SKRIFTER UTGIVNA AV SVENSKA INSTITUTET I ATHEN, 8°, 23
ACTA INSTITUTI ATHENIENSIS REGNI SUECIAE, SERIES IN 8°, 23

Going against the flow

Wells, cisterns and water in ancient Greece

Edited by Patrik Klingborg

STOCKHOLM 2023

EDITOR

Dr Julia Habetzeder, Stockholm

SECRETARY'S & EDITOR'S ADDRESS

Department of Archaeology and Classical Studies
Stockholm University
106 91 Stockholm, Sweden
secretary@ecsi.se | editor@ecsi.se

DISTRIBUTOR

Eddy.se AB
Box 1310
621 24 Visby, Sweden

For general information, see https://ecsi.se
For subscriptions, prices and delivery, see
https://ecsi.bokorder.se

Published with the aid of grants from Enboms donationsfond, Riksbankens jubileumsfond, Helge Ax:son Johnsons stiftelse and Gunvor och Josef Anérs stiftelse
The English text was revised by Rebecca Montague, Hindon, Salisbury, UK

ISSN 0081-9921
ISBN 978-91-7916-067-8

Printed by Taberg Media Group Stockholm, Sweden

ABSTRACT

Despite the prevalent picture of the water supply in the ancient world as being dominated by fountains and aqueducts, the large number of excavated wells and cisterns show that these were the primary water sources for most individuals. Yet, little research has been done on their construction, function and use. This prompted the organization of the workshop *Going against the flow. Wells, cisterns and water in ancient Greece*, held at the Swedish Institute at Athens on 28–29 September 2017, and subsequent publication of the contributions in this volume. The ten papers presented here offer new evidence as well as a wide range of new perspectives on the use and function of wells and cisterns in ancient Greece. Considering the ubiquity of these installations in every type of setting during antiquity, from pan-Hellenic sanctuaries and civic centres to domestic workshops and remote farmhouses, it is hoped that the breadth of interest among the authors will allow other scholars to advance their own work further, illuminating new and exciting aspects of life in ancient Greece.

Keywords: wells, cisterns, water supply, ancient Greece, archaeology, climate, sanctuaries

https://doi.org/10.30549/actaath-8-23

Edited by Patrik Klingborg

Swedish Institute at Athens
Mitseon 9, 117 42 Athens, Greece
patrik.klingborg@sia.gr

Department of Archaeology and Ancient History
Uppsala University
Thunbergsvägen 3H, 752 38 Uppsala, Sweden
patrik.klingborg@antiken.uu.se

Cover illustration: section of typical ancient Greek cistern, by Patrik Klingborg
Dust jacket: Photograph by Pavlos Karvonis. The rights of the depicted monuments belong to the Hellenic Ministry of Culture and Sports (Law 3028/2002). Delos falls under the responsibility of the Ephorate of Antiquities of Cyclades, Hellenic Ministry of Culture and Sports

YANNIS LOLOS

3. Water provisioning in a marine terrace environment

The cases of Corinth and Sikyon in the north-eastern Peloponnese

Abstract

This paper discusses how Corinth and Sikyon, the two major cities of the north-eastern Peloponnese, managed their water resources in antiquity with particular emphasis on wells and cisterns. Corinth provides some of the best examples demonstrating the ingenuity of its inhabitants that allowed a city of this size to make do without seeking external water sources for almost a thousand years. Hundreds of wells and cisterns have been explored since the early years of the excavations of the American School of Classical Studies at Corinth, along with extensive interconnected galleries and other subterranean hydraulic systems. Although Sikyon is much less explored archaeologically than Corinth, the present evidence suggests that wells dug down to the aquifer were the primary source of water for the inhabitants of the Hellenistic and Roman city. Thanks to the intensive urban survey led by the present author between 2004 and 2009, dozens of these wells were mapped and recorded, occasionally revealing interesting details of their upper structure.*

https://doi.org/10.30549/actaath-8-23-03

* I would like to thank the organizer of the symposium, Patrik Klingborg, for inviting me to participate in the workshop and for his hospitality. I am also grateful to him and to the other contributors for their comments and discussion during and after the workshop.

The water supply of Corinth and Sikyon

In ancient Greek thought underground water flow was a fascinating phenomenon.[1] For Strabo (9.2.16–18), who had a special interest in hydrology, waters follow either a subterranean course, inside channels, or a surface route, forming lakes and rivers. Pliny the Elder imagined water penetrating the earth "by means of a network of veins radiating within and without, above and below" (*HN* 2.166).[2] Seneca the Younger is even more explicit: "There is vacant space underground; moreover, all liquid by its nature is carried to a lower and empty region. And so the rivers received into that empty region continue their course out of sight, but as soon as anything solid meets them so as to obstruct them they burst through the section that offers the least resistance to their exit, and recover their course on the surface" (*Q Nat*. 3.26.3).[3] Such statements show that ancient Greeks and Romans had some basic understanding of how springs were formed, with rainwater seeping into the earth and eventually finding an outlet on the surface. Seneca's statement fits well both Corinthian and Sikyonian hydrology. I shall begin by outlining the basic

[1] For a brief discussion of ancient perceptions of the hydrology see Robinson 2011, 23–26.
[2] Translated by Rackham 1938.
[3] Translated by Corcoran 1971.

geology of the north-eastern Peloponnese with emphasis on hydrology, and continue by discussing how the inhabitants of this area, Corinthians and Sikyonians, sought to fulfil their water needs based on local resources.

The northern Peloponnesian landscape is characterized by a series of marine terraces, running approximately parallel to the coastline. These successive terraces, which rise from the coast inland in a staircase formation, are the result of episodic uplift of the peninsula, extensional faulting and eustatic sea-level fluctuations during the last 500,000 years. Because these processes have been at work over such an extensive period of time, the geological stratigraphy differs from one place to the next. The Pliocene marly surfaces were overlaid unconformably by Pleistocene marine sediments, limestones, conglomerates and coarse sands, which in some places were eroded away, thus exposing the marl and producing badland formations.[4] The centres of ancient Corinth and of Hellenistic Sikyon were founded on respective terraces, formed some 200,000 years ago (see map in *Chapter 1*, *Fig. 3*).[5] Rainwater which seeps down the porous clastic sediments is trapped at the intersection with the impermeable marly substratum, thus forming an underground water table. The typical way of tapping the aquifer was by digging wells but the underground water also gushed as springs at specific spots along the terrace margins. In Corinth, the "trapezoidal flat area" (τραπεζώδες επίπεδον χωρίον) that the city occupies according to Strabo's description (8.6.21) was divided into two marine terraces, approximately 200,000 and 120,000 years old, by a ledge 10–35 m in height.[6] We know at least 24 springs emerged along the edges of these terraces, including Peirene and the Sacred Spring in close proximity to the Temple Hill, and the so-called "Baths of Aphrodite" *c.* 200 m east of the Asklepieion (*Fig. 1*).[7] In some cases ancient Corinthians enhanced the springs' outflow by means of tunnels dug into the aquifer, and architecturally elaborated the spot by building monumental facades. Catchment tunnels ranged from short stretches to a network of galleries, whereas the monumentalization of the spring was done in stages, and was subject to renovations and remodellings, often extensive. Thanks to the efforts of a number of scholars, especially those of Bert Hodge Hill, Oscar Broneer, Henry Robinson, Charles Williams, Mark Landon and Betsey Robinson, we know a great deal about the archaeology of these springs and fountains. Peirene, the emblematic fountain of Corinth and one of the most famous fountains of the Graeco-Roman world, was served by a network of catchment tunnels stretching over a kilometre in length through aquiferous bedrock (*Fig. 2*). A number of manholes, placed at intervals, gave access to the tunnels.[8]

In the case of Sikyon, three springs are known, all located along the eastern slope of the plateau, i.e. along the scarp of the 216 kiloannum marine terrace, but none has been excavated (see below, *Fig. 11*).[9] Moreover, in Ottoman and Early Modern times all three springs acquired fountains which certainly altered their past configurations. The spring of Mikri Vrysi is almost certainly to be associated with the "Dripping Fountain" seen by Pausanias before he reached one of the city gates (Paus. 2.7.4): "By the gate they have a spring in a cave, the water of which does not rise out of the earth, but flows down from the roof of the cave. For this

[4] On the geology of the northern Peloponnese see Higgins & Higgins 1996, 40–45; Keraudren & Sorel 1987; Hayward 2003, 15–17.
[5] See Hayward 2003, 16–17 (on Corinth) and Hayward 2021 (on Sikyon).
[6] *Corinth* 1:6, 15–16; Hayward 2003, 16–17.
[7] Landon 2003, 47, fig. 3.1; Robinson 2013, 343–344, fig. 1; Robinson 1962, 124–126.
[8] Robinson 2011, 11–14.
[9] Lolos 2011, 107–109; Hayward 2021.

reason it is called the Dripping Spring."[10] It is possible that this "cave" was entirely or partly artificial, that is, created by cutting back the marl from beneath the overlying natural ledge of conglomerate and sandstone, and that the water flow was augmented by means of a supply tunnel barely visible today. The two other springs, located further to the south, at the gully of Megali Vrysi, still to the present day discharge significant quantities of water. Both are located right at the contact of the harder Pleistocene sediments with the softer and impermeable Pliocene marl underneath. Here too tunnels have been observed, cut into the base of the cliff with their roofs at the level of the aquifer.

Table 1. Monthy and annual average precipitation (in mm) at the Corinth (1971–1983) and Sikyon (1981–1987) meteorological stations. Voudouris 2001, 23.

	Corinth	Sikyon
January	58	58.6
February	61	79
March	36.2	61.3
April	24.9	54.3
May	24	16.7
June	8.8	7.3
July	6.4	1.4
August	4	6.8
September	14.3	7.3
October	58.2	58.5
November	56.3	68.7
December	56.9	64.1
Annual average	409	484

WELLS AND CISTERNS IN CORINTH

In Corinth, as well as from springs, access to the water table was also ensured by means of wells. Strabo commented on the abundance of well shafts in Corinth (8.6.21), which also made an impression on many early European visitors to the city from the 17th century onwards.[11] This is what Thomas Wyse, who was in Corinth in 1858, wrote in relation to this phenomenon: "the wells and springs are so numerous, that modern Corinthians love to boast that they equal in number the days of the year".[12] In fact, more than 500 ancient and medieval wells, manholes and cisterns have been recorded in Corinth since 1896, when the excavations of the American School of Classical Studies at Athens began.[13] They certainly represent a part, perhaps even a small part of the total number of these hydraulic works, given that only a fraction of ancient Corinth has been excavated, and the rest has never been systematically surveyed. A comprehensive treatment of Corinthian wells and cisterns is still to be made,[14] and the extant publications are mostly concerned with the contents instead of the structure itself. Exceptions to these are the network of interconnected galleries beneath the western end of the South Stoa, the system feeding the wells of the South Stoa itself, and the massive subterranean hydraulic system of Anaploga, approximately 1 km south-west of the Roman Forum. All three demonstrate the high technical skills and inventiveness of ancient Corinthians, who managed to meet their water needs from local sources for almost a millennium.[15] This is a remarkable feat considering the size of the city and the fact that Corinth is a dry region, with annual precipitation of a little over 400 mm, unevenly distributed throughout the year (*Table 1*).[16]

The galleries under the South Stoa constitute an extensive cistern which runs over a to-

[10] Translated by Jones 1918.
[11] See Landon 2003, 54–55.
[12] Wyse 1865, vol. 2, 322.
[13] See Landon 2003, 54–55 with nn. 42, 47.
[14] This desideratum was pointed out by Landon 1994, 4; 2003, 55.
[15] That is, up to the construction of the aqueduct bringing water from Stymphalos under Hadrian's reign.
[16] As stressed by Landon 2003, 43.

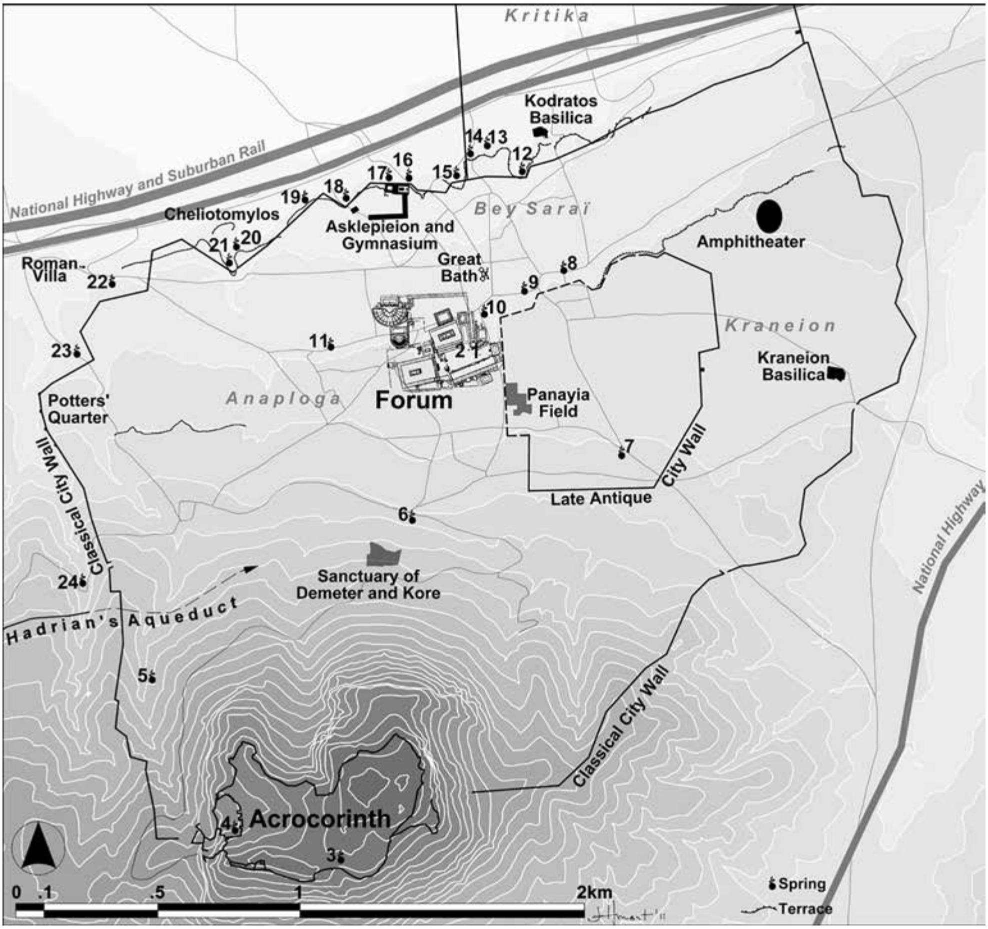


Fig. 1. Location of Corinthian springs. Robinson 2013, fig. 1.

tal distance of some 45 m (*Fig. 3*).[17] Broneer argues convincingly that their winding course must be due to the fact that the cistern's water served several establishments that existed in the vicinity prior to the construction of the South Stoa. The dimensions of the galleries vary, from 1.40 to 1.60 m in width, and from 1.90 to 2.75 m in height. The water source feeding this system has not been confirmed—it may be underground sources, perhaps the same ones as those that feed the fountain of Hadji Mustafa further up the slope, and possibly the roofs of surrounding buildings. The water in it was drawn via shafts, of which one is oval-shaped 1.10 × 1.70 m. This manhole extends to a depth of *c.* 30 cm below the floor of the cistern, and a catch basin cuts across the gallery a short distance to the north of the manhole (*Fig. 4*). Measuring 0.60 m (width) × 0.63 m (depth), this basin likely served to prevent silt from reaching the point where the water was drawn although other explanations have been

[17] See *Corinth* 1:4, 12–17; Klingborg 2017, nos. 214–215 (p. 217).

Fig. 2. Line of subterranean channels. ASCSA.net: Corinth Excavations, overlaid on ortho-rectified aerial photograph provided by Yannis Lolos.

also put forward.[18] The access shafts at the north-east and south-west ends of the galleries have steps cut out of the bedrock and leading down to the floor of the tunnel. They were obviously for cleaning the reservoir. The steps, as with the rest of the reservoir, are covered with a heavy coat of waterproof stucco, *c.* 3 cm thick, and are bevelled at the edge to prevent damage to the stucco.[19] Another point of interest is the presence of two stone piers built at the junction of two galleries with shafts 0.47 m wide, 0.30 m thick and 2.17 m high, which also feature bevelled edges and are topped by plain capitals.

The oval manhole mentioned above was not the only one found in the area: a second one, 0.97 × 0.56 m, leads to a much smaller and very narrow cistern, seemingly unconnected to the one just presented above, despite its close proximity (the south end of the cistern comes within just 0.55 m of the north wall of the western gallery).[20] What is remarkable here is the care and accuracy with which the waterproof cement is applied to the walls of the cistern despite the narrowness of the space (*c.* 0.50 m).

Broneer dated both cisterns to the middle of the 4th century BC, since both were abandoned and partly destroyed when the foundations of the South Stoa were laid, but he admits that immediate evidence for the date of their

18 See the discussion in Klingborg 2017, 48–50.
19 Note that the terms stucco, cement, mortar and plaster are used interchangably for water proof linings in this chapter.

20 Klingborg 2017, no. 216 (p. 218).

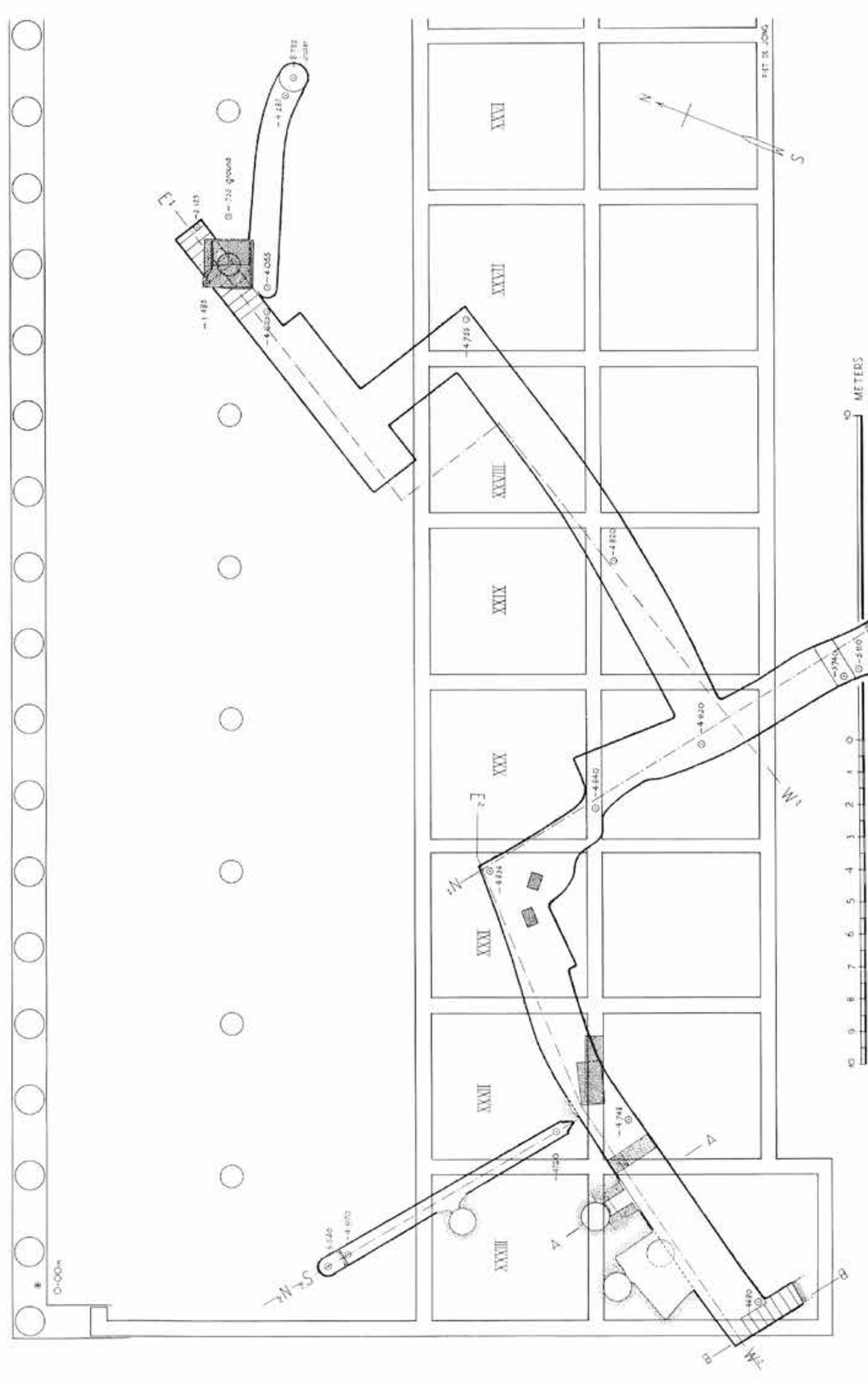


Fig. 3. The galleries under the South Stoa. Corinth I.4, plan VII.

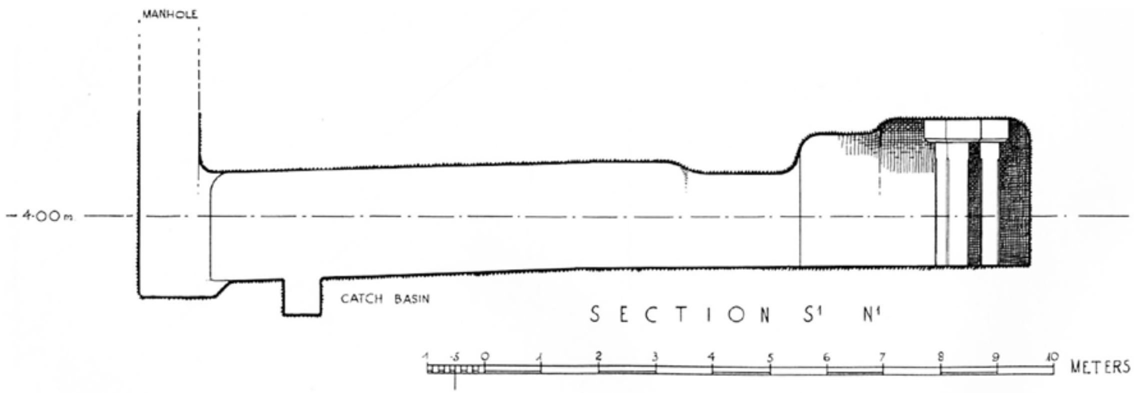


Fig. 4. Section S1–N1 of the great cistern under the South Stoa. Corinth *1.4, plan VIII.*

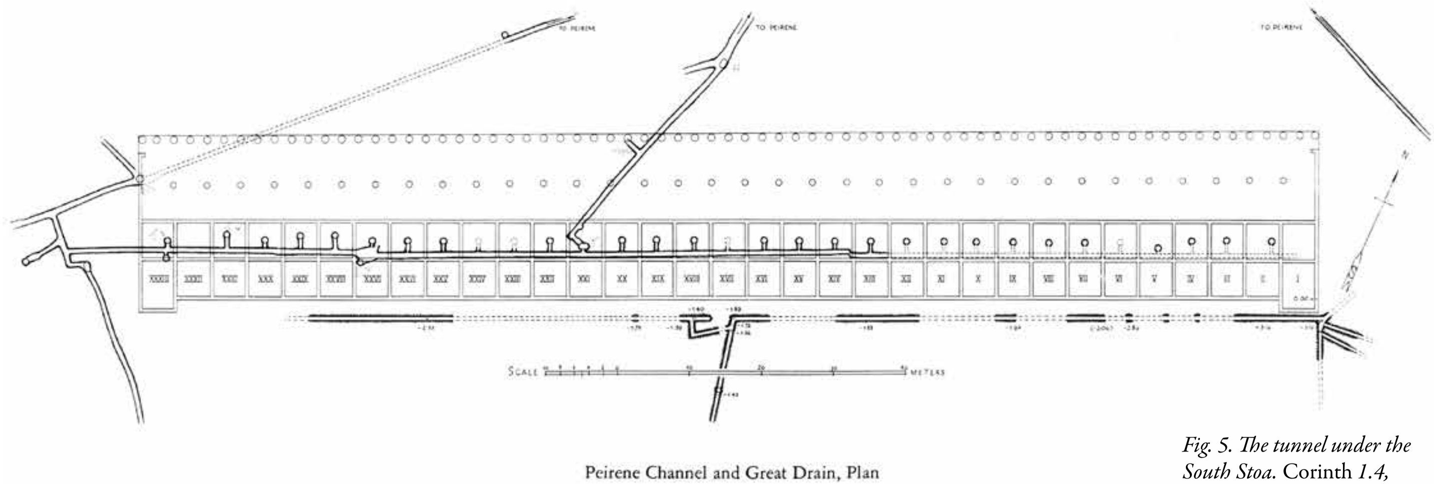


Fig. 5. The tunnel under the South Stoa. Corinth *1.4, plan IX.*

construction is lacking. At least we have a *terminus ante quem* for the construction of these systems: *c.* 300 BC when the South Stoa came into being.

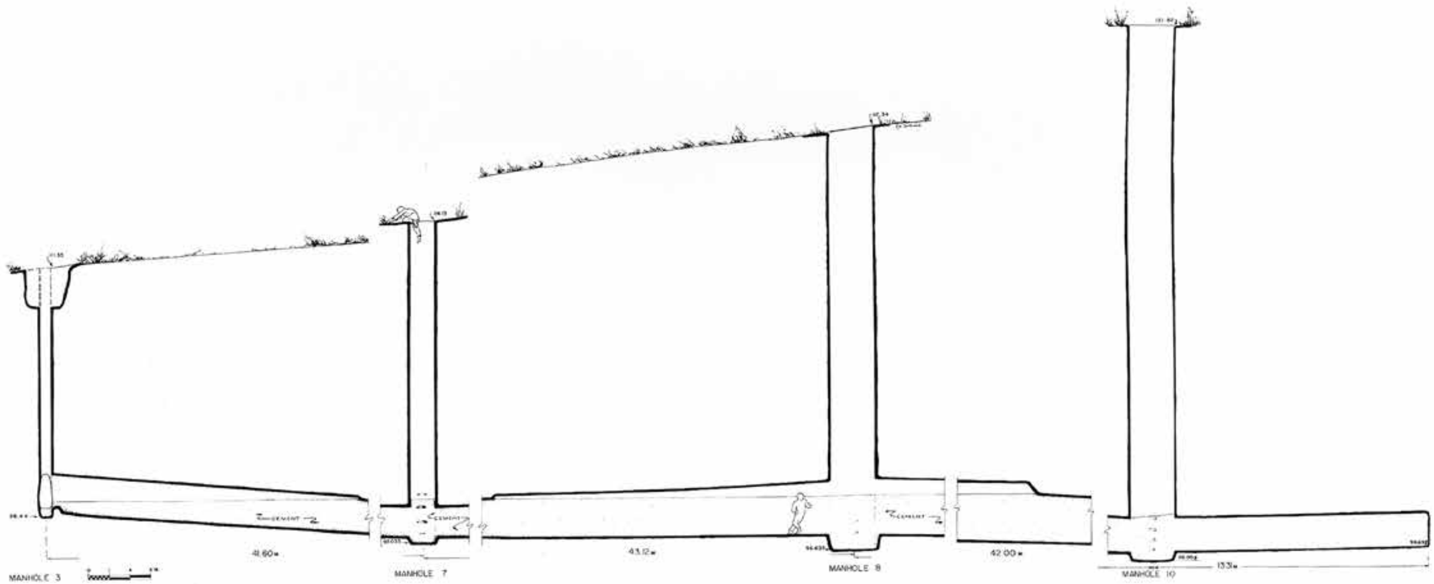
All but two of the shops of the South Stoa were furnished with a manhole, built either from the start or at a later phase, which connected with an underground water tunnel (*Fig. 5*).[21] There are 31 manholes in total, all with cylindrical shafts (i.e. circular in plan) except for one that becomes more elliptical in plan, and none of which are stuccoed. Details of the upper parts of the shafts including rims and wellheads are discussed below in conjunction with other wells found throughout the city. Here I want to focus on the hydraulic system below the shafts.[22] At its west end, the tunnel joins the south-west supply tunnel of the Peirene system. In other words, we are not dealing with a catchment tunnel but with an aqueduct, *c.* 0.60 m wide by 1.75 m high, running at a depth of *c.* 11.60 m. The floor level of the aqueduct is approximately 0.60 m below that of the segment of the south-west supply tunnel from which it branches. This ensures that water proceeds on to Peirene only after it reaches a metre's depth in each shaft of the South Stoa. Also interesting is the fact that the tunnel is not directly in line with the shafts. Lining up the tunnel with the shafts would have made the digging operation much easier, since the shafts would have served as manholes through which the earth could be removed. Instead the tunnel is set behind the line of the shafts, which meant that in each case a small branch tunnel had to be dug connecting the shaft to the main tunnel. The openings from the shafts into the branch tunnels are too narrow (0.20–0.40 m high) to allow a man to crawl through, so that subterranean communication between the shops was impossible.

The massive waterworks of Anaploga, near the church of Agioi Anargyroi, were explored in 1962 under the direction of Henry Robinson.[23] A long underground water channel, running *c.* 20 m below the surface, was traced over a distance of more than 800 m. It measures *c.* 1.75 m in height by 0.50 m in width, and seems to have tapped a natural spring on the lower slope of Acrocorinth, probably Hadji Mustafa. According to Robinson, the line appears to have been constructed in the late 4th century BC to direct the water toward a small and fertile valley to the north-west, perhaps for irrigation purposes. In other words, Robinson suggested that the whole installation operated according to the Persian qanat system. Neither the date nor the destination of this aqueduct have been confirmed. In fact, an irrigation purpose is unlikely given the plastering of the interior of the channel. This plaster is applied to a height of 0.40–0.50 m above the floor. Ten manholes were mapped along the main line, spaced some 60 m apart. Some of the water was diverted into at least two cisterns, stretching between manholes 1 to 11 and 3 to 10 respectively, the first of which was explored further. This "tunnel cistern" as Robinson called it, is *c.* 140 m long, 0.50–0.60 m wide and 1.50–1.60 m high, and it is accessed by three oval shafts of different dimensions (2.15 × 0.70 m, 1.80 × 0.90 m, 1.15 × 0.65 m, *Fig. 6*). Its floor features a downward slope from north-east to south-west, which explains why its walls were lined with waterproof mortar to a much higher level than the main tunnel. Robinson estimated its water capacity at 100 m^3 and reckoned that

[21] Broneer (*Corinth* 1:4, 59–65) assumed that the wells were planned from the start, unlike Scahill (2012, 253–260) who thinks that they were not part of the original design based on the fact that they are not centred inside the back rooms of the stoa.

[22] The subject has been treated by Broneer (*Corinth* 1:4, 59–65), Robinson (2011, 16–17) and Scahill (2012, 253–260).

[23] Robinson 1964, 100–101; 1965, 291–292; 1966, 138–139; 1969.



Manholes 3, 7, 8 and 10. Section of the Tunnel Cistern.

Fig. 6. Section of the Tunnel Cistern of Anaploga. Robinson 1969, pl. 1.

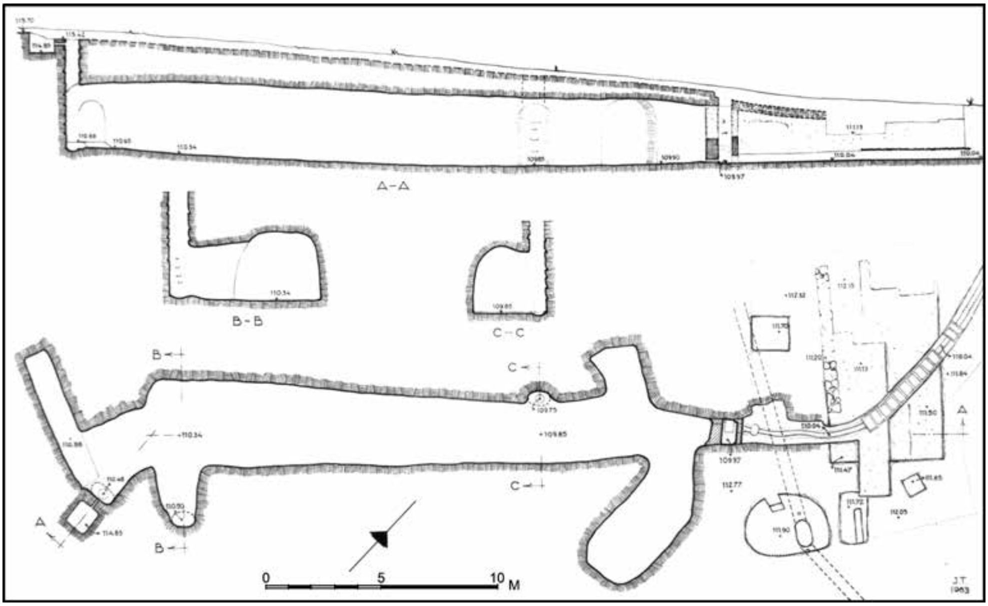


Fig. 7. Plan and section of the Anaploga Cistern. ASCSA.net: Corinth Excavations, Drawing 261.

this volume was enough to cover the needs of three households over a period of more than five months. In fact, such a volume would have probably been enough for four households throughout the year if we estimate the daily needs in water to 15 litres/person and assume five people per household.[24] Considering that the water running in the main tunnel would replenish the cistern, the cistern could have adequately supplied more than four households per year. It is conceivable that once this tunnel cistern ceased to function, whenever that was, the water supply was provided from a large chamber cistern located near manhole 1 (*Fig. 7*).[25] This cistern is also sizeable: *c.* 30 m long, 3 m wide and 3.25 m high.

These "tunnel cisterns" that were discovered under the South Stoa and near Agioi Anargyroi of Anaploga stand out due to their scale, but are not unique examples of this type of cistern in Corinth. In the area to the east of the theatre Williams recorded what he called a corridor-like cistern, 17.30 m long and 6 m deep, dating to the Hellenistic period.[26] A second one, perhaps built in the late 4th century BC, is reported from the area of the Centaur Bath.[27] In the Potters' Quarter, the far west district of the city, a cistern dated to the Archaic period has a cylindrical shaft, 0.90 m in diameter and 1.70 m in depth, leading into a straight-sided cistern 3.10 m high and as much wide, lined with hard cement.[28] So far we have the familiar bottle-/flask-shaped configuration, but the "drum", as the excavator called it, connects to a vaulted tunnel, 5 m long, *c.* 1.30 m high

[24] On estimates of daily water need see Klingborg & Finné 2018, 119–120.

[25] Robinson 1965, 79.

[26] Williams & Zervos 1982, 117, 124; Klingborg 2017, cisterns nos. 234–235 (pp. 223–224).

[27] Williams & Zervos 1991, 4–5. No dimensions are given for this "reservoir corridor".

[28] *Corinth* 15:1, 26.

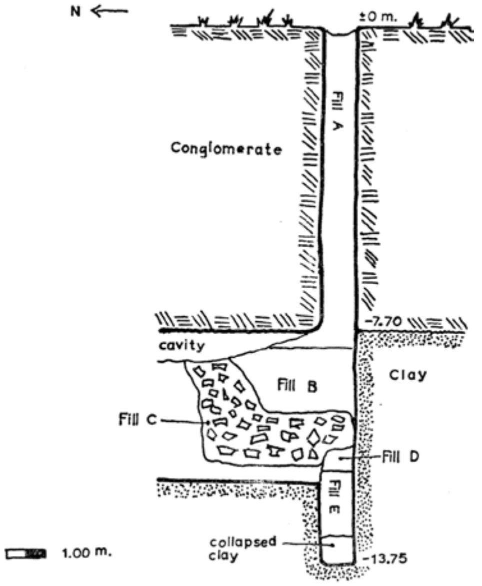
and 0.60 m wide, entirely lined except for the floor. A vertical shaft was found at the end of the tunnel, 0.68 m in diameter and 3.50 m high. The cistern excavated at the north-west corner of the Central Courtyard of the Sanctuary of Demeter and Kore (Cistern 1964-1) also comprised a tunnelled section to increase its capacity, which is estimated to *c.* 8,000–9,000 litres.[29] Dated *c.* 300 BC, it was placed in such a position as to receive rainwater from the roof of two buildings. An oval shaft leads down to two chambers opening off to the east and the west, with rounded ceilings. The eastern chamber is the largest, measuring 5 m in length, 1.40 to 1.90 m in height and 0.48–0.74 m in width. The floors of the chambers slope downwards toward an oval-shaped settling basin *c.* 0.40 m deep, with lies directly under the shaft.

A second cistern (Cistern 1965-1) excavated at the Sanctuary of Demeter and Kore, and seemingly dated to the Classical period, is smaller and closer in form to the ones found in other parts of the Greek world. It is built against the south wall of Service Room 3, with a shaft cut into bedrock to a total depth of 3.95 m, where opens a chamber measuring 0.70 × 1.49 × 1.48 m (height).[30] The sides of the cistern are stuccoed with waterproof cement and its estimated capacity is roughly 4 m^3. The cistern collected water from the roof of an adjacent building through an exterior rectangular basin, 0.60 (width) × 0.80 (length) and 0.88 m (depth), with its floor set level with the mouth of the cistern. Water flowed from that basin into the cistern through an opening 0.33–0.45 m wide and 0.61 m high. For the rest, it is rather surprising that hardly any bottle-shaped cisterns, typical in other parts of the Greek world, are published from Corinth, although some do appear in the digital archive of the excavations (accessible through ASCSA.net), and another was recently excavated (Cistern 2016-1) and awaits publication.

In the Sanctuary of Demeter and Kore we have a bottle-shaped well, not cistern, located *c.* 4.20 m directly south of the Roman Propylon.[31] This well was the major source of water in the sanctuary in Roman times and its alignment suggests that it was designed together with the Roman Propylon and the Roman Temple. The well is cut down through solid bedrock to a depth of 18.70 m. At a depth of 12 m the circular shaft, 0.90 m in diameter, starts to expand outwards to form a bell-shaped chamber 2.50 × 4.25 m.

The well excavated in the Sanctuary of Demeter and Kore is one of the few hundreds of wells recorded throughout Corinth and dating from various periods. Their depths range from *c.* 4 to 25 m depending on their location and dating. One of the earliest was excavated in the area to the east of the Museum.[32] This well (Well A) was clearly in use in the Early Helladic period. The shaft, oval at the top, *c.* 1.10 × 1.20 m, but circular at the bottom with a diameter of 1 m, is cut to a depth of 9.60 m. At about 8.50 m from the top it bells out sharply. This is not the only well of the Early Helladic period in Corinth. In 1930 Theodore Leslie Shear excavated a well located at the northern base of the Cheliotomylos Hill.[33] The shaft is described as having a diameter of 1 m and a depth of 16.50 m. From the top to the bottom there was a single-period deposit. The well excavated to the east of the Museum features some characteristics encountered in most Corinthian wells of the historical periods. All the way down the east and west sides of the shaft were cut shallow hand- and footholds, set only *c.* 0.30 m apart. A pit, *c.* 0.30 m deep, was

29 *Corinth* 18:3, 247–248; Klingborg 2017, no. 250 (p. 228).
30 *Corinth* 18:3, 191–193; Klingborg 2017, no. 251 (p. 228).
31 *Corinth* 18:3, 332–335.
32 Weinberg 1948, 201.
33 Shear 1930, 404–406.



Section through Katsoulis Well No. 3. Pithos came from Fill C.

Fig. 8. Well shaft near Oakley house. Boggess 1970, fig. 5.

dug at the bottom of the shaft, to act as a settling basin.

A large number of published wells from Corinth date between the Geometric and the Hellenistic periods. The majority have circular rims and cylindrical shafts, ranging between 0.75 and 1.10 m in diameter, 0.90 to 1 m being the commonest. In some cases the shaft widens towards the bottom, as in the 10-m-deep Well 1981-2 found to the east of the Theatre, which goes from 0.88 m at the top to 1.02 m at water level, or in the 24.85-m-deep Anaploga Well, which widens from 0.76 m at the top to 1.20 m at the bottom.[34] There is no doubt that a broadening of the well's diameter with depth would ease the digging operation. Hand- and footholds are cut into the sides of the shafts, at intervals ranging between 0.20 and 0.70 m but more typically *c.* 0.50 m. Settling basins at the bottom of the wells were a customary cleaning device as in the case of cisterns. In a few instances the excavators were able to establish the level of these depressions in relation to the level of the water table. A Late Archaic or Early Classical well excavated to the east of the Lechaion Road descends to a depth of *c.* 5.50 m, down to a layer of impervious clay and cutting slightly into it to form a collecting basin.[35] The deep well excavated by Henry Robinson some 650 m to the south-west of the Odeion and tentatively associated with a Late Classical or Early Hellenistic house met the aquifer marked by a shallow layer of gravel at a depth of 23 m.[36] The shaft continues down for 20 cm into the clay beneath the gravel. It is worth noting that this specific well has an oval instead of the more usual circular shaft, 1.25 × 0.63 m.[37]

In some cases Corinthians sought to augment the natural water supply of the wells by digging a tunnel to the side of the shaft into the aquifer. The best example of this practice is one of the wells, 9.40 m deep, dug by Henry Robinson near the "Baths of Aphrodite".[38] The mouth of a tunnel was observed in the side of the shaft, 6.50 m from the top, its roof positioned precisely at the level of the junction between the conglomerate and the underlying clay. The tunnel, 1–1.30 m wide and *c.* 1.90 m high, extended for a distance of more than 7.50 m, its roof and walls coated with lime incrustration and stalactitic formations. Clearly the tunnel tapped the thin water-bearing layer of sand and gravel between the upper conglomerate and the lower clay. At another location, "near Oakley

34 Williams & Zervos 1982, 120 (east of the Theatre); *Corinth* 7:2, 63–64 (Anaploga).

35 Robinson & Weinberg 1960, 245–246.
36 Robinson 1962, 117.
37 Williams (Williams & Zervos 1991, 4–5) observed that "ovoid shafts at Corinth are customarily used for access to cisterns of the Classical and Hellenistic periods, not wells", but there are exceptions both of wells with ovoid shafts and certainly of cisterns with circular manholes.
38 Robinson 1962, 124–126.

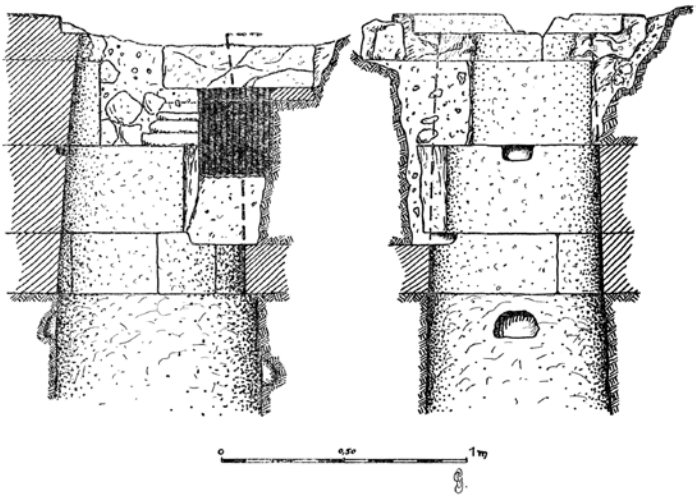


Fig. 9. The upper part of the well shaft in Shop XXVII of the South Stoa. Corinth *1.4, fig. 38.*

house", not one but three interconnected well shafts accessed the aquifer.[39] The system is tentatively dated to the Classical or Early Hellenistic period based on a pithos found in the fill of one of the shafts. Unfortunately no description is provided in the relevant publication, simply a section showing the shaft of one of them with a tunnel leading to it, situated between the conglomerate and the underlying clay (*Fig. 8*). The section also shows the presence of a settling basin at the bottom of the shaft, below the level of the floor of the tunnel.

Information on the upper section of the shafts, the rims and the wellheads is not abundant, partly due to the fact that most wellheads were found to be missing. The manholes of the South Stoa provide the best examples.[40] In cases of soft soil, the upper part of the shaft was lined with stones as in shop XXVII (later damaged by a drain) (*Fig. 9*). The uppermost 1.13 m section of the shaft is made of carefully fitted stones with a square cutting at the top, 0.80 m on the side, where the square plinth of the well kerb rested. The shaft narrows towards the top, from *c.* 0.80 m to 0.60 m, and the square plinth was set down approximately level with the floor of the shop. The circular drum of the kerb is *c.* 0.65 m high and *c.* 0.80 m in diameter at the top (*Fig. 10*). It features a cyma reversa at the top with a corresponding moulding at the base. The inner diameter of the kerbs is *c.* 0.41 m but there is considerable variation in the extant examples. None of the preserved kerbs show rope marks at the inner edge. Instead all have various cuttings through the mouldings, some of which were made to hold a vertical beam with a horizontal member at the top for the attachment of a pulley mechanism. Interestingly Broneer reconstructs a Γ-shaped wooden support for the mechanism, instead of a Π-shaped which would have been much more stable. This is because the extant examples of wellheads from the South Stoa do not preserve traces of diametrically opposed cuttings. In addition, Broneer argues that these wells served primarily as refrigerators and not as sources of water. The practice of cooling produce, particularly wine, in wells is literarily attested but considering the enormous effort of the Corinthians to bring fresh water under the Stoa described earlier, this cannot be the case.

[39] Boggess 1970.

[40] *Corinth* 1:4, 59–65.

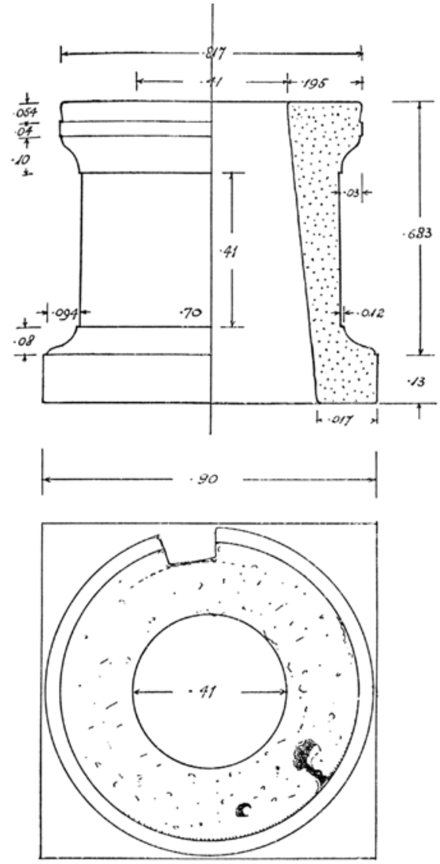


Fig. 10. Profile, section and plan of the well kerb in Shop XIV. Corinth *1.4, fig. 39.*

In several of the wellheads were found fragments of circular terracotta plaques with a hole in the centre, which were probably used as lids. One complete example is 2.5 cm thick and has a diameter of 0.65 m. The hole, 5 cm in diameter and with a raised edge around it, provided a means to lift the lid. Besides stone rims, Broneer reported finding some pithos rims which were probably also used as well kerbs. To my knowledge no other terracotta wellheads have been published from Corinth. In the Frankish Quarter Williams noted a hollowed-out Doric column drum which served as a wellhead.[41]

WELLS AND CISTERNS IN SIKYON

For some good examples of wellheads we have to turn to Sikyon. In general, much less is known about the Sikyonian wells and cisterns than the Corinthian ones. Only a few have been investigated, all but one during salvage excavations, and none has been fully published so far.[42] Seven wells have been reported from the coastal plain, brought to light in the course of the recent, massive excavations prompted by the construction of the new highway to Patras.[43] They all seem to be connected with domestic quarters of the pre-Hellenistic city. Usually circular, 0.80–1.10 m in diameter, they occasionally reach a depth of 20 m and show hand- and footholds carved on opposing sides of their shafts. In the course of the urban survey conducted between 2004 and 2009 on the site of the Hellenistic and Roman city, we mapped 34 wells and cisterns throughout the intramural area (*Fig. 11*). In addition, we found scattered architectural members belonging to four stone well kerbs. A number of these water-tapping installations allow us to address details of their construction. The majority are rock-cut with no traces of stone masonry or of terracotta circular drums lining the shafts. The shafts are cylindrical except for three that appear to be oval-shaped in plan, and many preserve hand-

---

[41] Williams & Zervos 1992, 145.

[42] Except for brief notes in the *Archaiologikon Deltion*: e.g. Anagnostopoulou 2006, 468–469 (well excavated on the Sikyonian plateau). Over the period 2016 to 2018, and in the context of large-scale excavations conducted around the agora of the ancient city, we excavated a well located within a room of a Hellenistic stoa on the west side of the agora. Our excavation proceeded to a depth of 12.20 m without reaching the bottom of the well. For preliminary reports on the well excavation see Lolos 2018, 206; 2019, 140–141; 2020, 93–97.

[43] ΛΖ’ ΕΠΚΑ 2012, 324, 327.

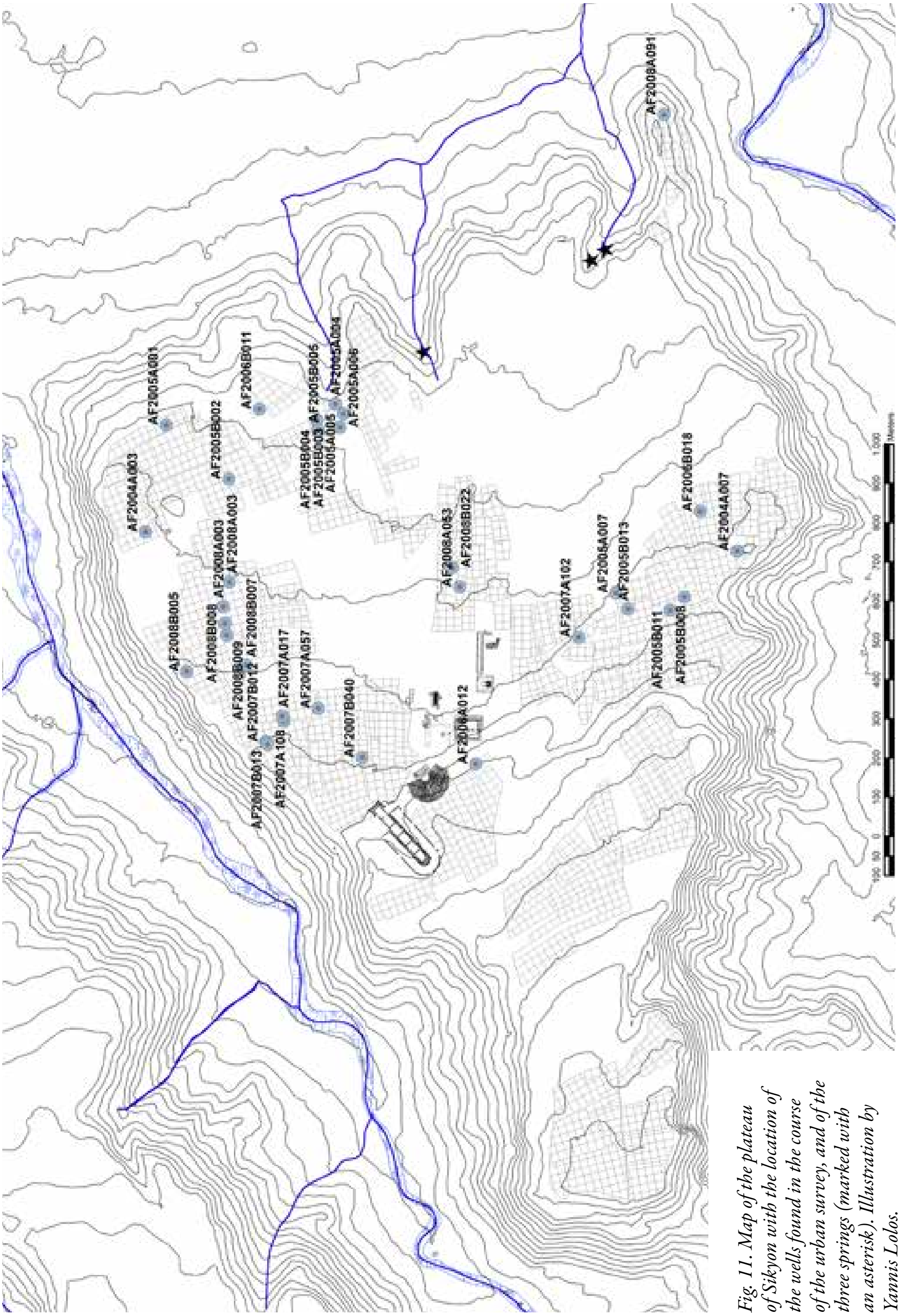


Fig. 11. Map of the plateau of Sikyon with the location of the wells found in the course of the urban survey, and of the three springs (marked with an asterisk). Illustration by Yannis Lolos.

Fig. 12. Fragment of a limestone wellhead (AF2005B003) from the plateau of Sikyon. Photograph: Yannis Lolos.

and footholds carved on the sides at regular intervals.

The rim or mouth of the wells and cisterns, wherever preserved, presents particular interest. It can be a simple, circular stone rim as in AF2005B013 where a quarter of the rim is still in place, or a proper stone wellhead. We are fortunate to have documented half of a limestone wellhead almost *in situ*, standing over the well (AF2005B003) and preserving traces of the lifting mechanism (*Fig. 12*). Based on the surviving piece, we can reconstruct the original member as a circular wellhead, 0.72 m high, with an inner diameter of 0.56 m and a wall thickness of 0.21 m.[44] The cylinder stood on a rectangular base, the two having been carved out of the same block. One socket preserved on the rim of the wellhead, 0.16 × 0.10 × 0.12 m, which must have had its counterpart on the second, missing half of the rim, was meant to receive the Π-shaped frame carrying the axle of the pulley. The frame was almost certainly made of wood. Similar devices for drawing water have been found elsewhere, as in the Athenian Agora and in Delos, although in most cases the frame is mounted on the square plinth rather than on the rim of the wellhead.[45] A second cylindrical well kerb with a square plinth cut out of the same block (AFN 1281) was recovered during the survey, although not *in situ* but set into the ground upside down (*Fig. 13*). The shaft tapers towards the top where its diameter is reduced to 0.65 m. The visible height of the wellhead is 0.60 m and its square base is 0.90 m on a side. Unfortunately the rim could not be observed so we cannot tell if a lifting apparatus was provided. On another occasion it was probably not, as suggested by the rope marks 4–5 cm wide and 2–3 cm deep preserved inside the scattered fragments of a cylindrical wellhead (AFN1121). Based on the surviving pieces the inner diameter of the wellhead must have been *c.* 0.50–0.60 m.

In two other cases we observed rectangular mouths built of stones atop the cylindri-

[44] Cf. the Delian practice, where according to Chamonard (*Délos* 8, 346) wellheads are more commonly found in connection with cisterns whereas wells tend to have a simple stone rim.

[45] Lang 1968, 9; *Délos* 8, 350–351 and pl. LXIII (House of the Trident); *Délos* 38, 66–68 and pl. 102.

Fig. 13. Upside down wellhead with square plinth (AFN 1281) from the plateau of Sikyon. Photograph: Yannis Lolos.

Fig. 14. The upper part of a well (AF2006B011) recorded from the Sikyonian plateau. Photograph: Yannis Lolos.

cal shafts of the wells and measuring 0.80 × 0.56 m (AF2008B005) and 0.71 × 0.68 m (AF2008B007). They were probably intended to receive the square plinth of the wellhead rather than being the actual rims of the well. However, in another instance (AF2006B011, *Fig. 14*), the rectangular mouth covering a circular well, 0.61 × 0.56 m, is included within a cylindrical basin of an estimated diameter of 1.10 m. Unfortunately only a small part of this basin was preserved and exposed on the surface, but it looks like it was carved into the soil and lined with hydraulic mortar. It probably acted as a receptacle for water to be directed to the well below.

The final type of water reservoirs that I want to consider are the stone-built cisterns. These are

Fig. 15. Cistern 2003-2. ASCSA.net: Corinth Excavations, bw 2003 029 11.

some of the oldest water-storing installations in Greece, with the Pre-Mnesiclean Cistern on the Athenian acropolis being one of the best-known examples.[46] The Corinthian examples tend to be small and humbly constructed, to use Williams' expression, who tentatively associates them with domestic structures of the pre-Roman period.[47] A cistern found to the east of the Theatre in 1926 (1926-2) measures 2.40 × 1.75 m and 1.65 m in depth.[48] Its walls are covered with waterproof cement and there is a stairway of seven steps preserved against its west wall. Stairways seem to be a common feature of these cisterns, as shown in the seven examples found in the Panayia Field and dated to the Hellenistic period (*Fig. 15*).[49] The problem is that we cannot be certain if these modest-size installations were meant to hold water or were used as cool storage places, and the fact that they are lined with mortar is not a decisive criterion. A much larger cistern (Cistern F), excavated to the east of the Museum, was certainly a water reservoir, lined with cement from top to bottom.[50] Measuring 4.60 × 1.20 m at the top and 5.50 × 1.75 m at the bottom, it features a concave floor giving it a depth of 2.30 m at the centre and 2 m at the corners. At the centre of the floor there is an oval settling-depression 1.35 × 0.80 m and 0.40 m in depth. The cistern also preserved a small section of the curve of the wall into the ceiling. The excavator tentatively dated it to the 4th century BC and argued that it was originally located below the courtyard of a house.

The Sikyonian examples of cisterns are, again, much fewer. A stone-built cistern was recently excavated in the coastal plain, adjacent to an ancient road within an area of houses and workshops.[51] It is reported as being of trapezoidal shape, 10.42 m^2 in surface area. The cistern was built with ashlar blocks and its interior (floor and sidewalls) was lined with lime mortar, 1.8 to 3.5 cm thick. The pottery and the rest of the material found in it is of Classical date.

46 See Tanoulas 1992.
47 Williams & Zervos 1984, 103.
48 Edwards 1986, 390; Klingborg 2017, no. 233 (p. 223).
49 Sanders *et al.* 2014, 47; Klingborg 2017, no. 248 (p. 227).
50 Weinberg 1948; Klingborg 2017, no. 218 (p. 218).
51 ΛΖ' ΕΠΚΑ 2012, 326.

The cistern was fed by a channel, the water of which was filtered through an elaborate system of settling basins. The few built basins excavated on the site of the Hellenistic and Roman city are of much more modest dimensions and remain unpublished with only sporadic mentions in the reports section of the *Archaiologikon Deltion*. Two of these, that came to light in the Thanopoulos plot, measure 1.60 × 0.90 m and have a depth of just 0.62 and 0.80 m respectively.[52] On the basis of the dimensions alone, it is not certain that such basins were meant to store water rather than some other liquid produce. More examples are needed from Sikyon in order to begin to discuss typology and function of such installations.

Concluding remarks

The Sikyonian plateau has an extensive network of underground galleries which remains to be explored. Rescue excavations have occasionally run into such systems by exposing their surface outlets. Their mapping and documentation is a significant challenge because of the difficulty in accessing them. Some of these tunnels must be connected to the lines of the aqueducts that brought water to the city from the south-west,[53] but others could be part of cisterns similar to those found in Corinth. Concerning Corinth, what I have presented here are some types and forms of wells and cisterns of pre-Roman periods that I selected out of dozens of published examples, which are still only a fraction of the ones excavated in the last 110 years or so. They invite a number of questions related to their form, function, development and context. Which of the wells served individual houses and which were of public use? Were they deepened over time, as occurred in the Athenian Agora, perhaps as a result of a dropping water table?[54] Did cisterns eventually outnumber the wells over time, as was the case in Athens and in other cities?[55] Did their form change from Classical times onwards and what happened to them when Corinth was refounded as a Roman colony? Only a thorough survey of wells and cisterns, both in the Corinth excavations archives and on site, can help us to address such issues and offer a reliable picture of these important features upon which the survival of Corinth depended.

YANNIS LOLOS
Department of History, Archaeology
and Social Anthropology
University of Thessaly, Greece

[52] Anagnostopoulou 2006, 469–470.
[53] On which see Lolos 2011, 571–584.
[54] Camp 1977, 226.
[55] Lang 1968, 10.

Bibliography

Anagnostopoulou, A.-M. 2006 (pr. 2014). 'Αρχαία Σικυών', *ArchDelt* 61:1, 468–473.

Boggess, E. 1970. 'A Hellenistic pithos from Corinth', *Hesperia* 39:1, 73–78. https://doi.org/10.2307/147554

Camp, J. 1977. The water supply of ancient Athens from 3000 to 86 B.C., Ph.D. thesis, Princeton University.

Corcoran, T.H. 1971. *Seneca. Natural Questions* (Loeb Classical Library, 450), Cambridge, Massachusetts.

Corinth 1:4 = O. Broneer, *Corinth* I:4. *The South Stoa and its Roman successors*, Princeton, New Jersey 1954. https://doi.org/10.2307/4390643

Corinth 1:6 = Hill, B.H. *Corinth* I.6. *The springs. Peirene, Sacred Spring, Glauke*, Princeton, New Jersey 1964. https://doi.org/10.2307/4390647

Corinth 7:2 = Amyx, D.A. & P. Lawrence. *Corinth* VII.2. *Archaic Corinthian pottery and the Anaploga Well*, Princeton, New Jersey 1975. https://doi.org/10.2307/4390661

Corinth 15:1 = A. Newhall Stillwell, *Corinth* XV:1. *The Potters' Quarter*, Princeton, New Jersey 1948. https://doi.org/10.2307/4390691

Corinth 18:3 = N. Bookidis & R.S. Stroud, *Corinth* XVIII:3. *The Sanctuary of Demeter and Kore. Topography and architecture*, Princeton, New Jersey 1997. https://doi.org/10.2307/4390705

Délos 8 = J. Chamonard, *Délos* VIII. *Le Quartier du théâtre. Étude sur l'habitation délienne à l'époque hellénistique. Construction et technique*, Paris 1922–1924.

Délos 38 = G. Siebert, *Délos* XXXVIII. *L'Îlot des bijoux. L'Îlot des bronzes. La Maison des sceaux*, vol. 1. *Topographie et architecture*, fasc. 1. *Texte et planches*, Paris 2001.

Edwards, C.M. 1986. 'Corinthian moldmade bowls. The 1926 reservoir', *Hesperia* 55:4, 389–419. https://doi.org/10.2307/148176

Hayward, C.L. 2003. 'The geology of Corinth. Study of a basic resource', in *Corinth* XX. *Corinth, The Centenary: 1896–1996*, eds. C.K. Williams & N. Bookidis, Princeton, New Jersey, 15–42.

Hayward, C.L. 2021. 'The geology and topography of the Sikyonian plateau', in *Sikyon* I. *The Urban Survey*, ed. Y. Lolos, Athens, 4–7.

Higgins, M.D. & R. Higgins 1996. *A geological companion to Greece and the Aegean*, Ithaca & New York.

Jones, W.H.S. 1918. *Pausanias. Description of Greece* 1. *Books 1–2* (Loeb Classical Library, 93), Cambridge Massachusetts.

Keraudren, B. & D. Sorel 1987. 'The terraces of Corinth (Greece)—A detailed record of eustatic sea-level variations during the last 500,000 years', *Marine Geology* 77:1–2, 99–107. https://doi.org/10.1016/0025-3227(88)90034-5

Klingborg, P. 2017. Greek cisterns. Water and risk in ancient Greece, 600–50 BC, Ph.D. thesis, Uppsala University.

Klingborg, P. & M. Finné 2018. 'Modelling the freshwater supply of cisterns in ancient Greece', *Water History* 10, 113–131. https://doi.org/10.1007/s12685-017-0209-y

Landon, M.E. 1994. Contribution to the study of the water supply of Ancient Corinth, Ph.D. thesis, University of California, Berkeley.

Landon, M.E. 2003. 'Beyond Peirene. Toward a broader view of Corinthian water supply,' in *Corinth* XX. *Corinth, The Centenary: 1896–1996*, eds. C.K. Williams & N. Bookidis, Princeton, New Jersey, 43–62.

Lang, M. 1968. *Waterworks in the Athenian Agora* (AgoraPicBk, 11), Princeton, New Jersey.

ΛΖ' ΕΠΚΑ 2012 (pr. 2016). 'Αρχαία Σικυώνα', *ArchDelt* 67:1, 321–328.

Lolos, Y. 2011. *Land of Sikyon. Archaeology and history of a Greek city-state* (Hesperia Suppl., 39), Princeton, New Jersey.

Lolos, Y. 2018. 'Ανασκαφή Σικυώνος', *Prakt* 2016, 185–225.

Lolos, Y. 2019. 'Ανασκαφή Σικυώνος', *Prakt* 2017, 111–163.

Lolos, Y. 2020. 'Ανασκαφή Σικυώνος', *Prakt* 2018, 93–104.

Lolos, Y., ed. 2021. *Sikyon* I. *The urban survey*, Athens.

Rackham, H. 1938. *Natural History*, vol. 1 (Loeb Classical Library, 330), Cambridge, massachusetts.

Robinson, B.A. 2011. *Histories of Peirene. A Corinthian fountain in three millennia*, Princeton, New Jersey. https://doi.org/10.2972/978-0-87661-965-0-a

Robinson, B.A. 2013. 'Playing in the sun. Hydraulic architecture and water displays in imperial Corinth', *Hesperia* 82:2, 341–384. https://doi.org/10.2972/hesperia.82.2.0341

Robinson, H.S. 1962. 'Excavations at Corinth, 1960', *Hesperia* 31:2, 95–133. https://doi.org/10.2307/147271

Robinson, H.S. 1964 (pr. 1966). 'American excavations at Corinth', *ArchDelt* 19:1, 100–102.

Robinson, H.S. 1965. 'Excavations at ancient Corinth, 1959–1963', *Klio* 46, 289–305. https://www.jstor.org/stable/147271?seq=1

Robinson, H.S. 1966 (pr. 1968). 'Excavations at Corinth', *ArchDelt* 21:1, 133–141.

Robinson, H.S. 1969. 'A sanctuary and cemetery in western Corinth', *Hesperia* 38:1, 1–35. https://www.jstor.org/stable/147638

Robinson, H.S. & S.S. Weinberg 1960. 'Excavations at Corinth, 1959', *Hesperia* 29:3, 225–253. https://doi.org/10.2307/147197

Sanders, G.D.R, S.A. James, I. Tzonou-Herbst & J. Herbst 2014. 'The Panayia Field excavations at Corinth. The Neolithic to Hellenistic phases', *Hesperia* 83:1, 1–79. https://doi.org/10.2972/hesperia.83.1.0001

Scahill, D. 2012. The South Stoa at Corinth. Design, construction and function of the Greek Phase, Ph.D. thesis, University of Bath.

Shear, T.L. 1930. 'Excavations in the North Cemetery at Corinth in 1930', *AJA* 34:4, 403–431. https://doi.org/10.2307/498708

Tanoulas, A. 1992. 'Pre-Mnesiclean Cistern of the Athenian Acropolis', *AM* 107, 129–160.

Voudouris, K. 2001. *Το κλίμα του νομού Κορινθίας*, Corinth.

Weinberg, S.S. 1948. 'A cross-section of Corinthian antiquities (Excavations of 1940)', *Hesperia* 17:3, 197–241. https://doi.org/10.2307/146876

Williams, C.K. II & O.H. Zervos 1982. 'Corinth, 1981. East of the Theater', *Hesperia* 51:2, 115–163. https://doi.org/10.2307/147744

Williams, C.K. II & O.H. Zervos 1984. 'Corinth, 1983. The route to Sikyon', *Hesperia* 53:1, 83–122. https://doi.org/10.2307/147941

Williams, C.K. II & O.H. Zervos 1991. 'Corinth, 1990. Southeast corner of Temenos E', *Hesperia* 60:1, 1–58. https://doi.org/10.2307/148226

Williams, C.K. II & O.H. Zervos 1992. 'Frankish Corinth. 1991', *Hesperia* 61:2, 133–191. https://doi.org/10.2307/148155

Wyse, T. 1865. *An excursion in the Peloponnesus in the year 1858*, London, 2 vols.