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PATRIK KLINGBORG

The cisterns of the Bisti promontory at Hermione

With a preliminary description of the Roman aqueduct

Abstract

This article reports the findings of the fieldwork exploring the cisterns at the Bisti promontory of Hermione, executed as part of a collaboration between the Ephorate of Antiquities of the Argolid and the Swedish Institute at Athens. In order to better understand the function of the cisterns within the water supply system, the article begins by presenting an overview of existing water resources in the area, primarily the naturally occurring sources and the city's 2nd-century AD Roman aqueduct. Following this the study describes the remains of the 14 potential cisterns on the Bisti. Based on the empirical material the similarities and contrasts between these are explored, as well as what they can tell us about the history and life in ancient Hermione. In particular, the article suggests that the presence of the cisterns contributes to our understanding of the urban fabric of the city, and reveals important information about when the city was moved from the Bisti to the nearby Pron Hill.*

Keywords: Hermione, the Argolid, water supply, cistern, aqueduct

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Introduction

During the 2018 field season in Hermione the cisterns on the Bisti promontory were explored. The aim was to locate, clean, and digitally record all visible cisterns in the area in order to improve our understanding of this part of the ancient city. While the lack of excavations prevents conclusions being made in some regards, twelve installations may be considered securely identified as cisterns based on observations of the shape and construction method. Another two installations may have been cisterns but the state of preservation prevents the drawing of firm conclusions.[1] All 14 potential cisterns were documented during the season, although two without further cleaning. This article reports on the result of the work, provides a brief summary of the ancient city's water supply, including the Roman aqueduct, and discusses what it reveals about life in ancient Hermione.[2]

The water supply of ancient Hermione

Beside the cisterns on the Bisti, the inhabitants of the ancient city had access to a number of other water sources, including a watercourse (sometimes called a river in previous research), springs and fountains, wells, an aqueduct, and further cisterns (*Fig. 1*). From the prehistoric period onwards the watercourse, formed by water collected in about 70 km^2 of mountainous terrain in the city's hinterland, had its outlet close to the settlement.[3] Originally the watercourse ran into the sea at Kapari Bay west of Pron Hill and about 2 km from the Bisti promontory and its settlement. As thick sedimentary deposits were created over time, the stream's channel was blocked and at some point it turned east before Pron Hill, heading through the plain and discharging in the Limani Bay.[4] Michael Jame-

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Editorial note: The section on Hermione, published in *OpAthRom* 14, comprises six articles: Papadimitriou 2021; Gerding 2021; Blid 2021; this contribution by Patrik Klingborg; Kossyva 2021; Wallensten 2021.

[1] Klingborg 2017, 15–51. Cisterns **2018.1**, **2018.2**, **2018.3**, **2018.4**, **2018.5**, **2018.7**, **2018.8**, **2018.9**, **2018.10**, **2018.11**, **2018.12,** and **2018.13** and are considered as securely identified. Cisterns **2018.6** and **2018.14** are less secure.

[2] For a description of the city's topography, see Gerding 2021 in this volume.

[3] Jameson *et al.* 1994, 173.

[4] For the current course of the watercourse, see Jameson *et al.* 1994, fig. 3.9.

Fig. 1. Map over the area of Hermione with attested sections of the aqueduct (red), the local watercourse (blue), cisterns (blue circles), and other selected water installations (green circles). Illustration by Patrik Klingborg, basemap by Google, ©CNES/ Airbus, European Space Imaging, Landsat/Copernicus, Maxar Technologies, Map data 2021.

son, Curtis Runnels, and Tjeerd van Andel suggest that this change took place in the Hellenistic or Roman period as they associate it with an economic decline during this time.[5] This interpretation must be viewed with caution as there is no evidence supporting a causal relationship between the changes to the stream and the economic decline in this case. Like other Greek watercourses it should be expected that this stream was largely seasonal.[6] In combination with the distance to the settlement it is therefore unlikely to have played an important role in the city's water supply, especially before the city was moved to the Pron.

No springs are known from the area of Hermione today, although this may be attributed to modern wells draining the available resources. Yet, if springs existed in the past, they should be expected to have been scarce. In the late 19th century Alfred Philippson noted that the mountains in the area were poor in water.[7] Despite this, at least two ancient fountains are attested in the city. The first was described by Pausanias as located in the western, post-Classical, Hermione, very old and so bountiful that it would not run dry even if everyone drew water from it at the same time.[8] According to Virginia and Michael Jameson this fountain has been generally identified with a large well that still existed next to the Kranidi road.[9] However, Pausanias calls the structure a "κρήνη" (*krene*), a word used to denote architecturally elaborated water sources with e.g. proper walls, staircases, and roofs. Whether a *krene* was supplied from a spring in the traditional sense where water is under pressure or tapping into the groundwater level did not matter. A well as perceived today on the other hand, i.e. a shaft tapping ground water which is drawn by a bucket or similar means, was usually called "φρέαρ" (*frear*) in Greek.[10] Since Jameson and Jameson do not mention any architectural remains associated with the well they believe to be Pausanias' bountiful *krene*, and the currently preserved well is a simple rectangular stone-lined shaft, the identification with this modern structure must be treated with caution.

According to Pausanias the city had a second *krene* which had been built in his time.[11] Presumably this fountain was fed by the Roman aqueduct still seen along the north side of Pron Hill. A Roman fountain was seen by early 20th-century scholars in the west end of the modern city, but has been lost since

[5] Jameson *et al.* 1994, 54–55, 591. See also van Andel & Runnels 1987, 150–151.
[6] Jameson *et al.* 1994, 169.
[7] Harper 1976; van Andel & Runnels 1987, 85; Jameson *et al.* 1994, 169–171, fig. 3.9; Philippson 1892, 58.
[8] Paus. 2.35.3.
[9] Jameson & Jameson 1950, 45. Possibly the "*Brunnen*" indicated on pl. 1 in Frickenhaus & Müller 1911 (see *Gerding 2021, fig. 2* in this volume). The modern well is not identified as identical to that mentioned by Pausanias in Gkatsos' (1996) section on wells (pp. 226–227).
[10] Glaser 2000; Tölle-Kastenbein 1985; Wycherley 1937. For the terminology of Roman water displays, see Rogers 2015, 30–80.
[11] Paus. 2.35.3.

Fig. 2a. Detail of the aqueduct along Pron Hill. Illustration by Patrik Klingborg, basemap by Google, ©CNES/Airbus, European Space Imaging, Maxar Technologies, Map data 2021.

some time before 1950.[12] The two small fountains found on the Bisti promontory today, one on the south side near the tip and the other in the middle of the area, are recent according to locals and supplied by modern water pipes.

Many wells are also known around Hermione today, and as at Dhidhima some 10 km to the north-east, some may be Classical or Hellenistic in origin.[13] At least one was identified as such by Jameson, Runnels and van Andel.[14] The geology of the city area itself, however, does not provide the necessary groundwater resources for wells.[15] In 1971 David and Susanna Harper identified four public wells in the plain outside the city, another six pumped by animals, and five that were abandoned.[16] Further wells were located by the Argolid Exploration Project.[17] Vassilis Gkatsos identified three types based on construction technique.[18] The first was a carefully constructed rectangular type, the second circular with walls made of small stones, and the third various modern constructions from the 19th century. Of these, he only knew of one example of the first type from ancient Hermione.

The aqueduct

The Roman aqueduct (*Figs. 1, 2a–e*) is the most substantial ancient remain in Hermione. It has been reported on by several scholars from Ernst Curtius onwards but never been fully published.[19] The water has been interpreted as originating from a spring still known in the Pikrodaphni Valley (*Fig. 1*).[20] However, in its current form this spring can foremost be described as a well, making it difficult to see how it could have fed the aqueduct. From there the aqueduct ran 3 km roughly eastwards before turning north in order to follow the eastern slope of the Aghios Elias. Today this section of the structure consists of a channel on a well-preserved low wall situated just below the modern ground surface. This construction method is typical for Roman aqueducts which are usually located 0.5–1 m below the ground.[21] At the point where the aqueduct passed the edge of Pron Hill a small rectangular basin was located (*Fig. 2a*).[22] From this the aqueduct exits towards the east, effectively creating a 90 degree turn. After the basin 18 m of the structure is visible today.[23] The aqueduct then crossed

[12] Frickenhaus & Müller 1911, 37, pl. 1. Jameson and Jameson (1950, 45) were unable to locate the fountain in 1950.
[13] Jameson *et al.* 1994, 171.
[14] Jameson *et al.* 1994, 591, fig. E.1.
[15] Jameson *et al.* 1994, fig. 3.10.
[16] Harper 1976.
[17] Jameson *et al.* 1994, 171–172, fig. 3.10.
[18] Gkatsos 1996, 226–227.

[19] Curtius 1852, 459; Miliarakis 1886, 251; Frickenhaus & Müller 1911, 37; Jameson & Jameson 1950, 45; Harper 1976, 47; Jameson *et al.* 1994, 108, 277, 400, 489, 494, 579, 583, 591, 594, 610; Gkatsos 1996, 115–117; Lolos 1997, 307; Tassios 2018, 3. Gkatsos 1996 is by far the fullest account.
[20] Harper 1976, 47; Lolos 1997, 307.
[21] Hodge 2002, 93; Grewe 2019, 75.
[22] Measurements below are in relation to this basin.
[23] For a similar basin, albeit somewhat larger, see Keleş *et al.* 2018, 193, fig. 13; Wiplinger 2019a, 49–50; 2019b, 294–296, figs. 27, 277–279.

Fig. 2b. House-shaped feature in the aqueduct. Note the pink plaster covering the aqueduct. Photograph by Patrik Klingborg.

Fig. 2c. The section with the arches. Photograph by Patrik Klingborg.

the lower area between the Aghios Elias and Pron Hill where the watercourse once flowed, presumably using arcades, none of which are preserved today. According to Gkatsos they could be observed to a height of four metres in 1980.[24] They are also visible in a photograph in a book about local herbs published in 1988.[25] From the west foot of the Pron the aqueduct clings to the north slope just above the modern road. The first preserved part at the west end of the Pron, located 235 m from the rectangular basin, is formed by a solid wall 2.25 m high and 0.95 m wide (*Fig. 2a*). As with the rest of the aqueduct, this section is constructed in a rubble stone masonry formed by small roughly rectangular stones bound together with a generous amount of mortar in between, often more than 0.03 m, sometimes up to 0.10 m. Almost no materials of terracotta were observed in any of the preserved sections, indicating that this was used only sparingly (*Figs. 2b–c*).

After this point the aqueduct is intermittently visible, always clinging to the north slope of the Pron, giving the structure a convex course. Such courses following natural contours in the landscape are the norms for most aqueducts.[26] In many sections the effect of this is that the south, uphill, side is covered by soil while the north, downhill, side is exposed. While this eliminated the need for expensive arches or substructures it created another problem as the aqueduct acted as an underground dam, blocking water seeping down the hill. Concerns about the stress this could cause are probably the reason why it is penetrated at irregular intervals by rectangular weeping holes measuring between 0.10 and 0.30 m.[27] A pink plaster (*Figs. 2b–c*) covering the aqueduct is also preserved in many sections.

The first notable feature associated with the aqueduct is found 600 m east from the basin along the course of the structure. This feature is formed by two walls, perpendicular to the aqueduct, 0.48–0.50 m thick and located 2.40 m from each other (*Fig. 2a*). Both walls are clearly later additions as they abut the aqueduct without any sign of bonding. The pink plaster, however, seems to have been applied to the aqueduct and walls at the same time. The western wall is preserved to a distance of 3.30 m from the aqueduct, while the other is a short stump. Traces in the plaster on the aqueduct show that the walls were at least 0.75 m high originally. At first they were interpreted as the sides of a basin but the presence of many other such walls, and not always in pairs, abutting the aqueduct to the east suggests that they were intended to buttress the structure. This may indicate an effort to relieve the pressure of the soils on the south, uphill, side.[28]

Right after the east abutting wall the aqueduct makes a slight turn to the south. In this section the water channel (*specus*) is briefly cut in the bedrock rather than constructed. After a short distance it turns again slightly to the south for a few metres. In this section (620 m from the rectangular basin) a house-shaped feature (*Figs. 2a–b*) is built in the wall. It is formed by a rectangular base 0.45 m wide and 0.35 m high, on top of which a 0.20 m high triangular roof-like structure is situated. The feature is 0.85 m deep and therefore does not penetrate the aqueduct completely. Preliminary observations of how the walls and roof of this feature are built indicates that it belongs to the original construction of the water supply system. Its function is, however, unknown although similarities with Roman *lararia* may suggest that it was a small altar.[29]

[24] Gkatsos 1996, 116.
[25] Papavasileios 1988, fig. 7. See also fig. 8.
[26] Hodge 2002, 105.
[27] For similar weeping holes in an aqueduct, see Wiplinger 2019a, 35.

[28] Comparable support walls were added the Değirmendere Aqueduct at Ephesus, constructed during the Antonine period, in sections built in similarly sloping terrain (Wiplinger 2019c, 501–504).
[29] For Roman *lararia*, see Boyce 1937. For a close parallel, see the *lararium* in House V.ii.15 at Pompeii. Numerous *lararia* in the city are

Fig. 2d. Imprints in the mortar of wooden moulds from the construction of the first arch from the west. Photograph by Patrik Klingborg.

Fig. 2e. Specus *of the aqueduct. Photograph by Patrik Klingborg.*

Another 15 m east from this feature the solid wall of the aqueduct is pierced by five low arches (*Figs. 2a, c*). These have been noted by several previous scholars.[30] The arches all seem to have rested on a solid continuous wall. The first arch from the west is the best preserved. It measures 1.50 m across at the base with an estimated height of 0.75 m. Practically all of the voussoir stones are preserved. On the inside of the arch the imprints in the mortar of at least four wooden planks forming the formwork used to create the arch are visible (*Fig. 2d*).[31] At the east base of the arch there is a wall abutting the foundation on the downhill side. The second arch is in a comparably poor state with most of the voussoir stones gone. The original diameter can be estimated to have been about 1.50 m, the height 1.00 m. The third, middle, arch has collapsed completely, leaving a gap in the aqueduct. The fourth arch still remains with a width of 1.70 m and height of 0.90 m. Notably, the outer layer of stones for the arch has been removed, leaving only an imprint. Between the fourth and fifth arch the imprint in the lining of a 0.15 m wide supporting wall can be seen. The dimensions of the fifth arch are similar to those of the fourth, and again the stones of the arch have been removed. A wider support wall, 0.55 m high and 0.55 m wide, abutted the aqueduct just to the east of the fifth arch.

While these arches would allow humans and animals to pass through, albeit not very comfortably, this was probably not their primary function. Similarly, the reduction in material used was rather minimal. Instead it seems likely that the arches were intended to allow rain water, perhaps even winter torrents (known as χαράδραι), to pass through. This interpretation is corroborated by the three walls abutting the aqueduct on the downhill side in this area, indicating that the structure was under considerable stress.

After the arches the aqueduct continues until, at 660 m from the rectangular basin, another wall abuts the aqueduct on the downhill side. This wall is 1.20 m long and 0.40 m high. At about 2.30 m to the east from this supporting wall a weeping hole measuring 0.20 × 0.30 m is found at the top of the aqueduct. After this point the aqueduct is often completely hidden underground and visible only intermittently further to the east. The last location where the aqueduct can be securely identified is located just over 1 km east (following the course of the structure) from the rectangular basin. Here a pit exposes the best-preserved section of the *specus* visible today (*Fig. 2e*).

Along the aqueduct a number of structures are visible, among them several built pithoi, cisterns, and tombs. Beginning from the rectangular basin, the first built pithos is located 600 m to the east along the aqueduct and just in front of the first set of supporting walls. The diameter is 0.56 m at the mouth below which the pithos expands sharply into a bulbous shape, the inside of which is covered by the same pink lining as the aqueduct. The maximum visible outer diameter is 1.45 m. Three similar built pithoi are located 4.50–5.20 m north of

house-shaped (e.g. Houses V.i.28, VI.xiv.5, and IX.vii.20) or equipped with an apsidal top (e.g. Houses VI.vii.23, VII.xv.12, and IX.v.9).

[30] Jameson & Jameson 1950, 45; Jameson *et al.* 1994, 579; Lolos 1997, 307.

[31] Similar imprints can be seen in the Hadrianic aqueduct to Corinth (Lolos 1997, 281).

the fourth and fifth arches. A fifth built pithos can be seen 1.04 km from the rectangular basin, 40 m east of the last visible aqueduct section. There is, however, no evidence for the function of these pithoi and such installations do not appear regularly along other aqueducts. Consequently no obvious connection between them can be established. Finally, along the eastern-most preserved sections of the aqueduct, remains of tombs and what appears to be the openings of cisterns, or possibly lined wells, are visible. Almost all of these are located uphill of the aqueduct.

Turning to the capacity of the aqueduct, the water channel (*specus*) is 24 cm wide, 20 cm deep (*Fig. 2e*), and made out of the, for this purpose commonly used, *opus signinum*.[32] Along the vulnerable bottom edges it is equipped with the usual quarter rounds, 6 cm wide and 3 cm high.[33] The lining is reddish with plentiful ceramic inclusions, the size of which ranges from 0.02–1.5 cm, as well as some small stones, *c.* 1 cm in size. The small dimensions of the channel suggests that the aqueduct provided a relatively limited amount of water compared to other aqueducts in Greece. Using the Manning formula Gkatsos calculated the output to 300–500 m^3 per day (300,000–500,000 l).[34] This can be compared to the Hadrianic aqueducts in Corinth (providing 80,000 m^3 per day) and in Athens (10,000 m^3 per day).[35] Yet, 300–500 m^3 per day is still significant compared to other water sources. The output of the relatively small Klepsydra Spring in Athens was only 2.4 m^3 per day when measured in August 1937.[36] The volume provided by a well is difficult to calculate but more than a few cubic metres per day seems unlikely in all but extreme cases. A cistern would, on average, provide no more than 0.5 m^3 per day and often considerably less.[37]

The Bisti cisterns

The presence of many cisterns on the Bisti promontory has been known since the inception of modern scholarship in Greece.[38] They were first noted by William Gell who wrote in 1810 that "on the point [the Bisti] are cisterns cut in the rock". Forty years later Curtius echoed this observation, adding that there were also cisterns a bit further landwards on the middle elevation around the chapel he identified as dedicated to Ioannes.[39] In the beginning of the 20th century August Frickenhaus and Walter Müller indicated on a map the location of three cisterns on the Bisti (probably cisterns **2018.10**, **2018.12**, and one not known today) and one on Pron Hill, outside the ancient city according to the authors, without any further information (*Gerding 2021, fig. 2*).[40] In 1950 the Jamesons explored Hermione thoroughly, and mentioned the Bisti cisterns in passing in an unpublished paper now kept at the American School of Classical Studies at Athens.[41] This was followed by the publication of the *Southern Argolid Exploration Project* by Jameson, Runnels and van Andel which included a chapter about Hermione, as well as other information about the city throughout the work. The cisterns on the Bisti are, however, only mentioned when discussing the city during the Roman period.[42] The Bisti cisterns were also briefly treated by Gkatsos, who summarily recorded basic traits in 1996.[43] Today the cisterns are well known locally due to their visibility. Their approximate locations are also given on a signboard at the entrance to the Bisti which is now a public park.

The fieldwork within the framework of the Hermione project recorded 14 potential cisterns during the 2018 season (*Fig. 3*). Of these, the nature of two (**2018.6** and **2018.14**) must be considered uncertain. One cistern (**2018.12**) appears to have been left unfinished in antiquity based on the lack of a lining. It is likely that a considerable number of cisterns are completely filled in and not visible today. This assumption is corroborated by the unknown cistern marked on the map by Frickenhaus and Müller (*Gerding 2021, fig. 2*) as well as a preliminary analysis of the results from Derek Pitman's magnetometry survey in 2018.[44] Scholars have also noted further ancient cisterns in the modern city of Hermione, but without providing specific information.[45] However, at least two cisterns of unknown date can be seen in the city today. One is located in an abandoned plot *c.* 85 m east of the Taxiarches Church. This cistern is completely subterranean and the visible section pithos-shaped, possibly indicating a Roman or even considerably later date. Another cistern is located *c.* 55 m north-west of the same church. This cistern probably post-dates antiquity by a considerable margin considering its shallow depth (probably no more than 2.50 m) and because the mouth is situated 0.50 m above the modern street level.

[32] This measurement is slightly larger than that given by Gkatsos (1996, fig. 15, p. 117). Grewe 2019, 75; Hodge 2002, 95–98.
[33] Gkatsos 1996, 117. Hodge 2002, 95–98. Similar quarter rounds are known from several aqueducts in Greece, e.g. in Nikopolis (Zachos & Leontaris 2018, 31) and Corinth (Lolos 1997, 281).
[34] Gkatsos 1996, 117. For the formula, see Hodge 2002, 353.
[35] Chiotis 2018, 72; Lolos 2018, 102.
[36] Parson 1943, 223.
[37] Klingborg & Finné 2018.
[38] For previous research about ancient Hermione, see Gerding 2021 in this volume.
[39] Gell 1810, 130; Curtius 1852, 457–459. For the middle elevation, see *Gerding 2021, fig. 1*, in this volume.
[40] Frickenhaus & Müller 1911, pl. 1.
[41] For the cisterns, see Jameson & Jameson 1950, 19.
[42] Jameson *et al.* 1994, 554. The sections about Hermione draw heavily on the unpublished paper by Jameson & Jameson 1950.
[43] Gkatsos 1996, 106.
[44] Frickenhaus & Müller 1911, pl. 1.
[45] Jameson *et al.* 1994, 595; Gkatsos 1996, 106.

Fig. 3. The Bisti promontory with cisterns indicated. Illustration by Patrik Klingborg, basemap by Google, ©CNES/Airbus, European Space Imaging, Maxar Technologies, Map data 2021.

METHOD

The presence of the cisterns was known already at the time of the inception of the Hermione project. However, with no reliable map of the visible remains it was necessary to perform a semi-structured field survey of the Bisti in order to securely locate all potential cisterns. During this survey 14 potential cisterns were located, 13 of which correspond roughly to those indicated on a local map at the site. Following the survey all but two of the cisterns (**2018.8** and **2018.14**) were cleaned without excavating them, i.e. loose pine needles and refuse was removed in order to allow documentation.[46] It was not possible to descend into any cistern. Each cistern was systematically measured, described, and photographed. Additionally, Stefan Lindgren used photogrammetry in order to create 3D models of all cistern openings.[47] These models were geo-referenced by Giacomo Landeschi. The models enabled further analysis after the field season including taking supplementary measurements and images, as well as observing the cisterns from angles unreachable in the field.

THE INVESTIGATED CISTERNS

The cisterns on the Bisti promontory are described below, from west to east. In the following discussion the term *body* designates the expanding chamber in the lower section of a cistern (*Fig. 4*). Above this a considerably narrower section, the *neck*, is commonly found. The top of the neck, i.e. the point where the underground section of the cistern begins, is called the *mouth*. The original mouth may have been considerably higher up than today if the ground has been cut down after its construction, or later after its abandonment. Often one or more blocks, forming a *capstone*, covered the mouth in order to protect this vulnerable section from wear. The capstone could, in turn, be crowned by a *puteal* (well-head).[48] The term *opening* designates the narrowest point through which the cistern could be accessed. In antiquity the size of the opening would usually be limited by the *puteal* or capstone. Finally, *lining* denotes the material used to make the cisterns waterproof in order to avoid otherwise common terms, e.g. cement, mortar, and plaster, suggesting specific manufacturing processes and composition.[49]

Cistern 2018.1

The westernmost cistern is found 18 m north of the south coast and 95 m from the modern south entrance to the Bisti (*Fig. 5*).

[46] The cisterns were not excavated as it would have been dangerous considering their state of preservation, and it was deemed more fruitful to study all of them in order to provide an overview, rather than focus on one or a small number.

[47] For the digital methods used by the project, see Landeschi *et al.* 2020.

[48] Klingborg 2017, 16–17.

[49] Klingborg 2017, 43–45.

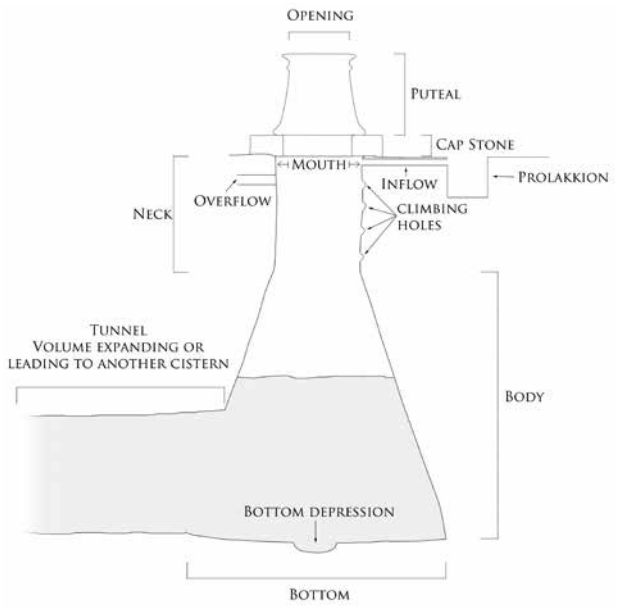

Fig. 4. Cistern section, with terminology and features indicated. Illustration by Patrik Klingborg, previously published in Klingborg 2017, fig. 1.

The cistern is filled almost to the top with modern refuse, stones, and organic material. Consequently, no more than 35 cm of the neck is visible. The mouth is formed by an irregular circle, 90 cm in diameter east–west where the full circumference can be seen. The irregularity of the mouth suggests that its ancient counterpart was higher up. The loss of the original neck and mouth is also supported by the observation that the neck seems to expand into the body just under the modern rubble. The lining in the cistern is a pale yellow, tending towards white where recently fractured. Small pebbles 0.1–0.2 cm in diameter are common in the lining. The thickness of the lining is 2–3 cm in most areas, but some sections are as thin as 1.5 cm. In a sharp bend the lining is up to 5.5 cm thick.

Cistern 2018.2

A second cistern is located at the top of the ridge, 40 m east of Aghios Nikolaos. It was filled with soil, stones, and modern refuse, with a fig tree growing in the neck (*Fig. 6*). The mouth is a slightly imperfect circle with a diameter of 90 cm both north–south and east–west. Within the mouth 35 cm (west side) to 45 cm (east side) of the neck can be seen. Below the neck the cistern begins to expand into the body which could be traced for another 100 cm in cavities in the deposited material. The lining of the cistern is pale yellow with small stone inclusions no larger than 0.6 cm. The total thickness of the lining is 0.5–2 cm. The shifting between a finer and cruder surface suggests that the cistern originally had two layers of lining: a cruder inner layer and a finer, thin, outer surface.

Cistern 2018.3

The next cistern is located 55 m south of the northern shore of the Bisti, and 210 m from the modern north entrance to the Bisti promontory. Today the cistern is visible as a rectangular depression measuring 265 × 80 cm and almost completely filled with soil, pine needles, and modern refuse (*Fig. 7*). The north side of the depression is formed by a wall belonging to the cistern's body. Perpendicular to the north wall a 20 cm stretch is preserved on the west end. Nothing of the cistern is visible on the south and east sides. As with the south and east walls, no trace of the mouth can be seen. The state of preservation suggests that a considerable section of bedrock has been cut away in this area after the period during which the cistern was used as a water source.

The northern wall of the cistern is more or less straight and 255 cm long. At 195 cm from the west end the wall turns south for 5 cm before turning east again for another 60 cm. The visible section of the west wall is 20 cm long. The maximum visible depth is 30 cm. The lining of the cistern is a pale yellow material with very small inclusions 0.1–0.15 cm in diameter with some slightly larger stones. In two places the bedrock protrudes through the surface of the lining. This seems to be the result of the original lining process, not later decay. The lining is 0.7–7 cm thick in different places and seems to be formed by a cruder inner layer and finer outer surface.

The shape of the cistern looks like it may be expanding outwards, either forming a larger body or just expanding slightly downwards. The cistern must once have been covered and possibly had a neck. It may be comparable with cisterns 1931-1 and 1940-1 at Corinth.[50]

Cistern 2018.4

Another cistern is located 45 m south of the northern shore of the Bisti and 50 m north-west of the temple foundations (*Fig. 8*). Unlike the previous cisterns this one remained unfilled to a level of 150 cm below the surface, ensuring that the capstone, neck, and upper body were visible. About 90 cm to the south of the cistern at least two stones seemed to form a wall running east–west with two further stones possibly belonging to the same stretch.

The opening of the cistern is formed by a capstone cut from one single block. While the outer dimensions of this block are unknown, the opening is circular, 50 cm deep, and slightly funnel shaped with an upper diameter of 53 cm and lower diameter of 65 cm. On the inside a thin layer may be the remains of lining or incrustations. At the south-east side

[50] Klingborg 2017, no. 219 (see also *Corinth* 7:3, 209; James 2010, 333–334) and Klingborg 2017, no. 218 (see also *Corinth* 7:3, 208; Sanders *et al.* 2014, 51; James 2010, 319; Weinberg 1948, 229–230, 235–240, fig. 1, pls. 88b–d).

*Fig. 5. Cistern **2018.1**, mouth, with a diameter of 90 cm. With detail of lining. Photographs by Patrik Klingborg.*

*Fig. 6. Cistern **2018.2**, mouth, with a diameter of 90 cm. With detail of lining. Photographs by Patrik Klingborg.*

*Fig. 7. Cistern **2018.3**, general view. With detail of lining. Photographs by Patrik Klingborg.*

*Fig. 8. Cistern **2018.4**, surface view showing the 53 cm wide opening and the repaired section. Photograph by Patrik Klingborg.*

a rectangular and slightly concave block, 40 cm long and 12 cm high, is carefully inset in the capstone, indicating that this had been damaged and repaired at some point (*Fig. 8*, top right of the cistern opening). Across from the repaired section, in the north-west side of the capstone, a depression may indicate the location of the inflow channel. A possible cutting for a lead clamp can be seen on the west surface of the capstone. Moreover, on the south side of the capstone three stones suggest that the mouth was raised during the cistern's period of use as a water source (*Fig. 8*).

Below the surface, on the west side the capstone rests on a stone beam 8–9 cm thick. This beam, in turn, rests on the natural rock outcrop, under which the cistern expands to form the body. There are no stone beams on the north, east, and south sides. Instead small stones and possibly pottery sherds were used to create a flat surface on top of the bedrock on which the capstone could be placed. Together, the use of the stone beam and small stones suggests that the cistern's mouth in the bedrock was irregular and too large for the capstone. Just below the capstone, a hole inserted in the north–north-west side of the cistern may have been an overflow.

The visible body of the cistern is estimated to be 100–150 cm in diameter and found directly below the capstone and stone beam without a neck in the proper sense. The walls are irregular rather than smooth and covered with what looks like a crude lining. Details could not be made out due to cramped conditions and a foul yellow substance which covered much of the inside.

Cistern 2018.5

On the other side of the Bisti a cistern is situated 35 m south of the central part of the edge of the temple foundations, and 25 m north of the south coast (*Fig. 9*). It was filled almost to the top with modern refuse and pine needles.

The preserved mouth of the cistern is round with a diameter of 90 cm. Below the top of the mouth the neck is clear of refuse for 35 cm. Another 10 cm of depth is visible under the rubble fill. Possibly the cistern begins to expand into the body at this point. On the north side of the mouth and neck a small outwards bulge is found, continuing from the preserved top to the visible bottom. This may indicate where the inflow was originally located. The lining is a pale yellow in colour and composed of a cruder inner and finer outer layer. Together they form a 1–9 cm thick surface, with the thickest areas being found in a "corner". The inclusions in the cruder inner layer are up to 1 cm in diameter.

About 1 m above the cistern a single lined stone block was found (*Fig. 9,* top right). It was unclear whether the block was loose or part of the bedrock. As in the cistern below, the lining on the block was executed in two layers. The inner was cruder and up to 5.5 cm thick, the outer considerably finer and only 0.7–1 cm thick. The outer layer was, however, not as smooth as that in many of the other cisterns. Near the bottom the lining makes a sharp turn from a sloping direction into a horizontal surface. It is unclear what this feature was. It may be part of the original neck of the cistern, in which case the horizontal surface probably formed a climbing hole. Such a loose climbing hole is known from a collapsed cistern at Agrileza in Attica.[51] Another possibility is that it was part of a water channel leading to cistern **2018.5** from above, possibly cistern **2018.6**. Finally, it could be part of a *prolakkion*, i.e. a water basin located before the cistern and used to remove silt and other impurities (*Fig. 4*).[52]

Cistern 2018.6

Located 8 m north of cistern **2018.5** a section of rock outcrop covered with lining is visible (*Fig. 10*). The majority of the remains are formed by a north–south section. At the north end the lining forms a half circle 20 cm in diameter. Thereafter the lining forms an irregular surface on the rock outcrop towards the south for 85 cm. The last 25 cm to the corner expands into a flat horizontal surface towards the south-west. At the south end the lined rock outcrop makes a 90 degree turn to the east and another 15 cm of lining is seen on the south-facing surface. The lining is pale yellow with pebbles inclusions ranging from a few millimetres to *c.* 1 cm.

[51] Klingborg 2017, no. 172. See also Photos-Jones & Jones 1994, 318, 323, 326, 357, figs. 1, 3, 4; Winter 1984, 467–468.

[52] For *prolakkia*, see Klingborg 2017, 38–40. These installations are rather rare for cisterns, but found at many sites (Klingborg 2017, cistern nos. 81, 143, and 143 in Athens, 208 in Argos, 210 in Asine, 251 in Corinth, 261 in Isthmia, 270 in Perachora, 292 and 293 in Olynthos, 347 on Delos, 358 in Kameiros, 390 and 391 in Larissa, and 399 in Miletos).

*Fig. 9. Photogrammetry model of cistern **2018.5**, mouth, with a diameter of 90 cm and the lined section in the top right corner. Illustration by Hanna Håkansson. With section of the lined feature. Photograph by Patrik Klingborg.*

*Fig. 10. Cistern **2018.6**, surface view. With detail of lining. Photographs by Patrik Klingborg.*

At present there is not enough evidence to identify this installation as a cistern with reasonable certainty. It is equally possibly that it was a *prolakkion* for cistern **2018.5**. The connection between cistern **2018.5** and **2018.6** is strengthened by similarity in lining and the presence of the lined feature situated between them.

Cistern 2018.7

On the north side of the Bisti, 23 m from the northern shore and 65 m north of the temple the round mouth of a cistern is found (*Fig. 11*). Almost the whole circumference is preserved, measuring 110 cm east–west and 115 cm north–south. There are no traces of lining. This may be due to the fragile nature of the bedrock in the area with pieces falling off extremely easily. The preserved neck is 40 cm deep on the south side. On the north side it cannot be traced. However, on the south side the cistern begins to expand into the body just below the modern rubble and pine needles.

Cistern 2018.9

The next cistern is found about 15 m north-east from cistern **2018.7** and 27 m to the south of the north coast. Today the mouth, neck, and upper part of the body are clearly visible to a depth of 190 cm and in a good state of preservation

*Fig. 11. Cistern **2018.7**, mouth, with a diameter of 110–115 cm. Photograph by Patrik Klingborg.*

(*Fig. 12*). The fill is a mix of rocks, organic material, and modern refuse.

The preserved mouth of the cistern is almost circular, measuring 76 cm east–west and 79 cm north–south. The maximum depth of the neck is 70 cm, but the upper 30 cm is only preserved on the west side. Below this there is a 20 cm long crack under which the full circumference of the neck is preserved, although less well on the south side, before expanding into the body. Presumably a natural crack ran through the bedrock forcing the neck to be constructed rather than cut on the south, east, and north side. Notably a large fragment of a ceramic vessel, possibly a body sherd from an amphora, was visible in the soil and stone wall above the preserved neck on the south side. It is possible that this belongs to the material used when building the upper section of the neck.

Below the neck the cistern expands into the body, gently at first and then sharply at nearly 90 degrees, forming an almost flat roof for more than a metre in all directions except east, where the vertical wall can be seen down to the level of the deposited material. This shape would give the cistern a comparably large volume. Preliminary observations also indicate that the cistern may expand into a considerable cavity or tunnel in one direction just under the deposited material.

With the exception of the upper neck above the crack, the lining of the cistern is 3 cm thick and a fairly uniform pale yellow colour. Only a small number of small pebble inclusions are visible. Above the crack the lining is very thin, no more than a few millimetres.

Cistern 2018.10

On the south side of the Bisti, about 34 m to the east of cistern **2018.6** another cistern is located, the remains of which can be divided into three sections (*Fig. 13a*). In the upper section the eastern half of the cistern's neck is preserved in a partly lined rock outcrop face. Below this the middle is formed by the full circumference of the neck. Furthest down the cistern expands into a wider body shape, filled with the ubiquitous modern refuse, rocks, and pine needles from a level 215 cm below the modern surface.

The upper section of the cistern is only preserved on the west face of the vertical rock outcrop, which is not cut to create a circular neck. It is, however, partly lined up to 85 cm above the modern surface. The lining is particularly well preserved in cracks in the rock. From the level of the modern surface the full circumference of the cistern neck is preserved. On the east side the opening is a continuation of the rock outcrop forming the upper section of the cistern's neck. On the west side the top of the mouth is formed by two fragile white stones 18–25 cm thick in the shape of a semicircle, clearly cut to fit the cistern (*Fig. 13b*). There are slight remains of lining only on the vertical face at the north-west end of these two stones. The stones would either have served as a capstone or to raise the opening of the cistern. The latter is more likely as the stone blocks would quickly have been destroyed by frequent use. At the north-west end of the stones forming the neck a depression is found. This may be a climbing hole intended to allow descent and ascent into the cistern (*Fig. 13b*, right side). A corresponding climbing hole is clearly visible on the east side of the cistern (*Fig. 13a*). This way of placing climbing holes on alternating sides is common in Greek cisterns.[53]

The neck below the mouth is 60 cm deep, irregularly oval in shape, and covered by lining. The mouth is 75 cm across east–west and 120 cm north–south. Below the neck the cistern expands into an irregular voluminous flask- or pear-shaped body.

The lining of the cistern is 1–8.5 cm thick, pale yellow, and executed in two layers. In the thicker inner layer pebble inclusions, 0.2–1 cm large, can be seen. In some areas a finer outer layer is preserved. The lining in the climbing hole on the north-west end of the mouth is partly covered by a very fine greyish white material, possible sinter.

Cistern 2018.11

The next cistern is found on the north side of the Bisti, about 25 m from the coast and approximately 45 m from the point where the coast of the promontory turns south. The opening and a large section of the body can be seen (*Figs. 14*). Inside the cistern modern refuse competed for space with a young fig tree.

With the exception of a small section in the south-west the whole circumference of the mouth, measuring 90 cm east–west and 85 cm north–south, is preserved at the modern surface level. The neck reaches a maximum depth of 40 cm. Below this the body of the cistern expands into an irregular flask

[53] Klingborg 2017, 45–46. See for example cistern nos. 169, 250, 251, 257, 259, 260, 261 and 378.

*Fig. 12. Cistern **2018.9**, mouth, with a diameter of 76–79 cm. With detail of lining. Photographs by Patrik Klingborg.*

*Figs. 13a–b. Cistern **2018.10**, a) upper section and opening, with the mouth measuring 75 × 120 cm, b) neck masonry. With detail of lining. Photographs by Patrik Klingborg.*

Fig. 14. Cistern ***2018.11****, mouth, with a diameter of 85–90 cm. With detail of lining. Photographs by Patrik Klingborg.*

shape visible to a depth of 225 cm below the modern surface. Part of the body is collapsed on the south side.

The lining of the cistern is 1–2 cm thick, but looks somewhat thicker lower into the body, perhaps reaching 4 cm. Overall, the visible lining near the surface is a pale yellow where not miscoloured and rather crude with lots of small pebble inclusions. Most of these are c. 0.3 cm in size, some up to 0.5 cm. Further down into the cistern a finer layer can be seen.

Cistern 2018.12

About 20 m directly south-east of cistern **2018.11** and 45 m south of the north coast a further cistern is found (*Fig. 15*). It is superficially similar to cistern **2018.10** with an upper section cut in a rock outcrop face and a neck continuing down below the modern surface until it expands into the body. As with the other cisterns a deposit of rocks, organic material, pine needles, and soils is visible at the bottom. Overall, this cistern is in a poor state of preservation.

The upper section of the cistern consists of a shallow cutting in a 90 cm high north-facing rock outcrop. This cutting forms the south side of the upper neck, but accounts only for a marginal part of the full circumference; however, it is distinctly shaped as part of a circular neck, in contrast to the upper section of cistern **2018.10**. On the south side of the neck a flat surface is cut into the rock 45 cm above the mouth, possibly allowing a wall to be constructed there. From the modern ground level downwards the full circumference of the cistern neck is preserved, measuring 105 cm east–west and 100 cm north–south. From the mouth the neck is gradually expanded in all directions making the transformation from neck to body almost indistinguishable. The total depth from the modern surface is 330 cm. There are no traces of lining in the cistern.

Notably, the bedrock in which the cistern was cut is very loose and flaky, fragmenting extremely easily. This would reduce the effort needed to construct the cistern, but also make it structurally unsound, as testified by the current state of preservation. The gradually expanding shape can almost certainly be attributed to the dangers of a more traditional approach. The complete lack of visible lining suggests that the cistern was never made waterproof. This may indicate that the construction was never completed, perhaps as it was viewed as unusually dangerous. A less likely possibility is that all the lining has fallen off the fragile walls. In Halieis similar installations have been interpreted as wells by Bradley Ault.[54]

Cistern 2018.13

A little way further inland, about 80 m south of the coast and 90 m to the north-west of the modern windmill, the unusually well-preserved, rectangular opening of a cistern is visible (*Fig. 16*). The opening is formed by two blocks (here termed "west" and "north") presumably belonging to the original capstone. The opening itself is covered by a massive cut block only leaving a small hole to the inside of the cistern.[55]

The west capstone block is formed by a hard stone, 20–25 cm thick and 140 cm long north–south where the east edge can be seen. A large crack runs east–west straight through the

[54] For a summary of the eleven wells in Halieis, see Ault 2005, 62–63. The wells are described as lined shafts, but lining is no longer visible in several cases.

[55] This block may belong to a wall located 2 m to the east of the cistern opening.

*Fig. 15. Cistern **2018.12**, upper section and opening. Photograph by Patrik Klingborg.*

block. The south and west end of the block cannot be seen today and at the north end it turns 45 degrees south-west, suggesting a triangular shape. The north block of the capstone measures 25–30 cm in thickness, the south side is 70 cm long, and the east side 50 cm long. The north and east sides of this capstone block are not visible. Due to the greater thickness the north capstone block stands 5 cm higher than the western one.

At the north end of the cistern there is a 25–30 cm large gap between the west and north capstone blocks. Below this the stone beam upon which they rest is visible. The beam, situated at the north end of the cistern, is 25 cm thick and runs about 120 cm east–west. As in the case of cistern **2018.4** the stone beam is propped up by smaller stones creating a flat surface. The east and south side of the cistern opening is formed by smaller and less regular blocks at the same level as the stone beam. They are of the same type of stone as the west and north capstone block.

The cistern expands into the body almost directly below the capstone blocks and stone beam. The visible surfaces of

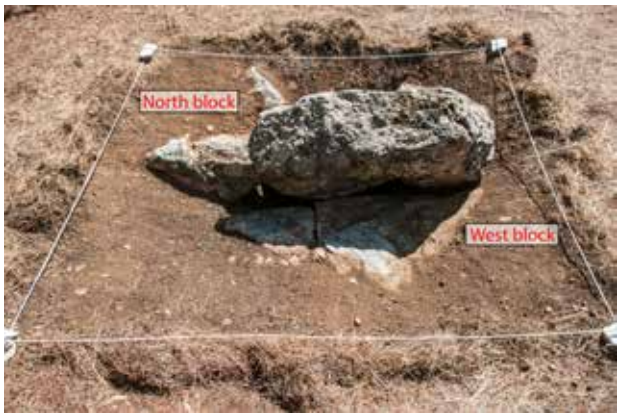

*Fig. 16. Cistern **2018.13**, surface view. Photograph by Patrik Klingborg.*

the body are covered with a smooth pale yellow lining without obvious inclusions. Some blocks in the cistern indicate that the body is partly collapsed.

OTHER CISTERNS

Two further cisterns on the Bisti, **2018.8** and **2018.14**, were not cleaned. Cistern **2018.8** has been reused in modern times and the surface structures associated with it are clearly the result of recent constructions. It was therefore not possible to record the original remains. The second, **2018.14**, is a lined space in, or possibly just outside, the ancient fortification wall hypothetically identified as a cistern.

Cistern 2018.8

The cistern located 35 m north of the north-east corner of the temple foundations is unique on the Bisti as it has clearly been reused in modern times; at least the surface structures and upper 150 cm of the neck are modern. Additionally, a basin has been constructed to the south abutting the square *puteal*. This may have functioned as a pre-basin (equivalent of the ancient *prolakkion*) when the cistern was used in recent times. It is not known from where the water was collected, as no buildings with suitable roofs exist in the area. Possibly surface run-off was used, but this would radically reduce the quality of the water.[56] The cistern seems to no longer be in use as burned wood has been dumped in it.

The mouth of the cistern is covered by a square *puteal* constructed in cement and local, roughly rectangular stones. On each corner a concrete and brick base projects upwards with a metal fastening for a (now missing) drawing mechanism. The construction technique is reminiscent of the 19th-

[56] Klingborg 2017, 34. For the quality of cistern water in Greece today, see de Kwaadsteniet *et al.* 2013.

*Fig. 17. Lining of cistern **2018.14** with miscolouration. Photograph by Patrik Klingborg.*

century wells found in the plain of Hermione.[57] On the south side a 20 cm deep basin measuring about 100 cm north–south is constructed in the same technique as the *puteal*. The inside is lined in order to make it waterproof and the bottom dips slightly towards the cistern and opening through the puteal. The lining inside the cistern seems to be modern to a level about 150 cm below the surface. At this point the colour and structure of the lining appears to change. The neck extends another 50 cm before expanding into a typical flask, or possibly pear, shape.

Cistern 2018.14

In the ancient fortification wall near the east tip of the Bisti a subterranean space is partly preserved, previously interpreted as a prehistoric tomb (*Gerding 2021, figs. 3.11, 13*).[58] The walls are formed by roughly cut rectangular limestone blocks of various sizes, ranging from no more than a few decimetres to upwards of a metre. The west wall is fully preserved. In 1950 it was reported as three metres high.[59] The north and south walls reach the full height in the west, diminishing towards the east until only one course is preserved. The south wall leans inwards, giving the structure a vault-like appearance. Only one small block remains of the east wall. One large flat block remains of the ceiling.

The lining is similar to that in the cisterns on the Bisti. It is a pale yellow in colour and applied in a cruder inner and finer outer layer. The thickness of the inner layer varies from less than a centimetre to several centimetres. In this layer there are inclusions of small stones or sand, but no pebbles. The outer finer layer is only a few millimetres thick, considerably smoother than the inner layer, but otherwise similar in nature. Lining has also been applied between the stones in the corners, corroborating the impression that the space was intended to be waterproof. The surface of the lining is not flat as in a room. Instead it undulates as in cisterns, forming a smooth but uneven surface. Moreover, about half way up between the ceiling and modern ground surface a miscolouration is visible (*Fig. 17*). Such miscolouration has been interpreted as indicating the water level in cisterns from Athens, Corinth, and Sparta.[60] Aristotle (*Col.* 794b) also writes that "anything moist, as has been said, as it grows old by itself and dries up, becomes black, as plaster does in its receptacles [δεξάμεναι]".[61]

Considering the nature of the structure the interpretation as a tomb is clearly incorrect. Instead the space may have been a cistern as indicated by the lining on the walls.[62] Cistern **2018.3** at Hermione offers a local parallel in terms of shape. Cisterns have also been found in connection to fortifications at other sites, where they presumably served soldiers or guards on watch. The most comparable examples in terms of potential function are found in Rhamnous, Corinth, and Phalasarna.[63]

CONNECTIONS AND CONTRASTS BETWEEN THE CISTERNS

Looking at the general characteristics, the cisterns on the Bisti are fairly uniform in terms of construction, with the exception of **2018.3**, **2018.6**, and **2018.14**. This reflects the situation at other sites as one construction method tends to dominate.[64] Ten of the cisterns (**2018.1**, **2018.2**, **2018.4**, **2018.5**, **2018.7**, **2018.8**, **2018.9**, **2018.11**, **2018.12**, and **2018.13**) have circular mouths. Of these the diameter for cisterns **2018.1**, **2018.2**, **2018.5**, **2018.9**, and **2018.11** ranges between 75 cm and 90 cm, which is common compared with the material at other sites.[65] The only well-preserved capstone (cistern **2018.4**) has a considerably smaller opening with a minimum diameter of 53 cm. This is also in line with comparanda.[66] The opening in the partly preserved capstone of cistern **2018.13** was probably about 75 cm in the north–south direction,

[57] Gkatsos 1996, 227.
[58] Philadelpheus 1909, 175; Jameson & Jameson 1950, 35; Gkatsos 1996, 99–100.
[59] Jameson & Jameson 1950, 35.
[60] Klingborg 2017, 44–45. For Athens, see Klingborg 2017, nos. 15 and 67. For Corinth, see Klingborg 2017, no. 238. For Sparta see Catling 1976–1977, fig. 33 (Klingborg 2017, no. 271).
[61] Translation by Hett 1936. "Δεξαμενή" was a fairly common word for cistern (Klingborg 2017, 66–71), see e.g. the Astynomoi inscription from Pergamon (*OGIS* 483). For a cistern with such miscolourations, see e.g. Stroszeck 2012, fig. 2.
[62] The presence of lining is also noted in Jameson & Jameson 1950, 36.
[63] Klingborg 2017, 110–112, see nos. 204 at Rhamnous, 241 and 242 at Corinth, and 376 at Phalasarna.
[64] Klingborg 2017, 113–116.
[65] Klingborg 2017, 32–33.
[66] Klingborg 2017, 32–33; Lang 1949, 120–121.

just slightly too large for most *puteals*.[67] The mouths of the unlined cisterns (**2018.7** and **2018.12**) are just above 100 cm in diameter. The slightly larger dimensions can be attributed to a lack of lining as this would have reduced the diameter by 2–20 cm, and the increased erosion of the unprotected surface. Thus, in terms of the size of the mouths the cisterns are consistent.

Below the circular mouths a vertical neck was cut, leading down to an expanding body. The length of the preserved necks varies from 35 cm to 145 cm. But although this is comparable to the material from the area around the Athenian Agora, the degree to which it reflects the original situation is uncertain considering that the bedrock seems to have been cut down in many cases.[68] In other cisterns fills prevent observations. Of the cisterns without a circular opening, cistern **2018.14** is a built structure incorporated in the walls of Bisti. Cistern **2018.3** is missing the entire upper section and may have had a circular opening. Cistern **2018.6** may have been a *prolakkion* for cistern **2018.5.**

The lack of excavations makes it impossible to ascertain depth and volume of the cisterns. Excluding those that are more or less completely filled in (**2018.1**, **2018.2**, **2018.3**, **2018.5**, **2018.6**, and **2018.7**) or cannot be measured for other reasons (**2018.8** and **2018.13**), the current depth ranges from 150 to 330 cm (**2018.4**, **2018.9**, **2018.10**, **2018.11**, **2018.12**, and **2018.14**). There can be no doubt that these figures represent a minimum depth as the general shape in all cases suggests a far greater total figure. In one case, cistern **2018.7**, it is possible to observe but not measure deeper sections. Yet, comparable cisterns in Olynthos and Athens tend to be up to 7 m deep. Based on this the cisterns in Hermione could probably hold between 15 and 30 m^3 of water.[69]

The lining is similar in all cisterns, although it was impossible to capture this adequatly on photographs due to the difficult circumstances in terms of available light and space. Overall, the impression was that the colour of the lining was a pale yellow in all cases. In Corinth this colour has been associated with the pre-Roman period.[70] Utilitarian linings from the Roman period, on the other hand, were viewed as commonly including crushed ceramic material manifested as ceramic inclusions and a pale pink colour. This is completely lacking in the lining of the Bisti cisterns. It is, however, debatable from what date crushed ceramics were used in linings. Wolfgang Müller-Wiener noted that this, otherwise with the Roman period associated practice, is attested in the Hellenistic period, for example at the bath in Gortys.[71] In Pergamon Werner Brinker dated cisterns with terracotta in the lining to the 2nd century BC onwards.[72] Kai Wellbrock associated pink cement used to waterproof pipes at the same site with the Byzantine period.[73] In contrast to the cisterns the aqueduct lining is a pale pink in colour, further corroborating the notion that the cisterns are pre-Roman. In the end, although at least some ceramic inclusions would be expected in a post-Hellenistic lining, the lack of ceramic material should not be taken as an absolute indication of date.

In seven of the nine cisterns where lining was preserved and could be documented two layers were found (**2018.2**, **2018.3**, **2018.5**, **2018.6**, **2018.10**, **2018.11**, and **2018.14**). In all of these there was an inner, cruder, lining and an outer finer one. These would have been made at the same time, essentially forming two sub-layers of one lining. This is common in Greek cisterns.[74] In cisterns **2018.1** and **2018.9** only a cruder lining could be observed. It is possible that the outer layer had been destroyed in the areas that could be examined. All inner linings had small pebble inclusions, often plentiful.

In terms of chronology cisterns are difficult to date due to a lack of a clearly defined gradual typological development. Often the date of the fills in cisterns are used to pinpoint their time of use, but this is problematic methodologically.[75] The lack of excavations furthermore eliminates this approach. However, cisterns were very rare before *c*. 400 BC and there is no indication that those in Hermione would predate this point. Their general flask or pear shape is also common in Late Classical and Hellenistic cisterns, while later cisterns tend to be rectangular, often with vaulted covers, and bricks used at least partly in the construction.[76] The lack of ceramics in the lining also suggests a Late Classical or Hellenistic date of construction.

After the PoPU (period of proper use i.e. as water sources) the cisterns were abandoned. In the current material seven of the cisterns are only partially filled in today (**2018.4**, **2018.8**, **2018.9**, **2018.10**, **2018.11**, **2018.12**, and **2018.13**). During the cleaning of cistern **2018.1** a local informant related that the cistern had not been completely filled previously and that there were metres of modern refuse in it. This suggests that the cistern's fill is recent. Considering the presence of modern refuse in all other cisterns it seems likely that many were more or less empty until not long ago.[77]

[67] Klingborg 2017, 40–42; Lang 1949.
[68] The bedrock has, however, also been cut down at the Athenian Agora in many cases, creating a similar situation (Klingborg 2017, 32–33, see e.g. no. 94).
[69] Klingborg 2017, 26. For a comparison see the cisterns at Olynthos (Klingborg 2017, nos. 289–307; *Olynthus* 8, 307–309).
[70] *Corinth* 2, 20.
[71] Müller-Wiener 1988, 53. Cf. Ginouvès 1959, 106–106.
[72] Brinker 1990, 32–33; *Corinth* 2, 35, 74. Cf. Vitr. 7.4.1.
[73] Wellbrock 2016, 84.
[74] Klingborg 2017, 44.
[75] Klingborg 2019.
[76] Klingborg 2017, 52–66.
[77] Compare to Syedra, Turkey, where the cisterns were filled in with brush when the site was cleaned (Murphy & Can forthcoming).

The fact that many of the cisterns are not completely filled indicates that they have either been cleaned out in later periods or were never filled to begin with.[78] The latter is far from unknown but remains unlikely for so many cisterns in close proximity.[79] It is therefore likely that the cisterns have been cleared. Possibly they were intended to be, or have been, reused as with cistern **2018.8**. This reuse may be modern or from when the Bisti was a fort. Equally possibly early explorers, in particular Michel Fourmont or Alexandros Philadelpheus, may have cleared the cisterns in order to make archaeological finds.[80]

THE CISTERNS IN CONTEXT

The cisterns on the Bisti can elucidate important aspects of life in ancient Hermione, both on a private and public level. In particular, they have the potential to provide evidence for the chronology, urban structure, and life in the city.

Notably, the cisterns are unevenly located on the Bisti (*Fig. 3*). Eight (**2018.3**, **2018.4**, **2018.7**, **2018.8**, **2018.9**, **2018.11**, **2018.12** and **2018.13**) are found on the north side, only one (**2018.2**) on the ridge, and five on the south side (**2018.1**, **2018.5**, **2018.6**, **2018.10**, and **2018.14**). Eight of the cisterns (**2018.3**, **2018.4**, **2018.5**, **2018.6**, **2018.7**, **2018.8**, **2018.9**, and **2018.10**) are located in the central area. Only two (**2018.1** and **2018.2**) are located in the western third of the promontory and four (**2018.11**, **2018.12**, **2018.13**, and **2018.14**) on the eastern third. Of the cisterns almost half (6 out of 14) are located between 20 and 25 m from the water-line (**2018.7**, **2018.9**, and **2018.11** on the north side, **2018.1**, **2018.5**, and **2018.10** on the south side).

The location of the cisterns can illuminate the layout of the ancient city as the vast majority of cisterns, up to 85%, were located in private dwellings.[81] Consequently, the presence of cisterns strongly suggests areas where private houses were located. On the Bisti the specific location of cisterns **2018.7**, **2018.9**, and **2018.11** may also indicate where a row of private dwellings was located. A less clearly distinguishable row of cisterns may indicate a second row of houses 40–50 m from the water-line (**2018.3**, **2018.4**, and **2018.12**, all on the north side).

In contrast to domestic areas, public spaces, *agorai* in particular, tend to lack cisterns.[82] While absence of evidence is not evidence of absence, the fact that only one of the cisterns (**2018.2**, at the west end) is known from the ridge of the Bisti may therefore suggest that this central area was dedicated to public structures. This notion is corroborated by the existence of the centrally located "Temple of Poseidon" and the monumental round structure close to the eastern tip (*Gerding 2021, figs. 3.2, 3.10*).[83]

Similar to the spatial distribution, the number of cisterns reveals aspects of life in the city. On the Bisti there are 1.4 cisterns per hectare.[84] This can be compared to Olynthos, destroyed in 348 BC, with 4.2 cisterns per excavated hectare.[85] The city is also similar in terms of a lack of other water resources. Yet, the cistern density at Olynthos is dwarfed by that around the Athenian Agora with almost 17 cisterns per hectare.[86] Similarly, 18 cisterns per hectare are recorded in *Insula* II–IV and VI of the Theatre quarter on Delos.[87]

There are many possible reasons for this relatively low cistern density on the Bisti. Chiefly, the excavations in Olynthos, around the Athenian Agora and the *Insulas* of the Theatre Quarter on Delos have been very thorough and unlikely to have missed any significant number of cisterns. In contrast to this it is likely that many cisterns remain unknown on the Bisti.

But if the number of cisterns on the Bisti was indeed considerably lower per hectare than in those cities, then other explanations are needed. Cost was probably an important factor as cisterns were expensive to construct, perhaps representing a year's income in the Late Classical period.[88] The population in a smaller and less prosperous city than Athens and Delos may accordingly not have been able to construct as many cisterns. But there is no reason to believe that Olynthos was considerably wealthier than Hermione. A more intriguing possibility is that the low number of cisterns is linked to the move of the city from the Bisti to the Pron.[89] This move is attested in the literary sources, Pausanias in particular, and generally accepted, but the exact date is unclear.[90] The low number of cisterns on the Bisti may suggest that it occurred before a large segment of the population had the opportunity to construct such installations. In practice this would mean not too long after 350 BC, assuming that cisterns became popular in Hermione at the same time as in the rest of the Greek world, i.e. from the early 4th century BC.

[78] On fill processes in cisterns, see Klingborg 2017, 52–65; 2019.
[79] Klingborg 2019, 49–50. For examples of empty cisterns, see the House of the Consul Attalos in Pergamon (Dörpfeld 1902, 168, 171, 182, fig. 1; 1907, 26–29, fig. 3; no. 410 in Klingborg 2017; no. 147 in *AvP* 1:4) and a cistern in Piraeus (von Eickstedt 1991, 232, no. 2.247; Klingborg 2017, no. 196).
[80] Fourmont is known to have destroyed medieval buildings on the Bisti in search for inscriptions (Jameson *et al.* 1994, 587).
[81] Klingborg 2017, 75, 108, 110.
[82] Klingborg 2017, 105–108.
[83] Jameson & Jameson 1950, 36.
[84] Area 10 ha; 14 cisterns.
[85] Cahill 2002, 31 (4.5 ha excavated); Klingborg 2017, nos. 289–307 (19 cisterns known).
[86] 152 cisterns (Klingborg 2017, nos. 1–152) in the area excavated by the American School of Classical Studies at Athens around the Athenian Agora (see Klingborg 2017, fig. 44), about 9 ha excluding the area of the Agora itself.
[87] 23 cisterns (Klingborg 2017, 118 n. 759). The area of *Insula* II–IV and VI is approximately 1.25 ha.
[88] Klingborg 2017, 72–75.
[89] For a discussion of this, see Gerding 2021 in this volume.
[90] Paus. 2.34.10–11. Jameson *et al.* 1994, 587.

Finally, a study of two cisterns in Olynthos and Dystos showed that a cistern could usually be expected to support basic needs of drinking, cooking, and limited hygiene for a household of seven individuals throughout the year.[91] Industrial production, regular bathing, and other activities demanding larger volumes of water would require access to other sources of water. Yet, the famous purple production of Hermione would not be affected by this as the manufacturing utilizes salt water.[92] But even considering this, the known cisterns on the Bisti would not be nearly enough to support the population. The currently available evidence therefore suggests that additional water sources existed in the city or that the population on a regular basis acquired water from sources further away.

Summary and conclusions

Ancient Hermione had access to fresh water from a number of natural and artificial water sources. The former included a watercourse which at some point came to flow through the plain north of the Pron towards Limani Bay, and a bountiful fountain fed by a natural spring or ground water. The inhabitants of the city also used wells and cisterns, as well as a Roman aqueduct and a fountain house presumably fed by this. Of these water sources the aqueduct and the cisterns on the Bisti promontory are the only preserved and securely identified components of the ancient water supply system.

The fieldwork conducted in 2018 recorded 14 structures on the peninsula, of which twelve are certainly identified as cisterns. Individually they testify to the domestic interest in, or need to, secure the water supply in the city. Constructing them was expensive, and required specialized labour and know-how. As a group they are, with three exceptions (**2018.3**, **2018.6**, and **2018.14**), quite uniform in terms of construction technique, materials used, and size. Collectively, the cisterns can illuminate the urban structure of ancient Hermione, as their presence strongly indicates areas occupied by domestic dwellings. In particular, a line of cisterns (**2018.7**, **2018.9**, and **2018.11**) on the north side of the Bisti seems to indicate a row of private houses, allowing us to begin visualizing the layout of the area. However, while the cisterns could provide the inhabitants with water for drinking, cooking, and limited hygiene, they would not be able to support more water-intensive activities including much industrial work.

Lastly, even as this study of the cisterns has improved our knowledge of ancient Hermione, the water supply still offers great research potential. The aqueduct remains largely unpublished and there can be little doubt that there are many unknown cisterns on the Bisti. In particular, excavation in and around a cistern, especially one with an uncontaminated deposit, would be able to improve our understanding of life in the city considerably as it would testify to domestic architecture, private material culture, and how individuals secured access to the basic necessity of life that water was and still remains.

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[91] Klingborg & Finné 2018.
[92] Susmann 2015, 92.

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