CHAPTER 3

The Water Supply Lines Outside the City

INTRODUCTION (Fig. 2.1)

Constantinople lies at the south-eastern extremity of the Thracian peninsula. Local geology dictated that the spring sources with the best hydraulic potential for the early Byzantine city were located at a considerable distance to the west of the city, in the Stranja hills rising in the west to over 1000 m.[1] In practice there are three distinct sources of water for the city of Constantinople/Istanbul which continue to be used until the present day. One group close to the city is divided by the valley of the Alibey Dere flowing into the Golden Horn. North of that stream is a series of sources in the area of hills known as the Forest of Belgrade (Belgrad Ormanı); this region was extensively developed in Ottoman times and is often referred to as the Kırkçeşme ('Forty Springs') system.

Even closer to the city, and south of the Alibey Dere, are the springs at Halkalı which, because of their elevation, could provide a gravity-fed supply to higher parts of the city, including the Bozdoğan Kemeri, although they were of more limited output (see Fig. 2.1). According to data recorded in 1921 and based on the Ottoman exploitation of local sources, the maximum discharge of sources immediately to the north and west of the city was around 25,000 cubic metres.[2] This figure approximates the maximum discharge of these local aquiferous zones and is startling in comparison to the estimate for Rome of 500,000–623,000 cubic metres at the end of the first century A.D., which reflects the quantity of water delivered to the capital and takes account of losses through leakage *en route*.[3]

The third group is termed the 'long-distance' or Thracian system and was most important for the Byzantine city up to the end of the twelfth century. Here the springs and aquifers were located along the Stranja Dağları, a range of hills running parallel with the Black Sea coast. The ancient water sources from this region were located as far west as Vize (Bizye), and included other major springs at Danamandıra and Pınarca. Modern exploitation combines the freshwater lakes at Terkos and Büyükçekmece, as well as dams fed by springs from the Stranja hills, all essentially using the same catchments as the Byzantine system. Since the main focus of our research dealt with the latter system we will consider this first and then consider the other sources closer to the city.

GEOLOGICAL SUMMARY (Fig. 3.1)

The metamorphic range of the Stranja massif defines the north-west–south-east alignment of the Black Sea coast of Thrace. Towards the Sea of Marmara (Propontis), the basement rocks deepen and become progressively buried by sedimentary formations.[4] Eocene limestones are scattered along the southern flank of the massif, particularly in the region between the Anastasian Wall (to the east and south of Gümüşpınar) and Vize. Abundant aquifers are formed where the impervious metamorphic basement outcrops below the karst limestone, and it was such sources at Danamandıra and Pınarca, and subsequently near Ergene and Vize, that were tapped for the principal channels for Constantinople. In contrast to the relatively stable but limited hydraulic potential of metamorphic water sources, the

[1] The name of these hills is written variously in Turkish as Stranja or İstranca (although on recent maps they are termed the Yıldız Dağları — Star Mountains), the name probably derives from a Bulgarian name Strandja-Страидя. The large village of Binkılıç was formerly called Stranja.

[2] Dalman (1933), 35.

[3] De Kleijn (2001), 53–60.

[4] See Bono, Bayliss and Crow (2001).

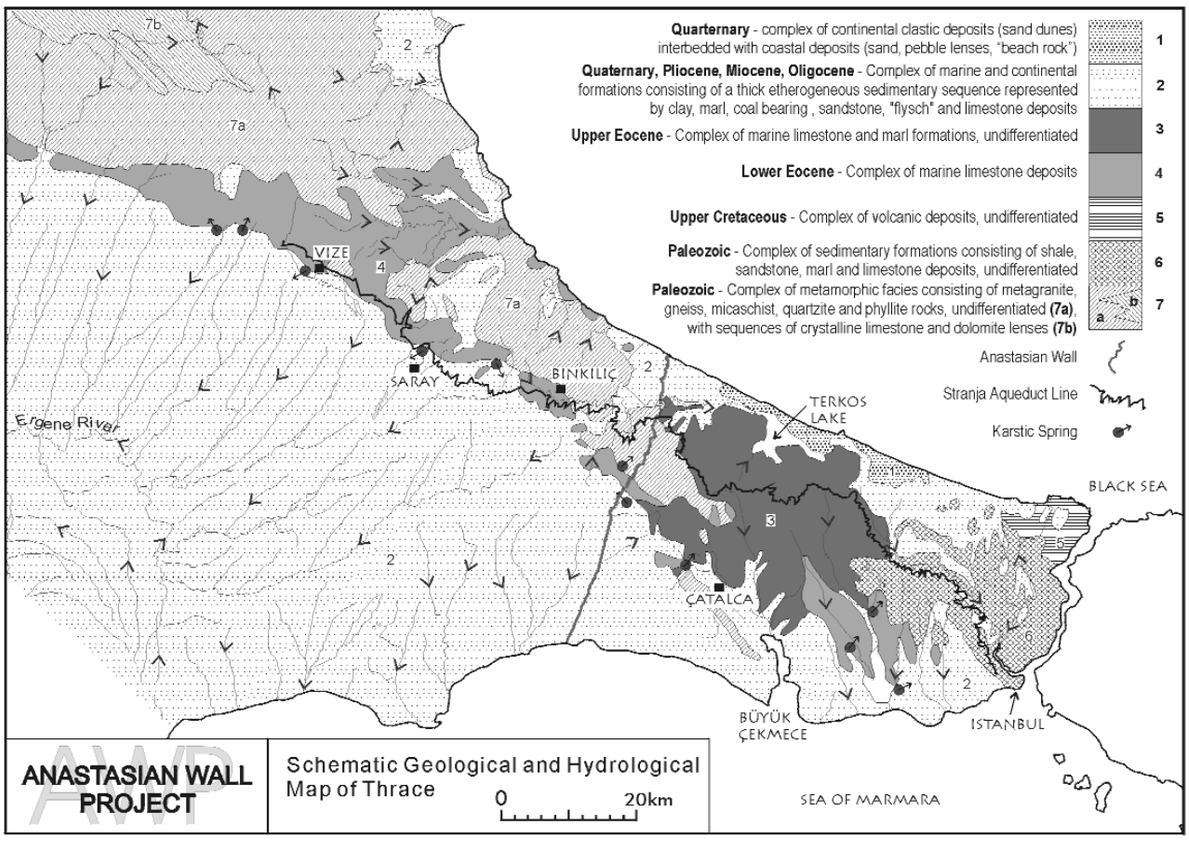


FIG. 3.1 Geological map of Thrace.

discharge of the karstic aquifers is seasonally variable, with a rapid response following heavy rain but limited yield in the dry season. This factor appears to have had a significant influence on the character of the city's water distribution network and can account for the extensive provision for water storage in the city.

SUMMARY OF THE TWO WATER SUPPLY SYSTEMS

Our own work on the Anastasian Wall and the water supply system commenced in 1994, but Professor Kâzim Çeçen had already begun a detailed reconnaissance of the water channels and aqueducts to the west of Istanbul to complement his important studies of the water supply of the Ottoman city.[5] This research provided the first coherent interpretation of the Thracian water supply for Constantinople. His study was, provocatively but accurately, entitled *The Longest Roman Water Supply Line*. He estimated that the system, from Istanbul to Vize, where he had traced channels, was 242 km in length. Subsequent research has suggested that it was in fact 592 km, longer than any previously known Roman supply system, including that of Rome, which had a total length of 520 km.

The long-distance channels (Fig. 2.1; Map 1)

At its maximum extent, this system drew water from the region of Bizye (modern Vize), over 120 km in a straight line from the city, and in total, between the furthest source and the city, its sinuous channel runs for more than 551 km. This was not the first aqueduct, constructed in the fourth century and completed under Valens, but an extension dating a few decades later, probably in the early fifth century. The

[5] Crow and Ricci (1997); Çeçen (1996a).

first channel supplying the aqueduct of Valens in the city began at the major springs in the valley of the Karaman Dere, near the village of Danamandıra. The length of the channel was 215 km, a distance only 30 km longer than Themistius' estimation of 1,000 stades (185 km).[6] We now also know of a second major source and channel relating to this primary phase of the system, beginning at the springs at Pınarca located east of the Anastasian Wall. The western extension coming from Vize joins at the Ballıgerme aqueduct (**K18**). Its most distant source is located on the outskirts of the village of Pazarlı, north-west of Vize, while another major spring at the source of the Ergene river lies 6 km east of the town. It is now clear that the entire system consisted not of a single line of water channels, but a more complex dendritic pattern of main channels and tributaries throughout its length, with at least two major periods of development — in some respects closer to the system of multiple aqueducts that developed around Rome.

The main surviving elements of the system as a whole are the bridges, built to carry the aqueduct channels across the steep-sided valleys and through the forested hill country of the Stranja range. Around sixty aqueduct bridges have been identified within the system as a whole, and nineteen of these are more or less intact, with high, massive stone piers and great vaulted arches.[7] The channel was constructed by 'cut and cover' techniques and was roofed with a mortared rubble-stone vault. In many places the hydraulic lime-mortar lining the sides of the channel survives, often with later accretions of distinctive travertine or sinter deposits that had accumulated with the passage of water. The vaults and the channel walls are constructed of metamorphic or limestone blocks, with some distinctive variation in construction technique depending on the period, locality and scale of the channel. Distinct widths of channels have been noted in different parts of the system. The primary channels from around Danamandıra and Pınarca are narrow with a width of 0.60 m and a maximum height of 1.60 m, but to the east of the Manganez Dere (near Binkılıç) the secondary Vize line flowed in a much broader channel, 1.60 m wide and over 2 m in height.

Where the two lines run parallel, after the bridge at Ballıgerme (**K18**), the broad channel is located over 6 m below the narrow channel. With this new channel, a new set of aqueduct bridges was built, including the great bridges at Kurşunlugerme (**K20**) and Büyükgerme (**K29**). In some places it seems that the earlier bridges continued in use but elsewhere they were abandoned. The two lines gradually converge in height by the time they reach the aqueduct at Büyükgerme near Çiftlikköy, but despite extensive exploration, no evidence has been found of a junction between the channels, and it remains likely that both reached the city as individual, unconnected channels at more or less the same height. Despite the clear differences in tunnel size, which can be seen in the area between the villages of Binkılıç and Çiftlikköy, further west towards Vize the channel is mostly observed at a narrow gauge, and towards Istanbul evidence for the broad channel is also absent.

The last third of the channel is rarely evident in the open ground, being covered by the expanding modern city of Istanbul. On its final approach to the city, this system followed the western edge of the Alibey Valley, although its remains are now lost beneath the dammed waters of the Alibey Barajı. The channel(s) would have passed the line of the later Theodosian Walls close to where the Edirne Kapı was later built. At this point their elevation would have been 63–64 m, which is confirmed by the 971 m-long aqueduct bridge, the Bozdoğan Kemeri or Aqueduct of Valens.

Consequently, much of the line of the channel, proposed first by Çeçen, and subsequently developed by us, is hypothetical, created by joining the positions of known bridges and sections of exposed conduit. Implicit in the projected line are a number of tunnels up to 1.5 km in length; these can be inferred east of Safaalan and west of Ballıgerme, although the physical evidence for them is limited. The sinuous nature of the supply line, as it followed the four major valleys in the Stranja hills between Vize and the city, is recalled in Themistius' oration to Valens, where he colourfully describes the Thracian nymphs 'who undeterred by rocks, mountains or ravines, skirted these obstacles, burrowed under them or flew through the air'. The physical undertaking of this project was huge, and today we can only marvel at the surveying and engineering skills which made it possible to lead water across hundreds of kilometres of difficult wooded terrain into the new city of Constantinople.

[6] Mango (1990) 42, n. 33.

[7] The detailed evidence for the channels and bridges is discussed below; see Chapter 4 for a description of the great bridges from Ballıgerme eastwards.

The Forest of Belgrade and Halkalı (Fig. 2.1)

Other water sources are located much closer to the city and we can reasonably assume that they were the first to be exploited by the colony of Byzantium. These springs were extensively redeveloped by the Ottomans from the late fifteenth century onwards, so it is often difficult to define the surviving Roman and Byzantine features of the system. Soon after the Ottoman conquest of Constantinople in 1453, Mehmet II ordered the restoration of the Byzantine water supply channels, most probably those to the north-west of the city at Cebeciköy and in the Forest of Belgrade. Following the establishment of this first supply line, a more extensive network, the Kırkçeşme system, was developed, maintained, and expanded throughout the Ottoman period, with a multitude of lines drawing water from such different sources as springs, streams, or substantial dams. Ottoman sources refer to earlier structures, and traces of earlier late antique and Byzantine work have been noted at a number of places in the Belgrade Forest.[8]

The closest aquiferous zone to the city is located some 15 km to the west, in the region of Halkalı, near modern Kücükçekmece. This area, too, was extensively exploited for its water resources in the Ottoman period, and several scholars have assumed that it was from here that the first aqueduct channel for the city ran. The elevation of the principal springs is significant because, unlike the Cebeciköy and Kırkceşme sources, they were located high enough (55–65 m at the Land Walls) to provide for the whole area of the city. Dalman, Eyice, Çeçen, and most recently Mango have argued that the surviving aqueduct bridge known as the Ma'zulkemer is most likely the last surviving element of the Roman and Byzantine system in this area. However, the Halkalı springs can only supply a relatively limited amount of water; in 1922 their output volume was only half of that of the Kırkceşme springs. This source may have provided some water for the Byzantine city, especially in the period after the Latin siege, but it is likely that fourth-century prospectors recognized that the source was insufficient for the ambitions of the new capital.[9]

THE EVIDENCE (Maps 1–11)

The long-distance channels may be treated in five main sections: from Vize to Ballıgerme (1), from Danamandıra to Ballıgerme (2), from Ballıgerme to Derinçatak (3), from Pınarca to Dağyenice (4), and from Dağyenice to Constantinople (5). The system is described from the sources to delivery, from west to east, and we have adopted the numbering system for channels and bridges introduced by Çeçen. Bridges are identified with the prefix K = *köprü*, hence (**K20**) for Kurşunlugerme, and G = *galeri* for channels, such as (**G3**) west of Vize. Where we have identified new structures these are located by the known structure to the west with a numerical suffix, thus Luka Dere (**K17.1**) is east of Kurt Dere (**K17**). In this account each of the main sections is preceded by an introduction which summarizes the topography and the key structural elements.

I VİZE TO BALLIGERME (Maps 1–6)

Introduction

This section of the water channel represents the western length of the extension of the Valens system made during the fifth century. Here the water supply line takes advantage of two major water catchments: the Ergene Dere and the Binkılıç or Stranja Dere, the former flowing west to drain much of Turkish Thrace into the Maritsa and the northern Aegean, while the latter is one of the main rivers draining the coastal ranges flanking the Black Sea and flows east into Terkos Lake, a catchment which still forms one of the major sources for modern Istanbul. Two major springs have been identified in the catchment of the Maritsa, one at Pazarlı west of Vize, and the other at

[8] See Chapter 2; Çeçen (1996b), 169–73.

[9] See Mango (1995), 10, quoting Dalman (1933), 35; see also Andréossy (1828), 422, who notes that the output of the Halkalı springs was only 15 lule, compared to 134 lule from the Belgrade Forest sources. However, Çeçen (1996a), 79, contradicts these figures and gives a total figure of 21,000 cubic metres from the various Halkalı waters, which is nearly as much as the totals presented from other sources, see above n. 2.

FIG. 3.2 Landscape between Ergene and Vize.

Ergene, near the village of Çakıllı, the source of the Ergene River; further springs may have been exploited west of Bınkılıç.

Within these catchments the line of the channels can be divided into three elements. Firstly in the section from Pazarlı, Vize and on to the crossing of the Galata Dere, north of Saray, the water channel runs along a limestone escarpment with limited tree cover (Fig. 3.2). This is infrequently interrupted by valleys and the major breaks in the line are at Vize, Ergene, and the Galata Dere. A number of single-arched bridges have been recorded along this line and traces of the water channel can be identified in a number of places. The escarpment remains at a constant height until the broad valley of the Galata Dere where the line turns to the north, although the major bridge at the Galata Dere (**K8**) is largely lost. An enigmatic element of this section is the large channel, referred to by Çeçen as the Büyük Galeri, in the valley of the Güneşkaya Dere.

1.1 **Pazarlı** (height 240 m asl) (Map 1)

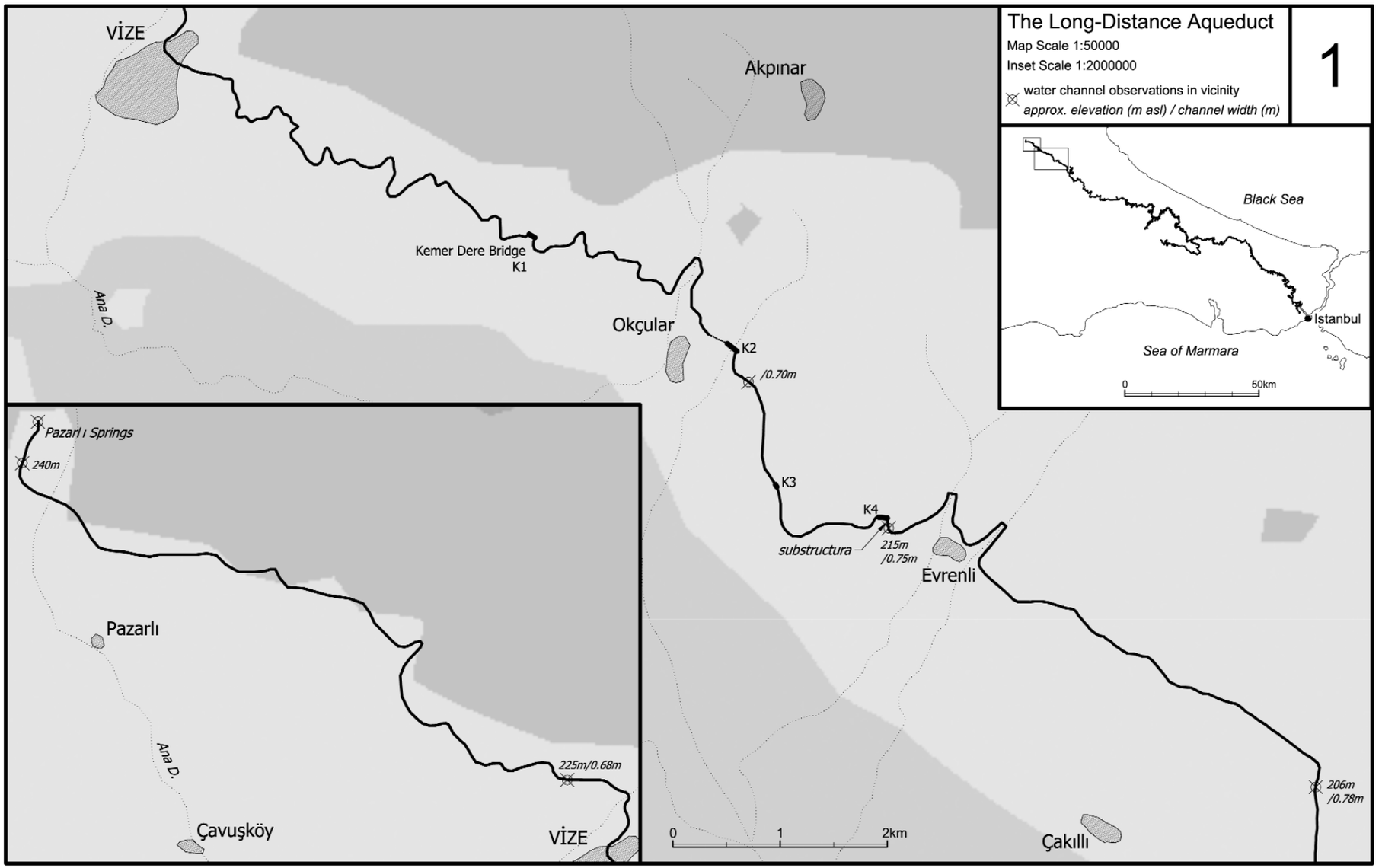
A major spring is located in the valley of the Değirmen Dere, 750 m north of the small village of Pazarlı, 6 km west of Vize. Çeçen has identified this as the major western source of the Constantinople water supply system[10] — an identification first suggested by a local Greek source in 1899.[11] Traces of old channels and structures can be recognized at the head of the valley, but all of these appear to be either modern in date or to have been extensively repaired in modern times, as indicated by the use of cement. Villagers informed us that around fifty years ago, an 'old' channel of narrow width (0.60 m) leading from the spring and a series of modern pools were restored using modern concrete, and in places it would appear that the earlier vault has been replaced with concrete slabs. There are also occasional inspection shafts. Ruined mortared walls near the source of the spring, at first mistaken for Byzantine structures, were said to be the remains of old, demolished Turkish water-mills and Çeçen reports the name of the stream as the Değirmen Dere (mill stream). On the west side of the valley, opposite the restored channel and towards the village, we were shown rock-cut basins, hollowed out from the limestone outcrop. Although they were not part of the main water supply system, they appear to be ancient and are similar to the rock-cut storage tanks found elsewhere in Turkey, often connected with olive-oil production. In Thrace, however, an alternative use needs to be considered. Along with the report of old mills, it serves to remind us of the many applications of water technology in pre-industrial societies.

West of Pazarlı a number of large water sources have been reported.[12] A major spring with a large pool is located in the small town of Kaynarca to the

[10] Çeçen (1996a), 102–3, 107, 132, channel **G1**, photos p. 108.

[11] Quoted in Mango (1995), 13, n. 17.

[12] Çeçen (1996a), 102–3, photo p. 107. Ancient channels were noted in a number of places, but are more likely to be associated with the city of Arcadiopolis, modern Lüleburgaz, or other ancient settlements; for these cities see Crow (2002).



MAP 1 Pazarlı to Çakıllı.

FIG. 3.3 Channel on the outskirts of Vize (Gazi Mahallesi).

north-west of Pınarhisar. Whilst this may have drawn the attention of the Byzantine water surveyors, its elevation, at 204 m asl, meant that it was too low to contribute to the channels located at Pazarlı. Çeçen also suggests the possibility that the main supply line began further west near Soğucak (between Pınarhisar and Vize, where the Davalıpınar and Kaynak streams meet). The springs here are higher than others at Pazarlı, but no trace of channels has been found in the area to confirm his suggestion.[13]

From the valley of the Değirmen Dere the channel emerges into the plain east of the village of Pazarlı, at about 240 m asl,[14] and follows along the edge of the limestone escarpment; no trace was found of small aqueduct bridges in the valleys it would have crossed towards Vize.

1.2 Vize

In the west suburbs of Vize (Gazi Mahallesi) a length of channel was found outside the garden of No. 10 Çeşme Sokağı, at an elevation of about 225 m asl.[15] The channel was vaulted with rough stones and measured 0.68 m in width at the springing, and 0.60 m in width lower down, due to the lining of hydraulic mortar and accumulated sinter (Fig. 3.3). The outline of a turn in the channel could be seen in section in the garden, 10 m to the north-west. The discovery provided useful evidence for the elevation of the channel in the Vize sector. From here the channel is likely to have wound around the north side of the Kale before rejoining the line of the main escarpment towards the village of Okçular.

Vize is the site of the major Classical and Byzantine city of Bizye. Recent excavations have revealed a significant Roman theatre; in addition there are extensive late antique and Byzantine walls and the major Byzantine church of Haghia Sophia. The city continued to be important throughout the Byzantine period and it is possible that the water channel from Pazarlı may have begun as the city's water supply for baths etc., which was then extended to form part of the major Constantinople line to the east.[16]

1.3 Vize to Ergene (K1–K4)

The first known aqueduct bridge east of Vize is located at Kemer Dere (**K1**).[17] Two substantial abutments survived, that on the west side of the valley showing bossed masonry on both its north and south faces, so that the width of the bridge could be established at 5.30 m. The estimated height of the bridge was 15 m. The water channel could not be traced in the valley, but traces of it were found east of the bridge amongst thick scrub.

North-east of Okçular are located the remains of the west and east abutments of a ruined aqueduct (**K2**).[18] The bridge was orientated at 300 degrees and

[13] Çeçen (1996a), 106.
[14] Cecen (1996a), **G2**, photo p. 107.
[15] Çeçen (1996a), **G3**, photo p. 109; he identifies it as the house of the grocer Emin Vardar.
[16] See Mango (1968); Bauer and Klein (2004).
[17] Çeçen (1996a), **K1**, 107, 132.
[18] Çeçen (1996a), **K2**, 107, 132, photo p. 132; photo p. 133 shows east bank.

FIG. 3.4 West side of the aqueduct near Okçular (**K2**).

was located across the valley of the İn Dere. The distance between the abutments was 4.80 m, presumably spanned by a single-arched bridge about 15 m high. The maximum width of the west abutment was 6.90 m, but this did not represent the full width of the bridge, since the south side had been robbed away. Looking westwards towards the west abutment, a vertical joint was visible 2.10 m from the north face of the abutment, indicating that the bridge had been widened or buttressed at a later date (Fig. 3.4). The additional work on the north face of the west abutment consisted of large bossed blocks,[19] whereas the surviving south face of the east abutment was of claw-dressed blocks, again indicative of a widening of the west abutment on its north face. The earthwork on top of the west abutment appeared to vanish into the hillside, leaving no evidence for the channel as it approached the bridge from the south-west. This may suggest that there was a tunnel through the ridge at this point. East of Okçular the edge of the escarpment is less dissected and there are few bridges. In places, the line of the channel top is very clear as a spread of broken mortar. Openings in the narrow channel indicate a width of 0.70 m and a height of 1.30 m. The line follows round to an embankment, noted by Çeçen, across a shallow gully. There was a small ruined bridge (**K3**) with substantial facing-blocks and evidence for dovetail cramping and possibly cribwork. In the north abutment, two different types of mortar were observed in the core of the structure. On the west side there was a white-yellow mortar with small pebble inclusions (less than 5 mm across); in the central and eastern sections there was pinky mortar with brick inclusions up to 10 mm in size. The approximate orientation of the bridge was 160 degrees, with an overall length of about 7 m.[20]

Less than a kilometre west of Evrenli village, the ruins of a large bridge, 7.22 m wide and originally about 14 m high and 60 m long, orientated at 100 degrees, were seen crossing the Akpınar Dere at a narrow point in the valley (**K4**).[21] The main structure of the bridge had a pink mortar with brick inclusions. The footing in the stream sides had been eroded away, but at the east end of the bridge, the channel made a sharp 90-degree turn, and was carried on an embankment (*substructura*), 7 m wide, constructed of dressed limestone blocks, in the same monumental style as the bridge (Fig. 3.5). Here, just to the north of the bridge, the channel was found to be 0.75 m wide, although no trace of the plaster, sinter, or upper vaulting survived. The embankment was aligned at about 200 degrees and cladding, 1.23 m thick, was noted on the south side and at the east end of the bridge. This had lighter coloured mortar with brick inclusions and may have been added later.

To the north of the village, Çeçen did not record bridges across the Evrenli and Değirmen streams.[22] East of Evrenli the channel heads in a south-easterly direction at the foot of the escarpment and then swings to the south beyond Çakıllı. The escarpment becomes steeper to the north and the channel crosses a wide shoulder of level ground. Here we were able to locate a series of tunnel openings before the line of

[19] The term 'bossed work' is used to generically to describe ashlar blocks dressed with quarry faces and drafted margins, also frequently termed rustication. The exact form of the dressing varies throughout the system and will be described in greater detail where necessary.

[20] Çeçen (1996a), **G4**, **G5**, **G6**, 107, photos pp. 110–11. He also writes that the villagers reported subsidiary channels adjacent to the main channel, but that none were seen in this sector. He calls the bridge the Küçükkemer, Çeçen (1996a), **K3**, 133.

[21] Çeçen (1996a), **K4**, 133.

[22] Çeçen (1996a), 107; no traces were seen by us.

FIG. 3.5 East side of the bridge at Akpınar Dere (**K4**), west of Evrenli.

FIG. 3.6 Channel at Kolağıl Mevkii near Çakıllı.

the channel swung north-east along the valley of the Ergene Dere. The openings lie in fields belonging to Kolağıl Mevkii; four small openings into the masonry channel were spotted in open fields and scrub. One could be seen to be stone-vaulted, with a width of 0.78 m. These correspond with the channels noted by Çeçen (Fig. 3.6).[23] The height of the channel is here *c.* 206 m asl.

1.4 Ergene Dere to Ayvacık Dere (K4.1–K5) (Map 2)

From Kolağıl the channel loops around a low-lying spur to join the west side of the Ergene Dere. At the head of the valley are the major springs of Ergene at an elevation of 216 m asl. We first visited these with Akif Işın of Tekirdağ Museum in 1997 and they are a major tributary spring connected with the main line from Pazarlı. These are karst springs like those at Papu and Pınarca. The remains of a vaulted tunnel, 0.60 m wide, leading south-east in the direction of the main channel, are located close to a small modern pumping station below the spring.[24] This subsidiary channel seems to follow the south (right) bank of the stream to join the main channel as it crosses lower down. A section of channel was found at a lower elevation of 206 m as it turned to cross the valley. Only the top of the channel was visible and it was not possible to establish its width. Opposite this was found the east abutment of a bridge (**K4.1**, not recorded by Çeçen) of about 3 m in width and a raised embankment 25 m in length. The channel here was 0.76 m wide. The south wall of the channel had fallen away, but the sinter survived 5 cm deep in possibly four or five layers (Fig. 3.7). On the north side was a 3.5 cm thickness of sinter to a slightly higher level than on the south side. At its east end the channel turns south and curves away to join the main

[23] Çeçen (1996a), **G7**, **G8**, 107–8, photos pp. 112–13; on p. 134, he gives dimensions of 0.85 m.

[24] Çeçen (1996a), **G9**, 107–8, 135, photo p. 113; he refers to the subsidiary valley as the Ambar Dere.

FIG. 3.7 Sinter deposit near Ergene (**K4.1**).

valley of the Gökcesu. No trace of the subsidiary channel could be identified on the left side of the tributary valley, so it is assumed that the two channels came together to cross at the bridge **K4.1**.

Gökcesu aqueduct (**K5**)

The line of the channel can be followed as a shallow depression to the main aqueduct across the Gökcesu, a tributary of the Ergene Dere.[25] Originally the bridge was about 130 m long. On the north-west (right) bank there was a prominent arch visible on the south face. It was over 3.69 m wide, with voussoirs 0.72 m high, and *c.* 0.34 m wide, and 0.95 m deep. This arch extended northwards about 2 m, at which point the blocks met a mass of mortar that filled the opening and extended north for a further 4 m, indicating that the bridge had once been about 6 m wide (Fig. 3.8). The mortar fill clearly represented a later repair to the bridge, since the northern voussoir blocks showed damage in the vicinity of the junction with the mortar core. It seems, therefore, that the northern side of the bridge had collapsed and had been very extensively rebuilt. The mortar was very pink, and contained brick inclusions up to 10 mm across and an aggregate of weathered limestone fragments. Nothing survived of the arches crossing the river; however on the opposite bank where the embankment survived, a cross-section showed two southern faces, apparently corresponding to the phases represented by the stone arch and the later mortar core seen in the centre of the bridge. In the secondary facing to the north, a reused bossed block was visible. Towards the south-east end, the bridge could be seen to have carried two channels. The core and stone face on the southern side of the bridge measured 0.80 m in width to the southern inner face of the southern channel (Fig. 3.9). This channel was 0.70 m wide to its northern inner face. The other channel was at a slightly higher elevation; its width could not be determined, since only its northern inner face could be detected, 1.5 m to the north of the north face of the lower channel. The northern external wall of the higher channel was 0.96 m wide, but was only

FIG. 3.8 Arch at Gökcesu (**K5**).

[25] Çeçen (1996a), **K5**, 107–8, 134–5 and photo; he merely notes that it is 'completely ruined'.

FIG. 3.9 South channel at Gökcesu (**K5**).

traced for a 1.3 m stretch. The northern external face of the bridge was a further 1.8 m to the north, bringing the total width of the bridge to 5.76 m.

Following a survey using a Total Station, it was possible to establish that the north channel had been blocked and that a second parallel channel had been established to the south. This alteration can be associated with the extensive rebuilding seen on the western part of the bridge surviving across the stream. There, as noted, the north side of an arch had been filled up and strengthened with mortared rubble, probably following flood damage. Çeçen suggests that additional water sources may also have come from the Dedepınar and Gökcesu springs to the north.[26] We followed the latter valley but there was no trace of a channel on either side, despite recent clearance and erosion.[27]

To the east of the bridge, the channel could be followed as a broad platform.[28] A small ruined bridge (**K5.1**) was noted at the crossing of a small valley *c.* 300 m south-east of **K5**; beyond this, a forest road had cut through the platform and revealed the base of a single narrow channel. Although at one stage we had been uncertain whether the two channels at the Gökcesu bridge were contemporary or successive, this discovery indicated that there had been only one main channel, which was seen in two successive phases at the bridge.

FIG. 3.10 Abutment on the west side of Gelin Dere (**K6**).

1.5 Ayvacık Dere (K6–K7)

Gelin Dere (**K6**)

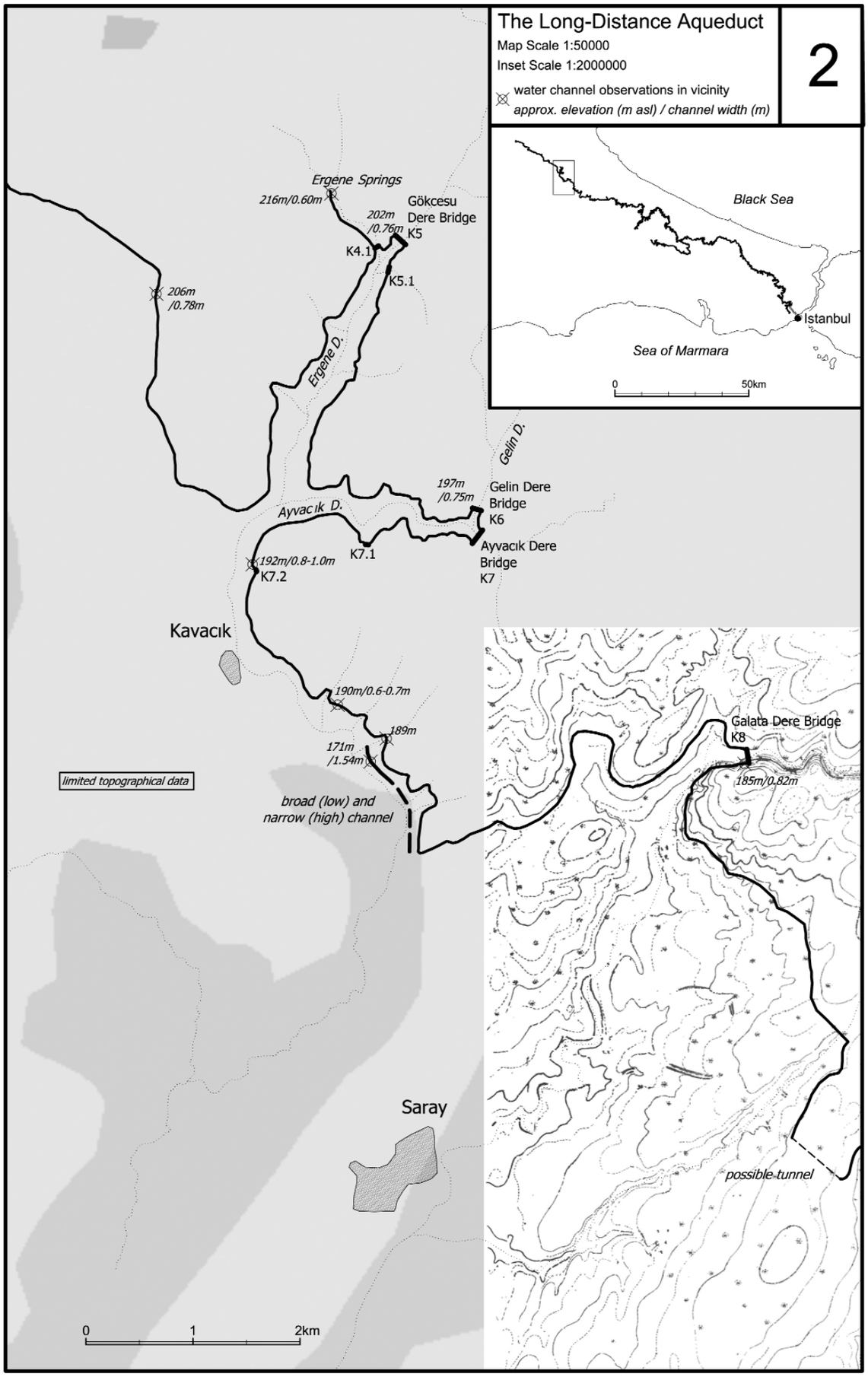
The line of the channel continues along the east side of the valley of the Ergene Dere for 3 km and then turns due east and enters the tributary valley of the Ayvacık Dere, where the width of the tributary valley forces the channel to divert from the side of the main valley. Two major bridges are known, located 1 km south-west of the centre of Ayvacık village. The first, over the Gelin Dere (**K6**), consists of an abutment on the north-west side and robbed-out remains on the south-east.[29] The north-west abutment had originally measured 4.15 m wide, faced with limestone rubble, but a later facing had been added to the north side, increasing the width by 0.50 m (Fig. 3.10). The abutment on the opposite side of the valley survived when first visited in 1997, when the width of the

[26] Çeçen (1996a), 107–8, 135.

[27] In 1998, we had considered that the aqueduct in the Ayvacık Dere (Çeçen **K7**) showed signs of reduction from a broad to a narrow channel and we had interpreted the aqueduct across the Gökcesu Dere (**K5**) in a similar way Crow *et al.* (1998), 19–20.

[28] Çeçen (1996a), 109, notes a channel on the east side of the Ergene Dere (**G10**).

[29] Çeçen (1996a), 109, 135, calls the valley the Palamut Dere, but this is located further to the west; the area is locally known as Kemerli Mevki.



MAP 2 Ayvacık to Saafalan.

FIG. 3.11 Channel on the east side of Gelin Dere (**K6**).

abutment was recorded as 4.20 m, but subsequently it had been completely dug out during the construction of a village road into the Ayvacık Dere and only the channel survived in section.[30] Only the north face of the abutment survived so that the full width could not be determined. The channel was 0.75 m wide, its sides surviving to a height of 0.98 m. The base was lined with 15 mm of plaster, above which was between 70 and 90 mm of sinter. On the south face of the channel the sinter was up to 40 mm thick, in four clearly-defined layers, each with a varying number of finer bands (Fig. 3.11).

Ayvacık Dere (**K7**)

The channel continues and rejoins the main tributary valley of the Ayvacık Dere, which it crossed by a wider bridge, although very little survives apart from the abutments on the north-east and south-west sides of the valley.[31] We can estimate from GPS readings that the bridge was about 85 m long with three major arches; fragments of one single pier are visible on the south side of the valley floor. It is likely that this was the 'belle ruine antique' noted by Visquenel during his visit to Thrace in 1847. He writes that seven cart-loads ('sept arabas') were removed by Russians (*sic*) from a place north-north-west of Saray, including two inscriptions. He marks the location on his sketch map to the east of Tchéherli, modern Çakıllı, beyond a main river, presumably the Ergene Dere; nothing is known of the inscriptions, which, like the Russians, may be a local invention.[32] The channel can be estimated to have been 11 m above the stream bed, with a total height for the bridge of between 13 and 14 m. On both sides, the remains of the abutments indicate that the channel had been constructed in more than one phase. A feature of the surviving work on the bridge was the use of small stone facing-blocks as part of the upper stonework associated with the channel (cf. the bridge at Talas (**K22**)), seen to have fallen on the south side of the valley floor.

The abutment on the north side of the valley comprises part of the base, the east wall, and part of the west wall (Fig. 3.12). The fragmentary remains of the lower abutment with large blocks survive down the slope and represent the pier for the first arch. The upper remains are 3.40 m wide and project 4.40 m from the hillside. The structure consists of three main elements: to the east (upstream) there is a high, standing section of wall, 0.60 m wide; the outer

FIG. 3.12 Ayvacık Dere, north abutment (**K7**).

[30] See photo in Çeçen (1996a), 135.
[31] Çeçen (1996a), 135–6.
[32] Visquenel (1868), 301, pl. 19, fig. 1.

FIG. 3.13 South abutment at Ayvacık Dere (**K7**), showing the inner face of the east wall.

facings are mostly robbed away to a depth of 0.45 m. A level base is structurally part of this wall on the west side and the level core survives to a width of 0.70 m to the west where it is broken away; there is no clear evidence for a plastered channel base. The middle of the abutment appears to have been robbed away for 1.10 m and only soil fills this space. A section of core and fallen wall survives to the west. There is no clear trace of a channel base on this side.

On the south side of the valley, the south abutment survives to a width of 4.19 m, with an additional footing on the east side of 0.25 m. The east wall is well preserved with a width of 1.49 m; the outside face is constructed with small blockwork, the interior being less well preserved (Fig. 3.13). A feature of this east wall is the use of long blocks 33 cm high as levelling courses low down on the east face. The only evidence for an associated channel floor can be seen mid-way down the slope, otherwise the channel floor on the east side, as seen on the north abutment, is not visible. However, to the west side clear traces of a channel base, 0.79 m wide, are visible together with fragments of the west side wall, 0.65 m wide. In 1998 it was possible to identify two distinct layers of plastered floor abutting the west wall, 15 mm apart (Fig. 3.14). On the south side it is clear from the alignments that the channel is turning away from the west side of the valley.

From the field measurements and observations, it is apparent that there are discrepancies between the surviving remains of the channels and abutments to the north and south of **K7**. Çeçen interpreted the evidence from the south abutment to indicate that: 'It

FIG. 3.14 Ayvacık Dere (**K7**), detail of west abutment showing the two layers of the channel base.

can be seen quite clearly from the remains of two parallel channels 85 cm in width on the "exit" side of the aqueduct that these channels passed over the latter. It is not possible, however, to explain why there should have been two channels'.[33] From our survey and observations, we can conclude that the east (upstream) side walls of the north and south abutments have facings using small blockwork and this suggests that this facing was continuous across the bridge. On the west side, the only evidence for this is a fragment of this type of masonry which can be seen in the valley bottom, probably fallen from the west side of the bridge. The north abutment survives as a narrow structure only 3.85 m wide. The south abutment is recorded as 4.19 m, which is comparable with the abutment of **K6** in the adjacent valley with a width of 4.15 m. It seems clear that part of the west face of the north abutment of **K7** has been lost to

[33] Çeçen (1996a), 136.

robbing or erosion. Evidence from **K6** and elsewhere indicates that the channel was normally situated in the middle of the long axis of the bridge, yet at the south abutment of **K7** there is clear evidence for a well-preserved channel with a surviving plaster floor positioned on the west side of the abutment and the bridge, although the full width of the bridge is unclear on the east side.

We suggest that the visible channel on the south abutment, being offset, is a rebuild. The original channel would have been in the centre of the bridge, as can be seen at **K6**. On the north side of **K7**, there is a hollow in what can be inferred as the centre of the abutment. This could correlate with the first-phase channel. However to the east of it is a single phase of core work, forming a reversed L-shape in profile, and representing a levelling course and the side wall of the abutment (see Fig. 3.12). It seems likely that the first channel was constructed in the mortared core, similar to the surviving work on the west side of **K6**. It is unclear why the later channel is located on the west side, although it conforms with the arrangement seen at the Gökcesu bridge (**K5**) and observed elsewhere. Possibly a substantial collapse of the east (upstream) side of the bridge necessitated repairs; there is clear additional work on the upstream side of nearby bridge **K6**. If so, we can imagine that the original channel was blocked to strengthen the structure and that the bridge was possibly widened along its west side and a new channel was built into this new façade. It is important to recognize that both the original channel and its replacement channel were narrow channels. No evidence was found for two parallel narrow channels as reported by Çeçen.

On the south abutment of **K7**, the waterproof plaster base of the west channel was particularly well preserved and at its junction with the side wall we observed that the surface was drawn up at 45 degrees — common practice on Roman aqueducts and intended to ensure water flow and reduce turbulence. A similar feature was also noted in the base of the high-level channel at Kurşunlugerme (**K20**) and Büyükgerme (**K29**).

1.6 Ayvacık Dere to Güneşkaya Gorge (K7.1–K8)

On the south side of **K7** the channel turns to the west but is only visible as a slight terrace for *c.* 200 m; further along the valley the hillside has slipped, revealing the outer face of the tunnel high on the hillside. A steep-sided, narrow valley enters from the south, east of Yanosman Tepe, and there are the fragmentary remains of a small bridge, **K7.1**.

The channel leaves the Ayvacık Dere and re-enters the Ergene Dere about 2 km west of the junction with the Gelin Dere, passing the village of Kavacık to the south. Çeçen notes a channel opposite the village (**G11**). Here the river passes through a gorge with the high cliffs of Güneşkaya on the south side; the channel now passes on the north side of the valley, running in a south-easterly direction. The main limestone ridge, which separates this gorge from the Ayvacık Dere to the north, is known as the Delikli Mağara, and Çeçen notes three sections of channel

FIG. 3.15 Bridge abutment (**K7.2**) at Çingene Dere.

(**G11a**, **G11b**, **G11c**) in the locality, with an elevation of 185 m asl.[34]

Our observations were similar, although it was not possible to identify exactly the points illustrated by Çeçen. We noted channels and structures running just below the edge of the escarpment at an elevation of 190 m. North-west of Kavacık the channel was seen to be constructed with small rubblework with little plaster surviving and was *c.* 80–100 cm wide (**G11.1**). A bridge (**K7.2**) was found at a crossing of a small valley (Çingene Dere); the bridge was *c.* 4 m high and 15 m long, with a width recorded at the south end of 4.40 m (Fig. 3.15). Further south-east the channel was seen in a cutting in a limestone quarry, 1.80 m wide (**G11.2**), and was visible in several places over a 50 m stretch. It was clear at one point that a supplementary channel fed in from the plateau to the north. This was presumably derived from a spring, and a number are marked on the Turkish 1:25,000 map; a less likely alternative is that it represents a tunnel across the higher Ayranbayır ridge from the Ayvacık Dere. Further traces were located where shallow holes dug out by treasure-hunters revealed a narrow channel, 60–70 cm wide, and the remains of bridge footings.

Further towards the floor of the valley, Çeçen reports a large channel below Delikli Mağara, measuring 1.54 m wide by 2.30 m high, which could be traced for 100 m.[35] He states that this was parallel with the 0.85 m-wide main channel but was about 15 m below it and was connected to it by a steeply-inclined channel with a stepped bottom. He writes that this big channel supplied the castle which stands where the Ergene valley opens out into the plain. We identified this channel 22 m below the narrow channel and its course could be seen as a substantial platform of 4–5 m in width. It is located about half a kilometre north-east of the modern dam in the Ergene river where the gorge opens out, close to Saray. We were also told by villagers at Kavacık that there was a castle, although we are inclined to believe that it is a local legend and that no castle exists. This isolated length of wide channel in the Güneşkaya Gorge, or 'Büyük Galeri' as Çeçen termed it, remains an enigma, since it remains unprecedented in this sector of the aqueduct line.

From the gorge the water channel follows the 190 m contour through a military camp and was then reported to us at the disused stone quarry beside the road to Ayvacık village (**G12**),[36] where more extensive traces were destroyed thirty years ago. From there it follows round the hills towards the wide valley of the Galata Dere[37] in the neighbourhood known as Dumlucadeğirmen Mevki.

1.7 Galata Dere (K8) (Map 2)

Although little survives of the bridge over the Galata Dere, it is important for the history of research on the water supply system, as it was amongst the earliest reported aqueduct bridges outside the city. Visquenel, in the section of his geographical account of the peoples and resources of Ottoman Thrace entitled 'Indications sommaires de quelques ruines antiques reconnues dans la Thrace en 1847', reports that having 'entendue parler à nos guides d'aqueducs antiques', he was informed by the Mudir of Saraï that there were man-made caves in the valley of the Galata Dere, '(E)t des canaux qui passent sous le plateau calcaire et conduissaient autrefois l'eau à Constantinople'. His informant continued that, 'il éxiste encore de distance en distance des restes d'aqueducs qui traversent les vallées et vont se relier aux canaux soutererrains, larges et élevés, qui traverses les montagnes. Le mudir pretend qu'en peut suivre les traces de conduits d'eau jusqu'à Constantinople'.[38]

No further details of the bridge are given, although there are artificial hollows next to the ruins of the abutment corresponding to the man-made caves, and it is not clear how much of the stonework had already been robbed by the mid-nineteenth century, since the aqueduct is not marked on his map and there is no evidence he visited the site.[39]

From the high ground of the plateau to the west the water channel must have been carried on a raised wall or embankment, similar to that which survived until recently beside the crossing of the Manganez Dere (**K9**) (at Galata Dere this was possibly removed as a result of the construction of the main road from Saray to Güngörmez). Traces of core survive on the north-west bank of the river and there is a second

[34] Çeçen (1996a), 109, photos p. 114, where they are referred to as Güneskaya from the name of the gorge.

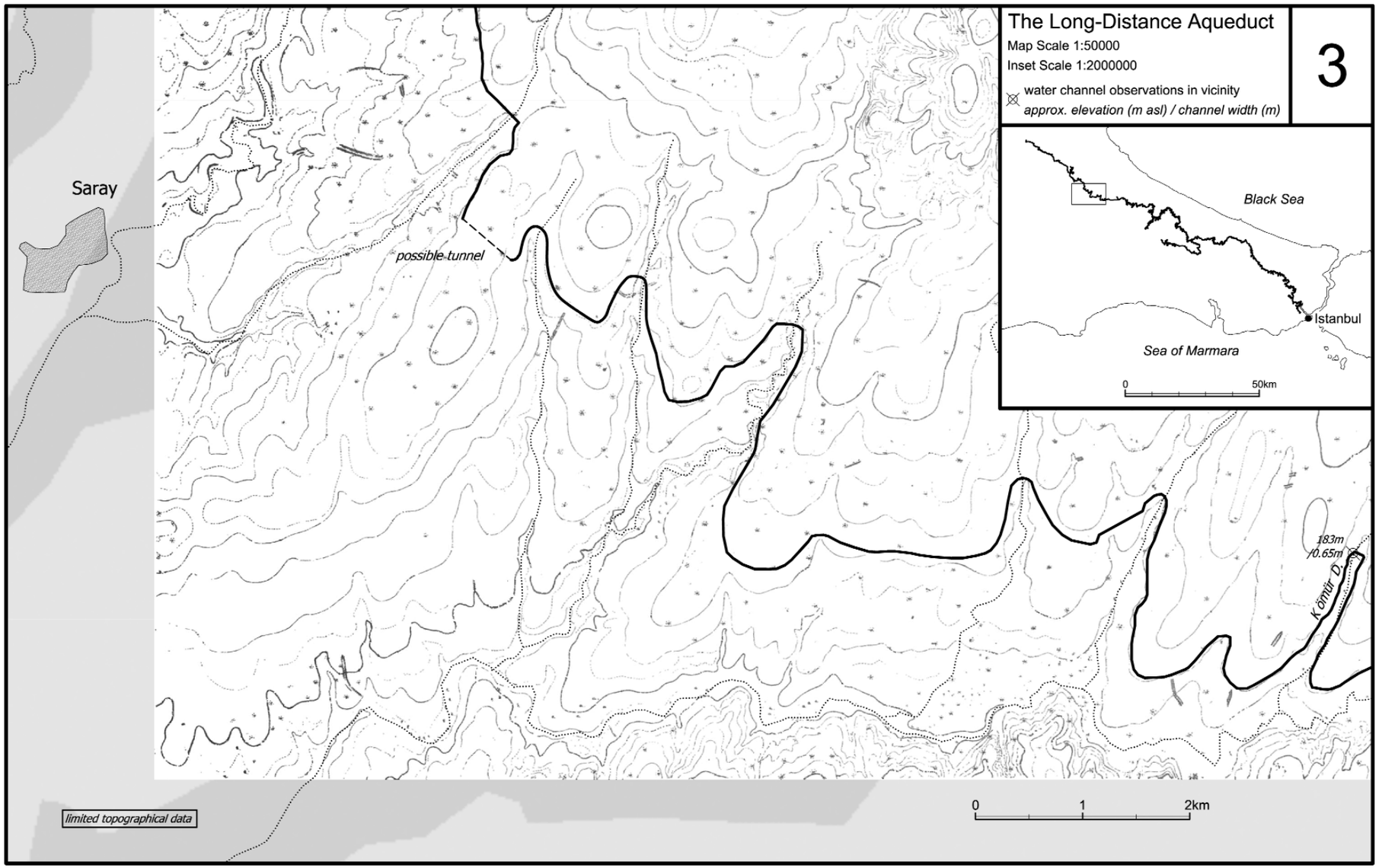
[35] Çeçen (1996a), 110, 137 (with photo p. 116); on p. 62 he notes that this was the largest recorded channel on the line.

[36] Çeçen (1996a), 110, notes the remains of an *opus caementicum* wall close to the quarry (see photo p. 116).

[37] Note the river is called the Saray Dere on the Turkish 1:25,000 map.

[38] Viquesnel (1868), 291, 302; the map on pl. 19 provides no information about the aqueducts. See also the general comments by Dirimtekin (1968), 117.

[39] As noted above, the seven carts of stone carried away from a bridge are likely to be from Ayvacık Dere (**K7**), Viquesnel (1868), 301.



MAP 3 Saray to Kömür Dere.

earthwork bank to the north of it. The bridge core survives to 20 m in length and a height of 3 m. We estimate the original height of the bridge to have been between 20 and 25 m, with a length across the river of *c.* 130 m — this is certainly the largest bridge encountered since the source at Vize.

The east bank rises very steeply to the Taşağıl ridge and there are traces of the east abutment, much disturbed by stone robbing, together with artificial hollows in the bedrock. At the foot of the slope, a large block with drafted margins, 0.58 m high, 1.28 m wide, and with a depth *c.* 0.64 m, indicates the monumentality of the bridge, comparable with others further east. The facings of the abutment are visible in places on the south side, but elsewhere little survives. To the south-west of the abutment a narrow channel is visible, 0.88 m wide, with a maximum surviving height of 0.97 m. The side walls have a block size of 0.08 by 0.14 m, with large blocks at the springing of the vault (**G13**).[40] A second opening reveals the channel to have a width of 0.82 m, with well-preserved plaster and sinter, and a surviving height of *c.* 1.40 m; there is no evidence of the broad channel in its vicinity. As the channel crosses the steep hillside, a collapse shows how at this point the tunnel was constructed on a right-angled platform, 2.45 m wide, cut into the bedrock.

1.8 Galata Dere to Binkılıç (K8–K9) (Maps 2–4)

The low, rolling hills east of Saray represent the watershed between the catchment of the Ergene Dere, flowing towards the west and the north Aegean, and the Stranja Dere and its tributary the Karaman Dere, which flow east to Terkos Lake and the Black Sea, culminating in the high ground between Safaalan and Binkılıç traversed by a tunnel 1.5 km in length. From Pazarlı to Saray the course of the channel is quite clear as it follows the line of the limestone escarpment, interrupted only at Vize and north of Saray. Further to the east, however, there are few known traces of the channels or bridges, although in places the line must have been cut across headlands in a deep trench rather than a tunnel as it proceeds to contour across the broad ridge running east towards Safaalan. Significantly the Turkish 1:25,000 map notes an area of woodland marked as 'kemerler' (arches) beside the main road 2 km east of Saray, but no remains have been reported. We were able to locate Çeçen's observed channels at **G14**, **G15**, and **G16**[41] and to make one new observation of a small collapsed section of the narrow channel (**G13.1**) to the west of **G14**. All the channels were narrow, with a measured width in one case of 0.65 m and an elevation of 183 m asl; the valleys are shallow and, as Çeçen suggests, there are likely to have been small bridges across streams such as the Kömür Dere,[42] although no trace of this was seen in 2004.

South of the village of Safaalan, the plateau rises to 220 m and the channel was forced to enter a long tunnel in order to break into the catchment of the Binkılıç Dere. This was probably located 2 km south of the village, between the head of the valley of the Mitakenyeir Dere, on the west side, and the Yayın Dere, to the east; the total length is likely to have been *c.* 1,500 m. Çeçen reports a channel south-east of the village (**G17**);[43] this was not located, but he does not take into consideration the high ground of the Safaalan ridge and on his map the line appears to be arbitrary in this area. Beyond this ridge the channel line enters the Binkılıç Dere (old name Stranja Dere) which cuts a deep valley through the Stranja hills towards the north-east.

1.9 Manganez Dere to Binkılıç (K9)

The channel turns south off the main valley into the Manganez Dere. In 2002 we were able to record the west abutment of an aqueduct bridge (**K9**),[44] 26 m long, surviving as mortared core-work (with large limestone blocks in the core) and standing to a height of 1.5–2 m (Fig. 3.16). This represents the surviving remains of an 80 m-long bridge, *c.* 10 m in height. Revisiting the site in 2004 at the request of the local Jandarma, we observed extensive piles of cut stones and rubble with pink mortar attesting the recent total destruction of the upstanding remains and the buried foundations of the bridge (Fig. 3.17). Amongst the rubble which survived were large squared blocks with quarry-faced work and drafted margins, characteristic of the monumental bridges seen elsewhere on the system. The Jandarma also drew our attention to construction work at the

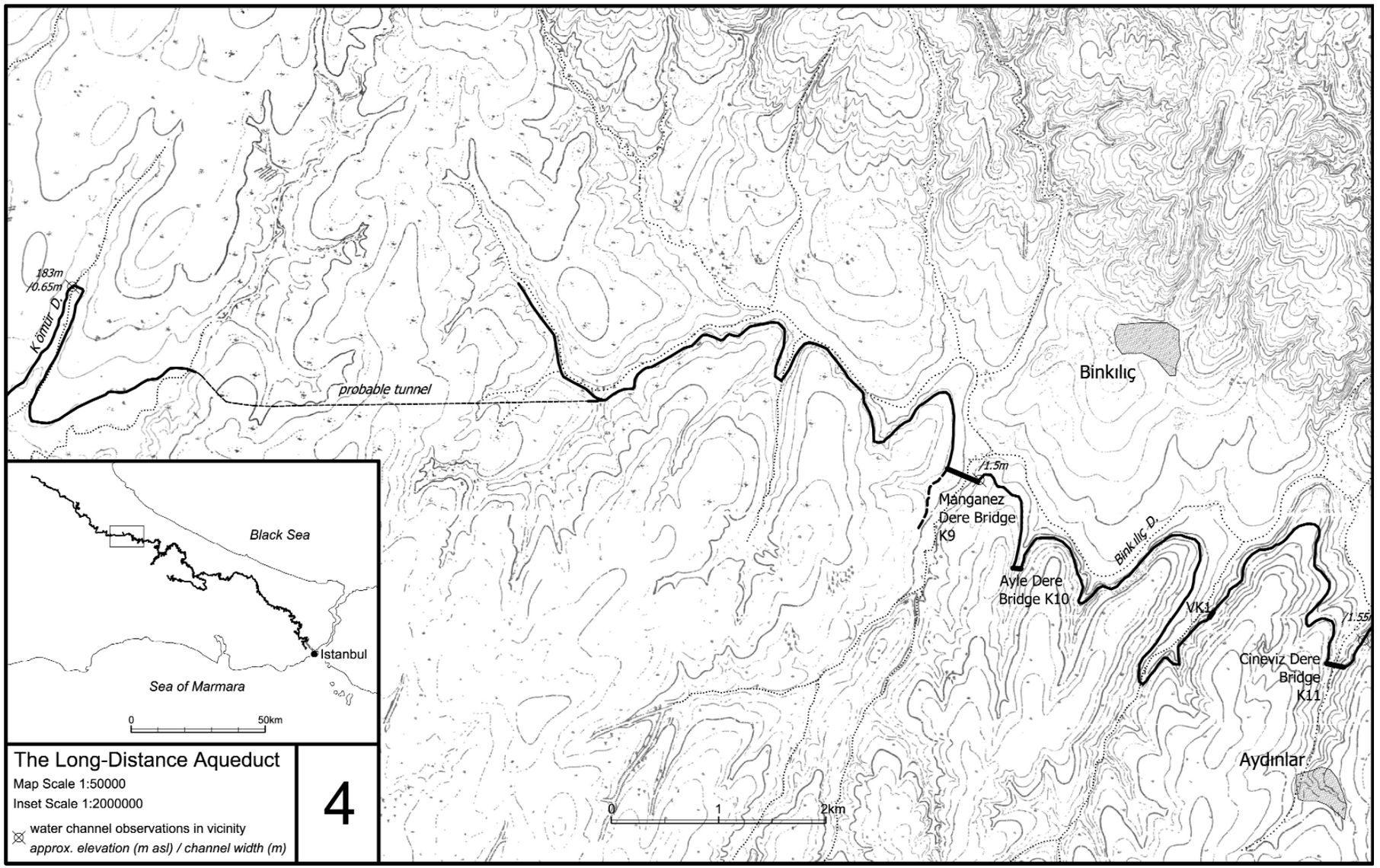
[40] Çeçen (1996a), 110, 137, 140, notes that little survives of the multi-arched bridge. He notes one channel at **G12**, (1996a), 110, 140.
[41] Çeçen (1996a), 110, 116.
[42] Çeçen (1996a), **G15**, 140, photo p. 116.
[43] Çeçen (1996a), 110.
[44] Çeçen (1996a), 111, 140, with photo p. 136.

FIG. 3.16 West abutment at Manganez Dere (**K9**).

FIG. 3.17 Ruined abutment at Manganez Dere (**K9**).

Byzantine kale on the isolated hilltop north of Binkılıç, and whilst the new works had not affected the archaeological remains there, we did observe that some of the ancient stonework included large, re-used limestone blocks with clamps, no doubt derived from the aqueduct bridge in the valley below. The main channel will have approached the west abutment from the north-west; however a clear terrace to the south-west and significant quantities of limestone suggest that in addition there was a supplementary channel approaching from that direction.

The channel is visible to the east of the river where a clear example of the broad channel may be seen. The vault has a shallow triangular cross-section, 1.50 m wide, and the tunnel can be followed for about 20 m turning to the north-east (Fig. 3.18). In the next valley to the east, Ayle Dere (**K10**), Çeçen notes that a few foundation stones of a bridge remain on either side of the valley. The channel then turns towards the south-east. The broad tunnel east of the Manganez Dere is the first example of a wide tunnel encountered along the line, apart from the enigmatic 'Büyük Galeri' near Saray. Up to this point, from the main sources at Pazarlı and Ergene, all channels measure *c.* 0.65–0.70 m wide, but from this point until Dağyenice the broad channel is continuous. One explanation for its absence further to the west, is that there are a number of major sources in



MAP 4 Saafalan to Aydınlar.

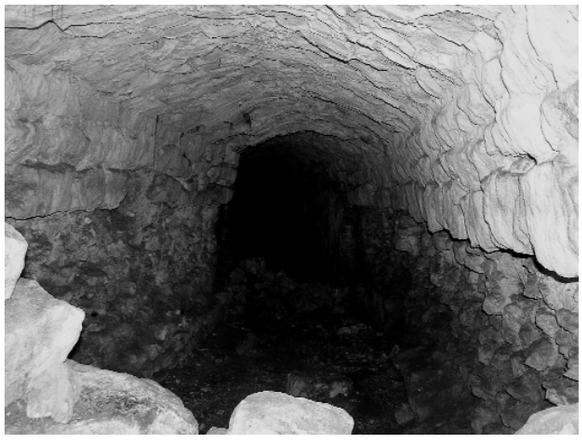


FIG. 3.18 Broad channel east of Manganez Dere (**K9**).

the vicinity of Binkılıç which significantly added to the volume of seasonal water flow and required the construction of this larger tunnel.[45] East of the Manganez Dere, Çeçen records a three-arched structure (**VK1**), located on the east side of the Kocaköprü valley, where there is an arched embankment to carry the channel across the very steep hillside.[46] From here the channel turns north-east and into the Binkılıç Dere once again.

1.10 Aydınlar (K11–K13) (Maps 4–5)

North and north-east of Aydınlar (formerly Alaton), three significant bridges and lengths of broad channel are known from the Cineviz Deresi (**K11**), the Elmalı Dere (**K12**), and the Karamanoğlu Dere (**K13**).

Cineviz Dere (old name Alaton Dere) (**K11**)

The remains lie 1.3 km north of the village of Aydınlar.[47] An active stream flows between two surviving piers of the bridge, which was constructed of rough blockwork masonry with a rubble-work core. We estimate that the bridge would have been 20 m long and the height of the channel about 10 m. The west pier is *c.* 6.1 m wide, with a span between piers of 10.6 m. Clamp sockets are visible on some blocks and there is evidence for rebuilding, since facing-blocks with drafted margins are re-used in the west pier (Figs 3.19; 3.20). Midway between **K11** and the Babadar Dere a well-preserved length of broad channel is visible in the hillside (**G17.1**). The channel survives to a height of 2 m for a length of 40 m and is 1.55 m wide, although the base is not clear. The

FIG. 3.19 Cineviz Dere (**K11**), view of west abutment.

side walls of the channel are constructed of small blockwork (0.23 by 0.08 m maximum block size; other small blocks *c.* 0.145 by 0.08 m), with two courses of large blocks at the springing of the vault. On the face of the small blockwork (i.e. up to the vault springing) is a layer of very pink plaster, 10–20 mm thick; on the face of this is white plaster 13 mm thick. Over the bigger blocks of the vaulting is lime incrustation, 35–50 mm thick, formed by the percolation of groundwater. Much of the small blockwork has been robbed away so that lime plaster now litters the floor of the channel.

Above the Babadar Dere the course of the channel, **G17.2**, emerges from the hillside and appears to traverse a gully in the rock on a raised platform (*substructura*), 11 m long, 3.5m wide and 3 m high. On the north-west side of the gully the channel is constructed within a rock-cutting 3.5 m wide, rather than on the normal 'cut and cover' platform in the hillside. Within the rock-cutting is a well-preserved

[45] The line of a terrace from the south-west has already been noted on the west bank of the Manganez Dere. The War Office 1:25,000 map indicates a number of spring sources north-west of Binkılıç in the Soğuksu Dere, Büyük Göl, and Ayazma Koru.

[46] Çeçen (1996a), 140, 143, photo p. 137.

[47] Çeçen (1996a), 111, 143 with photos on p. 137; his name of the Ceviz Dere is not attested locally.

FIG. 3.20 Evidence of clamp socket at Cineviz Dere (**K11**).

length of tunnel, 1.60 m wide. We assume that the gully had been formed by quarrying stone for the bridges, such as those at the crossings of the Ceneviz (**K11**), Babadar (not found), and Elmalı Dereler (**K12**), and it was then crossed by an embankment left on the unquarried rock when the channel builders had reached this part of the system. The quarry face, however, was dug away towards the hillside, indicating that the quarry-men continued to work, respecting the line of the channel. The remains of the continuation of the channel survive to the south-east, with a very clear profile of the base of the channel (Figs 3.21; 3.22).

Elmalı Dere (**K12**)

The single-arched bridge over the Elmalı Dere is the first fully preserved arch along the line east of Vize.[48] The bridge was 5.35 m wide, 8.0 m high, and 32 m long, with a single-arched opening, 5.30 m wide and 4.70 m high. The limestone facing-blocks are bossed, and no masons' marks are visible. No decorative features survive on the stonework of the bridge, although there is a clear chamfered string-course 1.5 m below the top of the bridge; this appears to have a downward taper, but it is very weathered. A square projecting course marks the springing of the main arch, although this is quite eroded. An opening for the broad channel (**G18**) is visible on the west side of the bridge and there are clear traces of the ledge

FIG. 3.21 Channel above Babadar Dere (**G17.2**), seen in a stone cutting in the hillside; note the small blockwork facings.

[48] Çeçen (1996a), 143 with photos pp. 138–9; he records the span of the central arch as 5.5 m, and the width of the bridge as 5.67 m. On the left side he noted that the channel **G18** of the bridge was 1 m wide, (1996a), 111, photo p. 116.

FIG. 3.22 Channel above Babadar Dere (**G17.2**), showing the east side and the raised stone platform.

formed by the buried tunnel, 4–5 m wide. In places this widens to 10 m like a passing-place; however we were informed by villagers that these were old charcoal stances used by the 'Rum' inhabitants a century ago. Close to Elmalı Dere, traces of an old road were seen with cobbles and rock-cuttings. It was called by the villagers the İpek Yolu (Silk Road) and led to the south-east.

Karamanoğlu (**K13**)

The channel continues to follow the south side of the main, steep-sided valley of the Binkılıç Dere up to the high spur of Karamanoğlu Tepe which projects to the north. At this point the main channel cuts through this spur in a tunnel; the approach to the tunnel is raised on five distinctive arcades (**K13**) across the broken ground where two small streams come together. Çeçen gives the width of the arches from right (west) to left as 5.35, 5.40, 5.25 and 5.40 m, and states that the springing of the arches was 1.76 m above modern ground level. He could not determine whether there was a fifth arch. He describes and illustrates the crosses decorating the arches of the bridge.[49]

We first visited the bridge in 1997 and were able to photograph the decorated key stones (see Chapter 7), most of which have now been badly vandalized. Fieldwork in 2001 revealed evidence for both narrow and broad channels. The surviving stone arcades belong to the broad channel phase and will be considered first. The elevation of the channel on top of the arcades was 185 m asl and it is oriented at 66 degrees. Where the channel could be measured in cross-section (Fig. 3.23), it survived to about 5 m in height from the base of the channel and was 4.6 m wide and 80–95 m long. A 10 m stretch of channel survived on top of the aqueduct towards the west; it was 1.6 m wide with walls 1.5 m thick. The side walls of the channel rose 1.6 m to the springing of the masonry vault (Fig. 3.24). The hydraulic mortar was 10 mm thick and pink in colour, with a high density of brick inclusions. A very thin layer of sinter encrustation survived to a height of 1 m, indicating the maximum volume of normal water flow. The arches were about 5 m in span and varied between 5 and 6 m in height. The bridge was built of squared blocks of limestone, quarry-faced with drafted margins (bossed work), about 0.35–0.50 m high. At the springing of the arches were string-courses with flat tops, projecting 0.23 m and tapering back. Unlike the surviving bridge at Elmalı Dere (**K12**), the springing of the arches was offset from the piers below. Normally the bossed blockwork was uniform in size; however on the south façade, level with top of the upper voussoirs, levelling courses of very thin slabs were clearly visible which were intended to 'fine-tune' the top of the arcades with the base of the water channel (Fig. 3.25).The structural mortar was pink with large brick inclusions.

Higher up the slope to the east is a stone-lined, vertical shaft, described variously as a well or an access-shaft (*muayene bacısı*) for an underground tunnel. We interpret this as a shaft for the tunnel through the spur of Karamanoğlu Tepe, where the channel bearing was 83 degrees; the shaft measured 1.4 by 1.3 m and was 20 m deep at an elevation of approximately 180 m asl. Çeçen's observation that the construction of this bridge is like that at Talas, and was therefore of quite a different structural technique from the other major bridges of the system,[50]

[49] Çeçen (1996a), 111, 143–5 with photos on pp. 116, 140–5, 198–9.
[50] Çeçen (1996a), 210, photos pp. 218–19.

FIG. 3.23 Karamanoğlu arcade (**K13**), cross-section across the broad channel.

cannot be supported from our study. The surviving remains for the broad channel arcades with their elaborate christograms and other decorations represent the most westerly surviving evidence for the decorated scheme found on the great aqueduct bridges of the second phase of building, such as Ballıgerme (**K18**) and Kurşunlugerme (**K20**). Previously at Galata (**K8**), Manganez Dere (**K9**) and elsewhere we had found only the occasional remnants of the large bossed blockwork characteristic of the major aqueducts found further to the east.

Beyond the west end of the arcades we also found traces of a narrow channel leading around the south side of the ridge towards the spur of Karamanoğlu Tepe. It was not clear to us whether this represented an earlier or later channel leading towards the tunnel. It is most likely to be a later provision, replacing the line of the channel carried on the arcade, since no other trace of a narrow channel is known in this section of the line.

FIG. 3.24 Karamanoğlu arcade (**K13**), interior of the channel showing fine-mortar facings.

FIG. 3.25 Karamanoğlu arcade (**K13**), thin levelling courses above the arch.

1.11 Karamanoğlu to Ballıgerme (K13–K18) (Map 5)

Between Karamanoğlu Dere and Ballıgerme, the course of the water channel is required to take a series of great loops away from the main line of the Binkılıç Dere in order to break into the catchment of the Karaman Dere and to follow the same line as the earlier Valens channel from Danamandıra. To achieve this course it crosses at least twenty valleys and tributaries, each of which is the site of a bridge; however fieldwork in this area has been limited. Çeçen was able to identify four bridges along this length of channel. He notes remains of the Balıksırtı bridge (**K14**) in a deep narrow valley, where only foundation stones survive. The line heads due south to turn again into the valley of the Kurt Dere. Here he records three bridges — a ruined aqueduct at Cangevrek (**K15**), and two further bridges, one unnamed but marked across a tributary on the north side of the Kurt Dere (**K16**), and a second apparently across the Kurt Dere (**K17**), noted as 'below Topuzçayır on the right bank of Kurt Dere' or 'a ruined bridge near Kamburcayiri hill', from where it runs to Ballıgerme.[51] It is clear, however, that the channel needs to cross further valleys before turning into another main valley, the Sarp Dere, and then towards the watershed marked by the main road west of the valley of the Karaman Dere.

Luka Dere (K17.1) (Figs 3.26; 3.27)

On the south side of the Kurt Dere is the narrow valley of the Luka Dere. The aqueduct here is aligned in a north-east to south-west direction, with the stream bed flowing down to the north-west. There is a single arch, 3.70 m wide and 5.70 m high, and the width of the bridge can be estimated at 7.25 m (Fig. 3.26). It was possible to estimate the length at 50 m. At its highest point the bridge was 10.40 m above the stream bed. A prominent string-course ran level with the top of the arch; this was of an unusual form, with a projecting upward-facing chamfer and a profile which reversed the usual downward-facing cornice blocks (compare with Karamanoğlu (**K13**)) (see back cover), but one seen at a number of other bridges where there is clear evidence for later repairs (notably the second-phase bridge at Talas (**K22**)). Although the main string-course at the base of the

[51] Çeçen (1996a) refers to these bridges on pp. 112 and 146; see also a photograph of **K15**, p. 146.

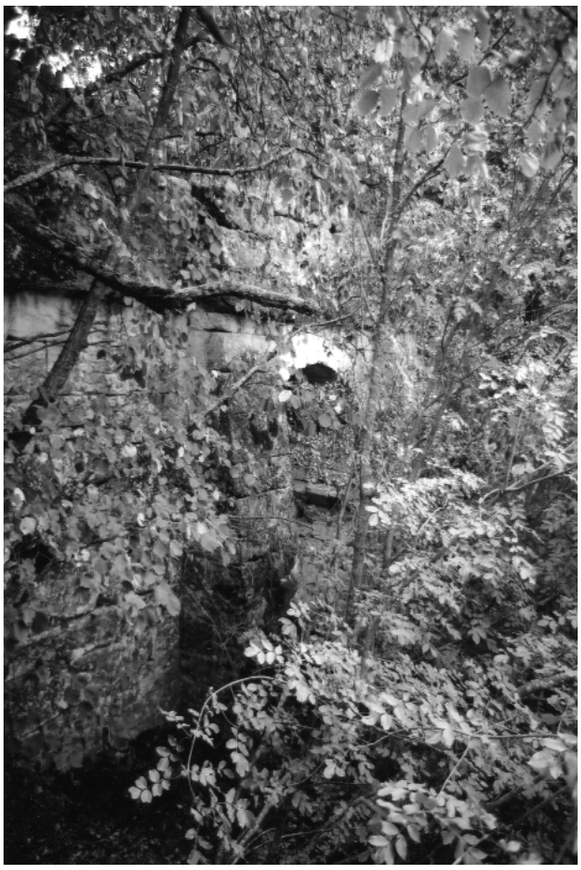


FIG. 3.26 Luka Dere (**17.1**), central arch and tapering buttress.

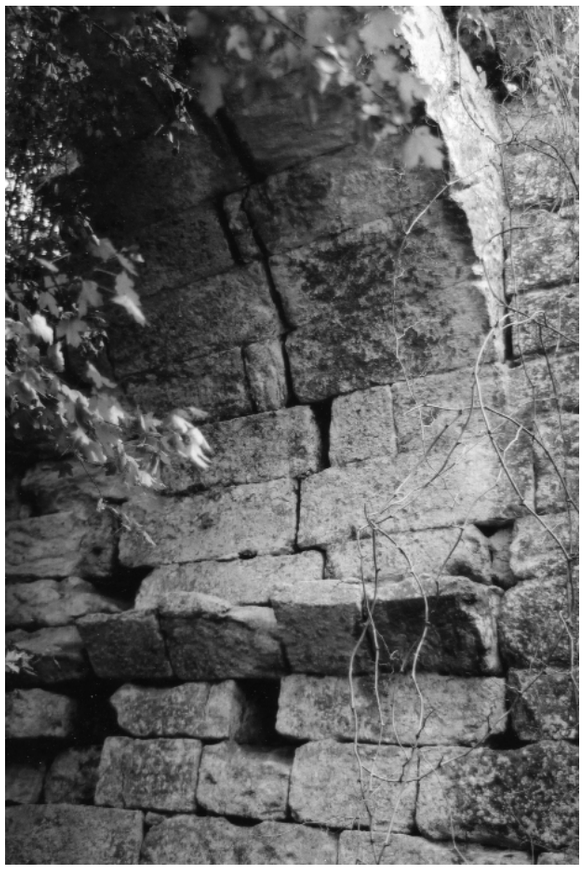


FIG. 3.27 Luka Dere (**17.1**), chamfered string-course at the springing of the arch.

water channel was of this form, the string-course two blocks below the springing of the arch retained the downward-facing chamfer seen elsewhere in earlier construction and was 0.38 m wide (Fig. 3.27). On the north-west face and on both sides of the arch and to the east was a sequence of tapering buttresses, 1.20 m wide, projecting 0.90 m at the base, and spaced 3.10 m apart (Fig. 3.26). These were bonded with the facings of the bridge and extended up to the main string-course. The downward-facing, chamfered string-course in the central arch could be seen to be part of the same build as the tapering buttress and the arch above, and it can be interpreted as the support for the timber form-work for the arch above — a feature not seen at other bridges of this type, e.g. Talas (**K22**) or Leylek Kale (**K23**). Like these bridges, the facings at Luka Dere were built of squared blocks of limestone, 0.30–0.70 m, with no evidence of bossed work, except possibly on a re-used block on the south-east side. Unlike other bridges with this form of buttress and chamfer, it was difficult to identify an earlier phase, which suggests that the bridge was completely rebuilt. The bridge survives best on its north-west side, the south-east side having largely collapsed.

In a dry valley east of the Luka Dere, close to a very large lime tree, were found the remains of a medium-sized bridge with an orientation of 250 degrees, originally about 6 m high and 4.4 m wide, probably with a single tier of arches (**K17.2**). Some limestone blocks were visible in the surface of the road on the east side, and a large abutment was also visible on the east side. On the north face of the west abutment, up to three courses of limestone blocks with bossed work survived, the courses being 0.3–0.4 m high. A 40 mm-thick brick fragment was noted close by. In many places the broad platform of the channel was clearly defined, although elsewhere the vegetation was extremely dense. It is clear, however, that the channel follows the valley of the Sarp Dere and then heads south-east to the head of the valley and cuts through the ridge with a tunnel *c.* 1,000 m long. In so doing, it crosses the watershed noted before, defined by the main road between

Karaman Dere and Karacaköy, at an elevation of just over 200 m, and the tunnel opens into the valley to the south-east between Bulgur Tepe and Ballıgerme Tepe, leading into the catchment of the Karaman Dere.[52] South of Bulgur Tepe the broad line can be seen to continue as a platform along the hillside; it is possible that the tunnel entrance was located in this direction, or alternatively that another line of a broad channel continued from the springs at Danamandıra (see 2.2 below). However since the only certain trace of a wide channel in the valley of the Karaman Dere to the south is an open rock-cutting of later date, this appears unlikely. Beyond the bridge at Ballıgerme the broad channel runs parallel to, and below, the earlier narrow channel of the fourth-century line. In establishing the course of the new aqueduct, the builders from Vize were clearly aiming the levelled line from the sources at Vize and Ergene towards this point.

On the west side of Ballıgerme Tepe (north-west of the bridge) the broad channel is very well preserved, with a wide platform; in places this has collapsed and can be recognized as a broad hollow 2 m wide, but elsewhere access can be gained into the tunnel. The dimensions of the tunnel could be seen in a number of places, extending up to 25 m in length before a collapse closed it off. It measured 1.5 m wide, with a maximum height to the vault of 2.20 m. The walls of the channel were constructed of small blocks of limestone, 0.10 m high, 0.12–0.30 m long. The vaulting was constructed with thick slates of schist (Fig. 3.28) and the springing for the vault was of squared schist blocks, in which beam-holes, measuring 0.12 by 0.12 m, survived about every 1.90 m. These will have supported the timber centering for the rubble vault. In places the hydraulic mortar survived about 15 mm thick, with fine sinter traces indicating that water had filled the channel to a height of about 1 m.[53] The platform can be traced towards the north-west abutment of the main aqueduct (**K18**), although the ground is very disturbed within 50 m of the bridge.

2 DANAMANDIRA TO BALLIGERME (Map 5)

Introduction

The source of the Karaman Dere lies to the south of the village of Danamandıra, and the channels following this valley to the north represent the primary phase of the Byzantine system constructed in the fourth century. At Ballıgerme the line of the later, fifth-century aqueduct from Vize joins the same route as the channels from Danamandıra, although initially there is a difference in height of 10 m between the two lines. The length of channel from Danamandıra to Ballıgerme is only 9 km, with the surviving evidence comprising narrow channels and one small bridge. Of particular significance for the system is the evidence of the major springs at Danamandıra village and along the line of the valley.

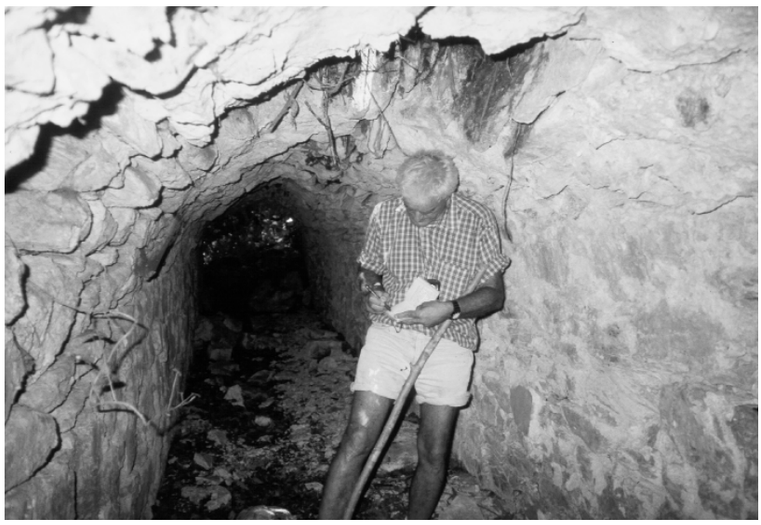


FIG. 3.28 Tunnel near Ballıgerme Tepe Çiftliği.

[52] The need for a tunnel below the main road is noted by Çeçen (1996a), 112, 147. On some maps this valley is marked as the Mandıra Dere and the village of Karamandere is also written as Karamandıra, the latter has the meaning of black dairy farm or byre.

[53] Dirimtekin (1959), 240 provides a description of this tunnel; Çeçen (1996a), 149 merely notes the schist roof; he does not give an account of channels in this section of the line, merely noting that there was no trace of the channel at either end of the bridge; see below Section 3.1.

2.1 Danamandıra to Hasan Dede Çiftliği

In 1997 we were informed of water channels near the disused trout farm at Hasan Dede Çiftliği in the valley of the Karaman Dere, 3.7 km south-west of Ballıgerme. There we found one narrow, stone-built channel, with inspection shafts at regular intervals of about 100 m, in which water still flowed (for irrigation), running above the east bank of the Karaman Dere. The line was followed no further north than the main road from Subaşı to Saray, but by using GPS we were able to establish that these channels were of sufficient elevation to have linked with the high-level, narrow channel seen further east at Kurşunlugerme. In the following year we were able to carry out further investigations as part of a more general study of the regional hydrogeology.

The main source for this branch of the system was identified as two springs located 1.9 km further upstream (south-west), on either side of the river at the village of Danamandıra. The spring on the north side of the river is known as the Paşa Pınarı, and that on the south as the Kaynarca Pınarı, at an elevation of 171 m asl. The channel from the Kaynarca spring would therefore have proceeded 2.5 km along the east side of the valley before receiving additional water from the Papu spring, itself located 800 m south of Hasan Dede Çiftliği, and then flowing on towards the Ballıgerme aqueduct, which it passed on the south side of the valley. The channel from the Paşa Pinarı spring would have proceeded along the west side of the valley; it is not clear if it crossed the valley to join the other springs or whether it eventually joined the main Vize–Ballıgerme channel as it emerged from the Ballıgerme tunnel and across the Ballıgerme aqueduct. This may have been a later option (as on Map 5), but in the primary phase a bridge further upstream in the vicinity of Hasan Dede Çiftliği is more likely.

Both of the springs in Danamandıra are closed with modern pump houses, but the Papu spring can be seen to be a substantial karst spring that emerges from a small cave. At the beginning of September 2001, effectively the end of the dry season, the water level in the cave entrance was 10 cm. It was reported to us that in winter the discharge is often six to ten times this amount, reflecting the extremely variable nature of the karstic sources on which the long-distance water supply line was dependent. The narrow channel survived in a number of places between the cave mouth and the trout farm. The channel had a width of 0.58 m, a height of 1.50 m, and an arched roof of masonry 0.30 m thick; it contained about 0.60 m of silt. The base and walls were covered with hydraulic mortar to the springing of the roof arch (i.e. to a height of 0.30 m below the crown of the arch). There were only limited deposits of sinter. Three inspection shafts were found at intervals of 190 m and 100 m. There were footholds in the shafts containing hydraulic mortar. Villagers reported that there were further springs in the neighbourhood of Papu and that formerly there had been a number of watermills. However no channels were seen by us between Papu and Danamandıra, although the muhtar (head man) reported that these had been seen in the past.[54]

2.2 Hasan Dede Çiftliği to Ballıgerme

As the valley widens to the north-east, further traces of the channel were found on the hillside to the east, beyond the former trout farm. The main road from Saray to Çatalca crosses the line of the channel; traces of the mortar with brick fragments are visible on the south side of the road, and to the north there are the disturbed remains of the narrow channel (Fig. 3.29) and a small bridge across a stream running parallel to the road. The bridge was located 50 m east of the modern roadside fountain and 6 km from Ballıgerme. The bridge would have been 11 m long, 4 m wide, and 4 m high, with a single arch, 3–4 m in span, and had an orientation of 131 degrees. The bossed limestone blocks were on average about 0.65 m long by 0.50 m high (Fig. 3.30). The channel was 0.6 m wide and survived to a height of 0.5 m,

FIG. 3.29 Narrow channel north of Hasan Dede Çiftliği.

[54] The origin of the name Papu is probably not Turkish, but modern Greek for 'grandfather', a legacy of the Christian Greek population who inhabited this part of Thrace until 1922. The name probably reflects the reliability and maturity of the spring.

FIG. 3.30 Bossed blocks at the bridge in a gully near Hasan Dede Çiftliği.

although the vault was broken away. The channel survived for a distance of 2 m.

The course of the narrow channel could be followed further along the east bank of the Karaman Dere towards Ballıgerme. After the modern road bridge for the Saray road, the valley opens out and traces of the narrow channel were found at a number of places. On the north side of the Katran Dere the course was marked by a platform and a small exposed section of the tunnel roof. Further along, the roof of the tunnel was exposed in a rough track. Then the valley turns to the east and narrows before the steep-sided gorge at Ballıgerme. Within a kilometre of the bridge the south (right) side of the valley becomes rocky and precipitous. We were able to identify a rock-cut ledge for the narrow channel at 400 m from the bridge. Beyond this point the cliffs are very steep and rugged and the line of the channel was located again on the south-east side of the valley above the bridge and the broad channel.

Channels were also reported on the west side of the Karaman Dere from Hasan Dede Çiftliği. We were able to identify sections exposed in the track running parallel with the river. In places below this line, there were traces of a wide rock-cut channel; this was cut into the bedrock but there were no remains of mortar or brick surviving and it is likely to have been a leat or channel for a watermill of later date. Further north, while following the main channel on the south (right) bank, it was reported to us that there were channels on the opposite bank, but we were unable to confirm these; their possible significance is considered below.

The narrow channel identified between Papu and Ballıgerme and undoubtedly sourced from the springs at Danamandıra and Papu represents the beginning of the narrow channel system to Constantinople — the primary water channel constructed in the fourth century. Narrow channels on the west side of the river are likely to have been fed into this line by a medium-sized aqueduct bridge, perhaps in the vicinity of the modern road bridge. No traces of this are known. Alternatively, they may have been later tributaries for the lower, broad channel which then crossed the gorge of the Karaman Dere at the single aqueduct bridge at Ballıgerme (**K18**); a similar arrangement of narrow feeder channels for the broad system is also known at Kurşunlugerme (**K20**).

3 BALLIGERME TO DERİNÇATAK (Maps 5 and 7)

Introduction

At Ballıgerme (**K18**) the broad channel crosses a steep-sided gorge over the Karaman Dere and both the high and low channels follow the south side of the valley around the high ridge traversed by the Anastasian Wall to the south-east (see Fig. 2.1; Map 5). The line crosses significant tributary valleys north of Gümüşpınar, including the major bridge at Kurşunlugerme. This ridge culminates in the summits of Küçük and Büyük Küşkaya, and the Wall running north-east towards the Black Sea crosses the line of the water channels south-east of Belgrat village. The line of the channels skirts around this high ground and turns towards the south-east, and then continues due south beyond Kalfaköy. The east flanks of the main ridge are cut by numerous deeply-incised valleys and by building the taller and longer monumental bridges of the fifth-century second phase it was possible to reduce significantly the length of the early line, notably at Büyükgerme (**K29**) and Kumarlıdere (**K31**). From Kalfaköy eastwards the line crosses the head of a broad valley to the north and then contours across the more gently rolling hills towards Dağyenice. Significant springs are known at Gümüşpınar, but beyond that point the water sources derive from metamorphic rocks and are more limited in their output.

A summary of the structural remains

This sector of the aqueduct system, *c.* 45 km in length, provides the clearest evidence for the major phases of construction and restoration and includes the six major monumental bridges, including Kurşunlugerme (**K20**) and Büyükgerme (**K29**). Not surprisingly, this part of the system has been the

subject of the most intensive fieldwork dating back to the surveys by Oreshkov and Dirimtekin.[55] Çeçen recorded sixteen bridges in this sector, to which number we have added fourteen more from our survey. In addition to providing evidence for the monumentality of the system, comparable to anything known from the Roman world, the sector also provides the clearest evidence for the structural complexity of the system of channels. At Ballıgerme the two main lines of channels coincide: the secondary broad channel originating from Vize, crossing on the main aqueduct bridge (**K18**), and the primary line of narrow channels from Danamandıra. Where the two lines run parallel, initially the broad channel is located 10 m below the narrow channel, reducing to 7.8 m at Kurşunlugerme (**K20**). With this new lower channel, a new set of aqueduct bridges was built. In some places the earlier bridges continued in use, but elsewhere they were abandoned. The new bridges at Büyükgerme (**K29**) and Kumarlıdere (**K31**) were able to reduce the length of the channels very significantly, replacing a sequence of earlier bridges with a single longer bridge. By the time they reach the aqueduct at Büyükgerme, the two lines gradually converge in height but despite extensive exploration no evidence has been found of a junction between the channels, and it remains likely that both reached the city as individual, unconnected channels at more or less the same height. Despite the clear differences in tunnel size which can be seen in the area between the villages of Gümüspınar and Çiftlikköy, beyond Derinçatak towards Istanbul evidence for the broad channel is absent. The sector also includes the clearest examples of additional channels augmenting the main supply line. This is best documented at Kurşunlugerme (**K20**), where channels are seen to feed into the high-level and low-level systems on both sides of the bridge.

This sector also provides the clearest evidence for major restorations. Two inscriptions are known; one was discovered in 1997 *in situ*, cut across a small aqueduct bridge at Elkaf Dere (**K20.3**). It records work carried out by the ex-consul and city prefect Longinus, known to have been active in the city in 541–2. The inscription can be associated with the major rebuilding of a number of bridges found to the east of this point, including Ortabel (**K20.6**), Talas (**K22**), Leylek Kale (**K23**), Cevizlik Kale (**K25**), and the raised substructure at Kara Tepe (**K29.4**), and is likely to mark the end of a specific sequence of works.[56] The second inscription cannot be associated with a specific bridge, but was recorded in Karacaköy and is likely to record work on a bridge in the sector between Ballıgerme (**K18**) and Talas (**K22**) in the reign of Basil II and his brother Constantine VIII.[57]

The structural evidence for these repairs is evident at several of the major bridges, excluding Kurşunlugerme and Keçigerme. At Ballıgerme it is possible to identify two major phases of repairs, both distinct from the characteristic sixth-century work at Talas and elsewhere, although the early phase is similar to repairs at Büyükgerme.[58] At Kumarlı Dere (**K31**) there is evidence for two channels crossing the bridge, one of which appears to have been abandoned and later blocked — structural evidence which is reminiscent of the sequence of channels from Gökcesu (**K5**) and Ayvacık Dere (**K7**) to the west.

3.1 Ballıgerme (K18) (Fig. 3.31)

The structural details of the main bridges, such as Ballıgerme (**K18**) and Kurşunlugerme (**K20**), are discussed in Chapter 4 below. The bridge is 90 m long, 7.4 m wide, with a channel height above the streambed of 37 m. Nothing is visible of the broad channel on the north-west side beyond the sections described above (1.11). On the south-east side of the bridge, the abutment turns towards the north-east and continues as a platform 6 m wide. It is faced with large blockwork and a well-preserved length of wide tunnel was found; this was 1.45 m wide and 1.60 m high (but partly-filled), and the side walls had good quality plaster to a height of 0.90 m. Construction of the side walls was of small limestone blocks, very similar to the channels seen on the north-west of the gorge, below Ballıgerme Tepe. The curve of the vault was very flat (Fig. 3.32). On the steep hillside above this channel were traces of the narrow channel, 60 cm wide; this crosses the slope *c.* 10 m above the broad channel and heads towards the north-east and the marked spur of Pilav Tepe.

[55] Oreshkov (1915) and Dirimtekin (1959; 1968).

[56] See also the bridge at Luka Dere (**K17.1**) which was reconstructed in the same way, but lies 10 km to the west.

[57] See below Chapter 4, p. 106; see Appendix 1.

[58] See below Chapter 4, pp. 90–2 for a fuller discussion of the structural evidence.

FIG. 3.31 General view of Ballıgerme (**K18**).

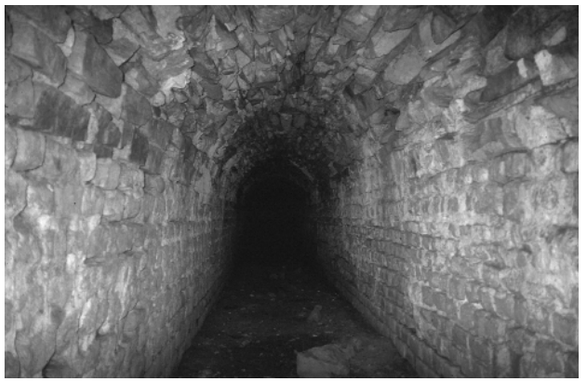


FIG. 3.32 Channel east of Ballıgerme.

3.2 Gümüşpınar Dere (K19)

At Pilav Tepe the channel turns due south away from the main valley into the narrow valley of the Gümüşpınar Dere, down which leads a rough road towards the old sand quarry in the Karaman Dere valley to the north. The track has partly damaged the remains of a ruined bridge noted by both Dirimtekin and Çeçen.[59] Dirimtekin considered this to be a single-arched bridge, but the valley width would suggest two to three arches. A low, ruined abutment survives on the west side, but the main remains are to the east, next to the roadway. The standing masonry represents a section cut through the main east abutment of the bridge. There is a very clear row of cribholes in the core: 0.24–0.20 m wide and 0.54–0.50 m apart. A second row is apparent at a higher level. On the north side of the abutment is an additional wall, 0.95 m wide, incorporating reused large blocks (Fig. 3.33). The course of the channel can be seen as a platform running to the north-east.

FIG. 3.33 Added facing to the north-east of the east abutment at Gümüşpınar Dere (**K19**).

[59] Dirimtekin (1959), 236, called it 'anonyme aqueduct en ruines'; Çeçen (1996a), 152, photo p. 155, identifies it as the Gümüşdere bridge.

Dirimtekin describes how he observed two channels with a 5–6 m difference in elevation in this part of the system. We did not observe a higher bridge to the south of **K19**, as might have been expected. The ruined remains of a stone culvert for the broad channel were seen east of the track, 300 m to the north of the abutment. In the same region Çeçen states that 'the remains of a number of other secondary branches joining the supply line we surveyed near Gümüşpınar were encountered'.[60]

The name of the village of Gümüşpınar translates as 'silver spring' and reflects a local abundance of water sources from both karstic and metamorphic springs. The streams in this area all feed northwards to the Karaman Dere and the inhabitants of Gümüşpınar have long benefited from these resources, both for their own subsistence and for distribution to Istanbul. Pumping stations collect water for the village at the head of both the Kürşünlügerme valley and further to the west in the Kürek valley.[61] On the ridge overlooking the valleys to the south a water depot extracts water directly from the water table and transports it by tanker to Istanbul. In one sense these tankers are the modern substitute for the ancient water supply system, although the ancient system is unlikely to have benefited the local economy as it does today.

At the head of the Gümüşpınar valley, which opens into the Karaman Dere just 2 km to the north, are the closest natural springs to Gümüşpınar village. Low on the eastern slope of the valley a linear earthwork can be seen, surviving to around 1 m in height. In one place, just 500 m from the modern pumping station, the erosion caused by a tractor path has revealed that the earthwork covers the rubble and mortar vault of an aqueduct channel beneath. This small channel runs north along the contour, before it intersects and connects to the major channel described above. The springs in this catchment can, therefore, be seen to perform a small but crucial supplementary role within the water supply system as a whole. The local villagers are very aware of the variable quality of the water in this region and the muhtar (Mustafa Nafiza) informed us that, although the villagers drew water from six sources in the Çakılcık Dere immediately to the east of the village, these sources were only used for washing and irrigation because of the lime in the water. The water for the bottling plant, which is sold to Istanbul, is pumped from the spring at Kurşunlugerme because these sources derive from metamorphic rocks.

FIG. 3.34 Dervişkapı Dere (**K19.1**).

The channel continues north around another high spur of the Sukarığı ridge into the valley of Dervişkapı Dere, leading down from the ridge of the Anastasian Wall, 4 km to the south-east. There the remains of a single aqueduct were located and plotted (**K19.1**). The two separate systems were visible. There were no traces of monumental rusticated masonry. On the west side of the stream it was well-preserved with a single face of blockwork similar to that seen at Talas (Fig. 3.34). The overall distance across the stream was 10.40 m and the width of the bridge was 9.55 m, including an additional face, also seen at **K19**. Beyond this valley traces were seen of the footings of a small bridge where the broad channel crossed a small tributary valley.

In his account of the aqueduct bridge in the Gümüşpınar Dere (**K19**), Dirimtekin observed that two channels were apparent in this area, 5–6 m apart.[62] The broad channel can be followed in many places between **K19.1** and Kurşunlugerme (**K 20**) as a wide, terraced path, hollow on the inside. In places the tunnel can be entered. It was 1.65 m wide and lined with water-proof plaster; in this area there was little evidence for sinter. As in the tunnels west of Ballıgerme, small holes were located at 1.2 m above the floor and 0.80 m apart, probably for beams supporting the centering of the vault. The maximum surviving height of the tunnel was 2.10 m. As noted near Elmalı Dere (**K12**), there were regular expansions along the line of the tunnel platform

[60] Çeçen (1996a), 112.

[61] The Kürek valley is shown on all maps available to us as lying to the east of the village; however we were informed by the muhtar that it was a valley to the west and all the maps show major springs in this area. The discrepancy between the toponyms attributed by map-makers and local usage is a common problem.

[62] Dirimtekin (1959), 236; Çeçen (1996a) never remarks on this, although he does note variations in channel size and separate bridges.

representing old charcoal-burning stances. The upper channel was located close to Kurşunlugerme but was difficult to follow in the dense woodland.

3.3 Kurşunlugerme (K20) (Fig. 3.35)

The aqueduct bridge known as Kurşunlugerme is the most monumental structure to survive from the Thracian water supply system, and its architectural details and decoration are discussed in Chapters 4 and 7. The archaeology of the Kurşunlugerme valley provides some of the best evidence for the chronological and logistical relationship between the narrow and broad channels. As Dirimtekin observed, the monumental aqueduct that still stands was not the first aqueduct to cross the valley; the foundations of an earlier bridge are located about 100 m to the south-east (upstream) (Fig. 3.36).[63] The south abutment of the early bridge towers over the bank of the stream, but otherwise few remains survive except masonry stumps and scraps of mortared rubble core in the hillside to the north. The elevation of these remains would indicate that the upper bridge was built to carry the high-level, narrow channel from

FIG. 3.36 South abutment of the primary bridge at Kurşunlugerme.

FIG. 3.35 Kurşunlugerme (**K20**), with the ruined north abutment of the early bridge in the foreground.

[63] Dirimtekin (1959), 236, mistakenly states that like the main bridge it was also faced in marble; Çeçen (1996a), 112 notes, 'On the upstream side of Kurşunlugerme above the aqueduct there is a single arch aqueduct 20 m lower than the former.' He envisaged this supplying 'local centres of habitation'. There is no reference to an earlier phase.

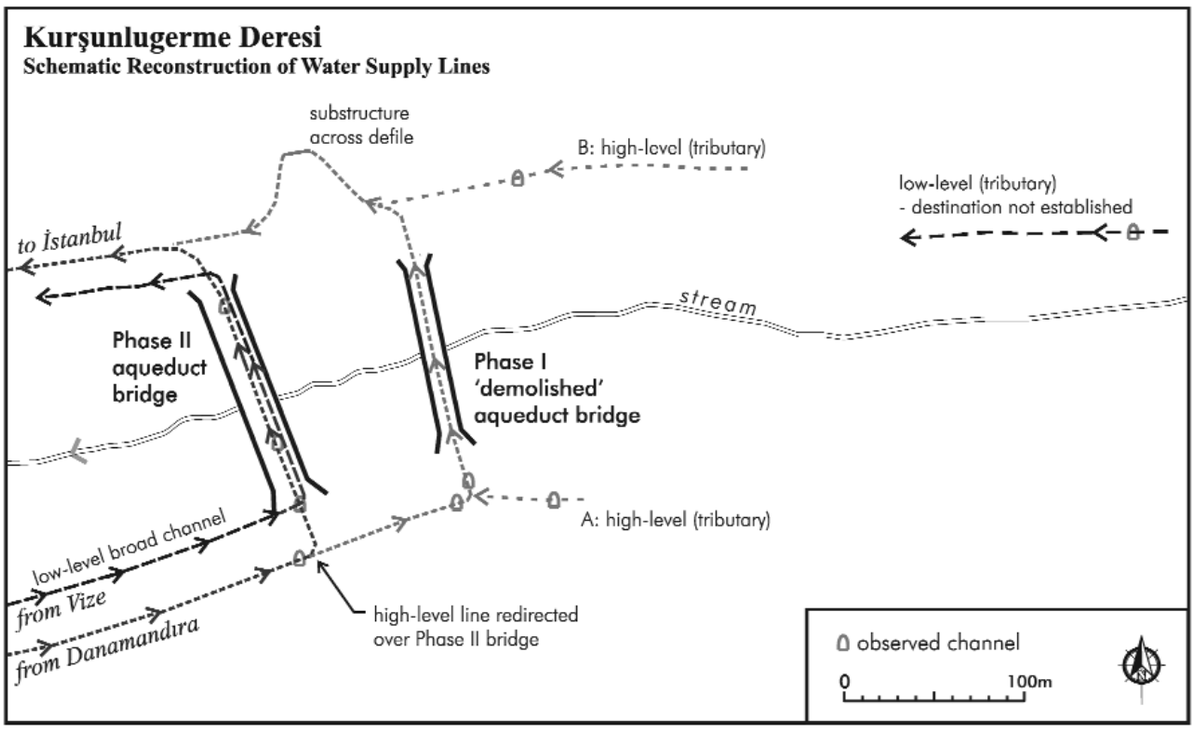


FIG. 3.37 Kurşunlugerme Deresi (valley); schematic reconstruction of the water supply line.

Danamandıra. This is confirmed by the traces of a narrow channel, 1 m wide, running on both sides of the valley, at the appropriate height, to the west (downstream) of the main bridge (see Fig. 3.37). Since the primary bridge was built east of a deep and narrow defile on the north side of the valley, the high-level channel had to pass across the defile, and the remains of a substructure across the head of the valley show how this was achieved. The later bridge was constructed to the west of the defile. Although in previous discussions we have suggested that both aqueduct bridges were in use simultaneously,[64] a more detailed analysis of the nearby channels has demonstrated that the earlier bridge was abandoned once the new bridge had been completed. This new bridge was built at the time of the construction of the low-level system from Vize, and it was designed from the outset to carry both the low-level channel and the original, high-level channel, which was diverted from the earlier bridge.

In the case of Constantinople's water supply, the two channels with different elevations were allowed to come gradually to a common elevation over a distance of many kilometres. The use of bridges or arcades to carry multiple channels in an evolving supply system is particularly well attested in Rome, where the arcade of the Aqua Marcia carried the channels of the Aqua Tepula and the Aqua Iulia 'piggy-back style' on the final 10 km approach to the city.[65] In this case it was a significant difference in the quality of the water that required the separation of the waters from the two sources.

The main, secondary bridge, the so-called Kurşunlugerme ('the leaded span'),[66] comprises two broad lower tiers and a narrow third upper tier. A ledge of just under 4 m in width ran on either side of the upper tier. The new, low-level channel was carried on this ledge, while the primary, higher channel was diverted from the earlier bridge and carried on the third tier. The new bridge was, therefore, built at the same time as the new, broad channel was constructed and the structural evidence demonstrates that the construction technique, mouldings, mortar and ornamentation are consistent throughout the bridge, from top to bottom. The primary bridge had never been adapted to carry the low-level channel, and it was abandoned with the construction of the channel from Vize and the second bridge. In other

[64] Bono, Bayliss and Crow (2001).

[65] Ashby (1935), 184, 128–49, fig. 15; Aicher (1995), 119, 36–9.

[66] The War Office 1:25,000 map refers to the bridge as Kurşun Kemer, the 'lead arch', a name derived from the lead settings for the iron clamps securing the outer facings. It also suggests how *-germe* may derive from *kemer*.

valleys, such as Talas, we observed that the upstream aqueduct bridge (**K21**) was succeeded by a lower bridge (**K22**), although the simple sequence of one bridge replacing another cannot be demonstrated in all cases (cf. Keçigerme (**K30**)). The evidence from the Kurşunlugerme Dere, however, is significant in that it demonstrates the nature of the channels associated with each aqueduct and also provides detailed evidence for the supplementary channels to the main system.

3.3.1 *High-level channel* (Figs 3.37; 3.38; see Fig. 4.7)

The line of the high-level, narrow channel can be seen west of the monumental bridge, on both sides of the valley, at the same elevation as the third tier of the bridge. Occasional openings into the channel revealed a dry-vaulted masonry tunnel, lined with hydraulic mortar, with dimensions approximating 0.90–1.00 m wide by 1.70 m in height. This channel was, presumably, carried across both the primary and secondary bridge as a flagstone-capped conduit, as on earlier Roman aqueducts. On the south side of the valley, as it approaches the later main bridge from the west, treasure-hunters had revealed that the masonry vaulted channel was constructed freestanding on a wide ledge cut into the bedrock of the hillside, with the channel located 1 m from the rock face. Further to the east, the line of the narrow channel could be followed to the primary, ruined bridge. At one point along this tunnel we discovered a well-preserved inspection shaft and at the primary bridge the narrow tunnel measured 0.90 m wide with a well-preserved vaulted roof 1.80 m high. In the north side of the tunnel (towards the bridge) there were two arched openings, 1.30 m wide and 0.90 m wide, 0.65 m apart; a third opening to the east had been blocked. The tunnel continued to the east and could be followed for a further 10 m. This extension showed that there was another source higher up the valley. This source will have continued in use once the new bridge was constructed and will have flowed past the old bridge to join the high-level channel at the monumental west bridge. Because of the build-up of material in the tunnel at the primary bridge, it was unclear whether the vaulted openings extended to the base of the channel, or whether they acted as overflows. The former explanation is more likely. Examples of similar side openings are apparent from the Ottoman channels on the Cebeciköy line where a supplementary channel is entering the main channel. Evidence for the narrow channel crossing the bridge is discussed in Chapter 4.

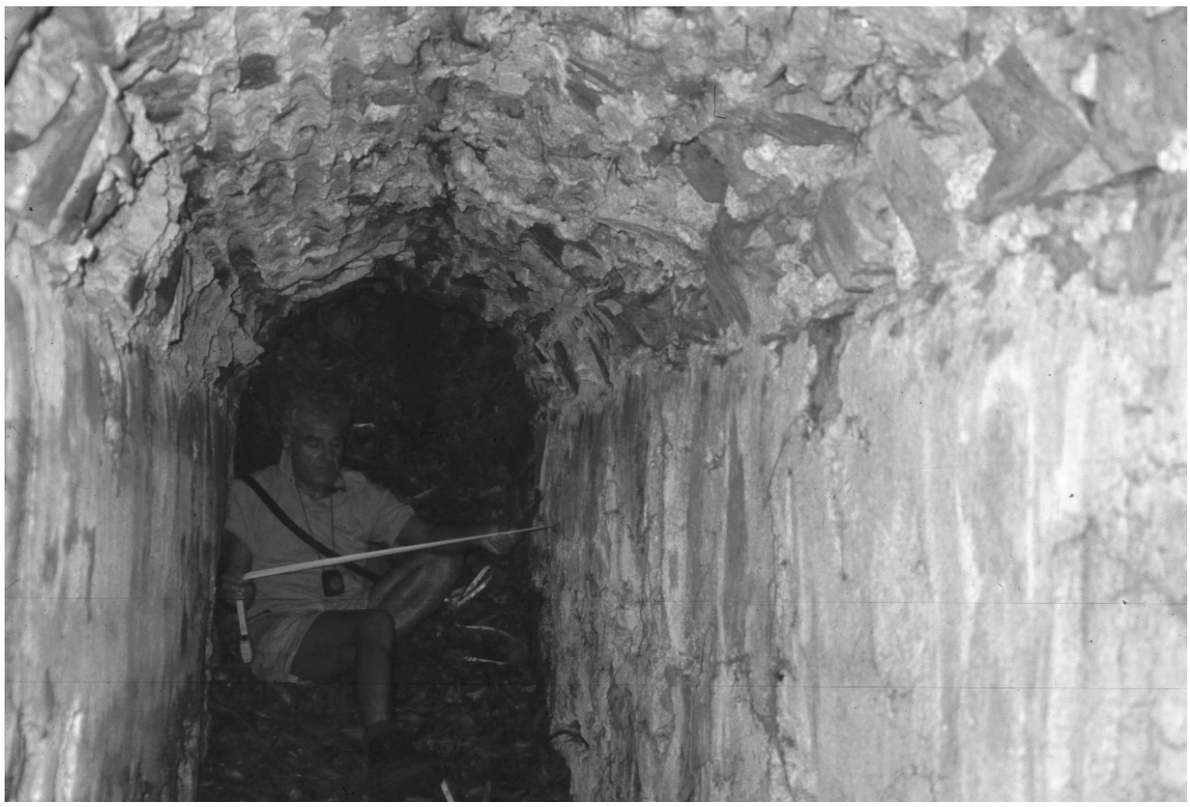


FIG. 3.38. Narrow channel on the south side of Kurşunlugerme valley (see Fig. 4.7).

FIG. 3.39 Excavated course of the broad channel on the south side of Kurşunlugerme valley, west of the main bridge (**K20**).

3.3.2 *Low-level channel*

The course of the broad channel from **K19.1** to **K20** has already been noted. As it approaches the south side of the main bridge, the terrace still serves as a path through the forest. The terrace can be seen to run at the same elevation as the ledge on the top of the second tier of the bridge and is a substantial platform built to contain a broad channel. Very recent disturbance by treasure-hunters (2006) has revealed the broad channel approaching the south end of the bridge (Fig. 3.39). Like the channel described at Ballıgerme, the side walls are constructed of small regular limestone blocks. Another pit dug by treasure-hunters had previously uncovered the broad channel where it passed beneath Arch 11 of the upper tier. Here the channel was contained within a deep rubble and mortar core from the bridge construction that rose above the level of the springing of the arches of the third tier. The vertical distance between the bases of the high and low channels at Arch 11 is 7.8 m. The channel emerged through the arch on to the east side of the bridge (Fig. 3.40) and it is clear from the surviving masonry that it turned sharply to the north to cross the bridge along the east ledge of the second tier. The side walls were of uncoursed rubble unlike the section more recently uncovered a little to the west. Much of the east side of the second tier has fallen away, but traces of the rubble and mortar core that contained the broad channel can be seen along the whole length of

FIG. 3.40 Remains of the broad channel passing below Arch 11 of Kurşunlugerme (**K20**) as it begins to turn along the east face of the bridge.

the east ledge. Further disturbance at the north end of the bridge had revealed clear evidence of the broad channel, 1.22 m wide, constructed in the upper east ledge; the inner face was located 1.30 m from the outer face of Arch 2 and the channel turned to the north-west beneath Arch 1 of the third tier. Waterproof plaster survived on the west face of the channel, but not on the east.

The broad channel was, therefore, carried along the east ledge of the second tier. It is possible that the channel split into two conduits flanking either side of the upper, third tier, but this could only be confirmed by excavation, since the west ledge of the second tier is heavily eroded and the places on the north and south sides where the channel could have split and rejoined are still buried. A split conduit would certainly have balanced the direct vertical load on the bridge piers, but, given the scale of the structure, the effects of uneven compression would have been negligible. It is more likely that the broad channel was first carried along the west face, which as can now be seen was extensively damaged, and was subsequently moved to the east side, thus explaining the variation in the construction of the channel walls. On the north abutment, the channel turns to the north-west and there is a substantial retaining wall of large blockwork with clear traces of the collapsed channel and beyond that a section of preserved tunnel along the hillside to the north.[67]

3.3.3 *Supplementary channels*

The Kurşunlugerme Valley also preserves some of the best evidence for the additional tributary channels (see Fig. 3.37). No less than three can be traced: one for the high-level channel on the south side and two others for both low- and high-level on the north. One particular example (A), located on the south side of the valley and to the east of the main surviving aqueduct, was fed from springs close to the Anastasian Wall; this south channel has already been described as extending beyond the known position of the primary bridge. On the opposite (north) side of the valley we noted another high-level narrow channel (B) exposed in the side of a forest track, running from the east to supplement the main line. At a lower level, we were shown the remains of a narrow channel (C) in the hillside opposite the pumping station and across the Kurşunlugerme stream. This revealed evidence for long-term repair and maintenance of the system. At a place where the tunnel turned, erosion to the surface of the hillside and possible pressure at the turn of the tunnel at times of flood had caused the outer face to collapse revealing the remains of its footings. The tunnel at this point was 0.70 m wide and there was a distinctive triangular or pedimented vault; there was water-proof plaster up to 0.85 m from the current floor, which is partly filled up with mud. The primary tunnel was closed ahead of the collapse by a blocking wall, which was 0.70 m high, and 0.80 m wide, and left 0.45 m clear to the roof of the channel, possibly to allow water to overflow in times of flood. The new channel turned into the hillside at right angles to the old line and continued, with the same width and a shallow curved vault, west towards the main bridge. A dump of mortar from the repairs survived in front of the dam wall. Fortunately the failure of a single tributary would probably not have been seriously detrimental to the discharge of the system as a whole, but such evidence serves to remind us that the maintenance of some 592 km of water channels would have consumed considerable resources and required careful monitoring. The date of the repair is not known.

3.4 Kurşunlugerme to Elkaf Dere (K20–K20.3)

From the valley of the Kurşunlugerme Dere, the main channels run parallel with the valley of the Karaman Dere towards the north-east, snaking in and out of the subsidiary valleys east of Danamandıra village to the end of the ridge below Yalnızağac Tepe. From here the valley joins the Binkılıç Dere and opens out towards Karacaköy, and the aqueduct line is obliged to turn towards the east and south of the villages of Belgrad and Çiftlikköy, following the east side of the main ridge of the Anastasian Wall. Dirimtekin noted that west of Karacaköy the channels are below ground and he described a narrow channel, 0.80 m wide and about 1.7 m high, apparently leading to Karacaköy.[68] Çeçen reports no aqueducts or channels between Kurşunlugerme (**K20**) and Talas (**K21/22**). In fact there are five significant valleys between **K20** and Yalnızağaç Tepe and we investigated only one of these, the Ceviz Dere, north-west of the Büyük Bedesten on the line of the Anastasian Wall.

[67] Dirimtekin (1959), fig. 33 probably shows this broad channel on the north side of the bridge.

[68] Dirimtekin (1959), 233; the open channels he describes elsewhere are likely to have been examples of the broad channel where the vault had collapsed.

Ceviz Dere (**K20.1**)

We approached this aqueduct from the Büyük Bedesten on the high ridge to the east. Unlike other parts of the forest, the tree cover is high in this area and most of the aqueducts would not have been visible from Çeçen's helicopter survey. Two bridges are located in this valley, 80–85 m apart. A narrow channel is seen leading to the upper bridge on the south-west side, 0.60 m wide, but only rubble core survives from the abutments. A broad channel was also seen for the lower bridge, 1.59 m wide, and 1.86 m high, leading on to the bridge from the west side; traces of water-proof plaster survive in places. This is a single-arched bridge with a span of *c*. 6.70 m and the piers are 4.50 m wide. On the north side, towards the valley, there is additional buttressing, surviving seven courses in height (3.50 m). The bridge is faced with regular limestone blocks, with boss work, 1.40 m by 0.50 m, with footings of large schist blocks. Within the span of the bridge there is clear evidence for a reduced stone arch, 4 m in width.[69]

Elkaf Dere (north) (**K 20.2**) (see Map 5)

Continuing around the high spur of Yalnızağaç Tepe the channels continue south into the Elkaf Dere, where two small bridges survive across the tributary valley but little trace is seen of the main bridge. We were shown this bridge in 2004 and it is a low, single-vaulted bridge currently being damaged by logging traffic, as the platform of the broad channel serves as a forest track. The construction is of large blocks with clear evidence of bossed work, similar to other minor bridges further to the west. The outer voussoirs have collapsed and it is not possible to accurately estimate the width of the opening; the length of the bridge was 8.3 m (Fig. 3.41).

Elkaf Dere (south) (**K20.3**)

In 1997 we were able to identify the crossing of the Anastasian Wall and the aqueduct line at Ömerağa Geçidi near Belgrat village and woodcutters reported to us another bridge further to the west with letters said to be in 'French'. Although little survived of the main aqueduct across the Elkaf Dere, we were shown the remains of a small bridge with an inscription in Greek. This was a horizontal inscription cut into the blocks running above the arch. The surviving text was 6.19 m in length and it recorded that the structure had been built in the time of Longinus, ex-consul and prefect of the city of Constantinople (Fig. 3.42). A prefect with this name is known from the reign of Justinian. He is recorded as having reconstructed the Basilica Stoa above the Basilica Cistern in 541–2.[70] A feature of the Longinus bridge was the absence of bossed work from the facing-stones and a distinctive arch-springing (chamfered

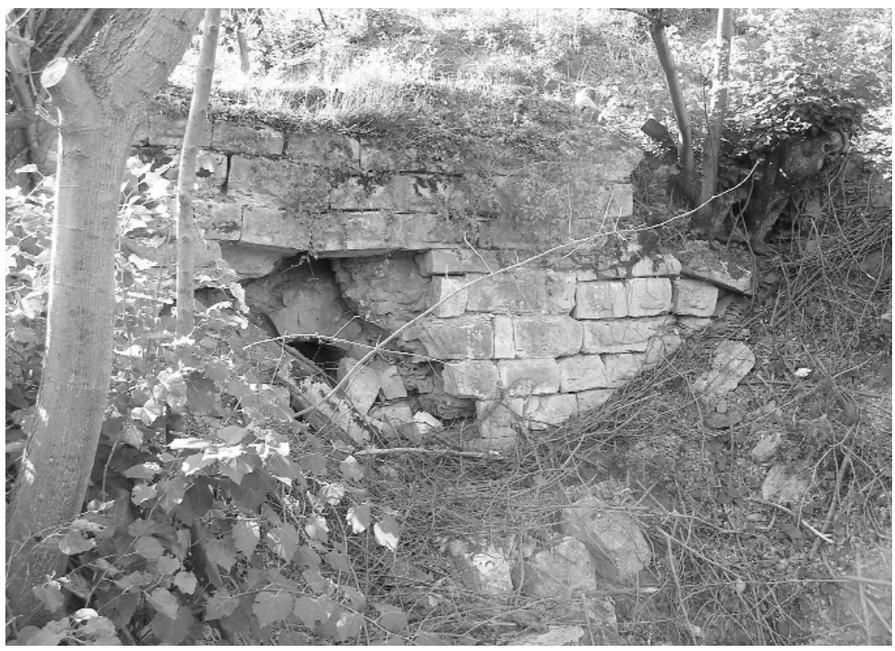


FIG. 3.41 Elkaf Dere north (**K20.2**), showing bossed-work facing-stones.

[69] Further fieldwork in the summer of 2007 revealed a number of previously unrecorded bridges in the neighbourhood of Danamandıra village.

[70] See *PLRE* III *s.v.* Longinus 2; see Appendix 1 for a translation of the text.

FIG. 3.42 Elkaf Dere (**K20.3**); the inscription is carved across a single stone course above the arch (see Fig. 2.4).

FIG. 3.43 Elkaf Dere (**K20.3**), downward-sloping chamfer on north-east side.

downwards and outwards), reminiscent of the construction of the major rebuilding at Talas (**K21**), Ortabel (**K20.5**) and elsewhere (Fig. 3.43). The arch was 2.70 m wide, with a height of 3.30 m. The line of the channel continued along the west side of the valley, although the crossing for a bridge is now obscured by the building of a modern track low down along the valley side.

3.5 The Anastasian Wall to Talas

The channels of the water supply line meet the Anastasian Long Wall at Ömerağa Geçidi east of the valley of the Elkaf Dere. From the valley the line follows along the west side of the spur followed by the Anastasian Wall into a side valley of the Elkaf Dere, where there are the remains of a ruined culvert for the low-level channel, and a section of the narrow high-level channel is exposed in the side of the track. At the crossing of the Wall the channel survives as a low mound in the woodland. East of the Wall, the tunnel is especially well-preserved and there is a broad inspection shaft (Fig. 3.44). Traces of the high-

FIG. 3.44 Ömerağa Geçidi, inspection shaft east of the Anastasian Wall.

level tunnel were also seen to the west of the Wall. The elevation of the two channels appears to converge as they flow east, and at the aqueduct at Maçka Dere (**K20.5**) the difference in elevation was estimated at between 2 and 3 m. From the evidence preserved at Nikol Dere (**K20.4**), the line was reduced in length in the sixth century.

Nikol Dere (**K20.4**)

Near Belgrat recent forest cutting had revealed three bridges in one valley, the Nikol Dere, located 500 m north of the known aqueducts across the Maçka Dere (**K20.5**). The presence of three bridges is most unusual and contradicts the standard practice of bridges in this part of the system: one for the high-level and another for the broader, lower channel, located 4–5 m apart. The upper bridge was single-arched and well-preserved (Fig. 3.45). It clearly carried a broad channel and at the north end the tunnel could be followed and seen to turn to the north-west. This is against the line of the contours. Below this was seen the more ruined remains of a second bridge with a single arch, constructed with long, bossed blocks, different from the equilateral blocks in the higher bridge. Below the second bridge was a third bridge; this was more ruined than either of the other two and was constructed with large schist rubble work.

A number of the features in the Nikol Dere are unique; these can be summarized as follows: the primary bridge was the middle bridge; this conforms with the pattern of high-level bridges, clearly seen in the Maçka Dere (**K20.5**) close-by. The second phase, broad channel can be expected at a lower elevation, in the site occupied by the bridge of schist blockwork. The equivalent bridge in the Maçka Dere was also extensively rebuilt, but did retain traces of earlier work; in its earlier phase it would have resembled the bridge at Elkaf Dere (**K20.2**). At Nikol Dere, however, the lower bridge appears to have been completely rebuilt using local materials, probably in the middle-Byzantine period.[71]

The main question at this point is why there is a third, higher bridge with a broad channel. Unusually the tunnel turns into the hillside to lead north-west, not north-east along the contours as would be expected. Only 200 m to the west, on the ridge above is the line of the Anastasian Wall. As noted before, the crossing of the Wall and water channels was located at Ömerağa Geçidi which is located about 750 m down the ridge to the north. It would appear that the new bridge was clearly intended for another tunnel beneath the Wall, about 300 m long, connecting the channels on the west side of the ridge and at a higher elevation along the line. The new tunnel and channel reduced the line by between 2 and 2.5 km and this necessitated that the bridge was at a higher elevation than the earlier work. How this bridge was subsequently integrated with the existing line is not

FIG. 3.45 Nikol Dere (**K20.4**), upper bridge.

[71] A quarry for schist blocks of this type was located west of Ömerağa Geçidi for the construction of the Anastasian Wall core.

yet clear.[72] This reconstruction can be associated with the work dated by the Longinus inscription in the reign of Justinian from the second bridge in Elkaf Dere (**K20.3**).

Maçka Dere (Kemikharman Tepe)[73] (**K20.5**)

The aqueduct bridges below Kemikharman Tepe (spanning the Maçka Dere) were originally identified as part of the survey in 1996. Here, two separate aqueduct bridges, standing close to their full height, were located *c.* 80 m apart. When we revisited Maçka Dere in 2004 the upper part of the east pier of the south-west bridge had collapsed to reveal the hollows left by the decayed beams of the cribwork construction within the rubble core of the pier. Since the bridge can be identified as belonging to the fourth-century aqueduct system, it is important to note that this construction technique was already in use at this time. Both abutments were still well preserved on the west and east sides of the stream. The north-west abutment was 5.20 m wide, with ten courses of facings rising to a height of 3 m and a square-section string-course projecting 0.38 m and running around all three sides (Fig. 3.46). The facings were of long, squared blocks, only some of which showed clear evidence of bossed work. The pier above is slightly inset and, above the preserved facings, survives as coursed rubble. Higher up the bank, above the north-west abutment, the cross-section of the narrow channel, 0.57 m wide, can be seen cut away by road-making; it shows very clearly the curved mortared base of the channel (Fig. 3.47).

FIG. 3.46 Maçka Dere (**K20.5**), primary abutments.

FIG. 3.48 Maçka Dere (**K20.5**), second phase pier (north); detail of masonry.

FIG. 3.47 Maçka Dere (**K20.5**), cross-section of the narrow channel above the north-west abutment.

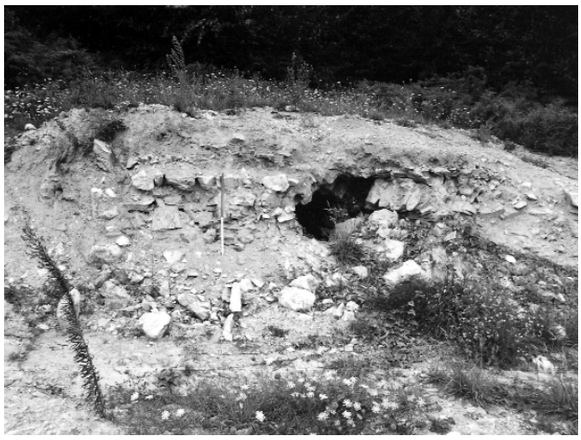


FIG. 3.49 Maçka Dere (**K20.5**), platform for the broad channel on the west side of the second bridge.

[72] See the discussion by Aicher (1995), 125–6 of the Ponte S. Gregorio on the Anio Vetus, with reference to Frontinus (18) for a similar situation; see also Leveau (1991).

[73] The Turkish 1:25,000 map gives the name Kemik Harman Tepe and marks the valley as Kayın Dere. However the local name is Geyik Harman, as marked on the earlier maps. Earlier interim reports have referred to this place as Kemik Harman Tepe, although Maçka Dere is to be preferred and reflects current use in Belgrat village.

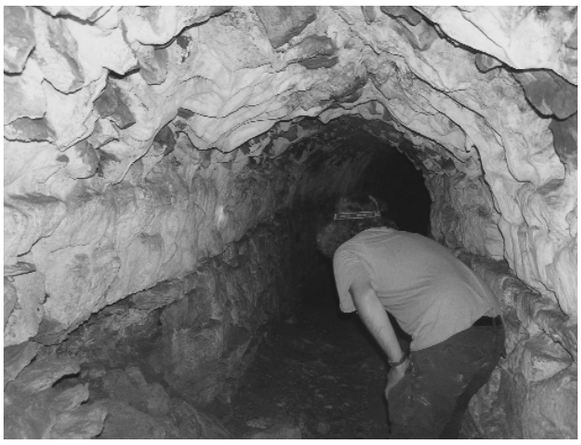


FIG. 3.50 Broad channel west of Maçka Dere (**K20.5**).

To the north of this bridge was a high abutment from a later bridge. The earliest masonry did not survive and it had been very extensively rebuilt with facings of coursed rubble and re-used blockwork. (Fig. 3.48). On the south face there were clear traces of beam-holes for scaffolding; the construction was similar to the north face repairs at Büyükgerme (**K29**). On the opposite bank of the stream, the broad channel, 1.38 m wide, is clearly visible where a track has cut through a built platform for the tunnel (Figs 3.49; 3.50).

Ortabel (**K20.6**)

The channels continued to follow around the high spur of Kemikharman Tepe into the valley of Ortabel Dere, south-west of Belgrat village. In places the broad channel followed a raised embankment (*substructura*), approaching the bridge from the north-west. Close to the west end of the bridge the broad tunnel was well preserved and there was a deliberate wiggle, probably to reduce the water-flow across the bridge. There was well-preserved, waterproof plaster on the tunnel sides and extensive leaching of lime from the bonding mortar of the tunnel vault. The cross-section of the tunnel could be seen crossing the bridge on the west side. The bridges at Ortabel have not been previously recorded. The remains of a ruined bridge were noted to the south, but the main bridge is to the north. It stands to a height of about 8 m; the first 2.5 m are offset by *c.* 0.20 m, the wall then rises by about 4 m, with another offset, then a further 1.5 m before there is a string-course marking the springing for the arch (Fig. 3.51). The string-course has the distinctive form (chamfered downwards and outwards) seen at the Longinus bridge at Elkaf Dere (**K20.3**) and is similar to the string-courses from Luka Dere (**K17.1**) and

FIG. 3.51 Ortabel (**K20.6**), west pier of the main bridge showing string-course.

Talas (**K21**). Behind the string-course are traces of the earlier springing for the primary arch. The total width of the bridge was 8.60 m and the width of the arch was 4.50 m. There is evidence for an added face of 2.80 m on the south-west side. The next bridge to the east, in the Ceviz Dere, was not visited.

3.6 Talas (K21–K22) (Fig. 3.52)

The boundary between the villages of Belgrat and Çiftlikköy is the stabilised road leading up a long spur to Kuşkaya Tepe. Because of the much larger territory and the greater distance from the latter village, the wooded district south-east of the track is less well-known and there is less certainty about toponyms in this area. Below the modern road, on the south-east side of the spur, there are traces of narrow tunnels and a very ruined small bridge for the broad channel crossing a tributary of the main valley, marked on the Turkish 1:25,000 map as the Kürt Dere, a name used by Dirimtekin and Çeçen. There are two bridges, the upper bridge for the narrow channel (**K21**) to the south and a lower bridge 200 m

FIG. 3.52 General view of the later bridge at Talas (**K22**) (1994); note the line of the broad channel on the hillside to the right; above can be discerned the faint line of the upper channel from the earlier bridge (**K21**).

to the north (**K22**); because of the structural importance of the latter bridge, it is discussed in greater detail in Chapter 4. The earlier southern bridge (**K21**) was a ruined single-arched structure. The abutments were 5.20 m wide and 4.95 m apart, and the lower part of the piers was constructed with long blocks of a metamorphic rock to a height of 5.22 m; these blocks were bossed and measured, for example, 1.57 by 0.27 m. Above this the walls were inset on all three sides by 0.45 m and were faced in coursed rubblework of the same metamorphic rock. (Fig. 3.53).[74] Traces of the narrow channel (associated with this phase) were located on the west side of the valley, south of the main aqueduct bridge, but on the east side of the bridge there was an excellent example of a narrow tunnel with well-preserved plaster on the left side (Fig. 3.54).[75]

The main bridge (**K22**) is 60 m long and 24 m high; there are two main phases of construction: the first with limestone blocks with bossed work and the second phase a major cladding of both sides of the bridge, with tapering buttresses on the north face and distinctive string-courses which are chamfered downwards and outwards, already noted from Luka Dere (**K17.1**) and Ortabel (**K20.6**). The platforms for both the broad and the higher, narrow channels were clearly visible after a forest fire in 1994, although since then the forest growth has obscured the hillside. In places the vault of the broad channel survives, elsewhere it is marked by a hollow, 1.5 m wide.

FIG. 3.53 Coarse rubblework on Talas bridge (**K21**).

[74] Çeçen (1996a), 163–4, photos pp. 173, 174; he refers to **K21** as the Yıkıkkemer, the 'ruined bridge'.

[75] Dirimtekin (1959), 230–2; Çeçen (1996a), channel **G20**, 113, 171–2, photos pp. 119, 120; **G21** is not illustrated.

FIG. 3.54 Talas (**K22**), narrow channel on the east side of the upper bridge.

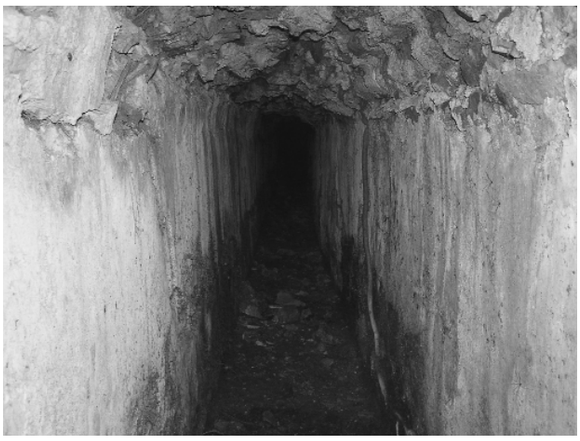


FIG. 3.55 Narrow channel west of Leylek Kale (**K23**).

3.7 Leylek Kale to Çiftlikköy (K23–K26)

Leylek Kale (**K23**)

The position of the next six bridges is noted by Çeçen from his aerial survey, but there is no written account of them. The broad channel can be followed with some difficulty to the east around the next spur from the Kürt Dere. Above the junction with the next valley to the east it is possible to see the side wall of the channel, built up at an especially steep section. Within 200 m of **K23** there was a very well preserved length of narrow channel, 0.75 m wide and 1.32 m high, with well-preserved plastered walls and a flat vault; there was no evidence for sinter (Fig. 3.55). In 2004 we were able to locate the aqueduct at Leylek Kale (**K23**), situated in a dense and barely penetrable section of forest; this, like Talas, had two major building phases. The aqueduct bridge was originally published by Dirimtekin.[76] He calls the bridge Leylek Kale or Şeytan Germe, crossing a stream called the Maden Dere, although these names are not marked on any published maps and were not known locally. The initial building was of rusticated blockwork, probably with a single arch; however later erosion and robbing had completely removed traces of this phase in the valley bottom, and all that survived was the shell of the later work (Fig. 3.56).[77] The facings were of smooth-faced blockwork, with buttresses on the north side, and are similar to the later phase at Talas (**K22**), with similar chamfered string-courses. The turn of the west side of the secondary arch could be traced in the south wall, and the east turn in the north wall so that it was possible to estimate the overall span of the central arch as 3 m.[78] The maximum width of the bridge was 9.20 m, but on the south face (upstream) the width was reduced on either side of the archway for 1.70 m, by a return 0.90 m deep, to a width of 8.30 m.[79] On the south (upstream) side were traces of a substantial wall along the stream-bed, presumably to restrict the stream when in spate and reduce erosion.[80] Significant features of the aqueduct were the four tapering buttresses on the north face; they were 1.56 m wide and projected 1.60 m, and were located 3.35 m apart. At the west end of the bridge there were the remains of a rectangular settling-tank, with a broad channel, 1.55 m wide, leading to it.

Cevizlik Kale (**K25**)

This bridge was illustrated but not described by Çeçen[81] and is situated west of Heyliye Tepe, in the district of Çiftlikköy. It is well preserved at the head of valley amongst some large chestnut trees, as the name suggests. The bridge has a well-preserved single arch, 5.54 m wide, and two tapering buttresses on the north (downstream) side; the string-course was preserved on the south side and was of the

[76] Dirimtekin (1968), 118–19.
[77] The cross-section published by Dirimtekin (1968), fig. 1 shows clearly the earlier facing.
[78] See the illustration in Dirimtekin (1968), fig. 3, showing the turn of both arches.
[79] Note that Dirimtekin mistakenly shows a buttress on the east side
[80] This is reminiscent of larger scale works north of the north water gate at Dara, see Zannini (2003).
[81] Çeçen (1996a), 175.

FIG. 3.56 Leylek Kale (**K23**), the interior of the bridge, showing the outline of the south arch, the robbed core of the primary bridge and the outer facings.

distinctive downward-facing chamfer seen at Talas (**K22**) and Leylek Kale (**K23**). The facings of the bridge are of roughly-dressed, quadratic limestone blocks, similar to the work seen at Nikol Dere (**K20.4**) and Elkaf Dere (**K20.3**), work characteristic of the major restoration associated with the sixth-century Longinus inscription. The course of the broad channel followed around and crossed a steep-sided gully, but few traces of a second bridge survived. It was possible to distinguish a shallow terrace above the main bridge which marked the line of the narrow channel, but as usual this was less clearly defined.

In 2000, further south towards Çiftlikköy we were shown the remains of the channel beyond Heyliye Tepe, the prominent hill marking the turn of the line towards the south. With the aid of Huseyn Güllen, a former village muhtar, we were able to visit the line of the channel as it crossed the hillside towards the village, above and west of the modern road from Belgrat. The site of an old village called 'Hiderleskoru'[82] was noted, but not visited. Near to the crossing of the Kayınlık Dere (**K26**), the two channels were seen running parallel, 4 m apart measuring from the centre lines of the channels. The narrow channel measured 0.65 m and the broad, seen as an open ditch, was about 1.5 m in width. The height difference could be estimated at 1.5–2 m.[83] A single broken arch, much overgrown by thorns, was seen at the stream-crossing, 1 km north-west of Çiftlikköy. A channel cut in the rock was seen beyond this.

3.8 Çiftlikköy to Büyükgerme (K27–K29)

West of Çiftlikköy the channels pass over bridges at the Ceşmekoru Dere (**K27**) and below Kilise Tepe (**K28**) (not visited), and then turn along the steep-sided valley, dominated by Sümbül Tepe, which leads

[82] This appears to correspond with the ridge below Heyliye Tepe, called Hızır İlias — Prophitis Elias — on the War Office 1:25,000 map.

[83] A single channel **G22** is noted by Çeçen in this area, (1996a), 113.

to Büyükgerme. A single bridge survives at the junction with the Germe Dere (**K28.1**), due north of Büyükgerme (0.7 km). The bridge is 8 m high, with a single arch 3 m wide. The abutments are 2.78 m wide. The footings are built of dressed schist blocks (similar to Talas (**K21**)) and the core is of mortared schist rubble. The bridge survives as two independent faces, since the inside of the vault and the channel above have collapsed; however, the plaster face of the channel does survive in places and the distance between the inner faces is 1.35 m. North of the bridge, a rock cutting beside the stream shows how there may have been an additional channel feeding in at this point.

A level track leads directly along the valley side from this bridge to Büyükgerme, utilising the level platform created for the construction of the broad and narrow channels. The former was situated below the track and the latter lay beside it, towards the hillside. Along its length there are seven sections of narrow channel, 0.6–0.65 m wide, surviving to a height of 1.20 m. In places the broad channel could be seen as an overgrown gully beside the roadway, and elsewhere there was a tunnel 1.6 m wide, surviving to a height of *c.* 1.7 m. It was difficult to assess the difference in height between the channels, but the narrow channel seemed to be about 0.50 m above the broad channel.

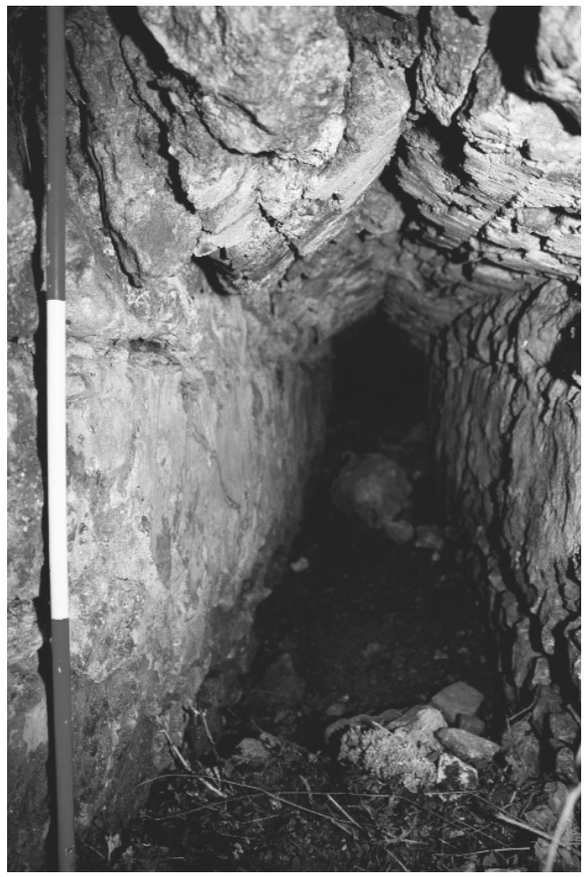


FIG. 3.57 Merdiven Dere (**K29.1**), the narrow channel east of the bridge.

3.9 Büyükgerme: the primary phase bridges (K29.1, K 29.2, K29.3) and main bridge (K29)

The surviving bridge at Büyükgerme (**K29**) belongs to the monumental second phase of the aqueduct system; it is 35 m high and 135 m long. The architectural details are discussed in Chapter 4. In the first phase it is clear that the narrow channel did not cross at this point (there is no parallel primary bridge as at Kurşunlugerme or Talas), rather it turned north-west around the spur now marked by an electricity pylon into the valley of the Merdiven Dere (**K29.1**) and from there followed around to the west across two further valleys: an unmarked stream flowing from the west (**K29.2**)[84] and the Kerezle Dere (**K29.3**).

At the Merdiven Dere there is a primary bridge (first seen by us in 1998). Traces of a narrow tunnel are visible between the spur and the bridge (Fig. 3.57). The bridge is now ruined apart from abutments and a high embankment to carry the channel to the hillside to the south, where a track marks the line of the narrow channel. Originally the bridge was high, with a single central arch and perhaps a second tier of two arches above. The abutment on the south side is 5 m wide and is constructed with long, bossed blocks; there is a clear breakwater on this side to prevent erosion caused by turbulence during floods (Fig. 3.58). Above, the rubble core survives with evidence for cribwork.

The line of the narrow channel leading south can be followed from small cavities in the track, one of which clearly marked an access shaft into the tunnel. The line is clear for about 400 m and then it diverges from the track and the channel is less easily followed. Traces of a second bridge are seen in the next steep-sided valley (**K29.2**). A modern road following the north side of the valley has cut part of the abutment on the north side (Fig. 3.59). The facings of small stones only survive on the west side and the core is of roughly-coursed limestone boulders, with a width of at least 3 m. This work would have formed part of the ramp on the north side leading up to the

[84] The second bridge (**K29.2**) is however marked on the Turkish 1:25,000 map.

FIG. 3.58 South-west bridge pier at Merdiven Dere (**K29.1**).

abutment since it is set back 8 m from the valley side; there are no traces of cribwork. The main abutment on the north survives best on the east side; here the footings of the abutment are of bossed limestone blocks, *c*. 0.20 m high; above this the facings are of small, squared limestone blocks. The next valley (**K29.3**) was not visited. The channel can, however, be expected to run north-east towards the north–south ridge running between Efemin Tepe and Karatepe.

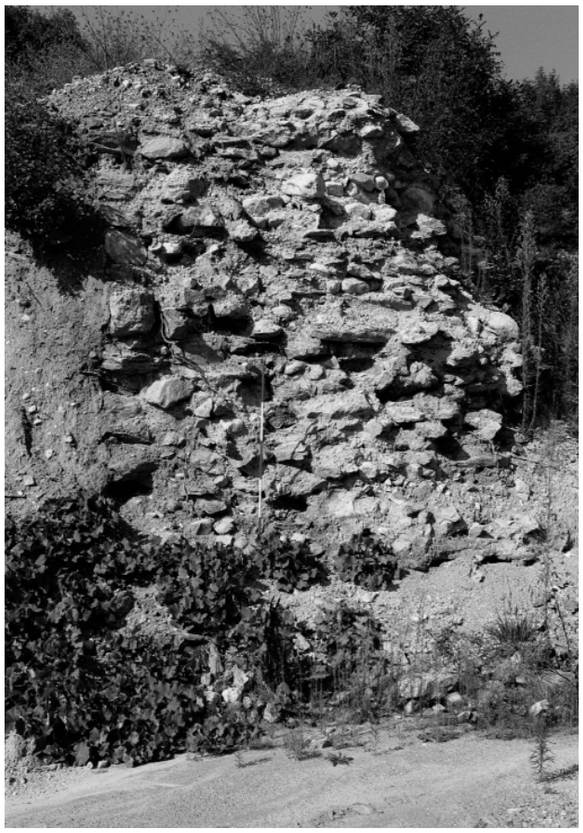


FIG. 3.59 Abutment on the north side of bridge **K29.2**.

At the main aqueduct (**K29**), traces of the broad channel are seen leading to the west abutment as a sunken hollow, which turns from the track onto the bridge. On the bridge a cross-section of part of the channel can be seen; part of the north wall of the channel survives as coursed rubble-work to a height of 0.50 m. The water-proof plaster survives on the side wall, but at the base there is a very clear and thicker curved angle of the channel. The plaster is very hard with large quantities of crushed mortar; the white mortar bedding for this layer is visible below. In the left corner there are traces of a later mortar layer which has eroded away. The south side does not survive and the width of the channel cannot be estimated.

3.10 Karatepe A (K29.4)

Traces of the broad channel were located at the east of the main bridge. Beyond this the ground rises to the long sandy ridge already noted between Efemin Tepe and Karatepe. On the War Office 1:25,000 map the southern end of the ridge leading south is called Kemer Yolu Sırtı (the Arched Road Ridge) and just south of the point where the modern track crosses over the ridge, a cutting reveals traces of the broad channel tunnelling across the ridge, probably no

more than 200 m long. The course of the narrow channel will have followed the hills round from the south to approximately the same place, as it is the lowest point along the ridge. The main channel leads south and after 300 m crosses the head of a valley where there is a long, embanked aqueduct (**K29.4**). Since there are clear indications of both the narrow and broad channels running parallel to one another at this point, it seems inevitable that the narrow channel must have crossed over the main bridge with the broad channel at Büyükgerme so as to avoid the problems already noted at Nikol Dere (**K20.4**), where a line is shortened and there is a resulting abrupt change in level.[85]

The bridge structure is 80 m long and 8 m wide and it was clearly intended in its final phase to carry both the broad and the narrow channels, which are visible along its length. The structure is very extensively overgrown with tree roots. The facings of large blockwork can be seen both to the east and west, but are best preserved on the former side. Here they survive to over 3 m in height, six courses of masonry topped by a downward-sloping, chamfered string-course (Fig. 3.60). There is no surviving evidence for bossed work masonry from these facings. The remains of an arch are seen midway along the embankment, suggesting that originally there was a small arch, walled up in a second phase. Running along the centre of the embankment was a raised core, and to the east was the line of the broad channel, shown as a hollow, *c.* 1.5 m wide, and with the turn of the vault visible on the outer face, 1.5 m from the external wall of the embankment. Parallel with this alignment, to the west, was the face of a second tunnel, although its outer western limit was not clear. This was offset by 0.40 m from the east face, indicating this to be the narrow line. The importance of this embankment cannot be over-estimated, since it demonstrates that the two channels flowed side by side and that this arrangement can be associated with the construction (or reconstruction) which had the same distinctive string-course as found at the rebuilt bridges at Talas (**K22**), Leylek Kale (**K23**), and elsewhere.

Karatepe B (K29.5)

The remains of a single-arched bridge are found 300 m to the south-east. Beyond this point the channel passes around the spur of Yamaçtepe and then carries on to the south and into the steep-sided valley of the Keçigerme Dere.

3.11 Keçigerme to Derinçatak Deresi (K30–K34)

Keçigerme

The main bridge at Keçigerme (**K30**) (see Chapter 4) is amongst the most dramatic along the line. Two bridges are known in the valley and the main bridge is located 100 m to the north-east of an earlier bridge (**K30.1**). The latter consists of a single broken arch, with high abutments on the north of the valley and

FIG. 3.60 Karatepe A (**K29.4**), east face showing downward-sloping chamfered string-course.

[85] See above n. 70.

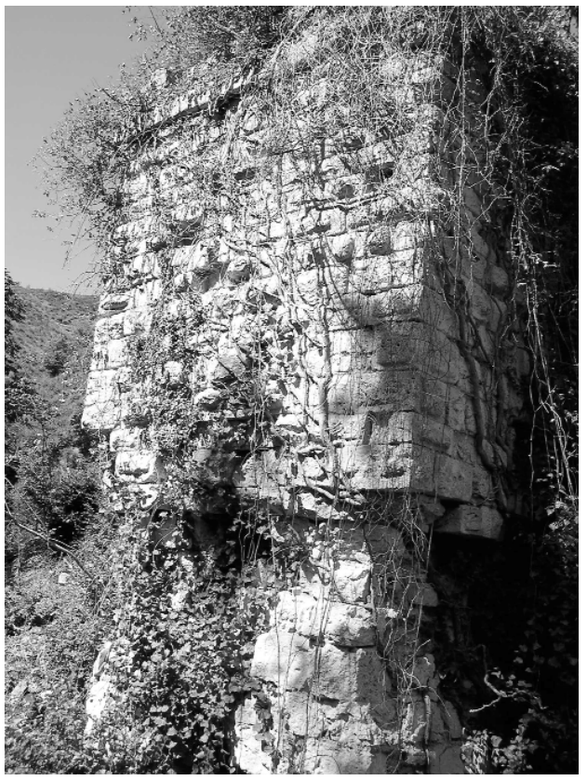


FIG. 3.61 Early bridge at Keçigerme (**K30.1**), north side.

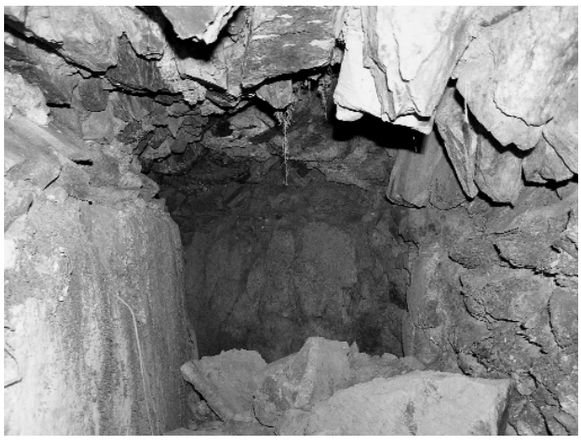


FIG. 3.62 Keçigerme (**K30.1**), tunnel to south-east of the early bridge.

less well preserved to its south. Dirimtekin estimated that the arch was 5–6 m wide, and in form it is very similar to the primary bridge at Kumarlıdere (**K31.1**) in the next major valley to the south.[86] The lower courses of the north abutment were of roughly squared blocks, and the footings have been washed away. Above this were sixteen courses of squared blocks with bosswork, topped by a square-sectioned string-course, from which rose smaller blockwork for the vault of the bridge (Fig. 3.61). On the south of the abutment was a well-preserved length of narrow tunnel, 0.60 m wide, with well-preserved plaster and a shallow, curved vault (Fig. 3.62).[87] Remains of the narrow and broad channels were located further to the north-west of the main bridge, and at the south-west end of the main bridge there was a clear ledge for the channels to turn onto the bridgehead. An opening in the track on the north-west approach to the bridge revealed the narrow channel, and this could be followed for over 12 m; along its length there was a light hole, 0.28 m square, too small for access, visible on the side of the road. The tunnel continued past the necessary turn for the main bridge, on towards the smaller primary bridge to the south-west (**K30.1**). Dirimtekin describes closed narrow and open broad channels at Keçigerme, although the only open channel we saw was the remains of the collapsed broad channel leading away from the bridge on the south-west side.[88]

Kumarlıdere (**K31**) *to Kalfaköy*

The long bridge at Kumarlıdere crosses a wide valley with high, built-up embankments, clearly visible from air photographs, extending to the south and north sides of the bridge. As with the other monumental bridges such as Büyükgerme, the later main bridge significantly reduces the length of the line of the primary water channel. A wide valley opens to the south-west of the main aqueduct and the earlier narrow channel loops around this valley for about 1.5 km. The stream entering the valley to the south-west is the Şarap Dere and there is a well-preserved bridge (**K31.1**) with its single arch still surviving and a second ruined bridge in a valley to the east (**K31.2**). At the first bridge the abutments could be measured as 5.35 m wide at the base (Fig. 3.63). Above this there are fourteen squared blocks with bossed work rising to a string-course, square in section, projecting

[86] Dirimtekin (1959), 225–6; we did not see the open broad channels Dirimtekin describes; Çeçen reports channels seen from a helicopter survey (1996a), 186. The Keçigerme bridge is probably about 3 m higher than the Kumarlıdere Bridge.

[87] See Dirimtekin (1959), 225, fig. 9.

[88] Dirimtekin (1959), 219. Open channels undoubtedly represent instances where the vault has collapsed. A possible explanation for the narrow channel not crossing over the later bridge is that in this instance it is located to the right of the broad channel as it flowed towards the city. At Karatepe (**K29.4**) we noted that the narrow channels passed on the left side of the broad channel, so perhaps what we see is the first narrow channel later relaid to cross the bridge in order to run left of the new broad channel.

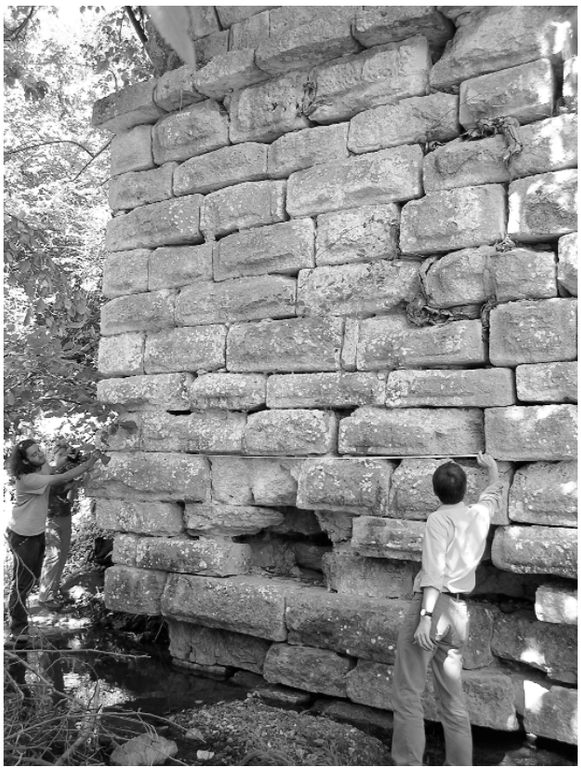


FIG. 3.63 Kumarlıdere (**K31.1**), early bridge on Şarap Dere.

10 cm. Above this the width of the abutment is reduced to 4.70 m with smaller, blockwork facings and the arch springing above. Significantly, at this primary bridge, while the main channel continues round the valley towards the east with a clear platform leading to the later main bridge, another channel can be seen to follow up the valley, where there is a spring and a low gorge, indicating that this was an additional source for the water supply system.

The platform could be followed along the south side of the valley and in a tributary valley the ruined remains of a bridge survived (**K31.2**). The west abutment was best preserved, although since almost all of the facings had been robbed, any measurements are approximate. The overall span was 4.50 m and the abutments were 4.60 m wide; the core was composed of pink-coloured mortar and limestone rubble blocks. On the hillside above there was evidence for modern works for collecting spring water — further evidence to support the existence of additional springs in antiquity.[89] The line of the channel could be seen to continue towards the raised embankment of the later bridge.

On the main bridge itself, although the upper tier of the bridge is very ruined, the channels survive on the north and south approaches. Because of the width of the valley, it was necessary for the builders to construct a long, raised embankment to the south. At the north end the channel can be seen to turn onto the bridge from the north-east; here there is evidence for a widening of the channel to *c.* 2.60 m, indicating a similar feature for controlling water-flow or a settling tank as seen at Leylek Kale (**K23**). The broad channel can be seen to continue towards the bridge as a wide hollow. At the southern end of the bridge the channel was identified 8 m south of the south upper arch. The west face of the embankment was well defined by regular large blocks, despite disturbance by dense tree roots. On the east, the outer face was not clearly defined and the total width was in excess of 5.20 m, falling away to a steep earth slope. Unlike the walled embankment south-east of Büyükgerme (**K29.4**) (Karatepe A), there was no clear indication of a channel on the centre of the bridge, although there were traces of mortar to the west side. What survived especially well, and also could be recognized on the north embankment, were the remains of a mortared face on the east side of a channel; the base of this was also visible, largely obscured by later rubble and mortar infill.

The evidence seems quite clear: a channel located 4.50 m from the west side of the bridge had been blocked by a rubble and mortar core, 0.50 m wide, with a rough face of coursed rubble work to the east. This later core sealed the west side and base of the channel; the east side of the channel was lost. We can suggest that severe damage to the east side of the embankment had caused the east side of this channel and the outer wall of the embankment to break away. As a repair the channel was filled and it is possible to see the thick, pink base mortar for the channel sealed by a layer of grey mortar with mortared rubble above (Fig. 3.64). At this edge the channel base may be seen to curve up, possibly indicating a narrow channel, less than 0.68 m in width. A similar facing of small rubble was noted on the east face of the north embankment. A feature of the embanked bridge below Karatepe (**K29.4**) was that it was 8 m wide, essentially continuing the width across the main aqueduct at Büyükgerme. Both narrow and broad channels were evident; it is likely that the embanked channel at Kumarlıdere was similar in dimensions, but the loss of nearly 3 m of the east face is indicative

[89] The springs in the Şarap Dere and in this valley are both marked as significant on the Turkish 1:25,000 map, indicating that the line beyond **K31.1** will have been retained after the construction of Kumarlıdere to feed the two channels known to cross the main bridge.

FIG. 3.64 Kumarlıdere (**K31**), mortar rubble fill of earlier narrow channel.

of the damage caused. Something similar is seen also at Keçigerme where there is a massive bulge in the east face of the abutment at the south end of the bridge.

The channels continue south towards Kalfaköy, and Çeçen refers to traces of bridges over Karlıpınar (**K32**), Kaşıkçı Dere (**K33**), and Ayazma Dere (**K34**) as well as the channel (**G23**) with inspection shafts.[90] Four large depressions known as Balcı Çukur, to the south-west of Kalfaköy, are 100 m in diameter and up to 10 m deep (Map 7). These are dolinas, natural features in the limestone, and their elevation at 170 m asl shows that they are too high to have formed part of the water supply system. From Belgrat village south-eastwards, the channels pass the margins between the cretaceous limestones and marls and the basement rocks and this is marked by springs, especially around Kalfaköy and Akalan. South of Kalfaköy the channels follow around the north side of the ridge between Kalfaköy and Akalan and then on towards the east.

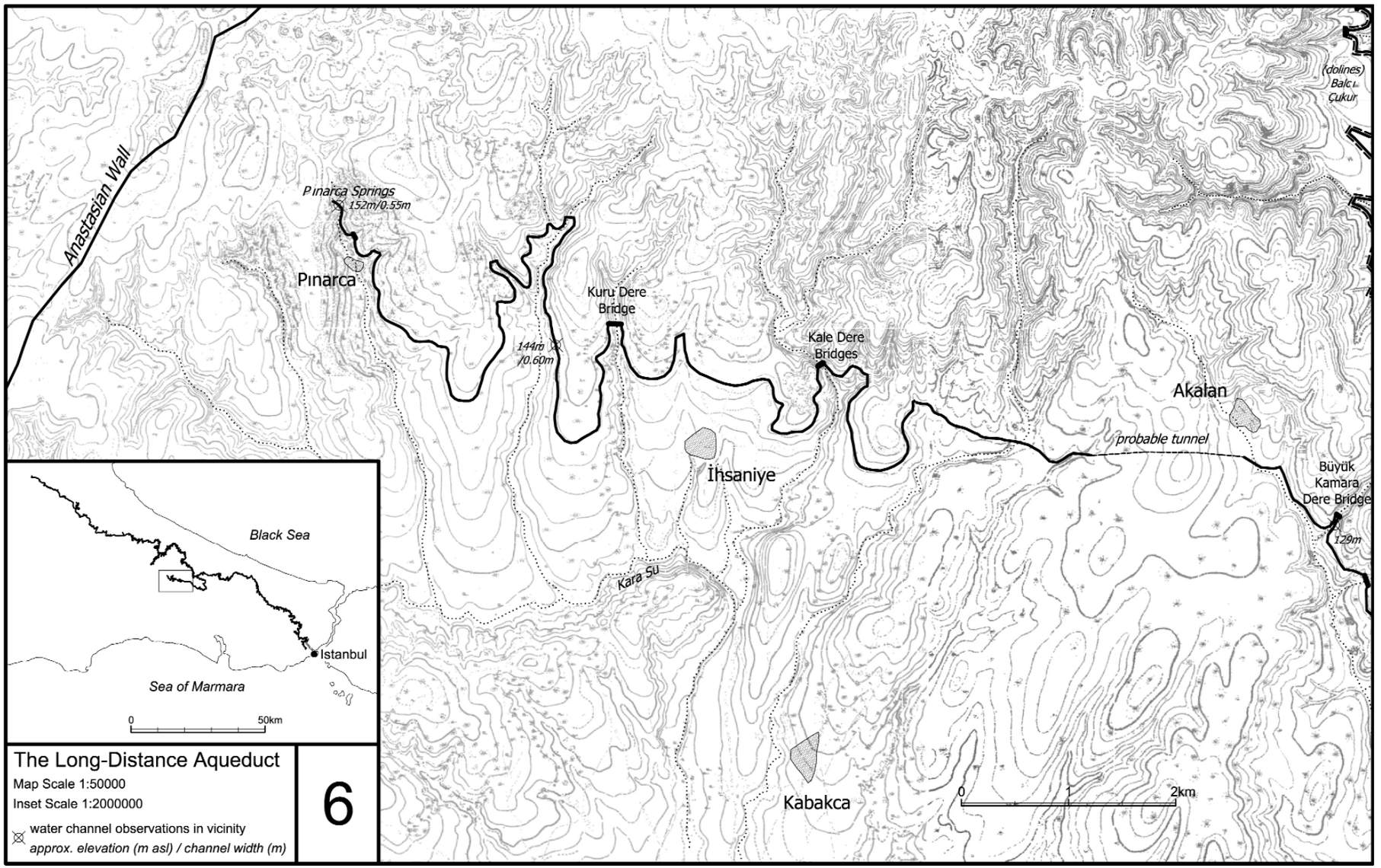
3.12 Derinçatak Deresi (Map 7)

Following across the head of the valley beyond Kalfaköy the channels cross tributary valleys and we were told of the remains of structures at Mıstık Kısla Dere (one aqueduct, collapsed), Kakarca Dere (two aqueducts, collapsed), and Derinçatak Dere, known as Balık Germesi (marked as Derin Dere on the Turkish 1972 map); we were able to visit the last site. Here we found the remains of a single-tier bridge. All that survived was the core and a few voussoir blocks. The bridge had an orientation of 300 degrees, with an estimated length of 30 m, a width of about 5 m and a height of 7–8 m. There was one arch about 5 m wide and 5 m high. Only a depression about 2 m wide (with the remains of core, 1.5 m wide, rising somewhat higher to either side) survived to indicate the approximate width of the channel. A second narrow channel was located to the south-west of the aqueduct (seen beside the track), which crossed the stream as a culvert, indicated by a platform of limestone in the stream bed. The channels continued north towards the crossroads at Haydut Tepe. In order to cross the ridge, running approximately north–south from the hilltop (marked on the Turkish 1972 maps as Nöbetci Yolu), the channel would have needed to tunnel across, since the minimum elevation is 135 m. From there the channel passed north of the large village of Dağyenice.

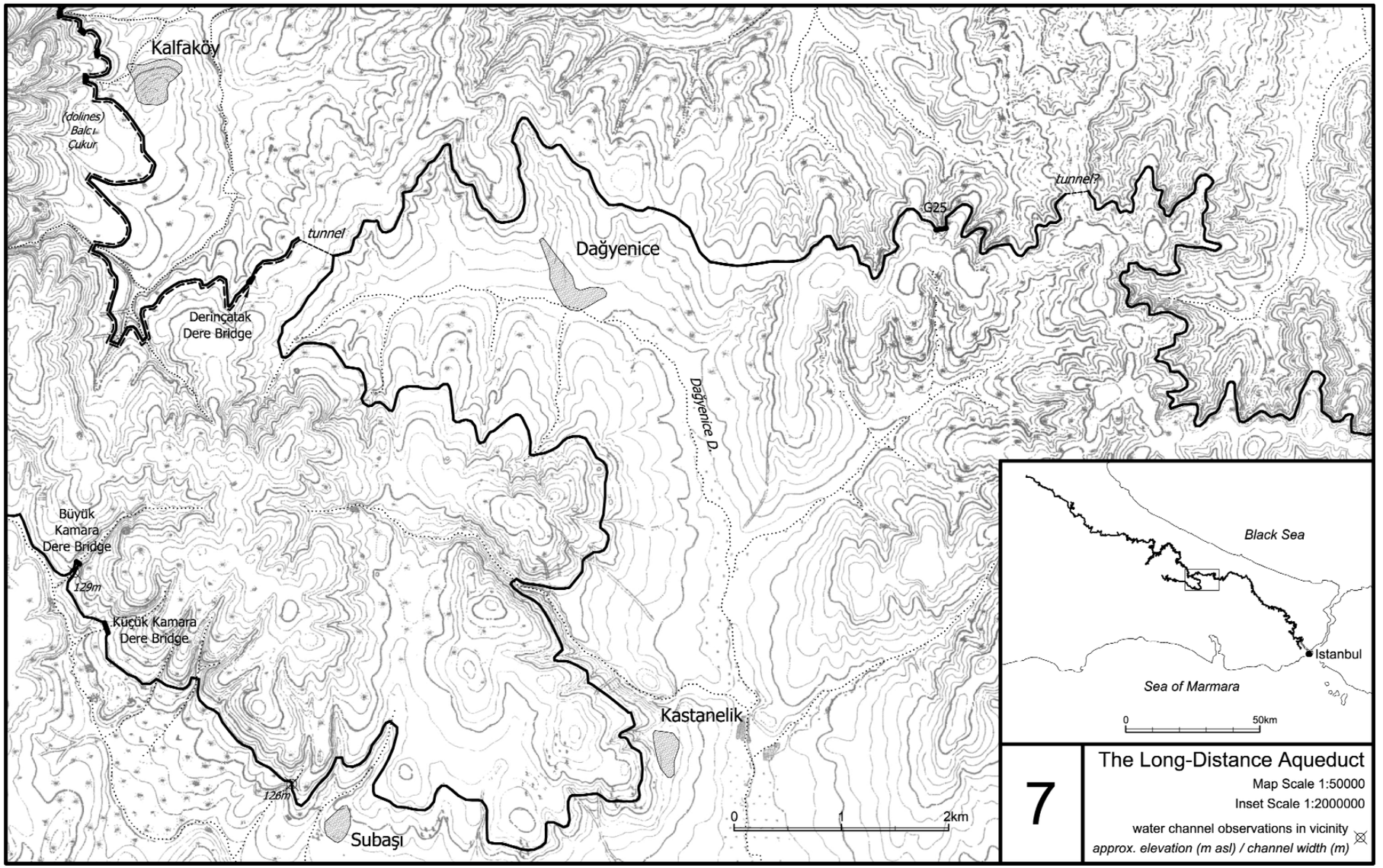
4 PINARCA TO DERİNÇATAK DERESİ (Maps 6–7)

The sources near Pınarca are distant from the main line of the aqueduct channels to the west and north near Gümüşpınar and Çiftlikköy. When we first visited these springs as part of our field work on the Anastasian Wall, it was not clear how they fitted into the broader system leading to Constantinople, especially since local archaeological opinion associated them with settlements on the Sea of Marmara to the south. Only in 2002 did we fully appreciate how these springs could be connected to the main water supply to the city, with evidence of a major separate channel system located within the security of the Anastasian Wall. The length of the channel can be estimated at 41 km.

[90] Çeçen (1996a), 113, 115, 188, photo p. 120; this was confirmed by local reports which noted two bridges at Ayazma Dere.



MAP 6. Pınarca to Akalan.



MAP 7 Kalfaköy to Yazliköy.

4.1 Pınarca

The Sources

A major group of springs and caves is located at the hamlet of Pınarca to the west of İhsaniye and 1,750 m east of the Anastasian Wall. Like the channels flowing from Danamandıra and Papu (see Section 2 above), these appear to form part of the primary system developed in the fourth century. Two major cave sources are known. The north cave, the İkigöz Mağara (two-eyed cave), incorporated a built *caput aquae*, 4 m in diameter, with a vaulted water channel leading from it. The basin was presumably constructed by opening out a small swallow hole within the collapse of the cave roof.[91] The stream emerges from an opening on the north side and an outflow into the karst bedrock can be seen to the south-west. The basin is roughly circular and is lined by karst rubble set in a hard pink mortar; the side wall is now broken towards the outflow (hence the name indicating two openings) (Fig. 3.65). The diameter of the basin is 4 m and it is 4 m deep. A vaulted channel leads away from the south side of the basin, 1.5 m below the modern ground surface; this channel initially leads away to the south-west and then turns towards the east; it is 0.55 m wide with a pedimented vault. A second channel leads off at a higher level and can be traced to flow into the outflow of the second cave; this will have functioned as an overflow from the basin. It is indicative of the potential discharge from these karst springs that at certain seasons it was necessary to provide an overflow, close to the top of the basin, although whether this implies some form of roofing is not certain.

The second cave has a wider opening and flows into a steep-sided streambed which has been stone-lined. The channel is 4 m wide at the mouth of the cave. Large blocks with fragments of pinkish mortar could be traced for 30 m. This stream was lower than the first source and was crossed by a fragmentary aqueduct from the higher system. Near to the mouth of the cave was a deep deposit of 'travertine', falling diagonally into the streambed. This represented the outflow of water from the overflow channel from the first cave, as the lime-rich water sprayed into the lower stream. While it is possible that the lower

FIG. 3.65 Pınarca first cave, İkigöz Mağara, showing built collecting pool.

[91] Many of these are shown on the Turkish 1:25,000 map (1972) F20-b4, in the vicinity of the Anastasian Wall to the north-west of Pınarca; the features are marked as *duden*.

canalised stream may have served local needs for milling and irrigation, it is more likely that it served as a dammed pool to raise the water level to the height of the upper system. Water channels are also seen to continue up the valley beyond the first cave; these will have tapped a third spring source higher on the hillside towards the south. No other springs were reported in the vicinity, although the group of channels and other hydraulic works indicates that this was a very significant source for the city, protected from the beginning of the sixth century by the Anastasian Wall to the west. The remains of a small abandoned settlement are located on the hilltop to the east of the springs at Pınarca, and among the stonework was a slab roughly carved with a cross with splayed ends, measuring 0.44 m high and 0.35 m across. This was probably a gravestone of Byzantine date.[92]

4.2 Pınarca to İhsaniye

The course of the main aqueduct channel proceeded eastwards towards Subaşı, following closely the margin between the metamorphic rocks and the limestone to take advantage of local spring sources along its course. The outflow from the springs at Pınarca is a major source for the catchment of the Karasu, the main river flowing into Büyükçekmece. Although the remains are less substantial than those of the main aqueduct line described in Sections 1–3 above, fieldwork has revealed one major aqueduct located in the Kuru Dere and sections of the channel were seen in exposures revealed by recent road construction between İhsaniye and Pınarca. The first trace was the remains of the channel top located beside the road at the turn of the new road down to Pınarca. Further east, a cutting for the new road through the chalk ridge west of Kaynarca Dere had revealed sections across the channel to the south and north (Fig. 3.66). On the north side of the road, although the upper part of the channel was truncated, in section it was possible to see the construction trench for the channel foundations cut into the chalk; these were filled with rubble and loose mortar; above this there was a thick layer of pink mortar, 0.08 m thick and 0.60 m wide, representing the floor of the channel; this could be seen to turn at the right end, showing the position of the channel wall. The section on the south side of the road was less well defined. Another section was visible in the south side of the road between Kuru Dere and Kaynarca Dere, showing the channel base to be 0.60 m wide .

The bridge in the Kuru Dere is aligned from east to west and was 2.70 m wide; on its east side it was faced with small, squared limestone blocks, measuring 30 by 40 cm, on the downstream side. On the upstream side the blocks were set in a very white mortar. There was a brick close to the east abutment and some brick fragments in the streambed. The abutment changed in construction with height. Closer to the valley bottom, the mortar was white with a limestone rubble core; higher up, the mortar was pinker with brick inclusions. A small channel can be seen (about 0.57 m wide) turning on to the east abutment of the bridge.

FIG. 3.66 Base of the narrow channel near Pınarca, revealed in road cutting (north side).

4.3 İhsaniye to Akalan

After crossing the Kuru Dere (at a point north-west of İhsaniye), the channel proceeded eastwards to cross the Kale Dere, south of two large sand quarries. Two major aqueduct bridges are located at the river crossing and were examined in 2003.[93] The main surviving bridge lay to the south-west and, although the main arch has collapsed, on either side of the valley the two abutments still survive 15–20 m above the stream below. The lower parts of the north abutment are lost; only the upper section, of squared blocks in a pink mortar, survives higher up the steep valley side. The abutment on the south side of the valley is better preserved, built of squared blocks. On

[92] The settlement at Pınarca is today only a hamlet of a few houses clustered around a fountain. The War Office map indicates a significant Muslim cemetery to the south of the current village and this suggests a once larger village, said by villagers to have been depopulated in the recent past by an epidemic.

[93] We are especially grateful to Mr Andy Byfield and Dr Caroline Finkel for informing us of their discovery of the aqueduct at Kale Dere.

FIG. 3.67
South-east main bridge on Kale Dere.

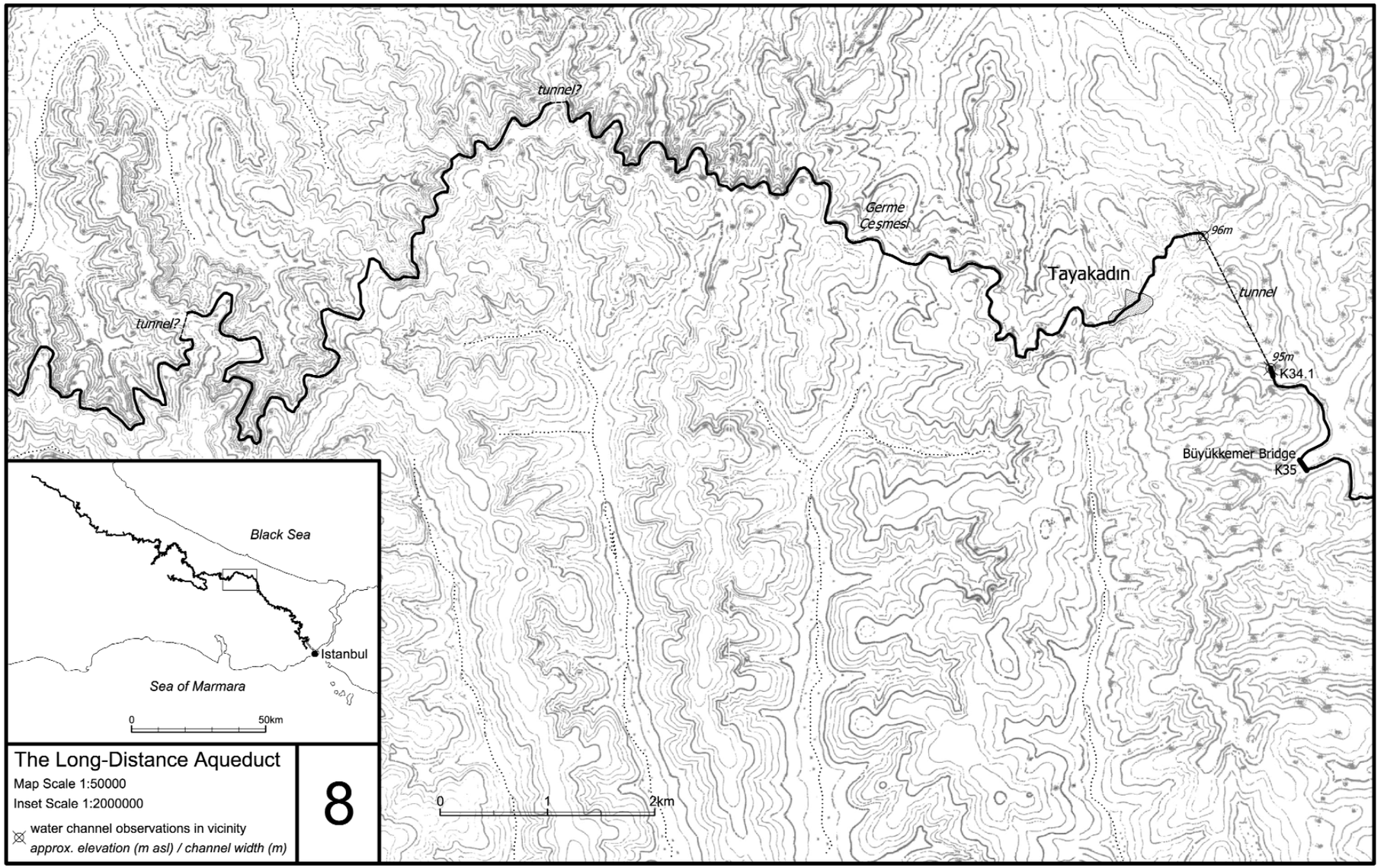
the west side, large blocks were employed set in dark pink mortar. Bossed blocks with clear drafted margins were still *in situ* in the facing at the base of the abutment, but had been reused in other parts of the structure (indicating repair) and were sometimes on their sides. Many of the blocks in the side elevation were long and only roughly squared (Fig. 3.67). This recalls similar repair work at Büyükgerme. The channel was not very clearly visible. Of particular significance was the presence of a second, presumably earlier, aqueduct constructed of smaller blocks and located about 200 m to the west. This had collapsed but the abutments survived high up on both sides of the valley. They had been built of small squared stones and the bridge was single-arched. This relationship matches the paired aqueducts found on the main system to the east of Ballıgerme, although it is important to recall that only a single, narrow channel is known and there is no suggestion of a sequence of broad and narrow channels.

4.4 Akalan to Subaşı

The remains of small bridges and channels are known to the south-east of Akalan; however it is not certain whether the channels would have needed to tunnel through the ridge to the north-west of the village towards the Kale Dere bridges. We were able to identify the remains of small ruined bridges east of Akalan at the Büyük and Küçük Kamara Dere and it is possible to continue the line of the channel to Subaşı. North-east from there, it would be possible for the Pınarca line to pass to the west of Kestanelik and to join the main system south-west of Dağyenice. At the Büyük Kamara Dere, the bridge was orientated at about 100 degrees, with an elevation of 129 m. The bridge was over 3 m in width. Only the east abutment survived, and its facing blocks on the north side are substantial (0.70 by 0.55 by 0.55 m). The facing blocks on the south side do not survive. A narrow channel was located on a rocky outcrop west of Subaşı at 126 m asl. The junction of the two main channels was probably located in open, arable farmland to the south of Haydut Tepe, south-west of Dağyenice. In addition to the springs at Pınarca noted before, it is likely that this line also was able to include the major springs at Akalan village.

5 DAĞYENİCE TO ISTANBUL (Maps 7–11)

From Dağyenice eastwards the country becomes more open, with less forest and a greater incidence of open fields and arable farming before the line of the aqueduct channel reaches the edge of the urban sprawl of the metropolis. Recent developments have radically altered the landscape and the survival of ancient remains; what follows therefore is a synopsis of reports by Dirimtekin and Çeçen, with our own observations for the final stage of the system.



MAP 8 Yazlıköy to Tayakadın.

5.1 Kemerler Mevkii, north-east of Dağyenice

Çeçen notes traces of channels (**G24**) north-east of Dağyenice.[94] The line continues on along the ridge and, as he observes, 'The morphological structure of the area between Dağyenice and Tayakadın is interesting. Some of the streams flow into Lake Terkos to the north and others flow into the Golden Horn and the Sea of Marmara to the south. In the middle, the ribbon-like watershed continues parallel to the Black Sea. The channel follows this watershed, running eastwards parallel to it for some 105–100 m along the contour line passing through short tunnels in some places'.[95] Dirimtekin reports that 1.5 km west of Yazlıköy, a major bridge on the Çerkes river was demolished to ground level, although he was told that some traces remained visible. He was informed that until twenty-five years before his visit (in *c.* 1955) it was in good condition, but was demolished for building stone. The size was estimated at 30 m long, 20–25 m high, and 6 m wide; he notes that it was faced with large stone blocks and had a core of stone and brick bands.[96] This river is marked on the War Office 1:25,000 map to the west of the village and the bridge was probably located on the tributary, the Kavak Dere, north-east of Kemerler Tepe, on the north side of the ridge. Çeçen was unable to find any trace of this bridge.[97]

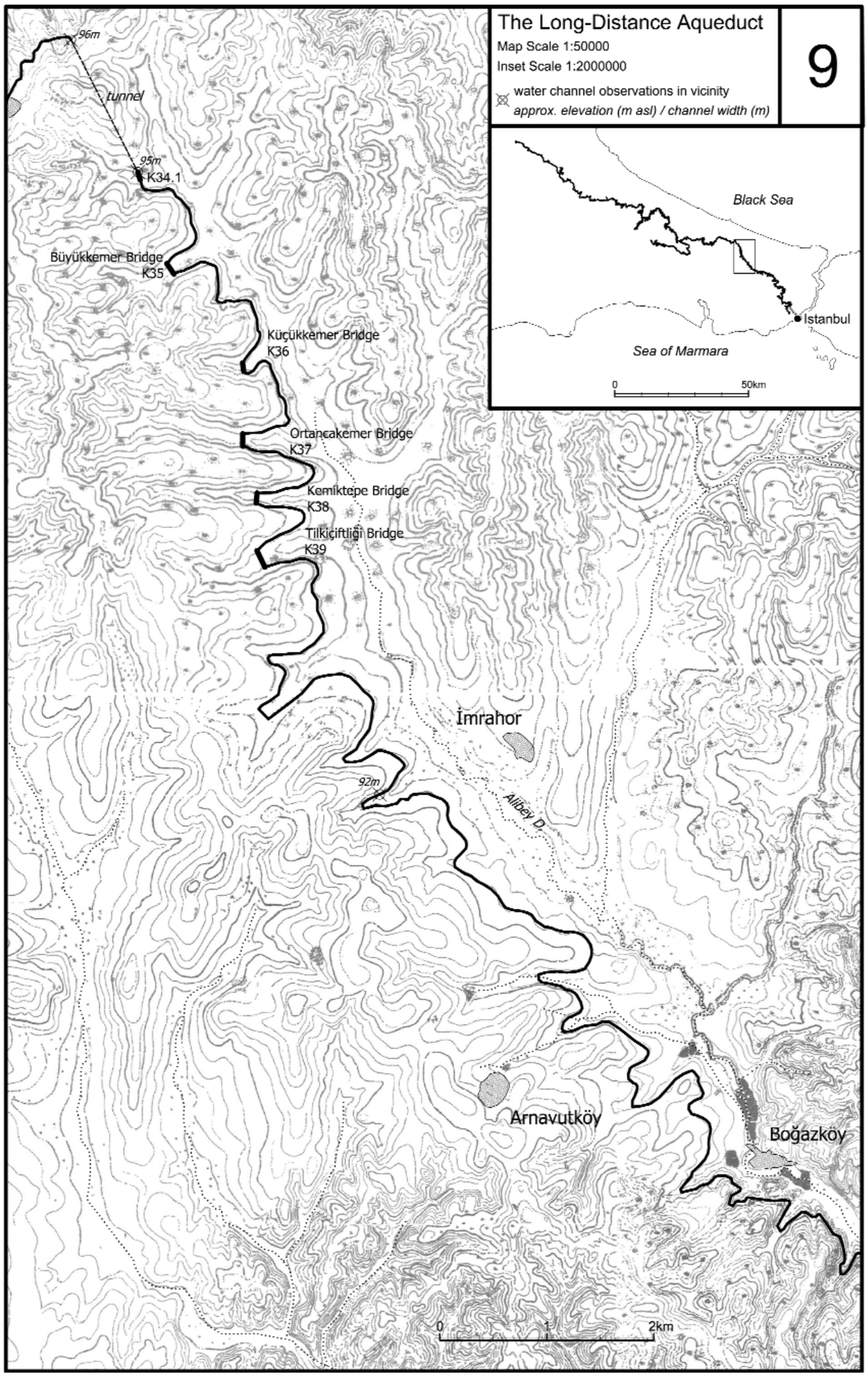
FIG. 3.68 Remains of Büyük Kemer bridge (**K35**).

5.2 Taykadın to Alibey Dere

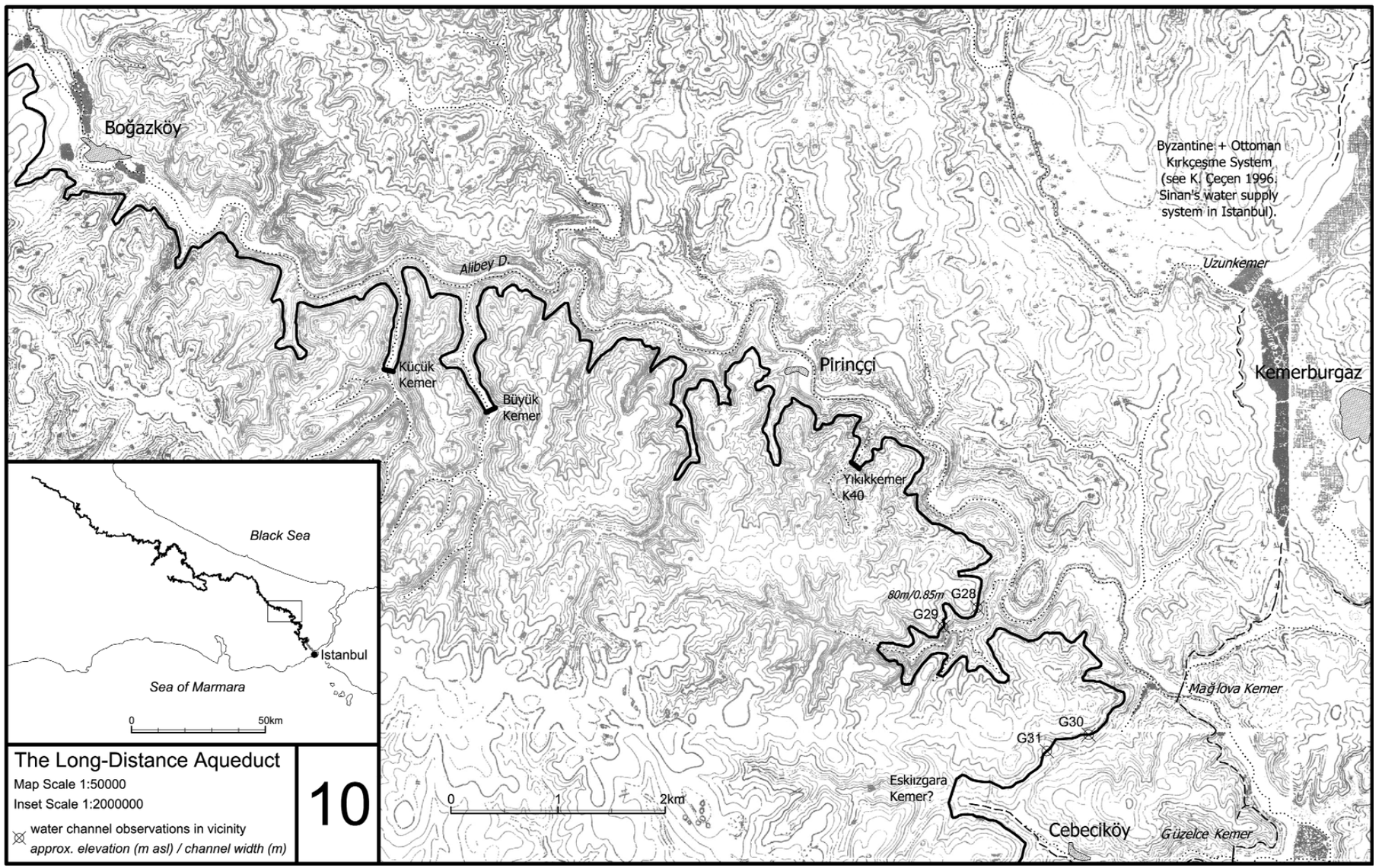
Few traces of the channels seem to survive; towards Taykadın, however, Dirimtekin records a stretch of channel (partly demolished in 1941) built on a low wall crossing a depression. This was located at the junction of two routes: from Terkos, and between Tayakadın and Deliyunus, close to a place marked on the War Office 1:25,000 map as Germe Ceşmesi. The mortar used in this bridge is reported to be hard and red in colour with large pieces of brick, and the wall was 1 m wide and 0.60 high (this was more likely to be the side of a raised channel, than the base of a substructure).[98] The channel is visible 300 m north-east of Taykadın village (**G27**), turning towards Terkos Lake; however in order to continue east it now passes through a tunnel at Körkuyu Dere below Bağlık Tepe, emerging at Sazlıdere, and then runs without further impediment south-east along the right bank of Alibey Dere towards Istanbul.[99]

A number of bridges are noted crossing tributaries to this main valley, at Büyük Kemer (**K35**), Küçük Kemer (**K36**), Ortanca Kemer (**K37**), Kemiktepe (**K38**), and Tilkiçiftliği (**K39**); Çeçen notes specifically that all of these had only been destroyed recently when he began his survey in the early 1990s.[100] The Büyük Kemer (**K35**) is the best preserved with an arch 3 m wide. Some of the voussoirs survive, but mostly the remains are core, with no facings surviving (Fig. 3.68). South of the bridge the

[94] Çeçen (1996a), 115, 118, 'Many remains of the channel can be seen in this locality'; the place is marked on the 1972 map as Kemerler Tepe.
[95] Çeçen (1996a), 115.
[96] Dirimtekin (1959), 220, calls Yazlıköy by its old name of Lazari; he was unable to visit the site since it was a restricted military zone.
[97] Çeçen (1996a), 115, and none knew of its existence; he places **G25** on his map to the south-east of Yazlıköy.
[98] Derimtekin (1959), 219, fig. 3; Çeçen 1996a, 115, photo p. 121, reports the same feature (**G26**) at a place called Germe, west of Taykadın, in the garden of the house of Hac Ali, at an elevation of 97 m.
[99] Çeçen (1996a), 115, photo p. 121.
[100] Çeçen (1996a), 118, 188, 197, photo of Büyük Kemer p. 197.



Map 9 Tayakadın to Boğazköy.



MAP 10 Boğazköy to Cebecıköy.

line of the channel may be seen as a raised bank about 1 m high, and further indications of the line of the channel are visible into the next valley, called Patlıkemer Dere. In the next valley, of the Küçük Kemer (**K36**), only the core of the pier survives on south side. There are indications of the channel on the north side but it is filled with earth. On the south side the channel is indicated by a low mound continuing south. In this valley only a single channel is apparent; however, at Tayakadın the muhtar reported to us that a large channel, 1.5 m wide and 2 m high, had been uncovered during building work, although the site was now filled in, and elsewhere near the village we observed a broad platform, 4 m wide, with a slight depression, associated with which were mortared rubble and limestone blocks. Nothing specific is reported in the vicinity of Arnavutköy or İmrahor, although Çeçen does note that 'traces of channel were found in several places at Arnavutköy'.[101]

To the east of Boğazköy, the War Office map records valleys south of the Alibey Dere, named Küçük Kemer and Büyük Kemer. 3 km to the east, Çeçen reports an aqueduct across the Soğuksu Dere, a single-arch bridge known as Yıkıkkemer (**K40**), and he notes that no other traces of aqueducts were known to survive further towards the city.[102] North of Cebeciköy the main line of the Ottoman channel from the Forest of Belgrade crosses the Alibey Dere at the Mağlova Kemeri and then runs parallel to, but below the Stranja system.[103] Channels on the high-level system are known at Tatlıburun Dere and have been revealed in two places (**G28**, **G29**) during recent roadworks north-west of Cebeciköy. Here the channel is described as a covered masonry channel, with a height of 1.65–1.70 m and a width of 0.85 m, and smooth, rendered walls to a height of 1.35 m; photographs show that it had a pedimented vault.[104]

South of the Mağlova aqueduct, the Stranja line turns towards the south to maintain height and pass west and south of Cebeciköy. Çeçen notes the channels at **G30**, **G31** and an inspection shaft, and goes on to describe a map drawn by a French water company in the late nineteenth century showing a Roman channel between this point and the Uzunkoltuk bridge (on the Belgrad system), an area which has subsequently been entirely altered by extensive stone quarrying. The map shows the channel crossing the Cebeciköy Dere by means of the Eskiızgara bridge, and then skirting the tributary on the right bank of the Taşlı Dere or Keç Dere valleys.[105] The Cebeciköy (or Eskiızgara) Dere forms part of a supplementary line used in the Ottoman Kırkçeşme line, which joins with the main line at Güzelce Kemer. These sources located to the west of Cebeciköy were used as part of the later Kırkçeşme system and with a higher level Ottoman channel linked with the higher level sources associated with Halkalı.[106]

To the south-east of Cebeciköy, Çeçen reports a channel (**G32**) close to the road, with dimensions 0.86 m wide and 1.76 m high. At this point he notes that the Stranja tunnel was 22 m higher than the Cebeciköy line.[107] Beyond the aqueduct at Güzelce Kemer, the Byzantine and Ottoman lines may be seen to continue in parallel. A channel (**G33**) is recorded at Fındıklı Dere (above Uzunkoltuk Kemer); identical in size to **G32**, it has rendered walls and a pedimented roof; the elevation is reported to be 72 m asl. This is the last recorded channel measurement before the city, although another early element of this line is the remains of an aqueduct abutment with part of a channel visible, seen near Kumrulukemer, close to where Çeçen suggests that the Byzantine high-level line would have run parallel to the Ottoman Kırkçesme line. A photograph of this abutment is illustrated in a number of his books, and since it is not included in his description of the system of aqueducts and channels for the Stranja, we can reasonably assume that he considered it to be part of the earlier

[101] Çeçen (1996a), 118; it is unclear whether these are in addition to **G28** and **G29** near Cebeciköy.

[102] Çeçen (1996a), 118–19, 197 with photo; a second Yıkıkkemer Dere on the projected course of the channel is marked on the War Office map at Kuçukkeui, see also Çeçen (1996a), 118.

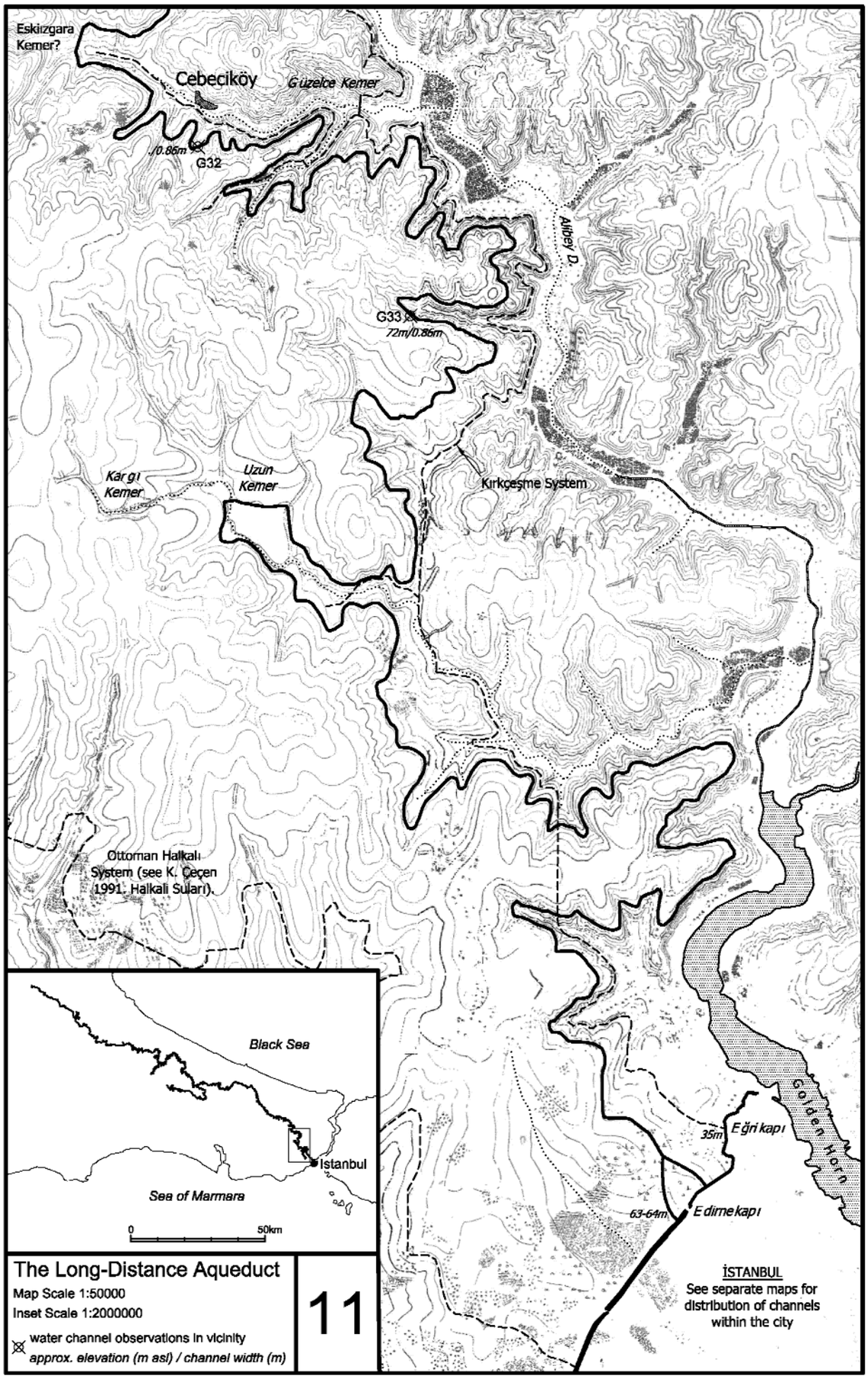
[103] For the Mağlova aqueduct, the so-called 'Aqueduct of Justinian', see Çeçen (1996b), 112–21; for the parallel channels noted as 30 m below see p. 47; in (1996a), 120 he states the channels are 22 m apart near **G32**.

[104] Çeçen (1996a), 118–19, photos pp. 100, 121; the caption notes that 'it is on mountainside at Sarpdere'. On p. 208 these channels are again referred to and are said to have a gradient of 0.0006.

[105] Çeçen (1996a), 119, photo p. 122; in Çeçen (1996b), 74, he notes that the manholes of the Roman channels in this length are covered by cone-shaped covers.

[106] Çeçen (1996b), 70–5, plan 1; a dam was built on the Cebeciköy Dere by Ahmed III (1706–10); the channels are recorded to be 0.55 by 1.75 m, p. 74; for the higher Ottoman line see Çeçen (1991), plan 7.

[107] Çeçen (1996a), 120, photo p. 124, points out that at Fındıklı Creek (above Uzunkoltuk bridge and near the Alibey dam), the channel (**G32**) is at 72 m asl, and measures 0.85 (or 0.86) by 1.70 m. The gradient of the channel is calculated at 0.0006–0.0007, and Çeçen estimates that it should have reached Edirne Kapı at about 63 m asl. The recorded differences of height between 22 and 30 m can be understood since Çeçen (1996b) was a second edition of an earlier work, begun before his full recognition of the Stranja line.



MAP 11 Cebeciköy to Istanbul.

Roman system sourced from the Cebeciköy and the Belgrad Ormanı.[108] Closer to the city, north-west of a hamlet marked as Küçükköy on the War Office map, are two places called Uzun Kemer and Kargı Kemer; the former is at about the right elevation for the main channel to continue towards the Edirne Kapı.

EVIDENCE FOR BYZANTINE REMAINS IN THE KIRKÇEŞME AND HALKALI LINES NEAR THE CITY

The literary and historical evidence for Byzantine remains in the area of the Forest of Belgrade, the source for the Kırkçeşme, has already been discussed in the previous chapter.[109] We were able to visit some of the major Ottoman aqueducts in this area and we would support Çeçen's suggestion that the lower parts of the Kovukkemer and possibly part of the Uzunkemer have early masonry similar to the late antique construction found on the Thracian line.[110] During a short visit we were able to see traces of early channels, similar to those we had seen in Thrace; however, in the absence of an intensive and detailed archaeological survey, together with limited excavation, it is unlikely that more precise evidence for earlier systems can be obtained.

The Halkalı region stretches to the west and north-west of the city walls to an extent of around 15 km. It is bounded on the east side by the Alibey River as it makes its final approach to the Golden Horn, and on the northern side by the first major east–west tributary to the Alibey, the Cebeciköy Valley. To the south is the Sea of Marmara, and the west flank is defined by the Küçükçekmece Lake. The elevation of the principal springs is particularly significant as they were of sufficient altitude to supply the whole area of the city, the lines crossing the Land Walls at an altitude of 55–65 m. These lines therefore required a bridge between the Fourth and Third Hills in order to progress to the centre of the city. It was for this reason alone that the Bozdoğan Kemeri, built in the fourth century for the long-distance aqueduct of Valens, was repaired and restored throughout the Ottoman period, despite the fact that the long-distance system itself had been abandoned. Although sources are plentiful and widespread in the Halkalı region, the springs are relatively weak with a low discharge. Water was therefore gathered from numerous small sources, thus greatly increasing the complexity of the Ottoman-period system.[111]

A number of early and ruined bridges have been discussed in earlier publications, most notably the Ma'zulkemer, which has been claimed to date from the late antique to the early Ottoman periods. Study of the bridge by Bayliss and Bardill concluded that the surviving remains are post-Byzantine in date and they are unlikely to form part of a pre-Ottoman water supply line from the Halkalı Springs.[112] In addition, Çeçen, in a number of studies, suggests two early bridges from his own work in this area: one known from eighteenth-century Ottoman sources and the second largely obscured within the urban fringe of the city.[113] The Karakemer was a three-arched bridge located 1.75 km west of Cebeciköy. From the photograph it is clear that the bridge has undergone very extensive rebuilding over a long period of time. It is possible to discern the outline of earlier arches, filled in by later work and indicating some antiquity; it formed part of the Sülemaniye water supply, which would have flowed across the Bozdoğan Kemeri. The second bridge is noted on an eighteenth-century map as the ruined Turunçluk Aqueduct and is located near Cicozçiftlik (Taşlı-tarla); the map shows the ruined four-arched bridge separate from the contemporary Ottoman line. The importance of these remains is that they suggest pre-Ottoman structures indicative of a Byzantine system, but certainly nothing from the Karakemer bridge is reminiscent of the late antique bridges known from Thrace or possibly evident in the Belgrade Forest.

[108] Çeçen (1996a), 123; Çeçen (1996b), 172.
[109] Chapter 2, 14–15.
[110] Çeçen (1996a), 58–61 with illus; see p. 94 n. 10.
[111] Çeçen (1991); (1996a), 43–59.
[112] Publication by Bayliss and Crow in preparation.
[113] Çeçen (1991); (1996a), Karakemer, 51, photo p. 56; Turunçluk p. 59, photo p. 61; see map of the Halkalı system, Çeçen (1996a), 77.