Introduction (Figs. 1-2)

In 2010 and 2011, Ghent University carried out two short excavation campaigns focussing on Cistern no. 1, located in macro-square A’51 just above the Industrial Quarter.¹ The excavations were directed by Roald Docter and co-directed in the field by Kim Van Liefferinge. Given the early stage of the investigations, the report will limit itself to a presentation of the main raw data and some first preliminary conclusions and interpretations. It is backed by two reports on the finds from the cistern (see elsewhere in this volume), in line with the project’s strategy to have a balanced input of effort and staff in the excavation and finds processing laboratory.²

The results of this excavation are part of an ongoing PhD research by the first author on water management in the Laurion region. The first-hand acquisition of data during the excavations at Thorikos may allow for a better understanding of similar workshops dispersedly published from the wider Laurion.

Remarkably, little attention has been devoted to Cistern no. 1 and its direct surroundings. Nonetheless, this zone has great potential to improve our understanding of the rich and complex history of Thorikos. The area was shortly discussed by H. Mussche (1998, 56) under whose directorship Cistern no. 1 had also been prospected and mapped for the first time in 1965 (Figs. 3-4). In his description he mentioned the presence of three mining and ore processing complexes on the

¹ The 2010 campaign lasted only 11 working days in the field (between 17 and 28 May 2010). The campaign was financially supported by the Belgian School at Athens and research funds of Ghent University. The equally short 2011 campaign lasted 9 days in the field (between 17 and 28 July 2011) and was financed by research funds of Ghent University. We acknowledge an additional funding by Utrecht University, that allowed the participation of a small team from that University in 2011. We would like to thank the secretary of the School, Mr. P. Iossif, as well as its director, Dr. S. Soetens, for their support. In Greece our thanks go Dr. I. Tsirigoti-Drakotou, Ms E. Andrikou and Ms D. Kai, Ms. M. Giota, as well as the staff of Lavrio Museum. The 2011 campaign could benefit from the generous hospitality of the Technological Park in Lavrio; our thanks in this connection go to D. Papadopoulos, A. Chadoumillis and the mayor of Lavrio, K. Levantis. In 2010 the following persons participated: Roald Docter, Kim Van Liefferinge, Thomas Pieters, Guy Dierkens, Winfred van de Put, Lissa Van Hecke, Evelien Vanderstraeten and Efthimos Kakavoyannis. In 2011 the team consisted of: Roald Docter, Kim Van Liefferinge, Thomas Pieters, Guy Dierkens, Winfred van de Put, Sophie Mortier, Koen Van Gelder, Floris van den Eijnde, Amber Brüsewitz, Dieuwke Becker, Eline Amsing, Roy Van Wijk and Vasiliki Ivrou.

² Since the analyses of the waterproof mortar and of the bone and shell finds has not yet been concluded, these data could not yet be included. The bone and shell retrieved during the campaigns are currently under investigation by Prof. L. Karali Giannakopoulou (National and Kapodistrian University of Athens) and her team and Dr. E. Yannouli.
lower slopes of the Velatouri hill (A-B-C; Fig. 2). Besides a central mine entrance, each complex consisted of several ore washeries, cisterns and living compounds for metallurgists, labourers and their families. Cistern no. 1 belonged to an elaborate complex organised around Mine entrance no. 2, a kainotomia at a level of about 40m. Four washeries (nos. 1, 2, 3 and 12) and four cisterns are associated with this complex. Two of the cisterns were underground bottle-shaped water reservoirs meant for storing drinking water, the other two were industrial cisterns, employed to supply the ore washeries. Already in 1998, Mussche considered Cistern no. 1 to be Thorikos’ largest water reservoir, having an estimated capacity of some 80m³.

Starting from this limited amount of information, the zone was prospected in April 2008 as part of a wider survey campaign, which aimed at digitizing and updating the old cartographic material of Thorikos in the archive at Ghent University (see elsewhere in this volume, pp. 5-14). In order to do so, all visible structures on the lower Velatouri, viz. in the Theatre Zone and the Industrial Quarter, were measured. In particular, the work conducted in the zone north of the Industrial Quarter proved to be worthwhile: a hitherto unknown structure, which in all likelihood can be identified as a cistern, was recorded approximately 16m to the north of Mine no. 2. Furthermore, several walls that stood in close connection to Cistern no. 1 were recorded, suggesting that the structure had been part of a larger workshop (Figs. 1 and 5, indicated in red). As of yet, however, no definitive interpretation of these remarkable structures has been made.

These observations clearly showed the potential of the area in addressing the unsolved question of water management in Thorikos, which had led to a fair degree of speculation in previous publications. In 1978, P. Spitaels wondered how the water supply had been arranged in insula 3 (Spitaels 1978, 44), and twenty years later Mussche stated in more general terms that Thorikos lacked the necessary cisterns to provide for a sufficient water supply for both washeries and personal needs of the inhabitants (Mussche 1998, 56). In order to enhance our understanding of this vital subject, it was decided to organize an excavation campaign focussing on these questions. In view of its large size in comparison to the other water reservoirs in Thorikos, Cistern no. 1 was chosen as the most promising point of departure.

**Methodology**

The fieldwork principally consisted of three parts:

1. Cleaning of the surroundings of the cistern. As already noted above, several structures were observed in the direct vicinity of the cistern; however, the poor visibility of the remains on the site prohibited a full understanding of these features. Removal of the overgrowth (mainly bushes and small trees, that had sprung up since 1965, see Figs. 3-4) was conducted during the first days of both campaigns;
Fig. 1. Thorikos. Cistern no. 1 and the Industrial Quarter (in black: excavated and recorded remains 1963-1989; in red: remains recorded in 2008).

2. Excavation of the cistern’s basin and architectural study. The main purpose of these activities was to establish the original capacity of the cistern and a terminus ante quem for its construction. The basin of the cistern was divided into five zones, A-E (Fig. 5). Although it proved impossible to finish the excavation of the entire structure, all five zones were at least partly investigated;

3. Registration and documentation of the artefacts and remains found during the excavation. This also included the precise drawing and measuring of the walls and other features, which have all been inserted into a GIS-system in order to facilitate the analysis of the data (see also Figs. 1-2, 5, 11-12, 14, 16).

Observations

Cistern no. 1: the structure
The main structure of the cistern has been relatively well-preserved, being partly cut into the bedrock and partly built up with ashlar masonry consisting of large, mostly rectangular blocks of (local) stone, averaging in length from 1 to 1.2m. In all probability, the irregular shape of the cistern (with sides measuring 9m, 4.5m, 7.5m, and 5.5m) can be related to the local, pre-existing topographical conditions.
To prevent seepage, the cistern's walls and the fractures in the bedrock surface were filled and lined with a waterproof mortar, which in places was still present in a fairly good state of preservation (Fig. 6). As with other cisterns in the Laurion, the mortar had been applied in two layers. Firstly, the inner basin of the cistern was lined with a rather thick layer of lime mortar. Subsequently, this layer was roughened with scratches in order to allow for a better adhesion of the upper coating. This second coating was a thin layer of only a few millimetres and represented the actual hydraulic plaster. Mortar samples have been taken and will be investigated shortly in Greece. Noteworthy in this context is the research that was conducted by C. Conophagos on the mortars of a cistern in Demoliaki. His analyses revealed the presence of SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, ZnO, PbO and MnO in the lining material. Especially interesting is the presence of litharge (PbO), which was a by-product of silver extraction ensuring the coatings' impermeability (Conophagos, Badécas 1974, 254-260; Conophagos 1980, 253).

Building a cistern on this specific location was certainly not a random choice. This part of the Velatouri hill seems to be particularly favourable for the catchment of water. The slope is not only steep, but the surface just above the cistern is also remarkably smooth and free of fractures. These conditions guaranteed an optimal water recuperation after rainfall. The cistern was also equipped with a kind of barrage to further optimize water catchment: the east wall of the cistern runs further uphill.
Fig. 3. Thorikos. Cistern no.1 during cleaning in 1965, picture taken from the west with spoil heaps of Mine no. 2 in the background.

Fig. 4. Thorikos. Cistern no.1 during cleaning in 1965, picture taken from the south.
forming a sort of blockage for the water running downhill during rains (Fig. 5). Thus, water was directly diverted into the basin through an inlet, which was created by cutting an opening into the bedrock on the northern part of the cistern (see Fig. 16).

![Thorikos Cistern no.1 map](image)

**Fig. 5.** Thorikos. The excavated zones in Cistern no.1 (A-B-C-D-E; Fixed points 1-2-3)

![Detail of waterproof mortar](image)

**Fig. 6.** Detail of the waterproof mortar in the basin of Cistern no. 1, Zone E (upper north corner).
Fig. 7. Cistern no.1. Blocked off drainage channel in the south corner of the basin (2011).

Fig. 8. The two drainage channels of Cistern no.1 (2010). Picture taken from the northeast.
Two drainage channels have been observed. The first channel, located in the south corner, was intentionally closed at some unknown moment, the second was probably operational until the cistern’s abandonment (Figs. 7-8). The latter was likely to have been built at the same time the cistern was erected: it rested upon a foundation entirely cut out into the bedrock, which was simultaneously used to support the western and southern walls. Furthermore, a large stone slab covering the channel was incorporated into the cistern’s walls. Unfortunately, a more detailed interpretation of this channel is obscured by the presence of a tree near the inlet (now cut, but with its roots still in place), which badly damaged the structure.

The cistern can be described as a typical example of an industrial water reservoir. Numerous parallels are to be found in the Laurion as a survey by the first author in 2011 showed. A strikingly similar cistern, in shape, size and building technique, may be observed close to the Soureza workshops; it belonged to the so-called Negris workshop (Fig. 9). The only difference with Cistern no. 1 at Thorikos is the presence of a small decantation basin, used to clarify the surface runoff before it flowed into the principal cistern. Oddly enough, no cisterns with decantation basins were observed in Thorikos itself. This is particularly surprising since they were widely used in the rest of the Laurion.

Cistern no. 1: excavation procedure and stratigraphy

Rather than a full description of every individual archaeological unit or context, the following text provides a synopsis of the most significant stratigraphical layers within the cistern.³ As noted above, the basin had been divided in five zones at the start of the excavation: A-B-C-D-E (see also Fig. 5). In 2010, Zone A, C and E were excavated simultaneously in order to have a clear view of the stratigraphy. In 2011, the same was done for B and D, but A was further investigated as well. Considering measures of safety and time, additional test trenches were dug in both A and C. Figs. 10-13 present the main results of these activities.

The recorded stratigraphy was very much in line with what could be expected in a cistern. It can be described as a multi-layered filling, containing all types of material, which through time had tumbled and washed into the basin. Cisterns were structures requiring high and constant maintenance. Generally, their basins were full at the end of the rain season, supplying the workshop until the rain resumed the following autumn. As it was mostly empty by the end of summer, people would then have taken the opportunity to clean the basin and, if necessary, to carry out repairs. This implies a yearly removing of the sediments, which had settled down on the bottom, and the restoration of the waterproof cement, where it showed signs of deterioration. Therefore, no stratigraphy of the cistern’s use period can be established. The resulting fill will not offer a precise construction date, but at the best a terminus ante quem of its last use phase, since upon abandonment no efforts would have been made to clear the cistern from residues anymore. The most accurate date for this moment may be

³ The full and detailed presentation of these contexts, with a Harris Matrix, will be published after the conclusion of the excavation.
Fig. 9. An industrial cistern in the Soureza area (Negris workshop).

Fig. 10. The five excavation zones (and extra test trenches) in Cistern no.1: A-B-C-D-E (2010).
expected from the archaeological finds contained in the lowest level of the fill, which, however, has not yet been reached. The fill above, excavated in part in 2010-2011, would be composed of material washed into the cistern from higher up the hill. One may reasonably suppose that it contains the same kind of material that one encounters at the surface around the cistern. To enable comparison, surface finds from within macro-square A’51 were systematically collected and studied as well in 2010 and 2011.

The four zones within the lowest part of the cistern (A-D) show a uniform stratigraphy, although the distribution of the material finds is not entirely similar. As of yet, five distinct types of sediments have been distinguished: topsoil (1) and four lower strata (2-5; Figs. 11-13).

The full area was covered with a topsoil layer (1). This was a humus deposit, mixed with very few pottery fragments and large stone blocks, reflecting a structural collapse of a possible superstructure and/or originating from structures that once stood in the vicinity of the inlet. The deposit had a top surface sloping down in southwestern direction (Figs. 8, 14). Considerable amounts of charcoal were found in the topsoil, particularly in Zone A. In all likelihood, these can be linked to the numerous bushfires that have ravaged the Velatouri in the past.

Under this concealing layer, a more compact, dark brown, silty sand deposit was encountered (2). The thickness of the layer differed considerably from location to location. Generally, the stratum was 40 to 60cm thick. Next to the channel in the west corner of the cistern, the deposit was dotted with mortar fragments, giving it an ash-like texture and colour. The large amount of mortar fragments, some of which measured 10 to 20cm, is easily understood in this location. As the channel extended beyond the cistern’s wall, it created more corners and thus elevated the risk of leakage. As a preventive measure, every corner was meticulously coated with an extra thick layer of mortar, a practice which has also been recorded in other cisterns of the Laurion. Furthermore, considerable amounts of cement originated from a heavily disturbed floor, which was found inside the channel. The floor was made of stone slabs with a substructure consisting of small stones in a matrix of lime mortar. In the upper north corner of Zone E, the same situation has been recorded. The mortar fragments were numerous and well preserved (see also Fig. 6).

A third stratum, ranging from about 50cm to 1m in thickness, was rather similar in texture (brownish, fine, silty sand) but considerably lighter in colour (3). It still contained pieces of charcoal and a fair amount of stones; however, their number and sizes were decreasing. As noted above, two trenches were dug (one in A and one in C) in order to enhance the work progress. Excavation was not continued in Zone B and D below this level.

In sharp contrast to the third stratum, the fourth layer can be characterised as a stone packing, mainly consisting of medium sized stones observed both in Zone A and C (4). The earth was also brownish in colour with a silty sand texture. Noteworthy was the large amount of bones in the west corner of Zone C. This stratum was about 80-90cm thick.
After cutting through this layer, the excavation was only continued in Zone A. There, another stone layer, consisting of significantly larger stones was encountered (5). The texture of the soil was still the same but it was somewhat darker in colour, which can easily be explained by the humidity of the soil. The frequency of pottery was greatly reduced. The depth reached was 4.7m, measured from fixed point 2 (see Fig. 5), which was at the highest level of the cistern’s walls.
Zone E, the top part of the cistern, can be described as the actual inlet of the cistern (Figs. 5, 8-right, 10, 11-left). The natural bedrock had been left untouched in most places; however, it used to be completely covered by waterproof cement, as suggested by some small fragments. Fissures in the rock were carefully filled with a mix of small stones and lime mortar (Fig. 15), implying that the cistern could – and would - have been filled with water up to this level. In contrast to the other sides of the cistern, which all consisted of nicely built ashlar walls, this part entirely made use of the natural bedrock. Part of this natural ‘wall’ was reworked to leave an opening, allowing the surface runoff to flow in. No traces of any extra infrastructure were found. The material recovered from Zone E, consisting of a mix of stones, mortar and very few pottery fragments, may with all certainty be considered as a modern infill (albeit solely composed of material of ancient date), since the area had been cleared to the level of the bedrock in 1965, when a first plan of the cistern had been made (see also Figs. 3-4).

Fig. 13. Cistern no. 1. East-west section of the test trench in Zone A (2010).

**Surrounding structures**
The cistern had clearly been part of a larger metallurgy workshop, as indicated by several features in its close vicinity (Fig. 16). On the western side of the cistern, an obvious working area was observed. The bedrock was adjusted in order to create a smooth rectangular platform. A few meters further to the west, a crushing table was recorded (Fig. 17). Crushing tables, together with grinding stones, were used to
**Fig. 14.** Cistern no. 1. Topsoil (2010); drawing KvL and E. Kakavoyannis, digitized by J. Angenon.

**Fig. 15.** Cistern no. 1. Fissures in the rock filled with a mixture of stones and lime mortar (2010).
prepare ores before they were brought to the washeries. The latter were large, rather flat slabs of (mostly) limestone, employed to reduce the grain size of ores by means of iron pounder. (Basalt) grinding stones could take different shapes; the fragments encountered during the excavation undoubtedly originated from the rectangular variant (see elsewhere in this volume, pp. 117-118, cat. 103, fig. 41). By means of this device, the ores were grinded until a flour-like substance was achieved (Conophagos 1980, 216, 220-221). Fig. 18 shows a reconstruction of how crushing tables and grinding stones were used (Conophagos 1980, 227, fig. 10-15).

In 2011, an important discovery was made at surface level within the macro-square: an ore washery that can be linked to the cistern and formed part of the workshop. It is situated 3m below the cistern and at a distance of about 16m to its west. Its location is easily explained by its proximity to the cistern’s most western overflow channel (Fig. 16). One of the settling tanks had been exposed, one side of which could be measured (1.3m), the rest is completely covered with topsoil and overgrowth.

On the east side of the cistern several curved walls, organised in a rather peculiar way, were built (Figs. 5, 16). As no parallels could be detected in other Laurion workshops, it is not yet clear what purpose they served.

As mentioned in the introduction, the Cistern no. 1 workshop was part of a mining and ore processing complex erected in relation to Mine no. 2. Several observations suggest that this complex was not of minor importance. In the first place, the capacity of Cistern no. 1 was sufficiently large to have served several ore washeries. In the second place, an important street ran through the area, the so-called Metallurgy Street, which linked Mine no. 2 with several workshops (see Fig. 1). When extending its axe, the street is likely to have led along insula 13 to Mine no. 2 and further up to the Cistern no. 1 workshop. Also worth mentioning is the possible presence of a tower (no. 5) close to the mine entrance (Mussche 1998, 57).

**Preliminary conclusions**

The present report has provided a general overview of the 2010 and 2011 excavation campaigns, focussing on the interpretation of the findings rather than a detailed description of every encountered context. Even though further excavations are necessary to fully understand the structure and its fill, a few preliminary conclusions may be drawn.

The stratigraphy can be described as a filling, characterised by two thick stone layers. These layers are likely to be explained as structural collapses, originating from a superstructure and/or buildings that once stood uphill. The first layer of stones is the top fill, the second one is represented by the fourth and fifth stratum.

The finds in the fill of the cistern, discussed in two contributions elsewhere in this volume, can be divided in two large chronological horizons. The bulk of the finds belong to the Late Archaic to Early Hellenistic period (see elsewhere in this volume,
p. 119, fig. 42), with two specific peaks in the 5th century BCE and the second half of
the 4th century BCE (see also elsewhere in this volume, p. 137, fig. 6). In the second
place, a smaller portion of the finds belong to the last period of Thorikos’ existence,
the Late Roman and Early Byzantine period, viz. principally the 6th and 7th centuries
CE (ca. 520-700 CE), extending into the 8th century. This chronology is later than
hitherto known for Thorikos. These finds consist mainly of larger fragments in
comparison to the finds of the earlier chronological horizon. These fragments also
show more joins, allowing for the reconstruction of larger profiles. Apparently this
part of the fill is of a more primary nature, deliberately dumped in the cistern during
the 6th, 7th and/or 8th century CE. The fragments of the Late Archaic till Early
Hellenistic period are generally smaller and often also more abraded and probably
originate in erosion processes. They, hence, may once have formed the make-up of
the stratigraphy higher up the hill.\footnote{How quick these erosion processes take place and cause the filling up of areas hitherto exposed may be illustrated in the example of Zone E, discussed above.} It is not unlikely that the cistern by the Late
Roman and Early Byzantine period had already been partly filled in with erosion
material containing solely material from the Late Archaic till Early Hellenistic period.
However, these levels of the fill do not seem to have been reached yet during the
present excavations, since even the lowest levels contained fragments of the late

\footnote{How quick these erosion processes take place and cause the filling up of areas hitherto exposed may be illustrated in the example of Zone E, discussed above.}
pottery horizon. That the cistern would have retained its original function in the Late Roman period and only got filled in thereafter seems very unlikely. Rather, one has the impression that the dumping of Late Roman/Early Byzantine pottery took place at a time when the erosion processes were still going on, causing the gradual filling of the cistern. This would at least explain the presence of these late fragments, sometimes clustering and connecting with assemblages of larger bone fragments, within the fillings composed of mainly earlier material. In this connection, it is remarkable that the quite numerous surface finds from the area around the cistern do not seem to contain fragments of this latest phase.

As a last word concerning the finds, it is noteworthy that several pieces of grinding stones of the Late Archaic and Classical periods were encountered in the cistern fill and during the systematic collection of surface finds in macro-square A'51 (see elsewhere in this volume, pp. 117-118, cat. 103, fig. 41). They may contribute to the functional understanding of this part of Thorikos.

Cistern no. 1 forms a clear example of an industrial cistern, which provided water for ore processing. This is not only suggested by a comparison with other workshops and industrial cisterns in the Laurion, but also by metallurgical features in the close vicinity of Cistern no. 1 itself (a.o. an ore washery, a crushing table, fragments of grinding stones and Mine no. 2).

The initial estimated capacity of the cistern needs to be recalculated. The structure is evidently considerably larger than scholars had previously estimated; it appears to have contained at least 135m³. As the bottom of the cistern has not yet been reached, the capacity will likely be substantially larger. Especially in connection with the newly discovered cistern during the 2008 survey, this result may seriously question the previous hypothesis on water shortage in Thorikos (see introduction). Rather, it seems likely that enough water had been available in Thorikos. The false impression was probably caused by a lack of interest in the subject in addition to the limited archaeological work conducted on water capturing installations in Thorikos.5

At this early stage of research, the chronology of the cistern and, hence, the workshop still remains uncertain. In comparison to other ergasteria in Thorikos and the Laurion, one may assume that the Cistern no. 1 workshop had been constructed somewhere towards the end of the 5th or in 4th century BCE (Kakavoyannis 2001; Docter, Van Liefferinge 2010). Future fieldwork, scheduled for 2012 and encompassing small sondages outside the cistern’s basin, as well as a further excavation of the fill inside, is expected to clarify this chronology.

5 Although cisterns seem to have been partly emptied before (as e.g. the two subterranean cisterns in insula 2), the results never made it into the publications.
Fig. 17. Crushing table west of Cistern no. 1 (for position, see Fig. 16).

Fig. 18. Crushing and grinding of ores (after Conophagos 1980, 233, fig. 10-15).
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