Flying Buttress and Pointed Arch in Byzantine Cyprus

Charles Anthony Stewart

Though the Byzantine Empire dissolved over five hundred years ago, its monuments still stand as a testimony to architectural ingenuity. Because of alteration through the centuries, historians have the task of disentangling their complex building phases. Chronological understanding is vital in order to assess technological "firsts" and subsequent developments. As described by Edson Armi:

> Creative 'firsts' often are used to explain important steps in the history of art. In the history of medieval architecture, the pointed arch along with the…flying buttress have receive[d] this kind of landmark status.[1]

Since the 19th century, scholars have documented both flying buttresses and pointed arches on Byzantine monuments. Such features were difficult to date without textual evidence. And so these features were assumed to have Gothic influence, and therefore, were considered derivative rather than innovative.[2] Archaeological research in Cyprus beginning in 1950 had the potential to overturn this assumption.

Flying buttresses and pointed arches were discovered at Constantia, the capital of Byzantine Cyprus. Epigraphical evidence clearly dated these to the 7th century. It was remarkable that both innovations appeared together as part of the reconstruction of the city's waterworks. In this case, *renovation* was the mother of *innovation*. Unfortunately, the Cypriot civil war of 1974 ended these research projects. Constantia became inaccessible to the scholarly community for 30 years. As a result, the memory of these discoveries faded as the original researchers moved on to other projects, retired, or passed away. In 2003 the border policies were modified, so that architectural historians could visit the ruins of Constantia once again.[3]

Flying Buttresses in Byzantine Constantia

Situated at the intersection of three continents, Cyprus has representative monuments of just about every civilization stretching three millennia. But engineering in stone must have always been a challenge. In this volume, scholars have analyzed stone monuments in some of the most active earthquake zones in the world. Cyprus is no exception. In the year A.D. 332 the island was

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[1]Armi 2004, 3.4.
[2]See the discussion in Ćurčić 2004, 7-8.
[3] I am grateful to the Department of Antiquities of the Republic of Cyprus for allowing me access to their photography archives in Nicosia between 2005 and 2007. I also thank Jean-Pierre Sodini and Vassos Karageorghis who discussed their research with me.

devastated by a series of violent earthquakes.[4] Emperor Constantius II used this as an opportunity to refashion Cyprus according to a wider agenda.

At this time the eastern Roman Empire was under the constant threat of Persia.[5] So Constantius II built his palace at Antioch, where he had located his military headquarters.After the earthquakes in Cyprus, the emperor literally reoriented Cyprus' capital, from Paphos on western coast to ancient Salamis on the eastern shore. (Fig.1) He wanted a new Christian city, and so he renamed Salamis to "Constantia"—just as his father rechristened Byzantium.[6] Afterwards Constantia became the seat of the island's powerful archbishop. The new capital would face east towards Antioch's harbor, Seleucia-Pieria, which is about 12 hours away by ship. All the island's cities were then connected to Constantia, through the reconstruction of the highway system as indicated by the mile markers that honor Constantius II.[7]

Fig. 1: Cyprus Satellite Image. Route of the aqueduct from the springs of Chytroi in the Kyrenia Mountains to Constantia

[4]Theophanes records two devastating earthquakes at Salamis in 331 and 341: *Chronographia,* AM 5824 and AM 5834.
[5]Theodoret, *Historia Ecclesiastica* 2. 26-30.
[6] John Malalas recorded: "In his [Constantius'] reign [337–361] the city of Salamias in Cyprus suffered…the greater part of the city was plunged into the sea by an earthquake. The remainder was leveled to the ground. Constantius restored it and gave many extremely generous gifts, undertook buildings and remitted taxes from the surviving citizens for four years. As he provided a variety of buildings for what was previously known as Salamias, he had its name changed from that time to Constantia. It is now the metropolis of Cyprus" (*Chronographia* 12.48, ed. Jeffreys et al. 1986); see also Elias bar Sinaya, *Chronographia*, ed. Delaporte 1910, 65. For Constantius II's building campaign and his activity in Antioch, see Henck 2001, 294 ff.: Socrates Scholasticus, *Ecclesia historia* 2.47.
[7] 35% of the surviving milestones were erected in the time of Constantius II (Bekker-Nielsen 2004).

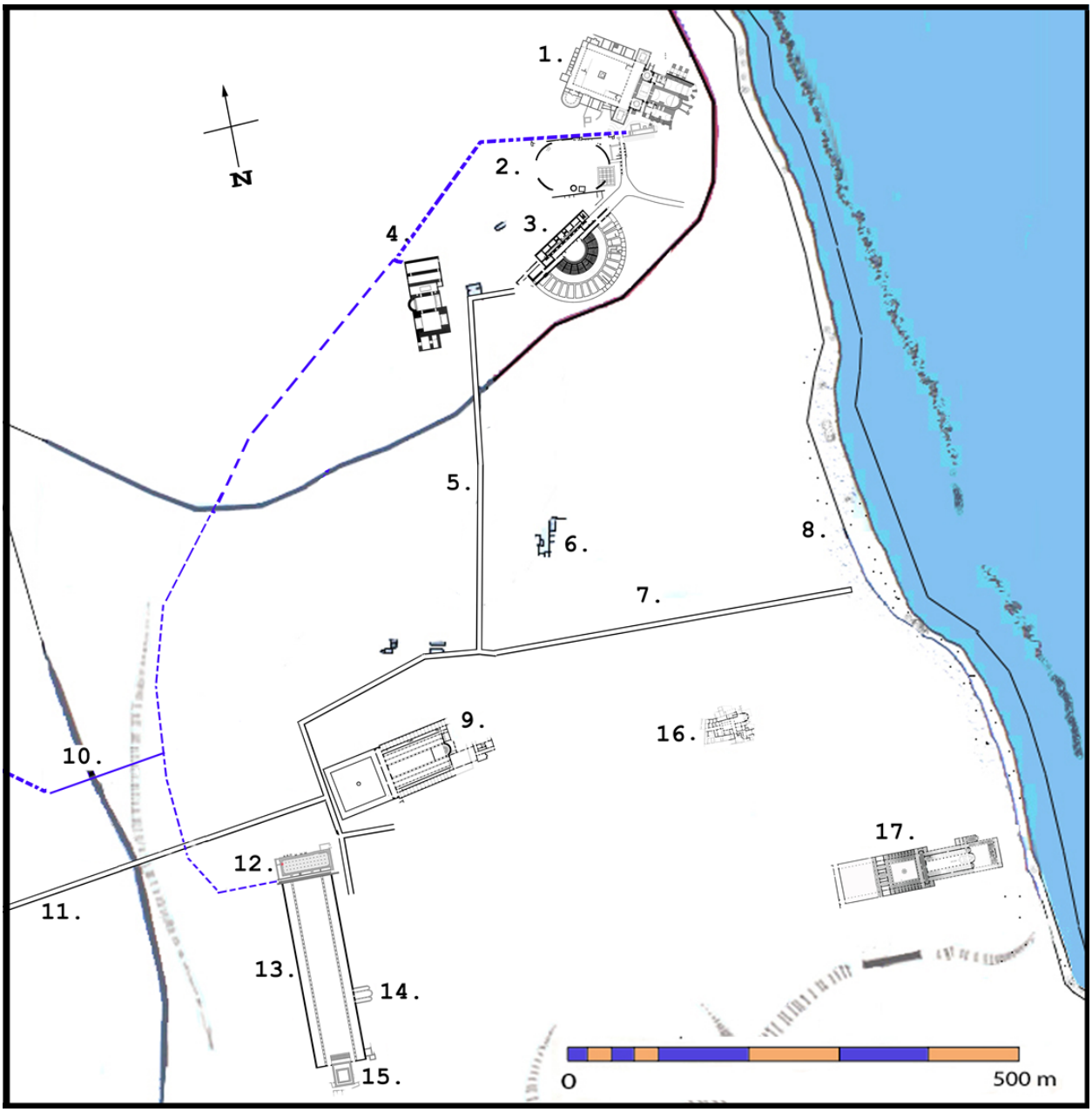

Fig. 2: Plan of the Constantia in the Byzantine Period as uncovered by excavations from 1940-1974. Blue dash line indicates hypothetical route of the Aqueduct. 1. Grand Baths/Gymnasium; 2. Amphitheater; 3. Theater; 4. "Roman" Baths; 5. Cardo Maximus; 6. Byzantine house; 7. Decumanus Maximus; 8. Harbor; 9. Cathedral of St. Epiphanius; 10. Aqueduct from Chytroi, remains of piers; 11. Road to St. Barnabas Monastery; 12. Loutron (Vouta); 13. Forum (Agora); 14. Basilica church; 15. Temple of Zeus/Capitolium (converted to church); 16. "L'Huilerie" (Byzantine villa); 17. Campanopetra Basilica (church) (Redrawn with modifications from Munro and Tubbs 1891; Bruce-Mitford 1980).

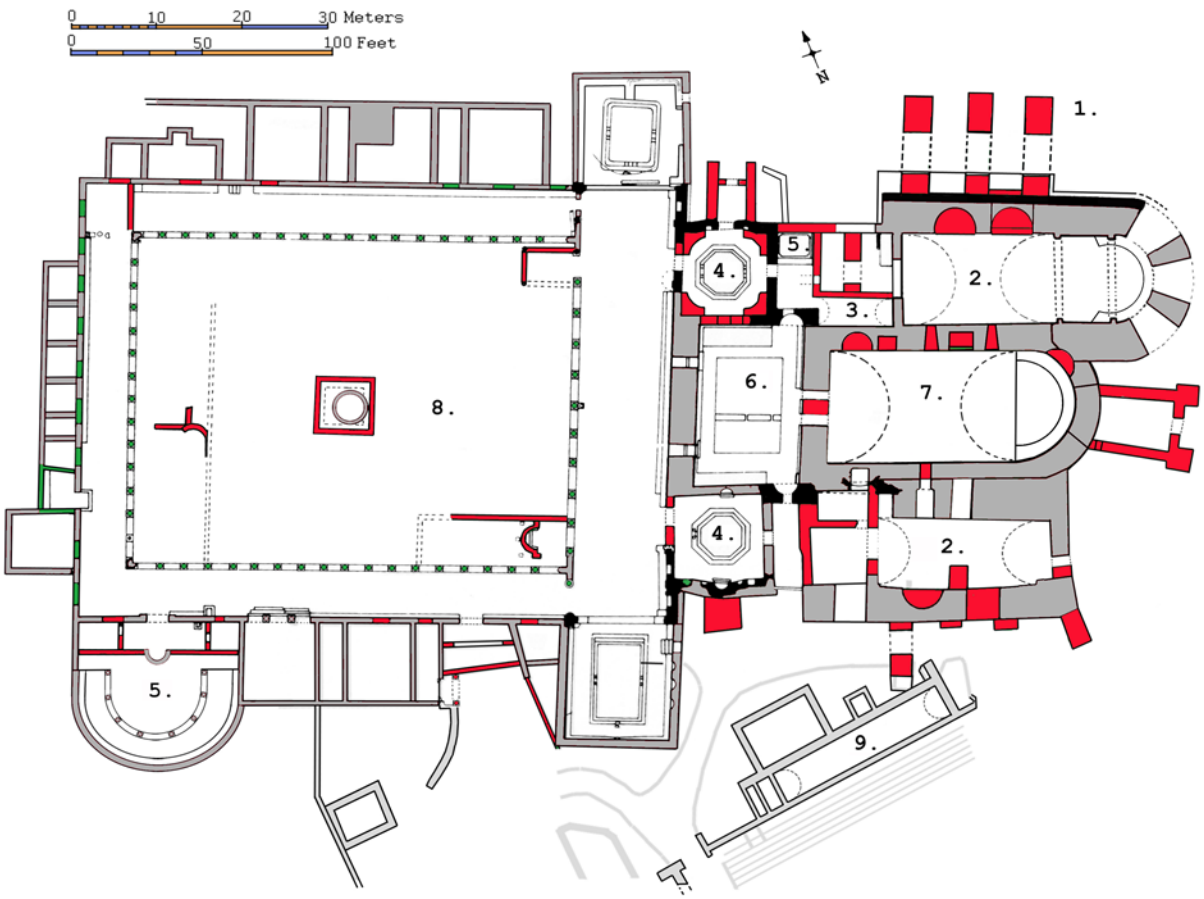

Fig. 3: Plan of the Grand Baths at Constantia. Key: Black = 3rd century remains or earlier; Grey = 4th century reconstruction over earlier foundations; Red= later renovations up to the 7th century. 1. Flying Buttresses; 2. Sudatoria; 3. Praefurnium; 4. Frigidaria; 5. Conclavia (latrines); 6. Tepidarium; 7. Caldarium; 8. Palaestra; 9. Cistern (Redrawn with modifications after Karageorghis, 1969b).

As his chief display of patronage, Constantius II renovated the Grand Baths and Gymnasium in Constantia. Such a project would benefit both pagan and Christian alike. (Fig. 2) The gymnasium was founded in the Hellenistic Period and expanded throughout the first centuries of Roman rule.[8] (Fig. 3) With the emperor's funding, the Baths were rebuilt with more rooms added around the palaestra and, presumably, new vaulting for each bath chamber. Though the excavations were never finished, progress reports were well-documented by the excavators Dr. Vassos Karageorghis, A. I. Dikigoropoulos, and A. H. S. Megaw.[9]

[8]Pouilloux 1966, 337-340.

[9] A.H.S. Megaw provided a series of progress reports as "Archaeology in Cyprus…" in the journal *Archaeological Reports* from 1955 to 1958 (vols. 2–5); afterwards, Vassos Karageorghis continued these reports as "Chroniques des fouilles…" in the *Bulletin de Correspondance Hellénique* from 1959 to 1973 (vols. 84–97); see also Karageorghis 1966a, 13-19; id. 1999; and id. 1964/1966. The French excavations at Salamis/Constantia between 1964 and 1974

In 1964 the excavation made a surprising discovery. Buried underneath sand dunes were a series of flying buttresses. The best preserved examples stood near the exterior side of the north wall. (Fig. 4) A fourth one was located inside, near the praefurnium, (Fig. 5) while other examples stood on the south wall but had collapsed. For the sake of brevity, I discuss the three examples in the north wall. Each consists of a massive pier-buttress built against the wall, measuring about 2 m wide, 1.5 m deep, and 5 m tall. Their masonry consists of large ashlars, rubble, and spolia, including column drums. [10] In order to brace the upper extremity of each pier, quadrant arches—known as flyers—rise from the ground at a 30\degree angle; their foundations are about 5 m in depth. Each flyer's top course was flat and rose up like a ramp; this facilitated the water runoff. (Fig. 6)

Fig. 4: Grand Baths at Constantia. View of north wall's flying buttresses, towards the west.

The catalyst behind this new support system was the lateral thrust exerted by the north sudatorium's barrel-vaulting. (Fig. 7) Integrity of the vault's springing was compromised by the two semi-domed chambers embedded in the north wall. (Fig. 8.) When the buttresses were constructed, these two chambers were filled-in with masonry, underscoring their structural weakness. It seems that the builders initially assumed that the pier-buttresses alone could resolve the shear failure.

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have ongoing publications in a series called *Salamine de Chypre* published by E. De Boccard of Paris. It should be noted that archeological excavation today at Salamis-Constantia is considered illegal by the Republic of Cyprus and the international community. And so my analysis here is based on previous excavation reports and personal observation of the aboveground monuments.

[10] Karageorghis 1966, 297-389. Compare the slightly restored sections in the photograph here (Fig. 3) with Karageorghis' excavation photo, fig. 144, pg. 382.

Fig. 5: Grand Baths at Constantia. Internal flying buttresses near the praefurnium. Substructure is beneath floor level.

Fig. 6: Grand Baths at Constantia. View of north wall's flying buttresses, towards the south.

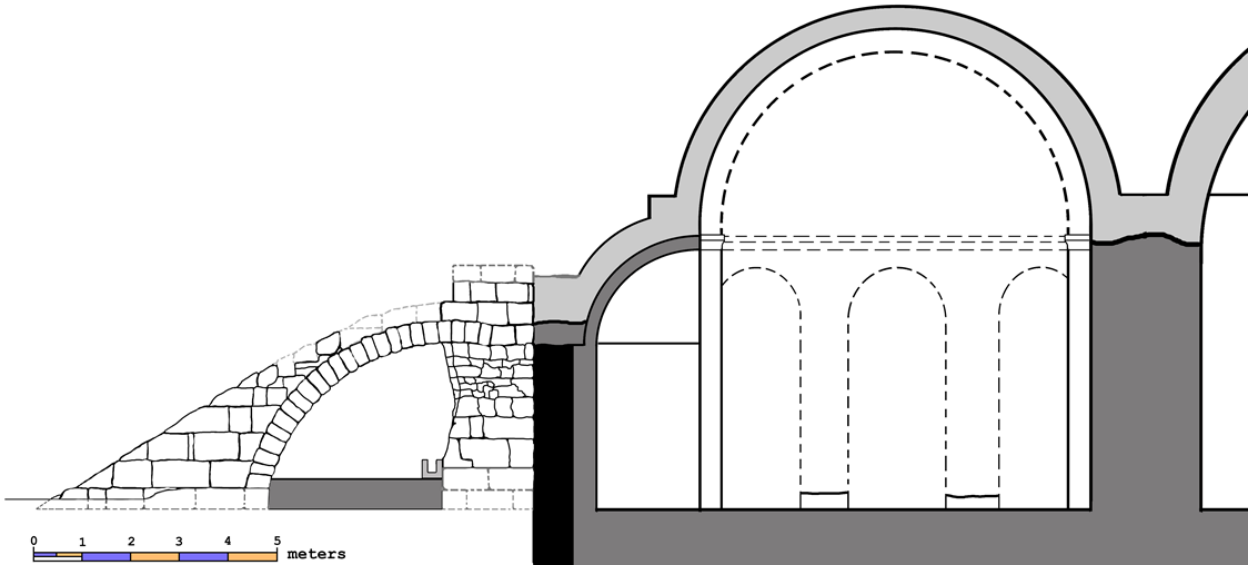

Fig. 7: Grand Baths at Constantia. Diagram illustrating the how the flying buttresses strengthened the barrel-vaulting of the north sudatorium. Key: Black = original Roman wall; Dark Grey = current remains of the bath; Light Grey = hypothetical vaulting.

Fig. 8: Grand Baths at Constantia. North wall of the sudatorium showing two apsidal chambers blocked up contemporaneously with construction of the flying buttresses on the other side.

At some point during the initial reconstruction, the builders redesigned the buttresses to include flyers. Their voussoirs were built into the piers rather than against them. The slanting surface of the arches served as a counterforce, pushing the piers against the vault's springing. It is not coincidental that the height of the piers equals the depth of the flyers' foundation. The master-builders here incorporated the so-called "Law of the Lever" which was widely understood by this time.[11] What I mean is this: the gravitational "effort" of the vaulting was resisted by the base of the flyer, which served as a fulcrum, while the flyer itself functioned as a lever.

It must be stressed that this was an experimental solution. If the pier-buttresses had worked, the flyers probably would not have been employed. In fact, massive pier-buttresses had already been used on the Bath's southern wall, tentatively dated to A.D. 528, based on an inscription (discussed below).[12] *So why did the builders use flyers instead of the conventional pier-buttress?* The water channel underneath provides an answer. This channel runs from the cistern in the south, around the eastern end, and on to the praefurnim and latrine. So the flyers gave the necessary support, while also bypassing the water channel that was already calibrated and functioning in place *after* the pier-buttresses were constructed. (Fig. 9) In other words, the construction of flying buttresses allowed the water to keep flowing, permiting the Baths to stay open while repairs were made.

One might argue that the Constantia examples were not "true" flying buttresses, as found in Gothic architecture, since these were remedial measures and did not have a decorative function. However, we must keep in mind that the first known use of flying buttresses in northern Europe was at Durham Cathedral (around 1093) and these were concealed underneath the roofing of the side aisles. Other flyers served primarily as gutters concealed by rooflines high above. And so, the function of Gothic flying buttress preceded its later aesthetic.[13] In contrast, the Constantia flying buttresses were at eye level, prominently displayed where citizens frequently gathered. We can imagine the average bather debating their qualities—whether ostentatiously unclassical or arguably stylish. Those with the latter opinion might have argued: to help facilitate their diagonal thrust, the piers were thicker at the base and curved inward. This design gave the structures a billowy sail-like quality. Plus their monumental scale and repetition created a sense of rhythm foreshadowing qualities integral to the Gothic aesthetic. Admittedly, the masonry is neither graceful nor of great craftsmanship. The danger of vault collapse was imminent and so construction was expeditious.

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[11] Usher 2011, 94.

[12] A.H.S. Megaw suggested (1957, 47–48)"…in the last repairs a massive buttress was built against its outside face, an addition which evidently post-dates the mid-seventh century Arab raids, since late material and much burnt matter is used in its construction. But the building is unlikely to have survived… [after] 691 A.D." Today archaeologists working in Cyprus no longer associate burnt materials in the mortar as necessarily a post-Arab characteristic of construction. This kind of mortar seems to have been used in the Levant from the early 7th century through the 13th: see Balandier 1999, 676 n.16.

[13] Regarding the origins of the Gothic arch, see Prache 1976; James 1992, 286-287; Clark and Mark 1984.

Fig. 9: Grand Baths at Constantia. Exterior of north wall showing the water channels running beneath the flying buttress.

Dating the Flying Buttresses

The flying buttresses at Constantia are also important for architectural history, because they can be reliably dated. Water channels below the flyers were built immediately above the debris of the 4th c. earthquake providing a *terminus post quem*. And so Vassos Karageorghis attributed the flying buttresses to the initial renovation by Constantius II: "Ils avaient été construits après les tremblements de terre du IVe siècle de notre ère, lors de la reconstruction des Thermes du Gymnase."[14] However, he did not provide any further evidence that led him to this conclusion. While the use of decorative pilasters was common in Early Imperial architecture, the employment of massive external pier-buttresses for vault strengthening was first realized in the Constantinian period.

The 4th c. nymphaeum known as "Temple of Minerva Medica" (Rome) is the earliest surviving example of massive pier-buttressing. (Fig. 10) It was a decagonal, domed structure about 80 ft in diameter. At each corner a massive pier-buttress channeled the weight from the internal vaulting.

[14]Karageorghis 1967, 354.

Later, two more massive pier-buttresses were constructed on the southern facade as remedial measures. Likewise, similar pier-buttresses were placed on the apse of the Temple of Venus and Cupid in Rome, also in the 4th century. Lynne Lancaster suggested that these elements were highly innovative in that "…both the 'Temple of Minerva Medica' and 'Temple of Venus and Cupid' were built on private imperial property where structural experimentation may have been more acceptable than in a structure designed strictly for public use."[15] But why would it have been unacceptable?

Fig. 10: Temple of Minerva Medica (Rome). External pier-buttresses for strengthening the internal vault. Dated to the early 4th c. A.D.

These use of the pier-buttress had an associated aesthetic that was antithetical to the classical *order*. Simply put, the *disorderly* exterior piers did not reflect the arrangement of the interior space. For lack of a better term, I call this a movement towards "architectural interiority"—the emphasis of the interior over the exterior aesthetic of the building. Of course this was not new to ancient domestic architecture. What changed is that public buildings no longer needed to wear a

[15] Lancaster 2005, 145-146; see Krautheimer 1986, 232. Apparently there are earlier examples of pier-buttresses that were necessary for vaulting, such as the 3rd c. Baths at Bir el Jabbana, Libya (Rossiter 1998, 103-115).

classical façade which masked an unclassical building underneath.[16] And this change began with the public baths. In 1893 Professor George Aitchison suggested that the pier-buttresses in the Minerva Medica and bath complexes of Rome "…contain[ed] the germ of the flying buttress, for almost all have an arched opening through them."[17] And so, flying buttresses at Constantia's Baths had developed as a matter of course, which gives credence to Karageorghis' interpretation of the archaeology. But could they date to a later period?

Without a doubt, the Grand Baths at Constantia were renovated several times after the 4th century. In 1957 the same excavators discovered an inscription associated with a final restoration above the tepidarium. It stated:

ΑΓΑΘΟΙΒΑΙCΛΕΙC ΕΥCΤΟΡΓΙC[TH]ΝΠΟΛΙΝΑΕΝ[ωCAN]

(…the Holy Emperors…out of love…the city restored…).

The wall inscription had collapsed with the vaulting into the tepidarium, which sealed coins within, dated to the middle of the 7th century. After some reflection, Megaw and Dikigoropoulos interpreted the "Holy Emperors" as Constans II and Constantine IV (joint reign 654–668).[18] This attribution is highly doubtful since the first Arab invasion of Cyprus occurred in 649 and the second one in 651, which led to occupation for three hundred years—so why would these emperors forego military aid, but fix the Baths?[19]

Instead I suggest that all the buttresses at Constantia were constructed prior to the Arab invasion but after Justinianic period. The massive pier-buttresses on the southern wall were constructed in the exact same manner as the flying buttresses. Their irregularity and experimental nature are actually quite different than the Constantinian-period buildings discussed above. In the Eastern Mediterranean, pier-buttresses become more common in succeeding generations, integral to the design of large semi-domes in basilicas, such as the late-5th c. St. Menas church near Alexandria (Egypt) and tetraconch structures, such as San Lorenzo at Milan and at Seleucia-Pieria (Syria).[20]

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[16] The Roman Coliseum and the Pantheon appear to have classical order on their facades, though they are built using brick, concrete, and round arches—techniques that has little dependence on classical Greek design.

[17] Aitchison 1893, 136.

[18] Dikigoropoulos 1961, 22-23; Megaw 1958, 31-32. Originally Megaw attributed this inscription to Emperor Justinian and Empress Theodora based on the "Titulature Inscription" from Chytroi which had similar epigraphy. He then suggested the regional earthquake of 528 as the catalyst for this later building phase at Constantia. He wrote (1957, 47), "In their last state the walls and vaulted roof of the tepidarium were likewise plastered and painted, but with simple geometric patterns…It seems reasonable to connect this inscription with the Byzantine restoration, of which the building of the tepidarium where it was found was one of the major undertakings…"

[19] In other words, it seems rather unlikely that the emperors would send money to repair a bath, while allowing the island to be pillaged and occupied by foreign troops, and counted as a tributary of the Caliphate of Damascus. All archaeological and textual evidence indicates imperial indifference to Cyprus at this time. Mitford and Nicolaou put it this way (1974, 6): "The lights already had gone out on the Cilician and Pamphylian coastlands as far west as Lesser Cibyra. That [Constantia]…sacked and its population massacred, should now indulge in a *floruit* is to us barely credible." For a thorough overview of the Arab occupation of Cyprus see Christides 2006.

[20] For the important role that the pier-buttresses played at San Lorenzo, see Kleinbauer 1976, 1-9; for the general discussion, see Krautheimer 1986, 110-112, 131, 137-138, 151. There is still no consensus if all aisled-tetraconch

Moreover, experimental buttressing in the Constantinan period became standard fare in Justinianic architecture. This is evident in the massive pier-buttresses around the domes of St. Sergius and Bacchus (536) (Fig. 11) and Hagia Sophia (532–7) in Constantinople. However Justinian had little interest in Cyprus. Rather the "Holy Emperors" mentioned in the inscription were almost certainly Heraclius and his son Constantine III who ruled jointed from 613–641.[21] So the date of the flying buttresses is best attributed to this timeframe.[22] As will be explained below, the renovation of the Grand Baths coincided with the renovation of its adjoining aqueduct.

Fig. 11: Sts. Sergius and Bacchus, Constantinople, ca. A.D. 536. External pier-buttresses for strengthening the internal vault.

Pointed Arches in Byzantine Constantia

The Grand Baths could only function if there was a steady supply of water to Constantia. While the island is surrounded by the sea, fresh water becomes scarce during the arid summer months. Therefore monumental aqueducts and reservoirs were necessary to sustain a thriving city. The

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buildings, such as Seleucia Pieria, were vaulted in stone (Kleinbauer 1973, 89; id. 1987, 280). In my opinion it seems that the entire point of the "double-shell" was to distribute the weight of roof to the columns beneath *and* the outer walls, indicating a substantial burden in the central space. The most monumental example of this type, San Lorenzo at Milan, was originally designed to carry brick or some other light-weight material.

[21] As mentioned in note 17 (above), Megaw (1957, 47) originally dated this inscription to Justinian I based on the "Titulature inscription" from Chytroi which he believed was also Justinianic. Mitford and Nicolaou (1974, 69-70) upheld this. However, Sodini (1973, 373-384) persuasively argued this inscription had to be later, and tentatively suggested Tiberius II (reigned A.D. 578–582). One weakness of Sodini's proposal, which he admits, was the fact that emperor's name was chiseled-out, which meant a *damnatio memoriae,* was issued. The only emperor who garnered such hostility was Phocas during the reign of the Emperor Heraclius (Ostrogorsky 1969, 85; Varner 2004, 8) or less likely, the Emperor Maurice (Efthymiadis 2011, 53).

[22] Dr. Karageorghis has kindly affirmed that his dating of the flying buttresses was open to an Early Byzantine date (Personal communication 2/30/11).

main aqueduct to Constantia spanned 25 miles northwest from the springs of Chytroi in the Kyrenian Mountains.[23] (Fig. 1)

Early surveys have found evidence that this Aqueduct branched out when it reached the city; one arm went north to the Baths, while another went south to the forum's main reservoir called "the Loutron".[24] Seven piers of the Aqueduct still stand above ground, the furthest about 2.3 km to the northwest of the city. (Figs.12-16) Fifteen more piers have been exposed over the last two years due to farming and road repairs. The westernmost section is the best preserved, displaying two intact pointed arches. By calculating the slope and distance between the other piers, we can assume that all the arches were pointed. In terms of measurements, the intact section stood about 7.5 meters in height; each base was roughly 2 meters square; from the base to the point of the arch was 3.2 meters in height; and the arches spanned 3.5 meters. The masonry consisted of local, irregularly-cut Cypriot limestone with a rubble core, mixed with tile fragments and burnt material.[25] Curiously, the masonry between arches and the channel consisted of smaller irregular stones laid in either two or three courses.

The Aqueduct had a very long history according to surviving inscriptions. One was found at Angastina, between Chytroi and Constantia, which commemorated the funds given by the Emperor Nero.[26] (Fig. 1) Another was found at Chytroi, which mentioned support by the Emperor Septimius Severus.[27] But perhaps the most important evidence comes from the imperial "Titulature Inscription" also found at Chytroi. It commemorates a considerable investment in the area of the Aqueduct. At some point, the Emperor's name was deliberately chiseled-out, which meant a *damnatio memoriae* was issued—most likely targeted at Phocas (reigned A.D. 602–610).[28] Such epigraphic evidence indicates that the Roman emperors had maintained the Chytroi-Constantia Aqueduct for about 600 years.

The Aqueduct, however, is far from the "typical" Roman examples in the region, such as at Caesarea Maritima in Palestine or Aspendos in southern Anatolia. The surviving sections near Constantia were built from scratch, showing no evidence of earlier foundations or spolia. Either

[23]Chytroi also held an important bishopric in the Byzantine period (Grégoire 1907, 209-212; Jenkins 1949, 267-275).
[24] Munro et al. 1891, 90-91, map.
[25] For the analysis of the water capacity in the Aqueduct, see Baur 1989, 208-211.
[26]Neronian inscription, see Nicolaou 1963, 48; *Supplementum Epigraphicum Graecum* 23 (1968), no. 675.
[27]Vessberg and Westholm 1956 17; Mitford 1980, 1323-4. Later in the Byzantine period, Procopius (*Buildings* V.ix.35-36, ed. Dewing 1940, 361) mentions τὸ πτωχεῖον τοῦ ἁγίου Κόνωνος. Τὸν ἀγωγὸν αὐτου ἀνενέωσεν ἐν Κύπρῳ (The Poor-House of St. Conôn; he renewed the aqueduct of the same in Cyprus). Some scholars (Hill 1940, 280) assumed this was located at Chytroi, though St. Conôn's cult was venerated 70 miles to the west on the Akamas Peninsula.
[28]See notes 17 and 20 above. Other inscriptions discovered within the Bath in 1958 mention a *hypatikos* and *consularis* named Ioannes who restored the sudatorium, which also refers to the Emperor Justinian. Mitford and Nicolaou (1974, 76) date this A.D. 542/3.

these pointed-arched sections replaced older areas of the Roman aqueduct or were built alongside it. But foundations of an earlier aqueduct have not yet been located.[29]

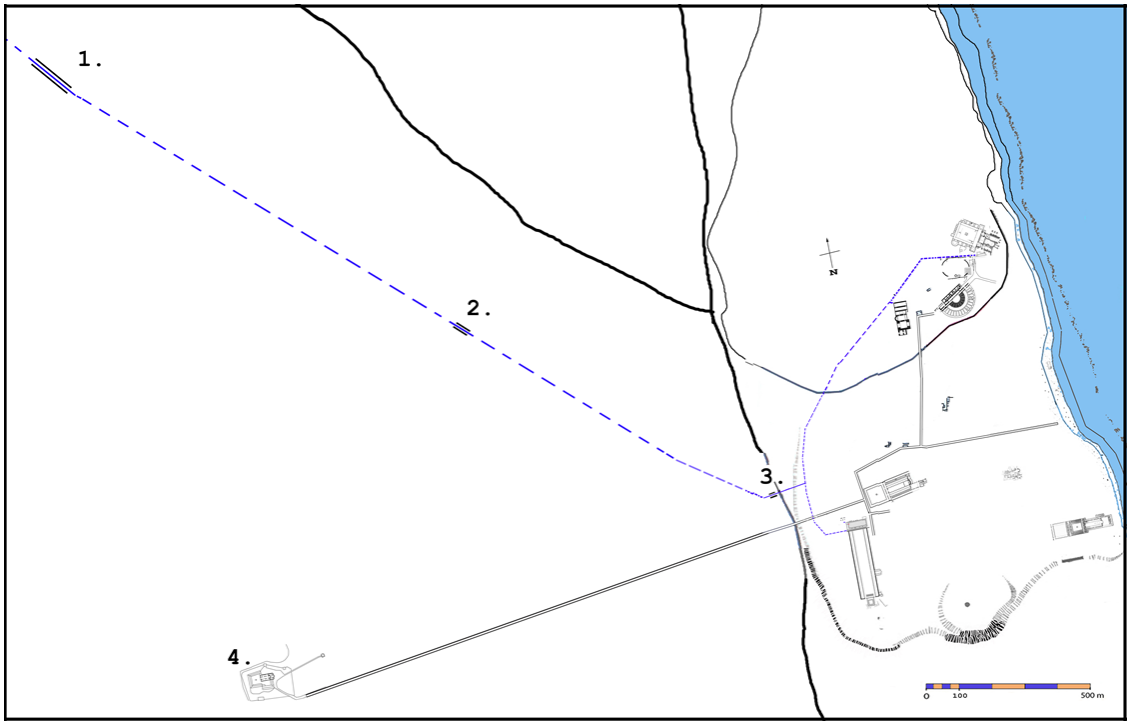

Fig. 12: Route of Aqueduct outside Constantia: 1. Remains of 18 piers and two arches; 2. Remains of two piers and partial arches; 3. Remains of two piers; 4. Monastery of St. Barnabas.

Fig. 13: Chytroi-Constantia Aqueduct (Photograph courtesy of Wilke Schram).

[29] According to Eugen Oberhummer (1931, 232), who conducted surveys around Chytroi, the aqueduct was "partly constructed above ground, and partly lying on the ground as a channel." Perhaps most of the older Roman aqueduct was at ground level and therefore, less conspicuous and easier to dismantle over the centuries.

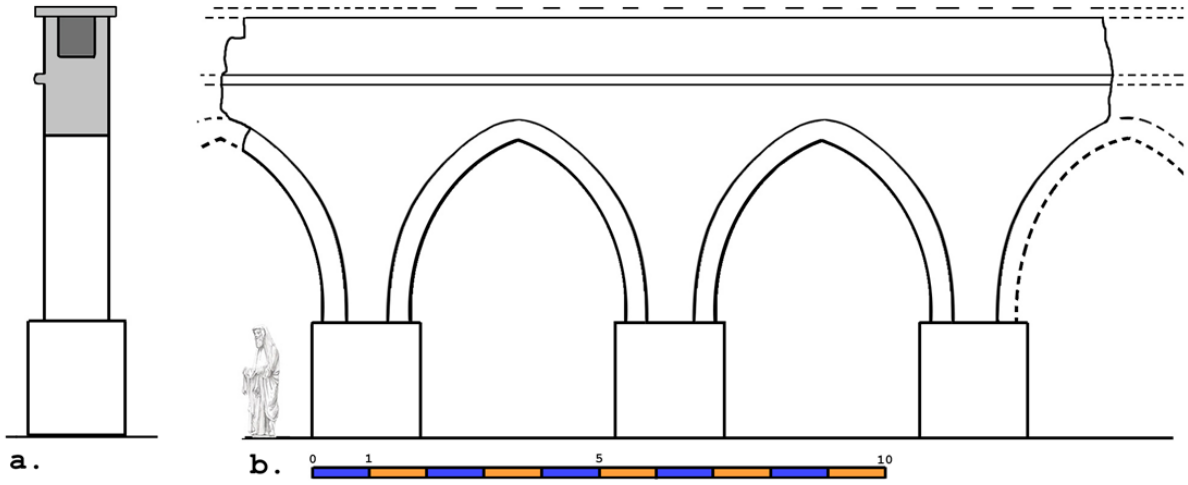

Fig. 14: Elevation of the Chytroi-Constantia Aqueduct: a. cross section; b. elevation.

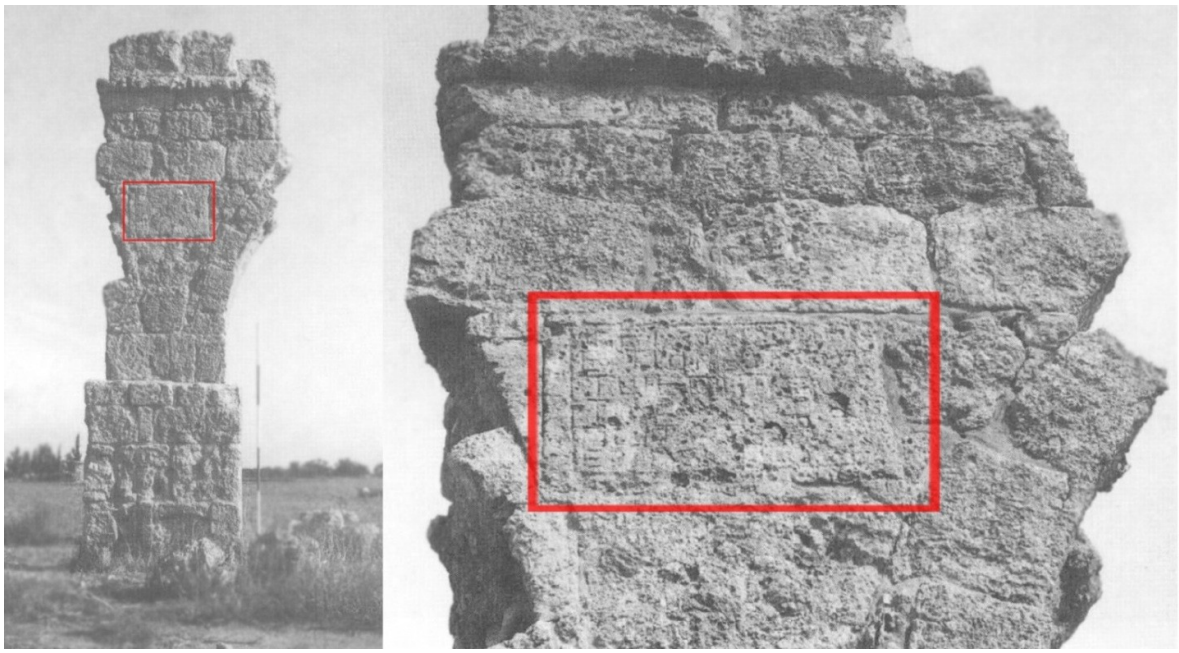

Fig. 15: Inscription (red highlight) on the Constantia Aqueduct. A.D. 619 (from Sodini 1998).

Fig. 16: Inscription (red highlight and insert) with the date A.D. 625 from the Chytroi-Constantia Aqueduct, in secondary use within the late-11th c. Panagia Theotokos Church at Trikomo.

Dating the Pointed Arches

On the surviving sections of the Aqueduct two inscriptions remain in the spandrels. The one illustrated here states: (Fig. 15)

✠ΕΓΕΝΕ[ΤΟΤΟ] ΕΡΓωΝΕ[ΚΤ]ΟΥΤωΕΠΙΠΛΟ[Υ]ΤΑΡΧ[ΟΥ]

Τω [Α]ΓΙωΤΑΤ[(ΟΥ) ΑΠΡΧΙ]ΕΠΙCΚ[ΟΠ]Ο[Υ] ✠

(✠ Erected were these, under Ploutarchos, the very holy Archbishop ✠)

Though these do not mention a date, six other aqueduct inscriptions survive with their indiction dates intact, and these have the same formula and style.

Professor Jean-Pierre Sodini has fully analyzed and published these inscriptions, so I will only briefly describe them here.[30] Three inscriptions mention Archbishop Ploutarchos, two mention the Archbishop Arcadios, and one mentions the Emperor Heraclius.[31] We can assume that the latter inscription was the last, since it contains the most information at the terminus:

✠Ε[ΓΕΝΟ]ΝΤΟCΥΝΘ[Ε]ω Κ[ΑΙ] ΑΥΤΑΙ Ε ΑΙΠΤΑ ΑΨΙΔΕC ΕΚ ΤΟΝ ΦΙΛΟΤΙΜΗΘΕΝΤωΝ ΠΑΡΑ ΦΛ(ΑΒΙΟΥ) ΗΡΑΚΛΙΟΥ ΤΟΥ ΘΕΟCΤΕΠΤΟΥ ΗΜΟΝ ΔΕCΠΟΤΟΥ ΑΠΟ ΤΟΥ ΙΠΠΟΔΡΟΜΟΥ. ΜΗ(ΝΟΣ) ς'Ιδ✠

(✠ Were made, with the help of God, these seven arches, also thanks to generosity of Fl(avius) Heraclius, our ruler crowned by God, from the hippodrome the sixth month, 4th indiction✠)

According to Sodini, these inscriptions can be dated as follows: Ploutarchos was responsible for portions of the Aqueduct built between 619 and 625; he was succeeded by Arcadios who constructed the final arches to Constantia; and lastly, Heraclius was credited for its completion in 631.

Because we have dates and fixed distances, calculation of the construction rate is possible. It took about twelve years to build the last 2.3 km of the Aqueduct. That seems rather slow. If the Aqueduct was built from scratch beginning at Chytroi, using the same work rate, then the entire project would have spanned 208 years. However, the inscriptions provide us a second set of information we need to consider: the final portion was completed in phases, with some inscriptions specifically marking out the number of arches built at each stage. These mention 5, 3, 10, and 7 arches. Therefore, none of the phases were consistent in duration or output; the workers' productivity was affected by external factors, such as the availability of local and imperial funds, and these fluctuated widely. Nevertheless, we can assume that the project started either in the late 6th century or in the early seventh at Chytroi, as indicated by the "Titular Inscription."

It should be stressed that the two inscriptions on the standing Aqueduct are contemporaneous with the pointed arches. As Sodini observed, it is highly unlikely that these inscriptions were reused in a secondary context, since 1.5 km separate them and yet they appear exactly the same way. That is, both inscriptions in the center of the spandrels, between voussoirs at the same level,

[30]Sodini 1970, 477-486; 1998, 619-634; see also the analysis of Denis Feissel, in Pouilloux et al. 1987, 83-85; Mitford 1950, 128-132.

[31]Sodini 1998, 633. While no Byzantine source records the Archbishop Ploutarchos, the early 7th c. Archbishop Arcadios was mentioned by John, Bishop of Nikiu (Egypt) in his *Chronicle* 120.64 (ed. Charles 1916, 190) and the Syrian Bishop, George of Reshaina, *Syriac Life of Maximus the Confessor* (ed. Brock 1973, 315–7).

and on the same side, below the molding marking the bottom of the water channel.[32] They appear to have been carved in situ after the arches was erected since some of the letters mark the adjacent ashlars. And besides, the masonry is uniform indicating no later repair or intervention.[33] By 1100 the Aqueduct was no longer in use, since its ashlars were mined by the builders of the nearby Panagia Theotokos Church at Trikomo.[34] (Fig. 1 and 16)

Why Pointed Arches?

Round arches had a long history in the Roman monuments of Cyprus. What would prompt Cypriot builders to break from this tradition? While any answer is speculative, there is enough data to provide a reasonable hypothesis. Cypriot engineers and architects were confronted with considerable problems. They were commissioned to rebuild an ancient aqueduct in a piecemeal fashion. Funding was erratic. Without an imperial garrison, the builders were drawn from the local population. So we can assume that they were less disciplined and experienced. Construction would start and stop over several years, if not decades. These conditions made traditional Roman building practices difficult. An aqueduct can only function if there is a constant slope from its tallest point to its lowest. Because months or years separated each phase, the Cypriot builders had the difficult task to recalculate the slope anew, and then design each section accordingly to match the previous work.

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[32]Sodini 1998, 623. In comparison, the Trajanic inscriptions at the Caesarea Maritima (Israel) aqueduct are located in the same areas of between the spandrels below the water channel molding. They mention the Tenth Legion as its builders.

[33] Though the Byzantine dating of the Aqueduct is straightforward, some prominent publications have described them as Gothic. This idea was first propounded by Camille Enlart (1899, 514), who assumed that pointed arches were a distinctly French invention. Though his scholarship was pioneering, Enlart's theories were colored by his slight nationalistic tendencies (Coldstream 1987, 3-4). And so he hypothesized that the Greek inscriptions were reused, when the Aqueduct was rebuilt with the pointed arches in the Gothic period (13th or 14th century). He imagined that the Crusaders rerouted it to the relatively new city of Famagusta. Famagusta is located five miles south of Constantia and by the thirteenth century, the former city had eclipsed the latter. It should be mentioned that even earlier, the 18th c. writer, Richard Pococke, categorized the Aqueduct as "Gothic" (Cobham 1908, 256). But Enlart's assessment had more influence on scholars; for example that hypothesis was republished by the art historian Rupert Gunnis and, rather surprisingly, by archaeologist G.R.H. Wright (Gunnis 1936, 420; Wright 1992, 233). However, most archaeologists to reject Enlart's theory, since Famagusta never had an aqueduct, as exhibited by its archaeological remains (Oberhummer 1903, 232; Jeffery 1918, 233; Chrysos 1993, 9; Megaw 1986, 508 note 17). In addition, there are no Gothic arches in Cyprus designed with the same curvature as those found on the Aqueduct. By the time Famagusta became a major city, Constantia was all but abandoned. In 1989 A. Baur published an important analysis of the Aqueduct, but further confused the issue. He provided (1989, 209) an elevation which depicted it employing "lancet arches" common to 14th c. Gothic buildings (compare Baur's Bild 4 with my Fig. 15). His illustration was dramatically different than the actual monument. It seems that Baur made the honest mistake of measuring from the ground to the rise which was 5 meters, and then he added the base's height again to the total height—this distorted the elevation by about two meters. Baur shows the total height of the Aqueduct at this point being 9.10 m; instead it is actually about 7.5 m tall. Moreover, his thick black outlines further narrowed the arcades, conveying an acute Gothic appearance. Nevertheless, he suggested that the pointed arches were categorically Byzantine.

[34] This church has well preserved frescos which are reliably dated to the early 12th century (Winfield 1972, 285-291). Therefore the structure was built sometime earlier.

Traditionally the Roman aqueduct employed round arches.[35] These arches were preferred because of their regularity: the width of the arch is consistently twice its height. Both imposts must be level, that is, parallel with each other to maintain balance. (Fig. 17 a-b) A horizontal arcade with these constant proportions is aesthetically pleasing because it has monophonic rhythm. However, with sloping aqueducts, this rhythm was not easy to achieve. Aqueducts use the natural slope of the ground, which meant that their arcades' height could only be controlled by having different impost levels for each arch; likewise if the span varied from arch to arch, so would the height of the rise (i.e. the bottom of the keystone). (Fig. 17c1) Therefore, each span, pier, and impost required precise calculation and, in turn, precise stone dressing, since each courses' height contributed the slope above. These factors are clearly illustrated at the Trajanic aqueduct at Caesarea Maritima (Israel), where span variation led to changes of impost, springer, and rise height. To compensate, secondary imposts were added which were diagonal; in some cases, a catenary arch was employed where the span was shorter. (Fig. 18) In contrast, the Cypriot master-builders realized that the pointed arch would free them from these constraints.

By using the pointed arch, Cypriot workers could build more efficiently and rapidly, with little peremptory guidance. This was achieved in four ways. First, slight irregularities in pier spacing and springer levels would not affect the slope above, and so proportions could be estimated rather than precisely measured. (Fig.17 c2) Second, the pier bases supported the centering for the arches, minimizing amount of wood needed. Third, the arches could spring directly from the pier bases, since each arches' height was not determined by the width, as in round arches. Fourth, the calculation of the water channel's slope could be determined *after* the pointed arch was already in place, which was easier to measure at this point than at ground level. That is why the masonry above the keystones varies in size and number of courses; this was where all the adjustments were made for the slope. These four advantages would allow construction to continue, even if months or years separated each phase.

How did the Cypriot architects arrive at this novel solution? I can imagine a frustrated draftsman realizing the constraints of the round arch while calculating the Aqueduct's slope. A compass makes drafting round arches effortless when working with right angles, and horizontal ground and roof levels, since all the arch dimensions repeat. In contrast, drafting an aqueduct's arcade, with variable slopes and ground levels, necessitates calculating each arch's impost level separately. The rigidity of the compass on a blueprint leaves no room for miscalculation in the actual construction process. By abandoning the compass, the pointed arch suddenly emerges as the only practical alternative. (Fig. 17 c2)

[35]Hodge 2002, 93 ff.

Pointed Arches in the Cistern

Most of the water from the Chytroi-Constantia Aqueduct was stored in the city's main cistern, the so-called "Loutron" (also known as the "Vouta").[36] It was the Forum's aesthetic centerpiece, serving as the pendant to the former Temple of Zeus which was converted into a church by the Early Byzantine period.[37] (Fig. 1, no. 12 and 15) The Loutron would be the largest vaulted interior space in Byzantine Cyprus; in 1394 Nicholai Martini stood amidst its ruins and exclaimed "an ancient cistern…no bigger one I think is found in the world."[38]

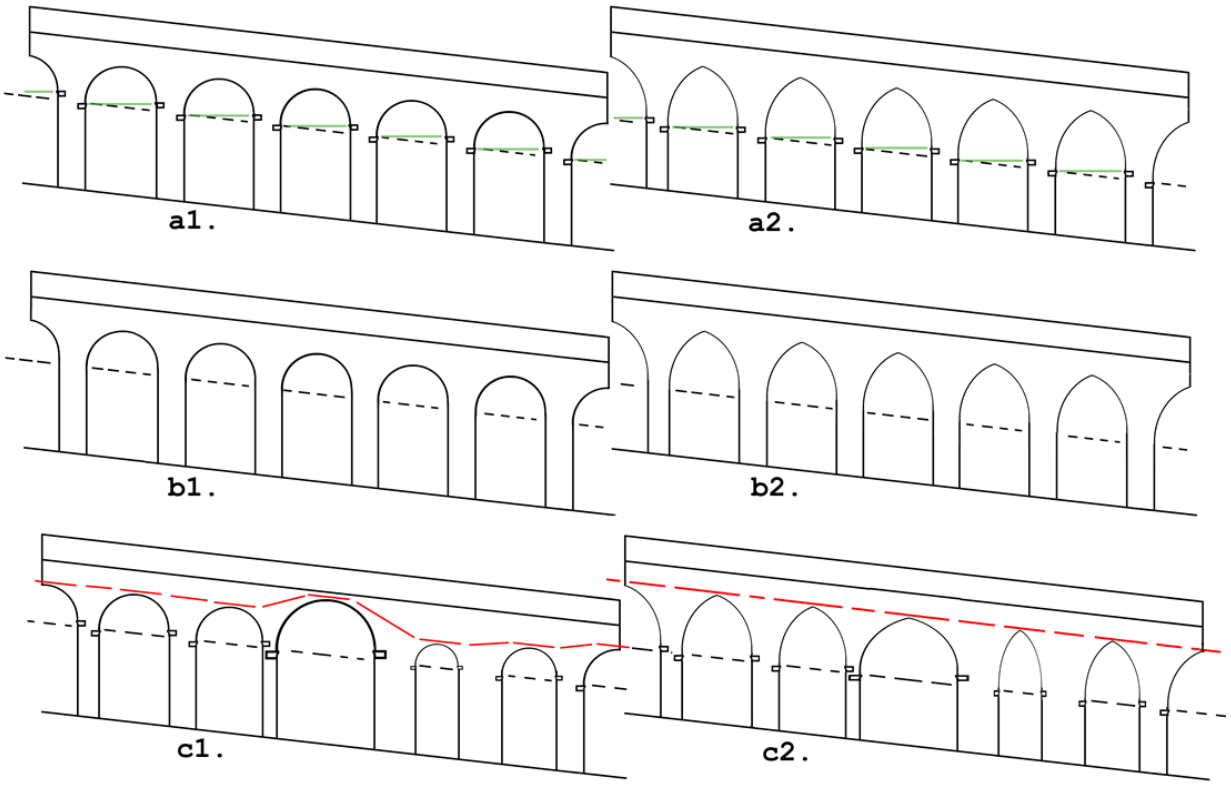

Fig. 17: Diagram comparing round and pointed arches on an aqueduct with a 7° slope; dash line represents the slope of the impost level; (a.) ideal plan with consistent pier width and span; imposts are level (indicated in green); (b.) with imports hidden b2 appears more proportional than b1; (c.) hypothetical example of an aqueduct with variable pier and span lengths but maintaining consistent impost height; c1 shows how round arches would lead to variable rise height (indicated in red); c2. shows how pointed arches on the same foundations could still achieve a consistent rise height.

[36] Mitford 1950, 122 note 2.
[37] Argoud et al. 1975, 140-141.
[38] Cobham 1908, 25.

Fig. 18: Aqueduct at Caesarea Maritima (Israel) renovated by the Tenth Legion of Trajan.

Fig. 19: The Loutron at Constantia. View towards the east.

It held up to 3,860 m^3 of water, serving a population of 120, 000.[39] The Loutron is also important because it was one of the earliest buildings to carry groin-vaulted bays with pointed arches.

All four sides of the Loutron's superstructure are intact up to the vaulting.[40] (Fig. 19) Its ceiling was supported by 36 piers and three responds, forming 52 bays.[41](Fig. 20 c.) The groin-vaults consisted of local ashlars which sprung from corbels along the wall. (Fig. 21) Transverse arches connected each pier—similar to the arrangement at the Basilica Cistern in Constantinople. But unlike Basilica Cistern, the Loutron was entirely above ground, which meant that the walls needed to be massive; the thickest section of the wall is about 4.5 m wide. Additional support came from three pier-buttresses which were part of the original design. The southern piers were decorated with engaged columns at their corners capped with a simplified Corinthian capital. (Fig. 22)

The Loutron's shape is highly irregular for such a large vaulted building. This caused much perplexity for the excavators who wrote:

> The north wall is especially irregular…I could find no reason for it. The remaining arches…form this point to the N.E. corner are different in character, resting on real corbels which have greater projection; those toward the western spring almost directly from the wall. Corresponding to the irregularity in the thickness of the walls, there is a difference in structure.[42]

and

> Irregularities in the structure have been remarked at every turn…there is one feature in the Loutron which can hardly be original to the first plan—I mean the deflection of the north wall. Moreover, this deflection corresponds, as has been seen, with a difference in the springing of the vaults—a difference which divides the building into two parts, of which the one is represented by the westward two-thirds of the north wall together with perhaps the western end, the other by the remainder of the building.[43]

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[39] Hill 1940, 242. The population of Constantia could have been much larger since there were other sources of water nearby, such as the Pedeios River. This was the longest river on Cyprus (110 km) and its delta formed the southern boundary of Constantia.

[40] A. Baur (1989, Bild 9) erroneously reconstructed the Loutron with nine barrel-vaults running in the north-south direction, like the first-century Grand Cistern at Bordj Djedid (Carthage, Tunisia). He explains: "Daraus kann geschlossen werden, dass Bogenreihen die Decke zu tragen hatten, welche wohl aus querlaufenden Tonnengewölben bestanden hat"; 1989, 214.

[41] G.R.H Wright records that it had "vaulted roofing carried on 39 piers and 12 responds"; 1992, 154. This is incorrect.

[42] Munro et al. 1891, 83.

[43] Ibid. 89.

The northern wall's deflection meant that the bays would be rectangular rather than square. If round arches were employed, the imposts would be carried at different levels. But this was not the case, since all four walls preserve the corbels displaying the same level. The excavators realized this, but assumed that this adjustment was compensated by having the corbels partially embedded in the north wall. However, from my calculations, the nine westernmost bays along the northern wall would still have been rectangular (about 2.8 m by 2 m). Moreover, as the excavators observed: "The vaulting springs from corbels…these do not always present a straight line, nor are the corbels of the north and south walls always directly opposite one another."[44] It seems to me that the only way to preserve the integrity of the vaulting was to use catenary arches throughout, and especially pointed transverse arches in the rectangular bays. (Fig. 20b)

Unlike the Baths and Aqueduct, the Loutron did not contain any inscriptions, and so its dating is more relative. Since the Chytroi-Constantia Aqueduct spans a 600-year period, archaeologists have assumed the same for this grand cistern. The excavators identified four distinct building phases: the original phase belonged to the 2nd century while the last rebuilding was Byzantine.[45] There are actually many more breaks in the masonry that implies several other restorations. But for the purposes of this chapter, I will discuss the final two phases. While the wall foundations are probably Roman, the piers and groin-vaulting belong to the final renovation—mostly likely dating to the sixth century or seventh century.

There are several reasons why we should reject a Roman date for the Loutron's vaulting as it currently stands. First, the excavators published a drawing showing that the Loutron was built using pseudo-isodomic masonry and segmental arches—these are particularly Roman features. (Fig. 23) This has led some scholars to assume a Roman date. However the drawing is erroneous, since nowhere in the structure are there such well-organized courses or these kinds of arches. Second, the use of massive buttresses was integral to the design of the structure, and these come into fashion no earlier than the Constantinian period (as discussed above). Third, between the corbels and the lower wall there is a distinct break in masonry style. (Fig. 24) The upper courses contain smaller, more irregularly carved ashlars. This would indicate that vaulting was reconstructed sometime after the original foundations were laid.

In comparison with known Roman period cisterns, the Loutron is quite different in design and construction. Roman builders preferred reservoirs designed with walls perpendicular to each other, covered by barrel-vaults.[46] In contrast to cisterns of the previous periods, the Byzantine groin-vaulted structures at Constantinople, as the Philoxenos and Theodosius cisterns, provide better comparanda with the Loutron. And an even closer parallel is found further east. The aboveground reservoir at Tiberias, Israel, is built on a trapezial plan, causing its 114 bays to be

[44] Ibid. 86.
[45] Ibid. 89-91; i.e. "later city…Constantia" means "Byzantine."
[46] The Roman cisterns that come to mind are Piscina Mirabilis (Bacoli, Italy), Aïn Mizeb and Aïn El Hammam (Thugga, Tunisia), and Aptera (Crete). The groin-vaulted cisterns at Alexandria (Egypt), as the El-Nabih, are currently inaccessible and cannot be reliably dated without an archaeological survey.

highly irregular. (Fig. 25) It was probably also rebuilt, with the nearby aqueduct in the 7th century, and continued to be used into the Umayyad period.[47] Its groin vaults had to have been supported by either catenary or pointed arches.

The Loutron's final renovation most likely took place when the Grand Baths and Aqueduct were reconstructed. At that time, a new vaulted corridor was constructed which concealed the ornamental piers on the southern wall. (Fig. 20, in purple) Apparently, this area was modified to facilitate water filtration as indicated by the apertures in the wall. (Fig. 26) At the same time, the north wall was reconstructed with a deflection, which compromised the integrity of the vaults. To further strengthen the vaults, five additional pier-buttresses were placed on its exterior—just like those at the Baths.[48] During this final phase, the pointed arch was employed within the Loutron.

Historical Context

Renovation of these waterworks should be understood within its economic and historical context. We can assume that such engineering projects depended on a steady stream of capital, achieved by in the city's population growth, episcopal support, and imperial investment. Regarding population growth, Cyprus was the destination for waves of Palestinian and Egyptian refugee fleeing Persian armies, respectively between A.D. 614–629 and 618–621.[49] It is possible that these new populations contributed by their tithes or taxes, or even influenced how these structures were engineered.

Regarding imperial investment, the Emperor Heraclius established an imperial mint at Constantia in 608.[50] Coincidentally in the first half of the 7th century there was a steep increase in gold coins on Cyprus, as recorded by excavation.[51] This indicates a particularly imperial interest in the island, since the gold solidus was used for official business such as public constructions or financing troops. As Constantius II saw Cyprus as a strategic region, so Heraclius too utilized the island to support his Persian campaigns. Moreover, on his march to become emperor in 608, Heraclius seems to have traveled from Egypt through the island, finding ready supporters to join his cause on to Constantinople.[52] If this was the case, then he would have believed the Cypriots were his close allies. Later, when he attempted to solve the Monophysitism problem, he personally asked the Archbishop of Cyprus, Arcadios, to implement a compromise formula

[47]Zalman Winogradov (2002, 306) wrote: "Most of the installations connected with the [Tiberias] aqueduct saw their chief use in the Byzantine and Early Arab periods…It seems that it was reconstructed in the 7th c. Perhaps its [original] construction is to be placed somewhere in the 3rd or 4th c.
[48] These buttresses were called "spurs" by the excavators (Munro et al. 1891, 86).
[49]Regarding Byzantine Palestinians fleeing to Cyprus, see Kyrris 1993, 203-235; for Egyptian refugees, see Leontius of Neapolis, *Vita S. Johannis Ellemosynarii*, ed. Festugière, and Rydén 1974.
[50] Grierson 1992, 41; Metcalf 2009, 143ff.
[51] Metcalf 2009, 151-155.
[52] For another perspective, see the discussion in Kaegi 2003, 47-48.

known as Monotheletism in 626.[53] Perhaps imperial funds for the Aqueduct became an incentive for cooperation. Nevertheless, Cyprus became a test case for this new doctrine. And apparently, there was some success, since in 638 Heraclius imposed Monotheletism on the whole Empire.

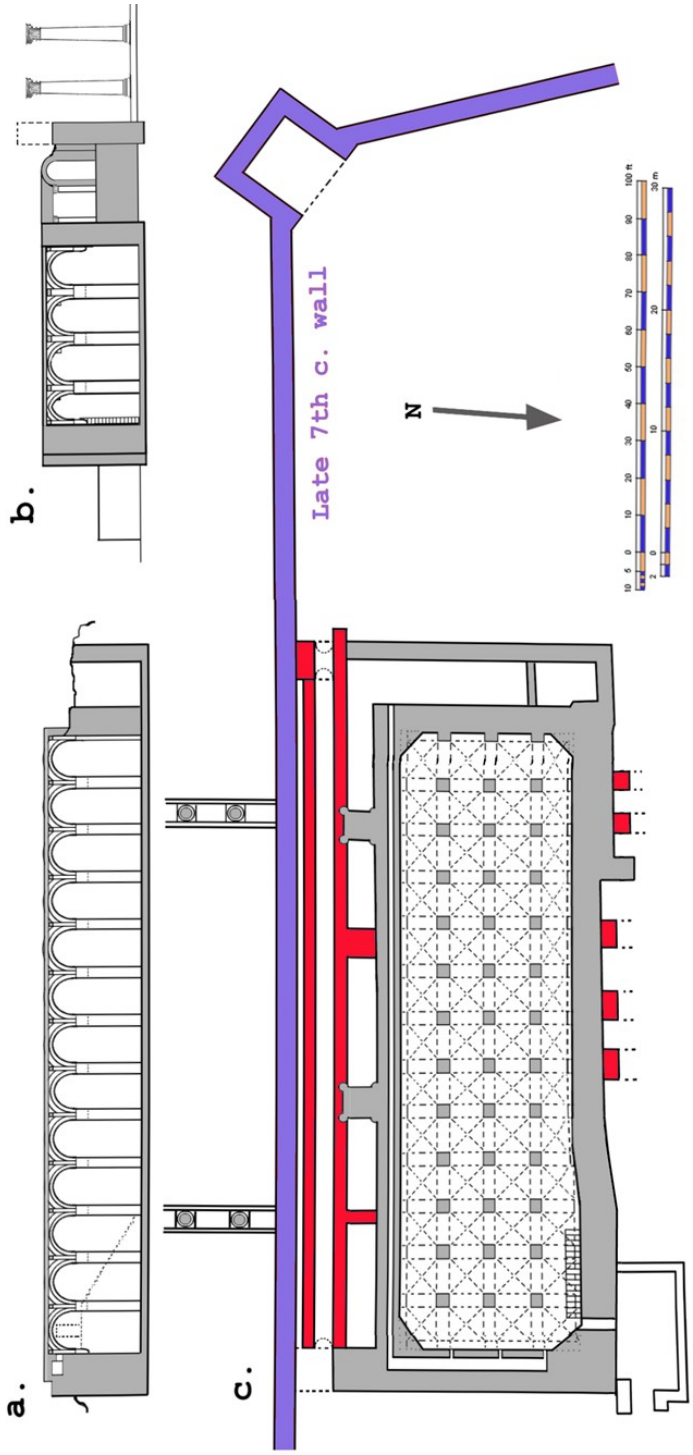

Fig. 20: The Loutron at Constantia; a. North-South Elevation; b. East-West Elevation; c. ground plan (Sketch redrawn based on Munro et al. 1890, PL 7). Key: Grey = 6th c. rebuilding; Red = early 7th century renovation; Purple = late 7th c.

[53]Brock 1973, 315–7. A letter dated A.D. 625 from Sergius, Patriarch of Constantinople, to Bishop Cyrus of Phasis (Georgia) survived mentioning Arcadios' role in the implementation of Monotheletism. This is quoted in the 12th session of the 3rd Council of Constantinople in 680 (CPG 7604, ed. Geerard and Glorie 1974-2003).

But then in 643 an ecumenical synod was held at Constantia, which included papal legates and the Patriarch of Constantinople, resulting in a condemnation of Monotheletism—much to the chagrin of the Emperor.[54]

Fig. 21: The Loutron at Constantia. Remains of the south wall interior, exhibiting corbels and vault arches.

Fig. 22: The Loutron at Constantia. South wall exterior. Corner of pier buttress decorated with an engaged column decorated with a simplified Corinthian capital.

[54] Krueger 1996, 12-14.

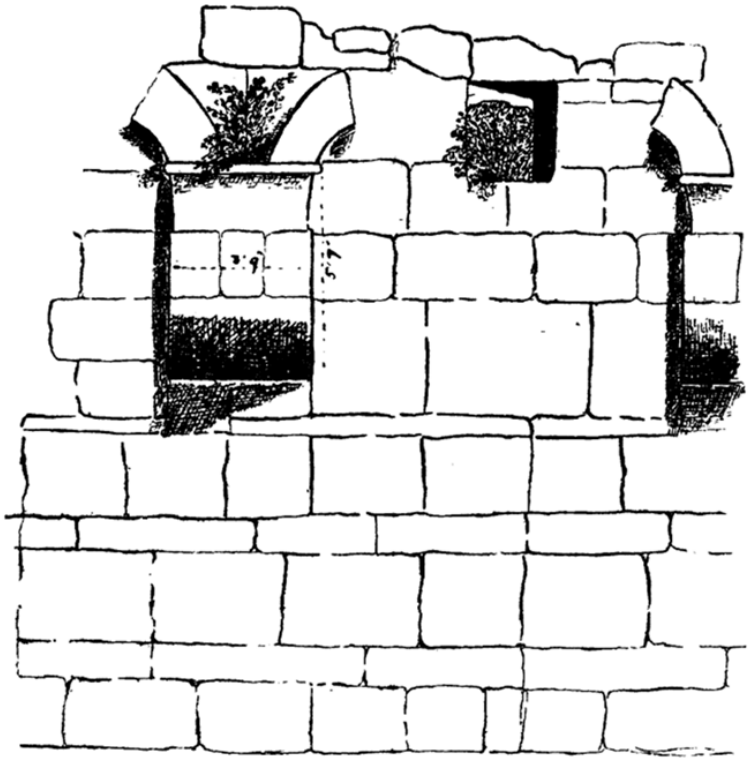

Fig. 23: The Loutron at Constantia. Drawing showing the vault corbels (from Munro et al. 1891, 87).

Fig. 24: The Loutron at Constantia. South wall interior. White arrows indicate break in construction.

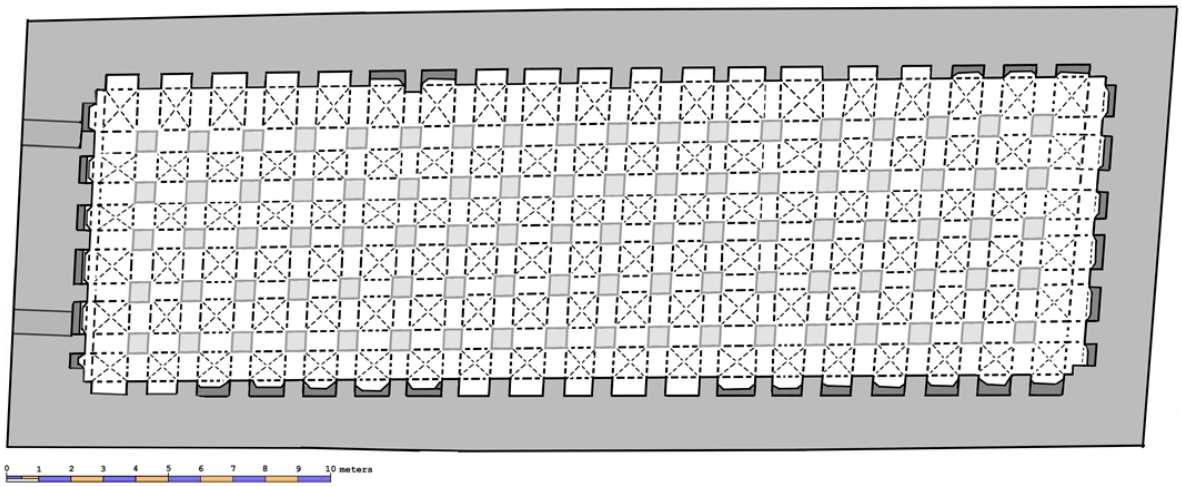

Fig. 25: Hypothetical support system of the urban reservoir at Tiberias, Israel. 6th-7th century (based on plan from Winogradov 2002)

Fig. 26: The Loutron at Constantia. South wall exterior. Area between pier buttresses showing perforations in the wall to allow water flow, perhaps used as a filter.

A New Byzantine Architectural Style?

Heraclius was the next great Byzantine emperor to arise after Justinian I. He had the charisma and intelligence that brought about economic reform and territorial recovery. Though we do not have a complete picture, scholarship in the past thirty years has provided us a glimpse of artistic renewal at the time.[55] And so, is it possible that the next great phase of architectural progress took place under Heraclius? Or in other words, do the flying buttresses and pointed arches at Constantia represent a new direction for Byzantine architecture?

The flying buttresses at Constantia were transitional forms. In the history of development, they lie between massive pier-buttresses and the fully-developed flying buttresses at Hagia Sophia. As discussed above, the use of external pier-buttresses in Constantinian architecture led to a significant shift towards "interiority"—focusing on lofty vaulted interiors with less emphasis on the facade. The next great development took place in the Justinianic Period, which fully realized the use of the buttress and arch. At Hagia Sophia, massive piers rose up on the south and north walls, which were crucial for channeling the weight of the central dome to the outer walls—this was an architectural first.[56] This brings to mind Hans Sedlmayr's theory of medieval "double-shell" design, though slightly modified. Justinianic architecture was conceived with small arches within larger arches, in a literal "overarching" fashion (*übergreifende*). Beyond the aesthetics of self-similarity, this interdependence of visible (*anschaubar*) inner arches and piers, supported by unseen external arches or piers, harnessed the full potential of stone engineering.[57] Once this was realized, the flying buttress would eventually emerge as a natural development.

Because of their early date, the Cypriot examples may shed some light on similar, but undated Byzantine structures. In A.D. 545 San Vitale at Ravenna was designed as a double-shell structure with pier-buttresses at its exterior corners. At a later date, the two northern piers were deemed insufficient, and so flyers were built against them. (Figs. 27–28) They are strikingly similar to those at the Constantia, in that they also rise at a 30 degree angle from ground level, like a ramp. Since there are no visible cracks in San Vitale's masonry, these flyers were built as a preventative, rather than remedial measure.

San Vitale has a long history with many renovation phases. These are difficult to date since brick was used in this region ever since the Byzantine period. Giuseppe Gerola found evidence that the original church was designed with wooden floors and roofs in the ambulatory and gallery level.

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[55] For general histories that describe the economic reforms, see Haldon 1990 and Kaegi 2003. For a general survey of the renewal of culture, see Reinink and Stolte 2002; for renewal of literature, see Pertusi 1959; for the flourishing of art, e.g. David Plates from Cyprus, and the Joshua Roll, see Leader 2000, 407-427; Henri Gregoire via Schapiro 1949, 66 note 49.

[56] Robert Mark (1990, 85-89) has argued that the massive pier buttresses were ineffective. However, his critique is directed at the materials—brick and thick mortar—rather than the "elegant" design. And besides, the structure has stood firm, more or less, after 1400 years on an active earthquake zone, which is an unparalleled achievement. I find it interesting that at the top of these massive piers are barrel-vaulted chambers which function like the pinnacles on Gothic flying buttresses.

[57] Gerola 1959, 87ff., 99.

He then theorized that sometime between 1000 and 1150 these areas were replaced by brick groin vaults, and assumed that the flying buttresses were used to strengthen these vaults a few years later.[58] However, this is not necessarily so. The flying buttresses could date well before the ambulatory vaulting, since they give no support to them; but rather, they function solely to brace the original pier-buttresses, which continued to support the central vault. That is why the flying buttresses engage areas of the pier in different places, unrelated to the vaulting levels on the other side. Moreover, if Gerola was correct that these later vaults needed strengthening, then such remedial measures would have been placed in the weakest areas *between* the piers, where the masonry is 60% thinner.

Fig. 27: St.Vitale, Ravenna (Italy). A.D. 546–8. Original external pier-buttresses for supporting the internal vault. Later flyers were constructed to further strengthen the pier-buttresses.

[58]Gerola 1913, 427-34, 459-71; id. 1915-16, 827-839. See also Deichmann 1976, vol. 2 part 2, 51.

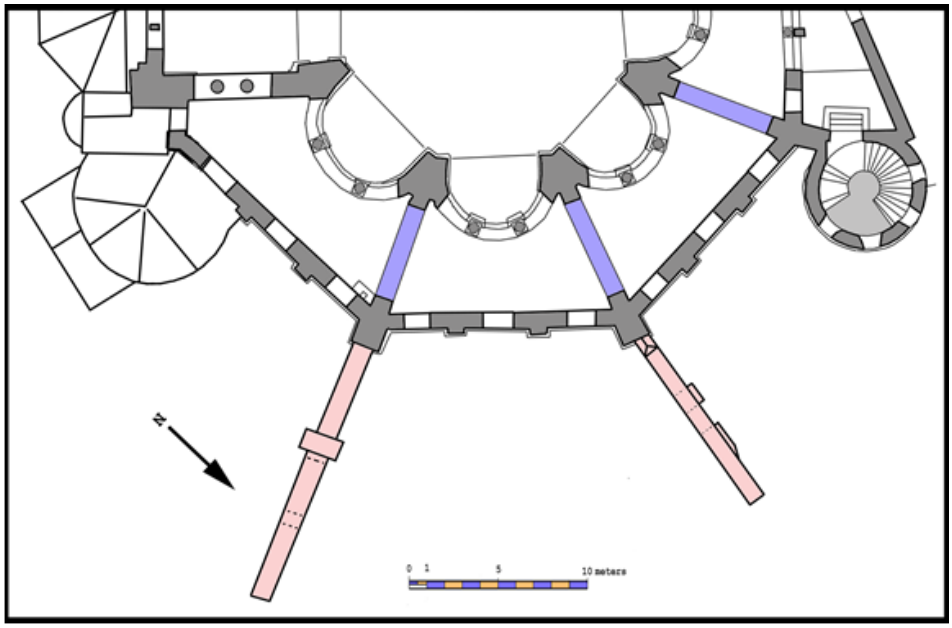

Fig. 28: St.Vitale, Ravenna (Italy). Ground plan: Flying Buttresses highlighted in pink. Transverse arches in light blue (redrawn based on survey by Deichmann 1976).

Fig. 29: Hagia Sophia at Constantinople. Elevation. Flying Buttresses highlighted in pink (redrawn based on survey by R. Van Nice 1995).

Did the western master-builders at San Vitale learn of the flying buttress from their eastern colleagues? Naturally, the prominent examples at Hagia Sophia come to mind. Rowland Mainstone suggested that three sets of Hagia Sophia's flying buttresses could date as early as the 9th and 10th century.[59] These were located in the center of the north, south, and west walls at the gallery level. (Fig. 29) More recently, Professor Slobodan Ćurčić has persuasively provided further evidence that strengthens the Byzantine provenance for their origins, citing additional examples such as the Rotunda of St. George (Thessaloniki) and Christ of the Chalke Church (Constantinople).[60] His underlining argument is crucial: all these monuments, which I would include San Vitale, have flying buttresses that do not resemble Gothic flyers in their construction, design, and overall style.[61]

Fig. 30: Pool of Bethseda, underneath the Byzantine Church, immediately north of the Temple Mount (Jerusalem).

[59] Mainstone 1988, 102-105. The larger, more massive buttresses on the east side of Hagia Sophia are additions sponsored by Emperor Andronikos II Palaeologos (reigned 1282–1328).
[60] Matschke 2001, 322 and Ćurčić 2004, 7-22.
[61] Two other examples should be mentioned. Three buttresses at Hosios Loukas monastery date to a period much later that the adjoining 11th century katholicon, but perhaps before the Late Byzantine Period. In Cyprus, the Panagia Phorbiotissa (Asinou) has a flying buttress, which I tentatively date to the 12th century.

Fig. 31: Smyrna Aqueduct (Turkey). Roman Foundations with Byzantine renovations.

Regarding the wider implications of Byzantine pointed arches, they were less common in areas around Constantinople and the Aegean. Byzantine monuments of Syria, however, began to exhibit catenary and pointed arches in the mid-6th century, such as at Qasr-Ibn-Warden.[62] And in Palestine, there are many examples of pointed arches used in Byzantine waterworks, such as those found in the Byzantine church over the Pool of Bethesda (Jerusalem) (Fig. 30) and the Emmaus reservoir.[63] Yizhar Hirschfeld, the excavator of the latter, writes:

> The pointed arch and vault used here are noteworthy. Vaulted arches are often thought to have originated in N Syria at the end of the Byzantine period, and to have spread in Umayyad Architecture… The pointed arch at Emmaus is certainly earlier but may be explained from a technical standpoint, since a pointed arch ensures a greater stability than the normal 'semicircular' Roman arch. The local engineer at Emmaus seems to have been aware of the technical advantages of the pointed arch to support masses of earth above an underground structure, and its use is comparable to various innovative building techniques found in Roman brides and aqueducts. The difference, then, is that the Syrian examples are decorative and above ground.

[62]Sodini 1998, 623; Krautheimer 1986, 248.
[63] For Bethesda, see Rousée 1962, 107-109; for Emmaus, see Hirschfeld 2002, 187-188.

This assessment is important, since it can also be applied to Cyprus' waterworks.

The existence of pointed arches on Chytroi-Constantia Aqueduct may prompt a reassessment of other structures. For example, the aqueducts at Smyrna (Izmir, Turkey, Fig. 31) or Skopje (Macedonia) have always seemed to fit within a "Byzantine" timeframe due to their construction method and geographical context, but their pointed arches often led to Ottoman attributions. Perhaps they are Byzantine after all. In terms of architectural history, it seems that once pointed arches were accepted, it would be just a matter of time that their technical advantages would be realized in other kinds of buildings, such as fortifications and churches.[64] As mentioned above, the reservoir at Tiberias, Israel, was covered in pointed arches; nearby at Mt. Berenice, excavations also uncovered one of the earliest basilicas that employed pointed arches in its arcades. And so, at Tiberias, the aesthetic arose from practical.[65]

At this point in our discussion, the general development of cultural and architectural history becomes intertwined. Waterworks were transitional structures that eased the shift from classical ideals to medieval practices. The pagan public only experienced their temples from outside, and so the classical order was essentially an exterior aesthetic. In Late Antiquity, unclassical forms were allowed for public waterworks. In time, the growing Christian public would accept these new forms for their churches, distinguishing them from the pagan sanctuaries. Unlike pagans, Christians experienced their worship from within, naturally moving towards the "interiority" concept. This coincides with the dominant philosophy at the time, Neoplatonism, in which the inner soul was emphasized over the external body.[66] A mystical understanding of church architecture developed during the reign of Heraclius, and was directly undergirded by Neoplatonic concepts.[67]

Architectural renewal under Heraclius, however, is difficult to ascertain. With the defeat of the Persians and the recovery of Holy Land, perhaps the Empire was on the threshold of a "Golden Age." The beautiful Golden Gate at Jerusalem might be representative of the kind of grand

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[64] Regarding pointed arches in Middle Byzantine architecture on Cyprus, see Stewart (forthcoming), Chapter 8.

[65] Hirschfeld 2004, 75-134. It is unclear from the excavation report if these pointed arches are Byzantine or date from the Abbasid rebuilding. Moreover, the earliest surviving Islamic monuments with pointed arches were also waterworks, like the baths at Hammam as-Sarakh (mid-7th c.) and the "Romanesque" decorative arches of the nilometer in Cairo (A.D. 861) (Creswell 1969, vol. 1, 442-449 and vol. 2, 200, respectively).

[66] The main theological debates between the 3rd and 9th centuries focus on the relationship between Christ's mortal body and his eternal soul—known as the "Christological Controversies." For a general history of the influence of Neoplatonism in the Christian East, see Meyendorff 1979, 19-53, 134-137. In the 13th c. Thomas Aquinas, influenced by Aristotle, attempted to balance the value of the body and the soul; this idea gained a mixed reception by Byzantine theologians (Meyendorff 1979, 103-114).

[67] Maximus the Confessor's (580–662) treatise *Mystagogia* provided a symbolic interpretation of Byzantine architecture (ed. Cantarella 1931). These ideas would influence the Patriarch of Constantinople Germanos I's writings on *The Divine Liturgy* in the early 8th c. (ed. Meyendorff 1984). Maximus was a frequent traveler to Cyprus and contributed to the condemnation of Monotheletism at Synod of Constantia (Brock 1973, 299-346). For more on the relationship of Maximus and "Neoplatonic architecture," *see* Stewart 2008, 178-173 and Ozoline 1995, 30-38.

architecture Heraclius was sponsoring.[68] But this was never fully realized. The final years of his reign was marred by cultural conflict (i.e. between Chalcedonians and Monophysites), the utter failure of Monotheletism, and loss of Egypt and the Holy Land to Islam. Heraclius' bloodline proved to be weak and inept, preparing the way for the calamitous Isaurian dynasty and Iconoclasm. Nevertheless, without a doubt, the achievements of Umayyad architecture sprouted from the rich soil of Heraclian Palestine. Hence, this new Byzantine architecture style would find its fullest expression in Islam.

Conclusion

Combined imperial and episcopal investment led to the greatest engineering projects in Cyprus. The Grand Baths, the Chytroi-Constantia Aqueduct, and the Loutron were connected with the Emperor Heraclius' interest in the island as a cultural center and strategic base. In the process of *renovating* older structures, Cypriot master-builders developed*innovative* designs. Its flying buttresses can be considered the earliest datable examples; while itspointed arches were the first to be employed on such aconspicuous, monumentalscale. Though Constantia is now deserted and the Heraclian period is all but forgotten, this particular place and time producedbenchmarks heralding the course that stone engineering would take into the High Middle Ages.

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[68]Bahat 1999, 254-256.

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