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Pontius Pilate – An Aqueduct Builder? – Recent Findings and New Suggestions

Introduction

Μετὰ δὲ ταῦτα ταραχὴν ἑτέραν ἐκίνει τὸν ἱερὸν θησαυρόν, καλεῖται δὲ κορβωνᾶς, εἰς καταγωγὴν ὑδάτων ἐξαναλίσκων· κατῆγεν δὲ ἀπὸ τετρακοσίων σταδίων.[1]

According to the Jewish historian Josephus Flavius, the fifth – and best known – Roman governor of Judaea, Pontius Pilate (traditional chronology A.D. 26–36), was involved in the affair of building an aqueduct during his period of office, according to the above Greek passage which states: „On a later occasion he provoked a fresh uproar by expending upon the construction of an aqueduct the sacred treasure known as Corbonas; the water was brought from a distance of 400 furlongs."

Earlier scholarship and determination of the research subject

Previously the authenticity of the aqueduct project as described by Josephus has been questioned, modern scholarly attitudes serving as a good case study for how paradoxical questions dealing with ancient history and archaeology may be. A clear tendency among professionals on this point is to adher to ‚archaeological positivism' the representatives of which frequently and without criticism cling to the common argument ex silentio („argument of silence"), which means that the absence of evidence indicates that something cannot have existed or at least did not exist in the way it is described in the sources.

So far the problem of the research has clearly been – as we see it – that this archaeological dilemma has been approached purely from a historical perspective, by historians and archaeologists alike, rather than from an archaeological point of view. Furthermore, the archaeological and, for instance, numismatic sources on the subject have not been scrutinized fully. We felt therefore that the existing primary and secondary sources should be given the attention that they without doubt deserve. The main concern of this research paper is thus to answer some of the basic questions left unanswered as yet.

Did Pontius Pilate really build an aqueduct? If Pilate did build the aqueduct described by Josephus, could he as the acting Roman governor have appropriated funds from the Jerusalem Temple treasury without the approval, co-operation or at least encouragement of the Jewish High Priest or other leading aristocrats? If Pilate did embezzle large sums

[1] Ios. bell. Iud. II, ix. 4. Cf. Ios. ant. Iud. 18, iii. 2.

of money for the water project from the Temple treasury, would it still mean that it had been purely in Roman interests to build the water system? Assuming that Pilate was de facto, as Josephus tells us, responsible for the construction of the aqueduct, did he perhaps build the aqueduct as a showpiece only to irritate the Jews, or could it be that the Roman governor ordered only the refurbishing and expansion of Jerusalem's existing aqueduct system instead of constructing something entirely new? Do we have any archaeological evidence of Pilate's aqueduct? If such can be discovered, can the event as a whole be given a more precise date?

In this sense there is also an unavoidable tendency present to rewrite the history of the Tiberian period in Roman Judaea and especially to present a new view on the chronology of the Roman governors in Judaea in that period. If this view is accepted, it has serious ramifications for our understanding of the traditional chronology of the early Roman office-holders in Judaea in the 20s and 30s A.D. and the accuracy of Josephus' account on Pilate's aqueduct affair. However, the imperial administration in the Roman province of Judaea, as well as the technical aspects of the aqueducts and the hydraulic arrangements connected with them are not considered to the same degree.

New evidence for discussing the possible administrative and technical co-operation that may have existed between the Roman and the Jewish authorities on aqueducts built in the province has not been presented. The topic is very problematic and requires much more space than we can offer and a different forum for discussion. Suffice it to say here that the evidence is circumstantial at best. However, although there is little evidence for any straightforward conclusions regarding that avenue of research, we are still inclined to believe that collaboration on some level with the water projects should be assumed, certainly in terms of finance, and apparently also engineering and metalwork. It is to be hoped that future research will clarify some of these points. Before continuing with the subject, it may be of interest for the reader to know that our investigation published here which rendered the re-evaluation of the subject possible was originally in no way connected to any survey or study of the water supply of ancient Israel. Our aim from the outset was first of all to conduct an archaeometallurgical study on the chemical and metallurgical composition of the first provincial coinage of Roman Judaea and the monetary policy of the Roman administration in A.D. 6–66.[2]

Textual sources

The point of departure for this inquiry is what the historical account compiled by Josephus says about Pontius Pilate and the aqueduct and to see how this information correlates with the new archaeological information that our study yielded.

In both his major literary works, *Antiquitates Iudaicae* (18, iii. 2; hereafter ant. Iud.) and *Bellum Iudaicum* (II, ix. 4; hereafter bell. Iud.), Josephus indicates that Pilate used money that had been illegally obtained from a Jewish treasury to finance the aqueduct project. The text which Josephus compiled first, the bell. Iud., has the information that the event involving the construction of the aqueduct took place „on a later occasion" [during Pontius Pilate's period of office]. In the bell. Iud. Josephus places Pilate's aqueduct pro-

[2] The first part of this work was published in 1992 (vide K. Lönnqvist, A Metallurgical and Chemical Analysis of the Procuratorial Coinage of Roman Judaea, Berliner Beiträge zur Archäometrie 11, 1992, 13–34). The second part of the study is forthcoming and has been submitted for publication in Archaeometry.

ject chronologically just before the visit of Herod Agrippa I to Rome in A.D. 36 by using his favorite chronological expression „at this time" („about this time"). The text in the bell. Iud. says further that Pilate's source for the money was the sacred treasury called Corbonas, the Jerusalem Temple treasury, also mentioned in the New Testament.[3] Besides the provocative nature and the tragic outcome of the aqueduct affair, Josephus mentions in the bell. Iud. also that the length of the aqueduct was 400 ‚stadiums'.[4]

In the author's later account, as preserved in the ant. Iud. (18, iii. 2), the description of the uprising that the building of the aqueduct caused is followed by one individual fact of interest: Josephus narrows down the length of the water conduit to half of what he had stated it to be in the bell. Iud., to 200 ‚stadiums', or approximately 37 km, beside mentioning that the aqueduct led to Jerusalem. Unfortunately, Josephus does not elaborate on the subject and this is where our written information suddenly ends. Consequently, from now on we will have to resort to archaeology and its related disciplines to support our investigation and the following arguments.

Archaeological sources: ancient technology and materials used for the construction of water systems and aqueducts in ancient Israel

The water systems could be either open or closed, closed referring to channels in which the water was partly or fully contained in pipes of some sort. Open systems were easier to construct and cheaper to maintain, but the water was, of course, more vulnerable for dirt, pollution and unlawful use for example. Closed water systems provided a better and safer water quality, but suffered especially from incrustation caused by the build-up of s i n t e r (calcium carbonate), which often changed the configuration of the pipes and the velocity of the water flow eventually making the systems useless.[5]

Technically all ancient aqueducts were gravity aqueducts, which meant that the water was flowing free and had to be lead from a source higher up to a collecting point or place of use below that in a fixed, not too steep or too shallow gradient. If the gradient had been insufficient, the water would accordingly have run too slowly, perhaps stagnated, and in the worst case, would have become unwholesome. In too steep a system the water would have moved too fast and would rapidly have eroded the channel.

From a technical point of view, several different building techniques were used for the water conduits constructed in the Graeco-Roman period in Israel. The stone-built (limestone, basalt) aqueduct was a common type of water conduit in the area, partly being nothing but open rock-cut channels. At times the channels were fitted and covered with stone slabs or plaster.[6] Building of channels by cutting in the rock was usually not very

[3] κορβανᾶς in Ios. bell. Iud. II, ix. 4. Cf. τὸν κορβανᾶν in the NT and Mt 27.6.

[4] One ‚stadium' or ‚arena' was equal to 606.75 English feet (185 m) or close to 1/8 of a Roman mile. The distance of 400 ‚stadiums' is therefore approximately 46 English miles, or 74 km according to the metric system.

[5] T. A. Hodge, Roman Aqueducts & Water Supply, Trowbridge 1991 (1995), 219.

[6] Occasionally used for dating purposes, as in the case of the Tel Goded aqueduct. ^{14}C-analyses of the carbon traces in the plaster provided a tentative dating to the 4th-5th centuries A.D. However, at least in Nordic contexts carbon dating of mortar has proven to be very problematic with a wide margin of error for the dating results received, being as much as hundreds of years for samples taken from the same object, thereby casting a serious shadow on the dating method as a whole. Vide M. Hiekkanen, Några ord om 14C-datering av murbruk samt om bosättningskontinuitet på Åland (Some thoughts of radio carbon dating of mortar and of settlement continuity in Åland), Medeltids arkeologisk tidskrift 3, 1997, 54–59.

hard work in this area because of the widely spread soft sediments to which limestone belongs. Ceramic pipes have also been discovered, but their distribution is concentrated mainly in the coastal plain in Caesarea and Acco, while some have also been found in Jerusalem and the Wadi Kelt area in the Judaean desert. Roman ‚cement' was frequently used in the construction of water mains and aqueducts outside Judaea. The function of the cement was to make the channels or pipes resistant against leaks; it also provided a low friction surface for the water with no joints.[7] So far the paucity of lead pipes among the archaeological finds has been symptomatic.

In a short effort to trace the main lines of the building techniques and materials used for the water systems in Israel in the classical period, certain patterns seem to emerge, regardless of the existing heterogeneity in the use of ancient technology and materials. There seems for example to have been a conscious effort to „standardize" the unit length and caliber of the individual segments of the pipes to guarantee a certain flow of water.[8] For instance, at least two, but probably more ‚standards' emerge: one with a unit length of about 50–60 cm (bore approximately 30–40 cm) and another one with a unit length of some 30–40 cm (bore close to 20 cm). However, it is clear that the individual measurements of any pipeline built or any materials chosen would have depended to a large degree on regional building customs, materials, water consumption, cost of building, and so forth. We must hope that future archaeological research will clear also some of these differences.

Archaeological surveys in the Jerusalem area — present-day remains of ancient aqueducts

Surveys made in the area of greater Jerusalem have in recent years produced much new information of the city's water system throughout its history. A large survey of the ancient Jerusalemite water network was carried out in the late 1960s on behalf of the Israeli Academy of Sciences and Humanities. Since then separate studies and re-examinations of individual parts of the discovered water system have been published, although a comprehensive study for Jerusalem's part is still lacking as far as we know.[9] A whole system of aqueducts which supplied Jerusalem with water has been uncovered. Currently at least five ancient aqueducts, some of which may be connected, are known.[10] As scholars have remarked, the high efficiency of Jerusalem's ancient aqueducts is proved by the fact that they remained partly in use not only throughout the Hellenistic and Roman period but also into our times, until modern pumping installations and technology were introduced.

[7] Hodge (above n. 5), 98.

[8] Vide Y. Yehuda, Ancient Pipelines in Israel, in: T. A. Hodge (ed.), Future Currents in Aqueduct Studies, (Collected Classical Papers 2), Melksham/Wiltshire 1991, 130, Table.

[9] The standard works are the three studies by A. Mazar, The Aqueducts of Jerusalem, in: Jerusalem Revealed, Archaeology in the Holy City 1968–1974 (Ed. Y. Yadin), Jerusalem 1976, 79–84 (bibliography collected by Y. Shiloh on pages 131–137); id., Survey of the Jerusalem aqueducts, in: Papers at the Symposium of Historical Water Development Projects in the Eastern Mediterranean, Leichtweiss-Institut für Wasserbau, Mitteilungen 82, 1984, 7ff; id., Jerusalem, in: Geschichte der Wasserversorgung 2. Die Wasserversorgung Antiker Städte. Pergamon: Recht/Verwaltung, Brunnen/Nymphäen, Bauelemente, Mainz 1987, 185–188.

[10] The aqueducts are called the Arrub aqueduct, the Biyar aqueduct, the Upper aqueduct, the Lower aqueduct and the Herodian aqueduct. See Mazar 1976 (above n. 9), 83.

The hilly and rough topography that surrounds Jerusalem affected, without doubt, also the decisions of the Hellenistic and Roman engineers, directing them to use indigenous building methods and materials. Lengthy rock-cut channels (open, covered or built on foundation walls) and barrel-vaulted chambers, in addition to hewn tunnels and large stone segment pipes (‚siphons'), form the core of the discovered Jerusalemite aqueduct system. Bridges or dams that could survive the winter rains were also built to cross the wadis, or the aqueducts were directed in tunnels cut into the Judaean hills to overcome difficult topographical hindrances. Some of the subterranean sections and tunnels built in the 1st-2nd centuries A.D. have also access shafts and steps cut into the rock that permitted both cleaning and maintenance. Parts of the Jerusalem aqueducts were interestingly also used hydraulically so that ground water rose into the tunnel along its entire length (so-called *qanat*). An example of aqueducts of this type is the Biyar aqueduct from the Roman period, which, according to Mazar,[11] is unique in local terms, although the technique was in common use throughout the Middle East.

All presently identified ancient aqueducts brought water to Jerusalem from the area south – south-west of the city, i.e., from the hilly country between modern Hebron and the Bethlehem region. The water for the aqueducts was tapped from natural springs occurring in the 'Ain Arrub and 'Ain Kuweiziba area, and closer to Jerusalem from the springs in the Wadi Hoh and Wadi Artas region. The water was lead thereafter to the three successive rectangular pools called Solomon's Pools,[12] located approximately half way between the source of the water and Jerusalem, before being finally conducted to the city. The size of Solomon's Pools is very impressive, the upper cistern measuring 118 m × 71 m, with a total depth of 9.5 m to 11 m, and a water capacity of about 85,000 m^3; the lower two amounting to as much as 90,000 m^3 and 113,000 m^3 respectively, according to Mazar's[13] estimate. Altogether these three cisterns had a total capacity of about 288,000 m^3.

We may suppose that the pools served first of all the purpose of being settling pools for the water. The enormous size and capacity of Solomon's Pools purports, however, to tell that their primary function was definitely storage of water for massive future needs and not just to meet the demand of the following day. This is evidence of a calculated policy and must have been dictated by the scarcity of water in Israel and the fact that, for example Jerusalem and many other population centers lay basically in the Judaean wilderness.

The longest and most impressive of Jerusalem's ancient aqueducts is the Arrub aqueduct, which is of special interest for our case study, as will be demonstrated shortly. The dramatic topography in Judaea that the engineers who constructed the Arrub aqueduct had to conquer is, first of all, best shown by the circuitous route of the waterline. It actually quadrupled the distance of the aqueduct from the springs that fed the water to the reservoirs at Solomon's Pools, from ten to forty kilometers. Adding the last part from the local cisterns to Jerusalem, we have an aqueduct which had the tantalizing total length of some 60–65 km. In order to understand more about the engineering of the Arrub aqueduct, we decided further to make some calculations regarding the aqueduct

[11] Mazar 1976 (above n. 9), 81.
[12] Solomon's Pools are located in the area some 10 km southwest of present-day Bethlehem.
[13] Mazar 1987 (above n. 9), 188.

gradient[14] to see whether any correspondence to contemporary Roman technology can be seen. This was also done to cast some new light on the possible water capacity of the aqueduct and thereby its significance to the water supply of the city, which will be discussed in the concluding section.

The altitude of the springs which nurtured the Jerusalem aqueducts in the Wadi Biyar region average about 870 m and in the Wadi Arrub approximately 810 m above sea level. According to Mazar,[15] the altitude of the Arrub aqueduct varies between 90 m and 115 m above the Temple Mount, which was the destination area (735 m above sea level). The difference in altitude between the source and the destination of the water is thus about 90—115 m and the total distance of the aqueduct about 60 km, which is equal to 40—41 Roman miles of 1.48 km each. The equation provides an overall gradient of 1.5—1.9 m per km or 0.15—0.19%[16] for the Arrub aqueduct (for the Biyar aqueduct the average gradient is about 2 m per km). Measuring the straight-line distance between the source of the water and Jerusalem, which is 25 km as the crow flies, and dividing it by the difference in altitude, gives a theoretical gradient of 3.6—4.5 m per km. A look at the diagrams for aqueduct gradients[17] demonstrates clearly that such a steep overall fall would have been far outside the normal parameters for aqueducts and would have seriously jeopardized the whole water project. Probably the greatly increased distance, for example of the Arrub aqueduct, brought down the aqueduct gradient to an acceptable level, but would, on the other hand, have increased the cost of building and continuous maintenance costs.

The gradient of 0.15—0.19% determined for the Arrub aqueduct is quite shallow, but the slope would still have been enough to allow the water to flow continuously. Our result corresponds interestingly with the lower parameter, or the theoretical ‚standard minimum' that, for instance, Hodge[18] presented for Roman aqueducts. This entitles us perhaps to conclude that the engineers who were responsible for constructing the Arrub aqueduct were familiar with the general calculations of aqueduct gradients. Finally, we may assume that their intention was to produce a gradient close to the lower parameter of 1.5 m per km by multiplying the distance of the aqueduct.

Archaeological evidence which suggests that early first century A.D. lead from the Roman provincial coinage of Judaea may have been used for constructional purposes (aqueduct pipes?)

In 1987—1988 and 1993—1994 two series of coin samples of the early Roman provincial coinage of Judaea were investigated for their chemical composition and archaeometallurgically with respect to details of the ancient metallurgy and microstructure by using standard laboratory techniques.[19]

[14] The interrelation between the altitude of the source of the water and its distance from the place where it was used.

[15] Mazar 1987 (above n. 9), 188.

[16] The figure of 1.5—1.9 m per km is based on the real aqueduct distance in this case, differing from a calculated theoretical gradient where one would have to imagine the water running absolutely straight all the way down from the source to the destination in the same angle.

[17] Hodge (above n. 5), 180—183.

[18] Above n. 5, 179—181, Figs. 127—129. Hodge presumed that there were two ‚standards', an upper parameter consisting of a gradient of 3.0 m per km and a lower one of 1.5 m per km of line.

[19] See Lönnqvist (above n. 2), 13—34; forthcoming other. The chemical contents of the coins were analysed using destructive investigation methods by removing mechanically a few milligrams of metal from the edge

The most peculiar result of the studies that we carried out was that the Roman administration clearly used two different coin alloys to produce its first provincial coinage minted A.D. 6–66.[20] For most of the minting period a lead-tin-bronze (mean values: copper 78%, lead 11% and tin 10%) coin alloy was used. The rigorous sampling of clearly legible coins (clear date) only to our chemical analysis, and the controlled case study, made it possible for us to pinpoint the use of another, a pure tin-bronze coin alloy (mean values: copper 87%, lead 0.2% and tin 10%) to the years A.D. 17/18–31/32.[21]

The results of our chemical investigation show beyond any doubt that a pure tin-bronze coin alloy without any lead was introduced by the Roman administration in Judaea in the Tiberian period in A.D. 17/18. According to the dated provincial coinage itself, lead reappeared in the melt as early as A.D. 30/31,[22] although not in full scale, while the coins known with certainty to have been minted in Pilate's final minting year, in A.D. 31/32, were again lead-free. In the next coin series that was struck in the Roman province of Judaea under Emperor Claudius in A.D. 54, and later under Emperor Nero, the previously used lead-tin-bronze alloy was back in use. The intriguing question is therefore, what happened in Judaea in A.D. 17/18–31/32? Can we hope to find an archaeological, metallurgical or historical explanation for the behavior of lead in the coin

of each chosen coin with a micro-drill. After that the metal collected was dissolved in acids and its chemical contents analysed using atomic spectrometry techniques. The first investigation was conducted in Berlin and the second in Jerusalem.

20 Since most provincial coinages minted in base metals – especially in Roman East – are infrequently dated or not dated at all, it is usually difficult to have any statistically meaningful result of a coin sample even if a chemical analysis were done. Other difficulties involve pure technological limitations, weaknesses in the sampling strategy or a total lack of it, or, e.g., statistical errors in the analysis. None of these questions can be dealt with here because the space does not permit it. The case of Roman Judaea in the early first century A.D. is very rare, not only because coins were usually not minted in Roman provinces ruled by junior officers (prefects and procurators), but in particular because the coins that exist are dated (although minting was not in progress every calendar year). Consequently, knowing exactly when the coins were minted made it possible for the first time to see how the chemical contents of a whole Roman provincial coinage developed from one minting period to another – at times even on a year-to-year basis – when minting was prolific. Valuable information about the proportions of the metals in the coin alloy, the quality control of the Roman mint in Judaea, economic development of the value of coins in the province and the newly discovered relationship between Roman coinage and metalwork in general, was received. These latter topics require, however, more space and will therefore be dealt with in another forum. What we shall discuss here is mainly the chemical composition of the coin alloy and its direct implications for our research problem.

21 The author had the opportunity to select the coins for the investigation, including more than a hundred coin samples which were analyzed by standard reliable methods in a laboratory. As standard scientific and numismatical principles could fully be taken into account, we can confidently say that a representative sample was achieved which secures the statistical validity of the investigation. It is also of importance that the provenance of the coins is known; they come either from controlled archaeological excavations in Israel, or coin collections.

22 The quantities of lead detected in the coins show that the metal cannot have been included (5–14%) in Pilate's coin alloy accidentally. One contributory explanation may be that the year A.D. 30/31 is also according to our survey the year when the largest single issue of coins was minted under Pontius Pilate's whole period of office (see K. Lönnqvist, Roman Provincial Policy in Judaea in the Light of the Procuratorial Coinage of the Period, Helsinki 1988 (unpublished MA-thesis), Table 1, 101. As a rule, anomalies of all kinds whether being of technical or typographical nature did occur more frequently when the ancient coin production increased.

alloy? Was lead perhaps needed in such a degree for a more important purpose that it was not available for the coinage anymore?

Omitting lead from a coin alloy where it usually appeared may have several explanations, some of them natural.[23] We shall briefly examine the possible reasons. That lead would actually not have been available for commercial purposes for the Roman administration in Judaea in the early first century A.D. for a period of 10–20 years is, of course, possible. In our view, however, the fact that the metal could probably have been obtained from some of the neighbouring areas or Roman chief mints (Alexandria or Antioch) makes the theory too far-fetched to be credible. From the survived inscriptions published in recent years we have been able to conclude, for instance, that the Roman government directly owned or had leased the rights for mining in most of the profitable mines in the provinces. This has, for its part, influenced scholars to believe that there was a relatively good supply of metals, including lead, all over the Mediterranean region, although prices and transport costs certainly varied from region to region.

At this point we may return to the narrative of Pilate and the affair of the aqueduct, as related by Josephus. What would be more convenient than to connect the disappearance of lead from the Roman provincial coinage of Judaea in A.D. 17/18 and the hypothesis that lead was drained from the coin alloy because it may have been used for Pilate's aqueduct?[24] Lead would have been needed in particular for casting of lead pipes and for the solders or joints, if such were used. If the change of coin alloy in the years A.D. 17/18–31/32 reflects the building of the aqueduct, the building need not have continued for the consecutive 13–14 years, from A.D. 17/18 to 31/32, although it

[23] This was first brought to our attention by Prof. emer. Patrick Bruun in 1988. He also made another suggestion that is presented in n. 27. We disagree, however, with the idea that there might be a natural explanation for the phenomenon in this context. Whether the new unleaded coin type which was introduced in A.D. 17/18 was intended to represent a new coin denomination is uncertain, although it was evidently of better quality and subsequently worth more than its leaded counterpart. Given the same target weight and module size it is most unlikely. The unleaded coin would probably, despite the slight increase in metal value, still have passed in the same over-valued denomination as its leaded counterpart. That the improved quality of the coin alloy was, however, of some importance is shown especially by the countermarks discussed earlier by Lönnqvist (K. Lönnqvist, New Vistas on the Countermarked Coins of the Roman Prefects of Judaea, INJ 12, (1992–1993) 1993, 68). There is a possibility that the authority responsible for the countermarking was also aware of the records kept by the Judaean provincial mint of the chemical composition of the coinage. This is supported by the fact that the full range of issues chosen to be countermarked did not extend beyond A.D. 17/18, to the earlier series when leaded or highly leaded coins were produced. The coins sorted out to be countermarked in or around A.D. 36/37 are all of the pure tin-bronze series, also excluding the single-year issue (A.D. 30/31) when high proportions of lead occur, as established by our analysis. The impression of the countermarking is therefore that a considerable effort was made to choose coins made of the pure tin-bronze alloy only, possibly in order to distribute to the soldiers countermarked coins of a higher quality. The countermarks were probably made by a special task-force sent from Syria about A.D. 36/37 to depose Pilate from the post as provincial governor of Judaea (vide our n. 48).
As to the appearance of different metals in Roman coins of various denominations in the early Imperial period, chemical analyses clearly indicate that certain metals or combination of metals and alloys were reserved for certain coin denominations or even Roman mints only. Tin-bronze is, according to our knowledge, found in this period only in coins minted in Antioch and Judaea, which gives us a new and interesting tool for assessing the monetary arrangements in these two eastern provinces.

[24] Vide the n. above.

remains, however, a possibility.[25] We may perhaps presume that the amount of lead which had been reserved for the coinage bronze during the whole production period was directed to the building of the aqueduct and was probably used en masse during a very short period, possibly a few years at most.

We believe that this is the direction where the answer to the disappearance of lead from the alloy should be sought. Accepting that the change in the chemical alloy of the Roman provincial coinage of Judaea in the Tiberian period is to be connected to Pilate's aqueduct project, there are only two ways of explaining Josephus' historical narrative: a) Josephus erred as to who really initiated the aqueduct project, or, b) he recorded correctly that Pilate did initiate the aqueduct affair, but failed completely in dating the beginning of Pilate's period of office.

We shall demonstrate that the latter option is the most likely explanation, and that there are strong reasons to believe that Josephus was not able to date the beginning of Pontius Pilate's period of office. The argument that Josephus may have made a mistake in dating Pilate's mandate period is perhaps surprising, but is in itself not new. First of all, we should recall that beside Josephus there are no other sources for evaluating the chronology of the Augustan or Tiberian office-holders in Roman Judaea to any degree. Second, Pilate's chronology has not remained unchallenged, and weighty historical arguments have recently been brought forward in favor of an earlier date for the governor.[26] What is, however, new is that now also a group of primary evidence, the coinage of the period, can be brought forward to support the hypothesis that Pontius Pilate's chronology should be re-evaluated. When we combine our observations with the arguments below (i–iv) that are connected to Pilate's chronology, they all clearly speak in favor of that Pontius Pilate may have replaced Valerius Gratus (A.D. 15–26, traditionally dated) as early as A.D. 17/18, and not, as commonly believed, in A.D. 26. Chronologically Pilate may have initiated the aqueduct project.

New evidence for redating Pontius Pilate's period of office

For the following reasons we see the change (i) of the coin alloy[27] in A.D. 17/18 as representing the arrival of Pontius Pilate. The change of the coin alloy coincides with a new coin type which also was introduced in A.D. 17/18 (ii) featuring a palm branch. This particular coin type signified the arrival of a new Roman governor in Judaea in the majority of the cases,[28] also supporting the argument. The meaning and the appearance

[25] An estimate of, say, 3–5 years as the construction period for Pilate's aqueduct is in accordance with what we know of aqueduct building in antiquity. See, e.g., our n. 50 and Leveau's comments.

[26] Vide D. R. Schwartz, Pontius Pilate's Appointment to Office and the Chronology of Josephus' Antiquities, Books XVIII–XX, Zion 48, 1982/83, 325–345 [in Hebrew]. In English by the same author in: Studies in the Jewish Background of Christianity (Wissenschaftliche Untersuchungen zum Neuen Testament 60), Tübingen 1992, 182–201. We find Schwartz' basic hypothesis very interesting.

[27] Theoretically, V. Gratus (governor A.D. 15–26) could also have had access to this peculiar coin alloy, leaving the chronological arrangements of the Roman office-holders as they previously were believed to be. This is a possibility that cannot be entirely excluded, but it would certainly leave many other aspects of the problem unexplained.

[28] Vide Y. Meshorer, Ancient Jewish Coinage II, Herod the Great through Bar Cochba, New York 1982, Pl. 31, no. 17. This coin type was used unaltered on the following three coin series, minted in A.D. 17/18, 18/19 and 24/25 of the unleaded coin alloy. The positive image („good wishes") of a single upright branch (or several) of corn, laurel or palm is used as an obverse or reverse type on the early Roman provincial coinage

of the countermarks on Valerius Gratus' and Pontius Pilate's coins (iii) has been discussed elsewhere. The countermarks coincide with the change of the chemical composition of the coinage bronze alloy and the new coin type which appeared for the first time in A.D. 17/18, suggesting also that the reform coinage belongs to Pontius Pilate, and not to Valerius Gratus. The (iv) suggestions concerning Pontius Pilate's chronology and the changing of High Priests in Judaea under Valerius Gratus, made independently by D. Schwartz (although from a starting point different from ours), support perfectly the numismatic argument about the chronology of Pontius Pilate that we have drawn up above, i.e. that he may have been appointed governor of Judaea as early as A.D. 17/18.[29]

In Josephus' account, which forms the core of Schwartz' argument, Valerius Gratus changed High Priests rapidly four times before being satisfied with his final choice. According to this hypothesis, the change of High Priests started presumably soon after Gratus had assumed office around A.D. 15, meaning that the Jewish High Priest was replaced, on an average, once a year, or even more often. This would accordingly have ended Gratus' period of office about A.D. 18/19 at the latest. Therefore Valerius Gratus' period of office may well have terminated approximately A.D. 17/18, lasting for 2–3 years, which was the average for a provincial governor in the early Imperial period, leaving Pilate in charge from about A.D. 17/18 to 36/37. Such a period for a Roman governor is certainly unusual, also within the context of the history of the Roman Imperial administration, but it may have its explanation.[30]

of Judaea six times as follows: Coponius, A.D. 6; M. Ambibulus, A.D. 9; Valerius Gratus, A.D. 15 (?); Pontius Pilate, A.D. 17/18 (?); Antonius Felix, A.D. 54 (double palm branches crossed) and Porcius Festus, A.D. 59. It seems therefore that the palm branch is – as far as the Roman provincial coinage of Judaea is concerned – mostly or always connected with the arrival of a new Roman governor. Indirectly this seems to imply that the new coin type which was started to be struck starting in A.D. 17/18 may be connected in the same way, with the arrival of a new governor, prefect Pontius Pilate, as suggested above.

29 See n. 23.

30 Cf. Ios. ant. Iud. 18, ii. 2 and vi. 5. The odd character of Pontius Pilate's offensive coinage has always intrigued scholars and numismatics alike. Connections to the unique nature of Pilate's coinage have been sought from the governor's ‚anti-semitic policy', which would have been inspired by the invisible struggle of power which went on in Rome between Emperor Tiberius and L. Aelius Seianus during that particular time. In A.D. 17/18 Seianus started gaining power in Rome, in A.D. 19 the mass expulsion of Jews from Rome took place and by A.D. 23 Seianus was virtually the ruler of the city. In A.D. 32 his coup fell through, he was arrested and later executed for treason by Emperor Tiberius.
Whether or not combining the events of A.D. 17/18 in the numismatic development in Judaea with the rise of Seianus' power in Rome, we still cannot close our eyes to the fact that, e.g., Pilate's minting activity in A.D. 29–31 and the highly irregular coin types that must have been offensive to the Jews, overlap perfectly with the peak of power of the usurper in Rome. The height of Seianus' power fell on A.D. 29–31 (M. Cary – H. H. Scullard, A History of Rome Down to the Reign of Constantine, London 1935, 353, (reprint Hong Kong 1984), which coincides with Pilate's last three yearly series of provocative coin types. Assuming that the contact between Seianus and Pilate indeed existed would also well explain why Pilate was sent to Judaea in A.D. 17/18. Placing the beginning of Pilate's term of office to A.D. 17/18 would also explain why Caiaphas was chosen High Priest at this very time, given the close relationship between Pilate and Caiaphas (according to the account of the Gospels). It would also explain why Caiaphas officiated throughout Pilate's term of office, until the 30s A.D. Lowering the chronological limit to Pilate's term of office would not compromise the chronology of the events of the Gospels, but would, on the contrary, with regard to the numismatic and historical development, explain much better the events of the late 20s A.D.

Consequently, we have the strong impression that the aqueduct project which, according to Josephus,[31] Pilate carried out „on a later occasion" was initiated as early as A.D. 17/18. It seems feasible that Pilate's mint officials may have put aside the lead reserved for the provincial coinage and passed it on by the governor's orders to the aqueduct engineers. So far nobody has suggested this, probably because it was uncertain whether lead pipes had been used in the region in the Roman period. That lead was, however, definitely used for water conduits in the area in the early Imperial period is shown by new archaeological reports published a few years ago. This fact supports our argument and shows for the first time familiarity with the Roman technique of using lead for water pipes in ancient Israel.

This important archaeological evidence of the early use of lead pipes was discovered at Banias in the north of Israel and dates probably to the first century A.D.[32] The excavator reported that the water system found at Banias consisted of distribution pools and conical lead pipes. Two such pipes were discovered in one of the pools, while a third, broken one, in the second pool. Iron gratings that functioned as ‚filters' were also found.

It seems from Hartal's description that we are talking about a small shallow water tank called *castellum divisiorium*, where the aqueduct usually entered as a single unit. The regular Roman water distribution system was such that the water from the aqueduct was fed in a *castellum divisiorium* which formed a kind of junction box. From the *castellum* the water left through several outlets in the sidewall of the structure to the municipal water distribution network or water towers, ending in private mansions, baths, fountains, and so forth. Private users were normally prevented from overusing the water reserved for them by the waterworks staff, who installed a fixed connection, nozzle or tube in the wall of the *castellum* called *calyx* or *calix* (pl. *calices*), normally made of bronze. The size of the *calix* regulated and guaranteed the maximum agreed discharge of water to the customer. We know that the ancient sources stipulated that a *calix* had to be connected to a lead pipe of the same size at least to a length of some 50 feet following the nozzle.[33]

It is precisely such a Roman system with distribution pools and *calices* that we seem to meet at Banias, with the exception that Banias' *calices* were not made of bronze but of lead. According to Hartal's report, the lead *calices* at Banias were not connected to lead but to ceramic pipes. Apparently the discharge of these pipes was approximately 20-digits, i.e. they were of *vicenaria* size. The benefit of using bronze *calices* was, of course, that it was not possible to deform the tube in order to enlarge the water discharge illegally. It is quite probable that arrangements similar to those we find at Banias may have also been applied to other water systems in the Roman period in ancient Israel, although such have not as yet been discovered. If the reported finds at Banias are Roman-type *calices*, they are very rare even as such because they were found in an original

[31] Ios. bell. Iud. II, ix. 4 and ant. Iud. 18, iii. 2. For the archaeological remains of the aqueduct thought to have been built by Pontius Pilate see, e.g., Mazar (above n. 9).

[32] See M. Hartal, Banias, Aqueduct, Excavations and Surveys in Israel, Vol. 13, Number 100, English Edition of Hadashot Arkheologiyot, Archaeological Newsletter of the Israel Antiquities Authority, Jerusalem 1993, for the Banias aqueduct.

[33] Hodge (above n. 5), 296.

archaeological context under controlled excavations.[34] In any event, what the archaeological evidence discovered at Banias shows is that the Roman technique of using lead for water systems was not only known, but also used in the first century A.D. in the area.

Although we may not discuss the full complexity and technical intricacy of Roman water systems here, we may try to estimate however approximately in terms of metal what the Roman provincial administration in Judaea under Emperor Tiberius could have achieved by saving the lead from the coinage bronze alloy. Starting with estimating coinage volumes in antiquity, it always involves some guesswork and uncertainties, but we know for Judaea that the coin production in the early first century A.D. must have been relatively large, at times clearly huge. A rough calculation based on the estimated coin volume under a certain period of issue, the metrology of the coins and the analyzed proportions of the main components in the coin alloy according to what has been presented, suggests that the Roman administration in Judaea could have saved approximately 8—10 tons of lead in A.D. 17—32, depending on the total bulk of coinage minted,[35] by simply omitting lead from the coinage bronze alloy.

Thereafter we may try to estimate how far the metal would have sufficed, assuming that we are talking about a fully-fledged Roman aqueduct manufactured according to Roman standards and measures. The smallest pipe size used would probably have been a *vicenaria*. To cast a kilometer of pipeline of the size would have required about 26 tons of lead. For a *quinquagenaria* (25 cm in ∅) about 65 tons of lead would have been needed for each kilometer of pipe, excluding what was needed for the solders or joints, if made of lead.[36] In this perspective, the amount of lead that the Roman administration in Judaea could have saved in A.D. 17—32 from the coinage bronze alloy would have been enough for about 150—300 m of lead pipe, depending on its final caliber and capacity.

However, in standard Roman engineering terms lead would have been used only for those particular sections in the aqueduct that needed lead. What perhaps is surprising is that lead pipes or *fistulae* seem to have been used in Roman water systems mainly for the final part of the water system, usually where the aqueducts ended in the *castellum divisiorium* and further on in pipes close to the final destination of use.[37] Finding lead pipes in

[34] Hartal (above n. 32) who published the preliminary report on the excavations of the Banias' water system has not to our knowledge written any more detailed report of the find up until the time this paper was finished. Therefore, for the time being we must rely on the information presented in the preliminary report. It has not been possible for us to see, study or document the lead pipes on location in Israel for this purpose either. Therefore we do not as yet know exactly what the *calices* looked like. Neither do we know whether the *calices* had any names or numbers stamped on them, or if any real lead *fistulae* or signs of them were noted, since no such data is available in the preliminary report. Cf. C. Bruun, The Water Supply of Ancient Rome. A Study of Roman Imperial Administration (Commentationes Humanarum Litterarum 93), Ekenäs 1991, 40—44, for the relative scarcity of Roman *calices* in archaeological finds.

[35] The numbers are based on Lönnqvist's (above n. 22) statistical calculations and estimations of relative coin output under each Roman governor A.D. 6—66 (that minted coins), the calculated average coin weights and the individual proportions of different metals in the coin alloy, according to the chemical analyses made by us in 1987—88 and 1993—94.

[36] The figures have been calculated from Hodge (above n. 5), 467, n. 20.

[37] The author who described Rome's water system, Sex. Iulius Frontinus, indicates in his work *de aquae ductu* (aqu. 63) that *fistulae* larger than about 23 cm were not for instance used in private pipes in Rome. The largest diameter of the *fistulae* recorded with certainty in C. Bruun's study (above n. 34), 124, n. 31 and 137, n. 86 for Rome appear to be between 20 and 30 cm. It seems that few, if any, pipes with a diameter more than 30 cm have been discovered. In Ostia, for instance, (with population estimates ranging from about

this particular context of the mains in Banias is thus not very surprising. That lead pipes have not been found, for instance, in Jerusalem and its environment is connected to the intensive circle of destruction, rebuilding and settling that the city has experienced in the course of its history.

Finally, we may try to identify Pilate's aqueduct and say a few words about its possible significance for the water supply of Jerusalem. In the survey of the Jerusalemite aqueduct system Mazar[38] suggested tentatively that the Arrub aqueduct might be identified with Pilate's aqueduct. The Arrub aqueduct was undoubtedly constructed in the Hellenistic-Roman period, although it was later reused and refurbished in the Mamluk period. We agree with Mazar's identification, which is supported by the dating, size and some technical features of the Arrub aqueduct. The total length of the aqueduct that Josephus described to have been initiated by Pilate has usually been thought to be grossly exaggerated, but there is no contradiction between what Josephus described and the length of the Arrub aqueduct. As mentioned, the Arrub aqueduct stands out with an estimated total length of some 60–65 km, which agrees well with Josephus' estimate of Pilate's aqueduct (bell. Iud.. II, ix. 4, 74 km). However, even in the general Roman perspective, aqueducts longer than that are not unprecedented either. We have, for example, the *Aqua Marcia* with a length of 91 km and *Aqua Novus* with 87 km, both of which distributed water to the capital of the Roman Empire. Particularly in the provinces we find aqueducts exceeding these distances considerably.[39]

Peleg,[40] who has devoted much attention to the ancient water systems of Israel, suggested not long ago that the stone pipeline discovered near Bethlehem with a preserved length of about 2,500 m (Mazar's ‚Upper aqueduct', called ‚High Level aqueduct' by Peleg) was actually part of the Hellenistic aqueduct used by the Hasmonean kings, and later by Herod the Great, Pontius Pilate and other rulers, and may have formed the final part of the Arrub aqueduct from Solomon's Pools to Jerusalem. Mazar[41] believed that the High Level aqueduct was built in the post A.D. 70 period because the names of some of the commanders of *Legio Decima Fretensis* (Tenth Roman Legion) appear in the recovered aqueduct inscriptions. However, as Peleg[42] pointed out, the garrisons of the Tenth Roman Legion are not known well enough. It is therefore quite possible that the inscriptions referring to the Tenth Legion are merely to be connected to later repairs of the water main carried out in the post A.D. 66 period, rather than the period of its construction, as Peleg remarked. Accepting this theory brings a few more interesting details into the discussion since the stone pipe is relatively well preserved.

10,000 to 60,000) which has been well studied and where lead pipes were exclusively used, the largest single pipe size (internal size) measured is 16 cm, while smaller sizes around 7–10 cm are common. Another thing that becomes clear from Bruun's investigation of the water supply of ancient Rome is that the role of lead *fistulae* in the construction of water mains in general appear to be over-emphasized. Alternative materials in the construction of the conduits were often resorted to, especially by private individuals in their private conduits. This happened particularly in areas that lay outside major population centers (suggested, e.g., by the surveys conducted by C. Bruun (chapter IV. 2.4.) which seems to have been the practice also in other provinces.

38 Mazar (above n. 9), 80.

39 Hodge (above n. 5), 346. Carthage, 132 km and Cologne (Eifel), 95 km.

40 Above n. 8, 130–131.

41 Above n. 9, 84.

42 Above n. 8, 131.

The closed water system of Bethlehem with the stone pipe was built of limestone segments carefully fitted to each other, like a siphon that crossed a deep depression of approximately 34 m in the terrain.[43] Single stone segments measure 60 cm in length, 80 cm in width and 90–100 cm in height, joined together by well-fitted sockets and rims cemented together. The bore of the pipe is huge, portraying a diameter of as much as 38 cm. The Bethlehem stone siphon shows that the engineers did not try to cross the valley by building a bridge but decided to build a stone siphon instead. This was the practice especially in Hellenistic pipelines, where pipes were mostly made of stone and where bridges were not built,[44] which also supports an earlier date. This suggests perhaps that the Romans who improved the water pipe in the first century A.D. were using an older pipe- and waterline.

What could finally have been the significance of the Arrub aqueduct for the water supply of Jerusalem? There is much disagreement about the size of the population of Jerusalem in the Roman period, the estimates ranging from about 120,000 to as much as 250,000 people.[45] The water from the Arrub aqueduct alone was partly stored close to the springs in a reservoir that held an estimated 20,000 m^3.[46] Taking this as a starting point and comparing that number to the calculated capacity of other known aqueducts in the ancient world is one way of arriving at a tentative conclusion. Assuming that the minimum daily amount of water that the Arrub aqueduct brought to the city was about 20,000 m^3, and assuming further that all this water was spared for drinking purposes, then the amount would have been enough for about 100,000 people.[47] Beside that large amounts of water would have been needed especially in Jerusalem, for instance for the

[43] Peleg (above n. 8), 130. In the surveys of the area of the Greek city of Hippos-Sussita, located about 2 kilometers east of the Sea of Galilee, ‚siphons' made of stone were reportedly also found. See Z. Meshel – H. Fahlbusch – Y. Peleg – T. Tsuk, Survey of the Sussita-Hippos Aqueducts, Excavations and Surveys in Israel, Vol. 14, Numbers 101–102, English Edition of Hadashot Arkheologiyot, Archaeological Newsletter of the Israel Antiquities Authority, Jerusalem 1994, 29.

[44] Hodge (above n. 5), 31–45.

[45] Josephus quotes (in Ios. c. Ap. 1, 22. vi, Hecateus) the Hellenistic author Hecateus of Abdera (4th-3rd century B.C.) who claims that Jerusalem's population rose to 120,000 inhabitants even then. For our purpose a more precise figure is not needed since neither the capacity of the aqueduct under discussion nor the individual water consumption per person in antiquity is known precisely.

[46] Calculated by Mazar (above n. 9), 80.

[47] This seems a reasonable suggestion basing it on the calculated capacity/day of other known aqueducts. P. J. Aicher, Guide to the aqueducts of ancient Rome, Wauconda/Illinois 1995, 34–35), mentions, for instance, that the capacity of water of Rome's nine largest aqueducts varied between 48,000 m^3 – 190,000 m^3. The equation of water per person per day is based on the estimates that Hodge presented (above n. 5, 464, n. 4). The generous amount of 200 l per person/day is assumed here, in contrast to the 25 l per person/day for modern developing countries and the large amount of 500 l per person/day, estimated for ancient Pompeii. G. Garbrecht claims (Die Wasserversorgung des antiken Pergamon, in: Geschichte der Wasserversorgung 2. Die Wasserversorgung Antiker Städte. Pergamon: Recht/Verwaltung, Brunnen/Nymphäen, Bauelemente, Mainz 1987, 46) that second-century A.D. Pergamon with an estimated 160,000 inhabitants sustained on a discharge of 40,000 m^3 of water, i.e., 250 l per person per day. For Caesarea Maritima (Israel) we have several aqueducts preserved the water capacity of which has been estimated: Caesarea, Herodian ‚High Level Aqueduct' (1st-century B.C.), max. capacity of about 22 000 m^3 per day; Hadrian's ‚High Level Aqueduct' (2nd-century A.D.), max. capacity of about 39,000 m^3 per day: two 4th-century A.D. pipes with 3,500 $m^3$and 61,000 m^3 per day and the 13th-century A.D. pipe with 5,100 m^3 per day (calculated from Y. Peleg, Caesarea Maritima, in: Geschichte der Wasserversorgung 2. Die Wasserversorgung Antiker Städte. Pergamon: Recht/Verwaltung, Brunnen/Nymphäen, Bauelemente, Mainz 1987, 178). According to Aicher (above this n.), 34–35, Rome's two smallest aqueducts counted for 16,000 m^3–17,800 m^3 of water per day.

ritual baths and the maintenance of the Temple. Outside this estimate remain the rain water cisterns and the natural spring area of Jerusalem (Gihon), which would have contributed also to the water supply of the city.

We see that whatever the exact importance and water capacity of Pilate's aqueduct was, it must have, even according to a careful estimate, contributed significantly to the amount of water available in Jerusalem in the period. In fact, it seems justified to assume that the aqueduct increased the water surplus in the city to a new level. Its construction must also have involved great cost and labor, and it can thus hardly have been built as a showpiece only to irritate the Jews. Therefore, in our view there is hardly any foundation to believe that this enormous quantity of water had been meant only for the relatively small Roman garrison residing in Jerusalem, numbering about 1,000 soldiers.[48] In this perspective it is difficult to avoid any conclusion that would entirely exclude Jewish interest in Pilate's water project.

Of the organization, duration and cost of building of ancient aqueducts in general no requisite threshold of reliable facts exists. W. Eck[49] followed by P. Leveau[50] has estimated that the cost of building an aqueduct could have been very high. Leveau assumed a cost of some 2 million sesterces per kilometer of pipeline, projecting a speed of up to 20 km of waterline per year. Taking this as a guideline means that Pilate's aqueduct took some three years to construct. Any such figure should not, however, be taken as representing an exact value, but rather as suggestive creating an impression of the possible values we are talking about.

About the funding of Pilate's aqueduct, as it is presented in the account of Josephus, nothing certain can be said. It remains a possibility that Pilate did receive funds from the Jerusalem Temple treasury with the silent approval of the ruling Jewish class, which was eager to retain its privileged position under the Roman protection. What we can conclude indirectly comes from the Jewish Talmud. Talmud (Lamentations Rabba 4:4) reads: „The aqueduct which used to come from Etam, Sicarii once came and destroyed it". Etam is identified by Mazar[51] as 'Ain 'Atan, which lay close to the collection point of the water near Solomon's Pools, implying that Pilate's aqueduct may have been destroyed as early as during the First Jewish War (A.D. 66–73) by the hands of the Sicarii. This would suggest that the fanatic religious Jews had a good reason for destroying the aqueduct. We may assume that the reason was that the water project had been funded by desecrating the Temple treasury, which must have severely angered the religious Jewish population.

Summary

In conclusion, the archaeometallurgical evidence of the first Roman provincial coinage of Judaea (A.D. 6–66) suggests that the reason for the sudden change of the coinage bronze

[48] Lönnqvist (above n. 23), 66. The garrison of Judaea was reinforced in or around A.D. 36/37 with a *cohors miliaria* (1,000 soldiers) which probably arrived from Syria, increasing the total number of soldiers in the province from 3,000 to 4,000. The *cohors miliaria* was divided into three smaller detachments, with one unit in Jerusalem, one in Caesarea and the third one probably at Masada. As such the local garrison in Jerusalem may have been around 1,000 soldiers, including the newly arrived.

[49] W. Eck, Die Wasserversorgung im Römischen Reich. Sozio-politische Bedingungen, Recht und Administration, in: Geschichte der Wasserversorgung 2. Die Wasserversorgung Antiker Städte. Pergamon: Recht/Verwaltung, Brunnen/Nymphäen, Bauelemente, Mainz 1987, 74–79.

[50] P. Leveau, Research on Roman Aqueducts in the past ten years, in: T. A. Hodge, Future Currents in Aqueduct Studies (Collected Classical Papers 2), Melksham/Wiltshire 1991, 153–155.

[51] Mazar (above n. 9), 80.

alloy to lead-free occurring in the period A.D. 17/18–31/32 was that the Roman administration in Judaea needed the lead for ‚construction purposes'. The extant evidence implies that this construction purpose was the aqueduct project ascribed by Josephus to Pontius Pilate. The preparations, if not the building of the aqueduct, probably started as early as about A.D. 17/18. Furthermore, on the basis of the numismatic and historical evidence we may conclude that Josephus erred in the dating of the beginning of Pilate's period of office and that Pilate must have been the one who initiated the aqueduct project. We believe therefore that Pilate assumed office as early as A.D. 17/18, and not A.D. 26 as commonly believed. Shifting the beginning of Pilate's mandate period backward to the second decade in the first century A.D. would also better explain the general development in Judaea in that period.

Appendix

The following list is a select bibliography concerning the ancient water systems, with special emphasis on Roman Judaea: Mazar (above n. 9), 79–84; Hodge (above n. 5 and n. 8); Peleg, in: Hodge (above n. 8), 129–140; and the following articles in: Papers at the Symposium of Historical Water Development Projects in the Eastern Mediterranean, Leichtweiss-Institut für Wasserbau, Mitteilungen 82, 1984: R. Malinowski – Y. Peleg, Some pressure pipelines in Israel, 7ff.; Y. Peleg, Die Wasseranlagen von Megiddo, 1; idem, Wasserwerke aus der israelischen Zeit, 2; idem, The water supply system of Caesarea, 4; idem, The aqueducts to Dor, 7; (idem, Das Stauwerk für die untere Wasserleitung nach Caesarea, in: Papers at the Symposium of Historical Water Development Projects in the Eastern Mediterranean, Leichtweiss-Institut für Wasserbau, Mitteilungen 89, 1986, 15;) R. Reich, Domestic water installations in Jerusalem of the Second Temple, 13.

Another large symposium is found under the title Geschichte der Wasserversorgung 2. Die Wasserversorgung Antiker Städte. Pergamon: Recht/Verwaltung, Brunnen/Nymphäen, Bauelemente, Mainz 1987, with A. Mazar, Jerusalem, 185–188; E. Netzer, Masada, 189–192; J. Peleg, Caesarea Maritima, 176–179; W. Alzinger, Ephesos, 180–184.

Individual papers of interest are T. Tsuk, The Aqueduct to Legio and the Location of the Camp of the VIth Roman Legion, Journal of the Tel Aviv University Institute of Archaeology 15–16, 1988–1989, 92–96; B. Dror, Tel Naharon, Aqueduct, Excavations and Surveys in Israel 13, Number 100, English Edition of Hadashot Arkheologiyot, Archaeological Newsletter of the Israel Antiquities Authority, Jerusalem 1993, 35–36; ibd.: Y. Billig, Jerusalem, East Talpiyot, 83–85; R. Frankel, The Hellenistic Aqueduct of Acre-Ptolemais, Atiqot, English Series XVII, 1985, 134–138; Hartal (above n. 32), 1–2; Y. Porath, Caesarea, the High Aqueduct. Excavations and Surveys in Israel 12, Number 99, English Edition of Hadashot Arkheologiyot, Archaeological Newsletter of the Israel Antiquities Authority, Jerusalem 1993, 28–29; ibd.: A. Siegelmann, Upper Nahal Tanninim, Aqueducts, 29–30; Meshel – Fahlbusch – Peleg – Tsuk (above n. 43), 29–30; D. Syon, Nahal Zippori, Aqueduct, Excavations and Surveys in Israel 14, Numbers 101–102, English Edition of Hadashot Arkheologiyot, Archaeological Newsletter of the Israel Antiquities Authority, Jerusalem 1994, 46–49; ibd.: N. Sagiv, Tel Goded, 112–113; Y. Olami – Y. Peleg, The Water system of Caesarea Maritima, IEJ 27, 1977, 127–137.

For aqueducts in general see Aicher (above n. 47); G. Hauck, The Aqueduct of Nemausus, Jefferson/North Carolina 1988; P. Leveau – J.-L. Paillet, L'Alimentation en eau de Caesarea de Mauretanie et l'aqueduc de Cherchell, Paris 1976 and T. Jacobsen – S. Lloyd, Sennacherib's Aqueduct at Jerwan (The University of Chicago Oriental Institute Publications XXIV), Chicago 1935.