shows uniform brick production within the walls but variations between the walls. The building between these two baths is erected in a simple mixten technique. Again with this building there is a former building (the Nero House) that could have provided ample material for the construction.

The reconstruction of Guest houses I and II next to the Kladeos Bath in the 3rd Century A.D. fall into the local tradition of Olympia. For this section it was unnecessary to build a solid testaceum. Instead, simple walls of *quasi spicatum* and *quasi vittatum* from fieldstone and brick rubble were erected. This masonry shows hardly any identifiable brick content.

The renovation of the Pheidias workshop at the end of the 3rd Century A. D. represents the last building in Olympia to be built with its own brick. The subsequently built South Bath marks the beginning of the reuse of brick material for the erection of new buildings, and even the wall heating is based on recycled materials (tiles). Even the structurally important sections of the barrel vaulted rooms were erected as *quasi testaceum*. Large bands of *quasi spicatum* stretch across large sections of the walls. Likewise the Leonidaion Bath built in the late 3rd Century A. D. was constructed using reused material which is apparent by the contrast between the central part of the building and the courtyard. The Leonidaion Bath was erected to a relatively high standard, demonstrating the entire spectrum of masonry from *testaceum*, *quasi spicatum* and a *reticulat* based on reused *tesserae*. During the later periods, the building techniques change drastically. The Christian settlement in the

north is now erected in the technique of *opus africanum*. The choice of this technique is related to the discontinued use of the sanctuary that resulted in an ample supply of poros blocks for building. Fild stones served as filling material. Furthermore, with exception of the Byzantine church, no major new building were erected that required sophisticated building techniques.

REFERENCES

Aupert, P, 1990. "Évolution des appareils á l'époque impérial." *Bulletin de correspondance hellénique* CXIV: pp. 599-637.

Bechert, T, 1999. *Orbis provinciarum - Die Provinzen des Römischen Reiches*. Mainz am Rhein.

Lugli, G, 1957. *La tecnica edilizia romana con particolare riguardo a Roma e Lazio*. Roma.

Mallwitz, A, and Herrmann, K, 1999. *XI. Bericht über die Ausgrabungen in Olympia*. Berlin, DAI.

Mallwitz, A, and Schiering, W, (eds.), 1964. *Die Werkstatt des Pheidias in Olympia*. Olympische Forschungen. Berlin.

Martin, A, 2001. The South-West Building at Olympia: The Ceramic and Glass Evidence for its Dating. in Marc, J.-Y. and Moretti, J.-Ch. (eds.) *Constructions publiques et programmes an édilitaires en Grèce entre le II siècle av.J.-C. et le Ier siècle a.J.-C.*, Athens, pp. 313-22.

Martin, A, 1996. "Two Roman Contexts from Olympia." *Cretariae Romanae Factorum Acta* 33, pp.127 - 134.

Medri, M, 2001. La diffusione dell'opera reticolata. in Marc, J.-Y. and Moretti, J.-Ch. (eds.) *Constructions publiques et programmes an édilitaires en Grèce entre le II siècle av.J.-C. et le Ier siècle a.J.-C.*, Athens.

Sinn, U, Leypold, C, et al., 2003. *Olympia - eine Spitzenstellung nicht nur im Sport. Eine neu entdeckte Badeanlage der hellenistischen Zeit*. Antike Welt. Zeitschrift für Archäologie und Kulturgeschichte. 6, pp. 617-23.

Specht, S, 1996. "Bericht über das Forschungsprojekt "Olympia während der römischen Kaiserzeit und in der Spätantike" - Die Arbeiten im Jahr 1995, Teil 2." *Nikephoros(9)*: pp. 203-15.