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Dendrochronology and the Architectural History of the Church of the Holy Apostles in Thessaloniki*

Laskarina Boura in memory

A profusion of wooden structural members greets the visitor to the Church of the Holy Apostles in Thessaloniki. On the west facade, tie-beams connect the northern columns to one another and their flanking walls. In the two narthexes and parecclesia, beams may be seen spanning the vaults as well as the doors between the narthexes. And within the naos, an array of tie-beams is visible criss-crossing the space in two registers (Fig. 1).

Given the importance of the building, as the premier Palaeologue church surviving in Thessaloniki, it is understandable that it should have attracted our interest at the beginning of our dendrochronological investigations in Greece.[1] For, in addition to its architectural importance, it had three features of an ideal dendrochronological object: numerous wooden members in each of its various construction contexts, the potential for extending our absolutely dated reference master chronology for the region, and chronological problems having possible dendrochronological solutions.

Our analysis of the wood samples from the building and our interpretation of the results for the architectural history of the building went through several phases. Initially we were limited by an insufficient number of samples making up our absolute oak master chronology from northern Greece to which the tree-ring sequences from the Holy Apostles could be compared. For while the combined samples from its Byzantine and Turkish phases yielded a remarkable 321-year tree-ring sequence, our efforts to synchronize this sequence with the absolute chronology were inconclusive. We were thus led to a more careful examination of the building than might otherwise have been necessary; and this revealed additional evidence about its structural history that in several cases has direct bearing on current discussion about the building.

Finally, when our absolute oak chronology could be proven to be secure for the time period represented by the Holy Apostles tree-ring sequences, and the two synchronized, the date obtained for the construction of the Byzantine phase raised an unexpected set of new questions.

The authors extend their sincere thanks to the Greek Ministry of Science and Culture for research permission, to the 9th Ephoreia of Byzantine Antiquities and the clergy and staff of the Church of the Holy Apostles for assistance in our work, to the American School of Classical Studies for providing us a base of operation, to the British School at Athens for several early photographs, and to Professor Charalambos and the late Dr. Laskarina Bouras for hospitality, advice, support, and photographs. Our work was made possible by grants from the National Science Foundation, the National Endowment for the Humanities, the National Geographic Society and by gifts from many private donors. In the field, and in the analysis and preparation for publication we received help from a number of team members. We are grateful to all of these agencies and individuals for their support. Discussions over a number of years with Professor Slobodan Ćurčić and more recently with Dr. George Velenis were very helpful in clarifying our ideas. The church is presently undergoing extensive restoration by the 9th Ephoreia of Byzantine Antiquities revealing frescoes and other important evidence about its history. We are grateful to the supervising architect, Mrs. Anna Papadamou, and to Dr. Velenis for going over these findings with us at the church in June 1989. We mention this new evidence here only to the extent that it has bearing on our discussion. Preliminary versions of these results were presented by Striker at the 31. and 33. Koldewey-Gesellschaft Tagungen in Osnabrück in 1980 and Trier in 1984.

[1] For a summary of this work see P. I. Kuniholm and C. L. Striker, "Dendrochronological Investigations in the Aegean and Neighboring Regions, 1977–1982," *Journal of Field Archaeology*, 10 (1983) pp. 411–420 (= Kuniholm & Striker 1983); and *idem*, "Dendrochronological Investigations in the Aegean and Neighboring Regions, 1983–1986," *Journal of Field Archaeology*, 14 (1987), pp. 385–398 (= Kuniholm & Striker 1987).

General Description

The building is situated in the extreme western part of the city within the Byzantine walls, remains of which still stand some 50 m. to the west.[2] Originally it was the catholicon of a monastery from which survive a cistern to the northwest and a propylon to the southwest, the latter undoubtedly part of a wall originally enclosing the monastery precinct. The church in its present form is of the four-column, cross-in-square type consisting of bema flanked by pastophoria, naos, and esonarthex (Fig. 2). This core is enveloped by a U-shaped peripheral ambulatory forming longitudinal parecclesia on the north and south flanks connecting with an exonarthex to the west. The plan is bilaterally symmetrical except that in place of the open eastern bay of the north parecclesion there is in the corresponding location at the south an enclosed skeuophylakion, accessible only from the diaconicon. Domes on high drums surmount the eastern bays of the parecclesia and the bays flanking the esonarthex to the north and south. By contrast to other churches of similar date surviving in the city, the building is in an exceptionally good state of preservation with much of its original fabric intact and visible.

On the exterior west facade an inscription on the door lintel, and monograms on the same lintel and on bosses of the plinths of the capitals, as well as in decorative brickwork in the spandrels of the outer double arcades and on the west bay of the south facade, identify the patriarch Niphon (ruled 1310–1314) as founder or restorer *(ktitor)* of the building.[3] Another inscription in fresco in the esonarthex will be considered presently.

The original name of the church and monastery is unknown. Its designation as Holy Apostles is of recent date and is unsupported by Byzantine texts. The discovery in the years 1926–28 of a fresco of the Virgin in the esonarthex over the center door to the naos, a position usually reserved for the title saint, suggests that the church was dedicated to her, leading Xyngopoulos to the further proposition that this was the Monastery of the Virgin Gorgoepikoos, one of the two monasteries in the city known to have been dedicated to her.[4]

Byzantine Chronological Problems

The debate about the chronology of the building's construction and the role of Patriarch Niphon in it is almost as old as the history of scholarship on the building itself. In their simplest versions, the opposing positions are, on the one side, that the church was conceived and built at one time, essentially as it is today, and Niphon was its founder; on the other, that the core of the existing building, consisting of the bemata, naos and inner narthex, is an earlier church to which Niphon, as restorer, added the surrounding parecclesia and exonarthex bearing his inscription.[5]

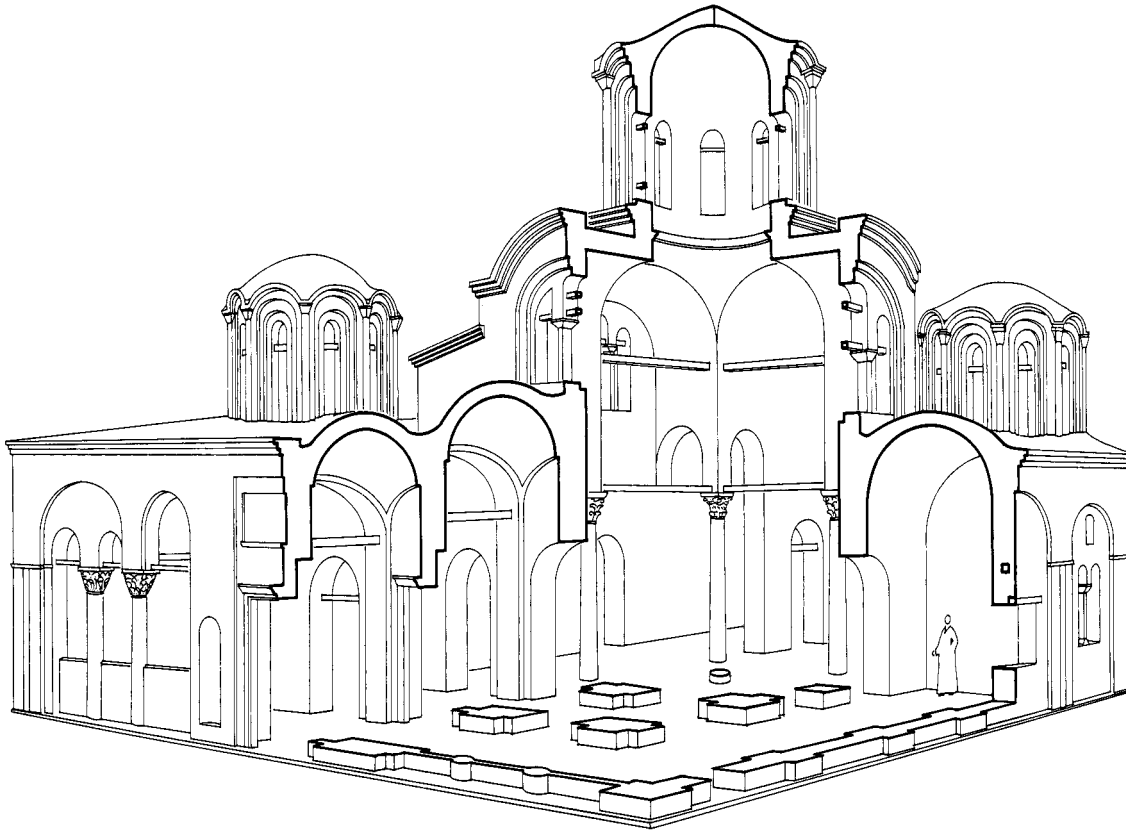
In the apparent absence of conclusive evidence or arguments one way or the other, there have also been compromise variations between these two. Thus, the peripheral structures were a secondary construction added to a preexisting core, but in very short succession, and built by the same masons; or, Niphon took

[2] The history of research on the building with full bibliography is reviewed in two recent dissertations, M. Rautman, *The Church of the Holy Apostles in Thessaloniki*, Ann Arbor, 1984 (= Rautman); and C. Stephan, *Ein byzantinisches Bildensemble: Die Mosaiken und Fresken der Apostelkirche in Thessaloniki*, Worms, 1986 (= Stephan). The first full study of the building with measured drawings (by Le Tourneau) was Ch. Diehl, M. Le Tourneau, & H. Saladin, *Les Monuments chrétiens de Salonique*, Paris, 1918, pp. 189–200 & pl. 62–66 (= Diehl). The most accurately surveyed plan and section of the building (by Tanoulas) are in N. Nikonanos, Οι Αγιοι Απόστολοι Θεσσαλονίκης, Thessaloniki, 1972, pls. 1 and 2.

[3] The inscriptions are most recently published by J. M. Spieser, "Inventaire en vue d'un recueil des inscriptions historiques de Byzance. I. Les inscriptions de Thessalonique," *Travaux et mémoires*, 5 (1973), pp. 168–170, with prior literature. Good drawings of the inscriptions are to be found in *Thessaloniki and its Monuments*, Thessaloniki Ephorate of Byzantine Antiquities, Thessaloniki, 1985, pp. 99–100.

[4] A. Xyngopoulos, "Μονη των Αγίων Αποστόλων η μονη της Θεοτόκου," *Prosphora eis Stilpona P. Kyriakiden* (Hellenika), Thessaloniki, 1953, pp. 726–735.

[5] One phase: O. Wulff, *Altchristliche und byzantinische Kunst*, Berlin, 1918, II, pp. 495–496. Two phases: P. N. Papageorgiou, "Θεσσαλονίκης βυζαντιακοι ναοι και επιγράμματα αύτων," *Byzantinische Zeitschrift*, 10 (1901), p. 33; Diehl, pp. 191–192; J. Ebersolt, *Monuments d'architecture byzantine*, Paris, 1934, p. 168; R. Janin, *Les Églises et les monastères des grands centres byzantins*, Paris, 1975, p. 352–353 (with a 13th c. date for the first phase).



1. Perspective section showing location of tie-beams (drawing: D. K. McCoubrey)

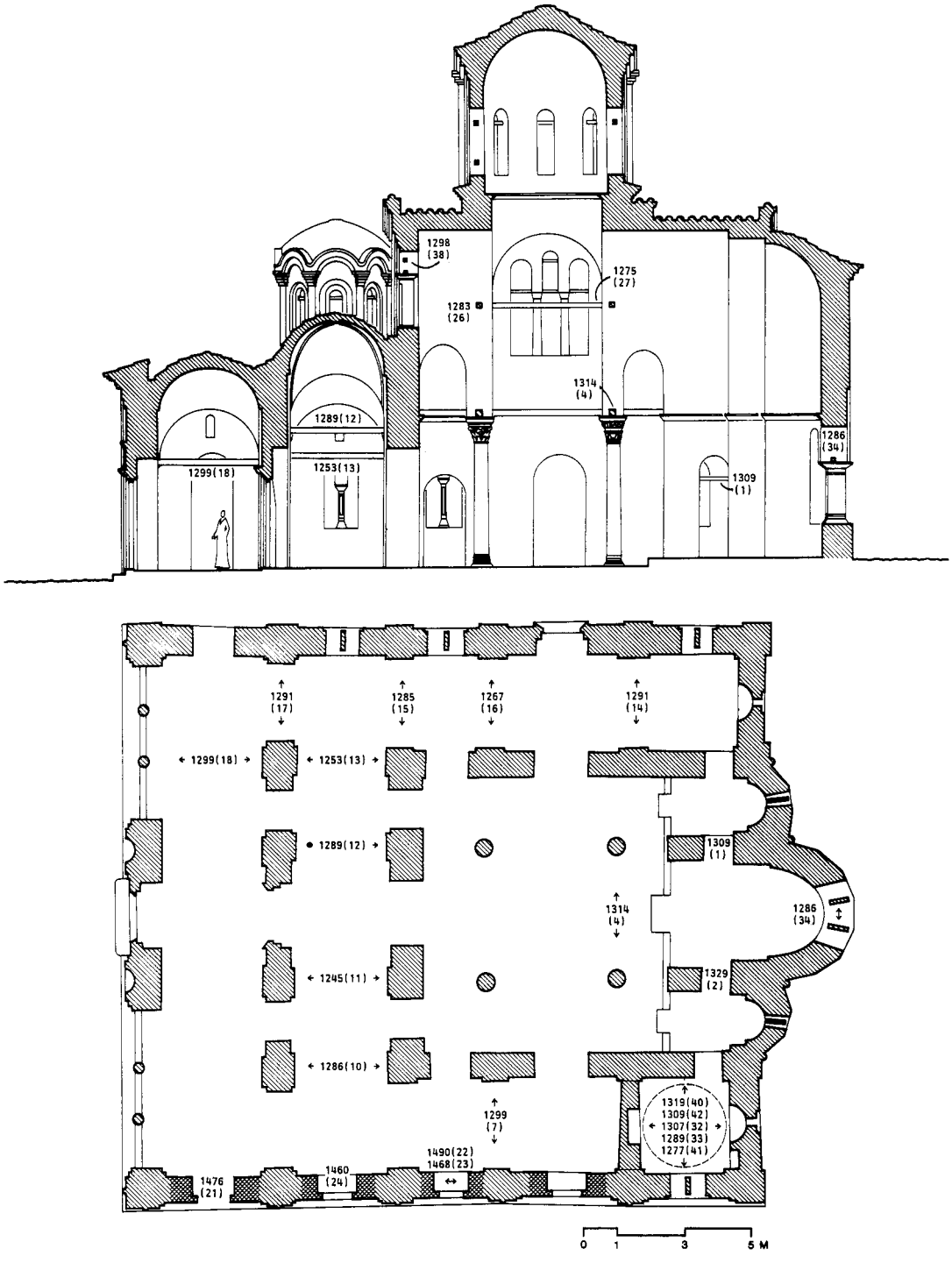
over the patronage of the entire building at an advanced stage of its construction just in time to have his name placed on the upper part of the west facade.[6]

The matter is not without significance, for it underlies the correct understanding not only of the design relationship of the various parts of the building to one another, but also of broader issues concerning the character of early Palaeologue architecture in Thessaloniki and its relations to Constantinople and the Balkans.

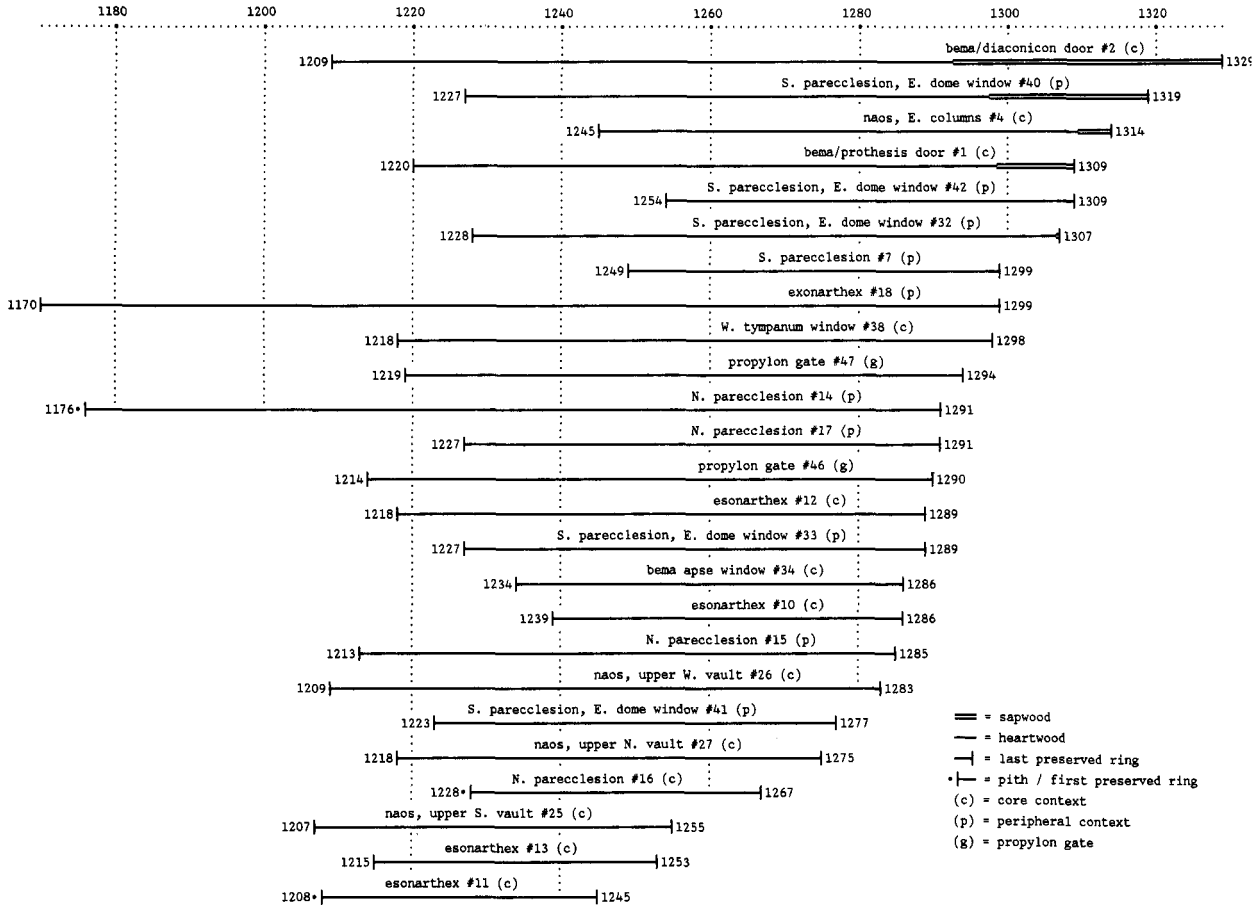
To the questions of the date of construction of the church and Niphon's role in this must also be added the evidence of its decoration. Accompanying the aforementioned fresco of the Virgin discovered in the esonarthex was the portrait of a suppliant monk with the following incomplete inscription: "Paul, monk and superior of this revered monastery and disciple of the most holy Ecumenical Patriarch and founder kyr Niphon, and second founder." The reference of this Paul, who is otherwise unknown in historical sources, to himself as second founder *(deuteros ktitor)* of the church has been variously interpreted to mean that he completed the decoration still under Niphon's reign or following his abdication.[7]

[6] Respectively, S. Ćurčić, *Gračanica*, University Park & London, 1979, p. 73 n. 15 (= Ćurčić); and Rautman, p. 13.

[7] The inscription was first published by A. Xyngopoulous, "Τά ψηφιδωτη διακόσμησις του ναου των Αγίων Αποστόλων εν Θεσσαλονίκη," *Archaiologike Ephemeris*, 16 (1932), p. 155, who attributes the frescoes to completion by Paul after Niphon's fall; then by Spieser, *op. cit.*, who reads *deuteros ktitor* to mean that Paul was second in rank rather than in time to Niphon and completed the decoration during Niphon's reign; and most recently by S. K. Kissas, "La datation des fresques des Saints-Apôtres à Thessalonique," *Zograf*, 7 (1977), pp. 52–57 (Serbian with French résumé), with an elaboration of Xyngopoulos' hypothesis.



2. Existing plan and section with location of dated wood samples. Dark hatching is Turkish. Sample numbers are in parentheses (drawing: D. K. McCoubrey based on Tanoulas)



3. Graph of dated wood samples from Byzantine phase

The Byzantine Dendrochronological Evidence

In 1977, 1979, and 1980 we took 44 wood samples from the building. Of these 34 were from Byzantine and 10 from Turkish contexts. Two additional samples were taken from the remains of the propylon standing to the southwest of the building. All samples were oak. When their annual rings widths had been measured and compared with one another, 30 samples could be synchronized with one another yielding the aforementioned 321-year sequence. Of these, 23 were from the Byzantine phase of the church, two from the Byzantine propylon, and five from the Turkish phase. The remaining 16 samples were either too short to achieve synchronization or failed to do so for other reasons.[8]

The synchronized Byzantine samples came from doors between the bema and pastophoria (Samples 2 and 1), from arch and vault tie-beams of the naos (Samples 4, 26, 27, and 25), from tie-beams spanning the esonarthex (Samples 12, 10, 13, and 11), from those of the exonarthex and parecclesia (Samples 7, 18, 14, 17, 15, and 16), and from windows in the bema, west cross-arm tympanum, and southeast dome drum (Samples 40, 42, 32, 38, 33, 34, and 41) (Fig. 2).

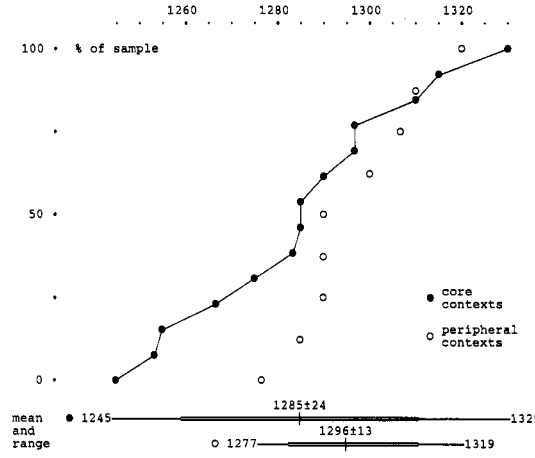
By 1981 we believed that our absolute oak chrono-

[8] The two fullest treatments of the dendrochronological method are M. G. L. Baillie, *Tree-Ring Dating and Archaeology*, Chicago & London, 1982; and F. H. Schweingruber, *Der Jahrring; Standort, Methodik, Zeit und Klima in der Dendrochronologie*, Bern & Stuttgart, 1983, and *idem*, revised English edition, *Tree Rings: Basics and Applications of Dendrochronology*, Dordrecht & Boston, 1988. An excellent brief summary is D. Eckstein, *Dendrochronological Dating* (European Science Foundation, Handbooks for Archaeologists, 2), Strasbourg, 1984.

logy for northern Greece was sufficiently secure, and that it extended backward in time from the present sufficiently far to overlap and synchronize with what until then had been a floating sequence from the building. Accordingly, we assigned absolute dates to the last preserved rings in the Byzantine and Turkish sets respectively at 1294 and 1455.[9] While these dates were in some respects inconclusive, when the loss of outer tree-rings was taken into account, they were not inconsistent with the accepted date, at least for the Byzantine phase. We shall consider presently the date of the transformation of the building to a mosque.

By 1986 the number of dendrochronological samples collected by us in northern Greece had more than trebled and included several very long individual oak samples bridging the years 1523–1546, the period of greatest uncertainty in our absolute oak chronology. On the basis of this new evidence and of a reevaluation of earlier evidence, we were obliged to conclude that we had made an incorrect synchronization of samples in the early 16th century, and that all components of the absolute oak chronology prior to 1546 would have to be advanced by 35 years. For the Byzantine tree-ring sequence of the Holy Apostles the date of the last preserved ring was now 1329, for the Turkish, 1490.[10] The correction brought the dendrochronological date of the transformation of the building to a mosque into much closer accord with the historical evidence, as we shall see. But it pushed the date of construction of the Byzantine church at least 15 years later than the end of Niphon's reign as patriarch (1314), the *terminus non post quem* presumed by all for the completion of the structure. The verification of this problematic date for the Byzantine phase required a more complex procedure than is usually necessary, and in light of this and of the many consequences that follow from it, we must examine the dendrochronological evidence in some detail.

Relative dates of core and periphery: Our first consideration is of the evidence that dendrochronology might provide in resolving whether the peripheral parecclesia and exonarthex were built simultaneously with or later than the core structures comprised of the naos, bemata, and esonarthex. Since this involves the comparison of the relative dates of wood samples from



4. Plots comparing dates of the last preserved rings from core and peripheral contexts

the two contexts only to one another, the issue is independent of the absolute dates of the samples.

The first indication that the two sets are homogeneous with regard to their date is seen in the bar graph of the 25 synchronized samples from the core, periphery, and propylon arranged in chronological order of their last preserved rings (Fig. 3). Although the span of 84 years from the latest (1329) and the earliest (1245) last preserved ring is longer than usual, it nonetheless conforms to a normal distribution of last preserved rings from a single lot of construction timber, resulting from differential trimming of outer rings by the carpenter to make squared beams. This is reflected in the smooth S-curve described by the right-hand side of the graph, typical for single-phase buildings. Moreover, the samples from the three contexts are randomly intermixed. Had the wood for the core and peripheral contexts come from two separate lots of timber of different date, we would have expected those

[9] Kuniholm & Striker 1983, p. 416, fig. 3 and p. 419, table 2.

[10] Kuniholm & Striker 1987, p. 387, p. 389 fig. B, & p. 394.

[11] Two tests used to compare the means of the two sets indicated that the sets are homogeneous. A *t*-test gave the *t*-value of 1.61 with a probability of .13 (degrees of freedom of 18.5) giving an 87% chance that the means are equal. An Analysis of Variance test gave a value of 2.20 for the F statistic. With the single factor (the last preserved rings) to nullify the hypothesis that the means are equal, the F would have to be 4.33 for the hypothesis to be rejected at the 95% significance level. Degrees of freedom were (1, 21). The statistical tests were made by C. S. B. Griggs.

from the later lot to cluster toward the top of the graph. We will explain below why the felling year of a tree and its use for construction may be presumed to be identical.

The relationship of the set of 14 samples from the core to the 9 from the periphery may also be represented as comparative plots of their last preserved rings (Fig. 4). The data set is too small to apply with any degree of confidence the usual statistical tests for similarity or difference in population.[11] But while the comparison does not prove the homogeneity of the two sets, it is fully consistent with this conclusion; and here, as well, a difference in date between the two would probably be evident even with these few samples. Since the samples from both sets, as well as the two samples from the propylon, synchronize closely with and are statistically indistinguishable from one another, we may consider the 25 synchronized samples from the Byzantine phase to be a homogeneous set for the purpose of absolute dating.

Absolute date of the Byzantine phase: Our ability to assign absolute dates for the tree-ring sequences represented by wood samples from the Byzantine phase of the Holy Apostles required our creation in advance of a dated sequence (master chronology) of measured tree-ring widths from the region. Beginning from the present with living trees in Greece and Turkey, we could extend the sequence continuously backward in time by overlapping progressively older synchronized samples (bridging) until the sequence included the general period in which the church was presumed to have been built. It would then be possible in theory to compare the undated sequence from the Holy Apostles year by year with the absolutely dated long sequence. If synchronization were achieved at a specific year of comparison (cross-dating), we could then date absolutely and to the year the span of time represented by the Holy Apostles sequence.

This process of creating a regional master chronology by bridging, and determining the absolute date of an undated sequence by cross-dating with it, is the essence of the dendrochronological method. The determination of whether sequences cross-date with one another, both in the process of bridging and in the final effort to place in time an undated sequence, is made by both a visual comparison of graphs (curves) of their respective measured ring widths and by statistical tests that give quantitative values for the similarity of one sequence to another. In the application of these tests to the Holy Apostles samples, we must bear in mind two other related features of the dendrochronological method.

First, the utility of a regional master chronology and the ease with which an undated sequence may be cross-dated with it depend largely upon on the number of samples making up each sequence. The greater the number of samples combined to create both sequences, the more likely it is that their averaged tree-ring widths are a reflection of climatic variation alone, unadulterated by growth anomalies of individual trees caused by non-climatic factors.

Second, despite the general validity of the foregoing, efforts to cross-date an undated sequence with a regional master chronology composed of large numbers of samples from widely distributed sources can be less successful when compared to the master chronology as a whole or to some selected components of it, than when compared to other selected components of the same master chronology. The selection process in such cases is empirical, by trial and error; but successful cross-dating achieved by this method reflects, among other factors, the existence of local sub-sets within the larger chronology whose valid climatic response has been obscured by the process of averaging. All of the above factors were pertinent to our efforts to cross-date the Holy Apostles Byzantine samples.

Once it had been established by us, there was never cause to doubt the validity of the segment of our North Greek Oak Master Chronology spanning the period from the present to the mid-16th century. The verification of the next extension backward in time was made possible by four sets of samples satisfying special needs. They were very long sequences, they spanned the uncertain period 1523–46, they cross-dated exceptionally well with one another and with the secure later segment of the North Greek Oak Master Chronology, they preserved bark or the probable terminal growth ring giving the exact felling year, and their dendrochronologically established dates coincided exactly with dates already known from inscriptions or other

Distribution of t-value (t) Distribution of trend coefficient (TC) Distribution of dating index (D)

1. Holy Apostles Byzantine phase compared to four-building dated master

t	number	%
0.0 - 0.5	248	64.2
0.6 - 1.0	66	17.1
1.1 - 1.5	39	10.1
1.6 - 2.0	18	4.7
2.1 - 2.5	9	2.3
2.6 - 3.0	4	1.0
3.1 - 3.5	2	0.5

t = ◂ 3.03 at 1329

TC	number	%
0.0 - 50.	221	57.3
50.1 - 52.	45	11.7
52.1 - 54.	57	14.8
54.1 - 56.	47	12.2
56.1 - 58.	10	2.6
58.1 - 60.	3	0.8
60.1 - 62.	2	0.5
62.1 - 64.	1	0.3

TC = ◂ 57.86 at 1329

D	number	%
0 - 10	372	96.4
11 - 20	11	2.8
21 - 30	3	0.8

D = ◂ 23.85 at 1329

2. Three-building intermediate master compared to four-building dated master

t	number	%
0.0 - 0.5	262	66.5
0.6 - 1.0	45	11.4
1.1 - 1.5	39	9.9
1.6 - 2.0	22	5.6
2.1 - 2.5	15	3.8
2.6 - 3.0	7	1.8
3.1 - 3.5	3	0.8
3.6 - 6.5	-	-
6.6 - 7.0	1	0.3

t = ◂ 6.81 at 1345

TC	number	%
0.0 - 50.	204	51.8
50.1 - 52.	48	12.2
52.1 - 54.	72	18.3
54.1 - 56.	44	11.2
56.1 - 58.	16	4.1
58.1 - 60.	8	2.0
60.1 - 62.	1	0.3
62.1 - 64.	-	-
64.1 - 66.	-	-
66.1 - 68.	-	-
68.1 - 70.	1	0.3

TC = ◂ 69.46 at 1345

D	number	%
0 - 10	373	94.7
11 - 20	18	4.6
21 - 30	2	0.5
31 - 130	-	-
131 - 140	1	0.3

D = ◂ 132.44 at 1345

3. Holy Apostles Byzantine phase compared to three-building intermediate master

t	number	%
0.0 - 0.5	87	67.4
0.6 - 1.0	17	13.2
1.1 - 1.5	8	6.2
1.6 - 2.0	10	7.8
2.1 - 2.5	2	1.6
2.6 - 3.0	3	2.3
3.1 - 3.5	1	0.8
3.6 - 10.0	-	-
10.1 - 10.5	1	0.8

t = ◂ 10.41 at 1329

TC	number	%
0.0 - 50.	77	59.7
50.1 - 52.	18	14.0
52.1 - 54.	11	8.5
54.1 - 56.	8	6.2
56.1 - 58.	6	4.7
58.1 - 60.	4	3.1
60.1 - 62.	3	2.3
62.1 - 64.	1	0.8
64.1 - 66.	-	-
66.1 - 68.	-	-
68.1 - 70.	-	-
70.1 - 72.	-	-
72.1 - 74.	1	0.8

TC = ◂ 73.51 at 1329

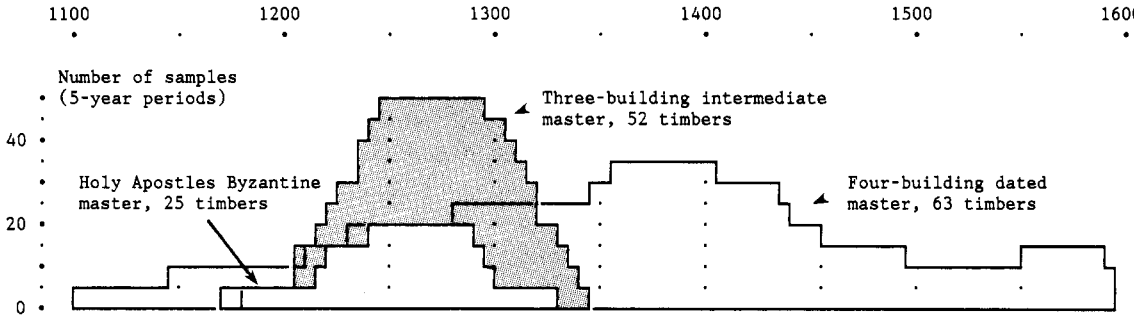
D	number	%
0 - 10	118	91.5
11 - 20	7	5.4
21 - 30	2	1.6
31 - 40	1	0.8
41 - 240	-	-
241 - 250	1	0.8

D = ◂ 244.65 at 1329

5. Distribution of statistical values for cross-dating Byzantine phase

textual evidence for the buildings from which they came. The four buildings and the inclusive years of their tree-ring sequences are the octagonal tower from the Vardar Fortress (1477–1597) and the White Tower (1210–1535) in Thessaloniki, the Mosque of Mehmet I. in Didymoteichon (1214–1418), and the Mosque of Murat I. Hüdavendigar in Bursa (1111–1384).

When the four sets were merged they formed a single sequence spanning the period 1111–1597; and since this included the period in which the Holy Apostles was presumed to have been built, there was reason to expect its sequence to cross-date with it. In this process the two sequences are compared to one another year by year, in this case with a minimum of 100 years overlap, across their full spans using three statistical tests that give quantitative values for the closeness of fit for each year compared. The first is a simple parametric *t*-test, the second a non-parametric trend coefficient (TC), and the third a dating index (D) that combines the two.[12] The distribution of these values is given in Figure 5.1, and shows that, of 386 possibilities, a cross-date at 1329 is the best for *t*-value (3.03), seventh best for the trend coefficient (57.86), and best for the D-value (23.85). But despite the fact that the *t*-value and related D-value are highest when the Holy Apostles sequence is cross-dated at 1329, the



6. Abundance and chronological distribution of sample sequences used to cross-date Byzantine phase

comparison at other dates gives values which are almost as high for these two tests, and the trend coefficient is only the seventh highest value. Accordingly, this would not be considered a secure dendrochronological date without further corroboration.

This was achieved indirectly with sequences from three other buildings. While the buildings were undated by inscriptions or texts and their samples lacked bark or terminal growth rings, the sequences were long and they cross-dated very well with one another. The buildings and the inclusive years of their sequences are the catholicon of the Prodromos Monastery near Serres (1178–1345), and Vlatadon Monastery (1199–1339) and the Church of Agia Aikaterini (1195–1315) in Thessaloniki. When merged, the three sets formed a sequence spanning the years 1178–1345 that could be compared in turn to the securely dated four-building sequence using the same tests (Fig. 5.2). The cross-dating here at 1345, the last year of the new sequence, gives a set of values of quite different quality. Not only is each value high on an absolute scale, but all are significantly higher than the next lower value in each test, with over 100 points separating the especially indicative D-value (132.44) from the two next lower values (in the 21–30 point range). By any criterion this is a very secure cross-date, and it was corroborated by the close synchronization of the curves when they were compared visually to one another.

The last step in this corroboration was to compare once again the Holy Apostles sequence, in this case to the intermediate three-building sequence. The results for each test (Fig. 5.3) and the visual comparison of curves leave no doubt that 1329 is the correct year for cross-dating. Absolute values for this date are even higher than in the foregoing comparison; the unusually high D-value of 244.65 is separated from the next lower value (in the 31–40 range) by over 240 points.

Confidence in these cross-dates is further supported by the large number of samples making up the combined sequences (Fig. 6) and by numerous sequences from other buildings in addition to those selected here that cross-date well with these sequences.

Construction date of the Holy Apostles: The interpretation of the foregoing evidence for the date of construction of the Holy Apostles requires the consideration of several further principles and assumptions of dendrochronology. The method works on the premise that wood to be used for rough construction, in contrast to that intended for furniture or panel paintings, is almost always green, that is to say from newly-felled trees. The reason for this is the ease of working green in contrast to seasoned wood, a difference especially great in oak, the preferred medieval structural wood in this region. It follows from this that the most precise dating information from a wood sample comes from those in which the felling year of the tree can be determined. This is obviously the case when bark is preserved, for we know with certainty that the last preserved growth ring is, as well, the terminal growth ring of the tree, giving the precise year when it was

[12] The three tests are described respectively by M. G. L. Baillie and J. R. Pilcher, "A Simple Crossdating Program for Tree-Ring Research," *Tree-Ring Bulletin*, 33(1973), pp. 10–13; B. Huber, "Dendrochronology" in J. Fletcher, ed., *Dendrochronology in Europe* (British Archaeological Reports, International Series, 51), Oxford, 1978, pp. 21–23; and B. Schmidt, "Ein dendrochronologischer Befund zum Bau der Stadtmauer der Colonia Ulpia Traiana", *Bonner Jahrbücher*, 187 (1987), p. 500.

felled. But if, as is usually the case, the bark and an unknown number of outer rings have been cut off by the carpenter in the process of squaring, the question arises whether means exist for estimating the number of lost rings and thereby the probable felling year of the tree from which the timber came. Some progress has been made in this. Extensive samples taken from freshly-cut forest oaks reveal that when the number of sapwood rings in mature oaks is plotted against the number of samples, the result is a normal distribution curve. Thus, even if only one sapwood ring is preserved in a timber, it is possible to estimate the statistical range of its felling year and, within the same limits, the construction date when it was used.

In the application of this principle there are, however, several important constraints. Not only is there significant regional variation in the mean numbers and distributions of sapwood rings; but differences exist between trees growing at different altitudes in the same region, and even between samples taken at different heights from the same tree. Thus the use of mean sapwood values for estimating construction years of buildings must always be with awareness of its statistical nature.

Our analysis for this purpose of 21 sets of Aegean oak consisting of 314 samples, while reflecting the high level of variability found elsewhere, nevertheless conformed to normal distribution with a mean of 25.6 rings ± 9 for one standard deviation, or an estimated range of 18 to 36 years added to the mean heartwood-sapwood border.[13]

Returning to the Holy Apostles, we note that while none of the samples end in bark, five preserve some sapwood (Samples 2, 40, 4, 1, and 32) (Fig. 3). The years when the sapwood begin span a 16-year period with 1309 (Sample 4) the latest, 1293 (Sample 2) the earliest, and 1301 the mean year for the border between heartwood and sapwood for these five samples. Using the above principle of sapwood estimation, if we now add the Aegean oak sapwood mean of 26 ± 9 (rounded to the next whole number) to the Holy Apostles mean heartwood-sapwood border of 1301 we obtain the date 1327 ± 9.

Now if fewer than 26 sapwood rings had been preserved in the Holy Apostles samples we would estimate statistically that the church was built in 1327 with a range of one standard deviation of ± 9 years. However Sample 2, in addition to having the latest preserved ring of the series dated 1329, also has 37 sapwood rings. Accordingly, not only must we conclude that the set of timbers was felled no earlier than 1329: we may estimate further from the 37 sapwood rings of Sample 2 that this is very close to the actual felling year, for 37 sapwood rings is already one more ring than might be expected from our standard deviation of ± 9.[14]

A final step in the confirmation of the original construction date of the church as a whole requires the reexamination of the structural context of those timbers yielding the samples most critical for establishing this date. No doubt must exist that they are part of the original construction and could not have been inserted or replaced later. While we have already set forth the reasons for considering the core and peripheral timbers to be of the same lot, we may for the sake of caution confine this verification to samples from the core alone.

Sample 2 is from a tie-beam used in the construction of the arch over the door between bema and diaconicon. Both of its ends are imbedded in masonry, and even if it were physically possible to replace it, there would be no reason for doing so. Moreover, it must have been used in the earliest stages of building the core structure. We have already explained the significance of its great number of sapwood rings in determining its felling year.

Sample 4 is from the large tie-beam spanning the two eastern columns of the naos above their capital plinths, and projecting to the north and south beyond them to

[13] Kuniholm & Striker 1987, pp. 87–90. For the problems of sapwood estimation see Baillie, *op. cit.*, pp. 54–60 and Eckstein, *op. cit.*, pp. 29–33. A particularly sobering demonstration of the limitations of sapwood estimation is given by M. K. Hughes, S. J. Milsom and P. A. Leggett, "Sapwood Estimates in the Interpretation of Tree-Ring Dates," *Journal of Archaeological Science*, 8 (1981), pp. 381–390.

[14] With the exception of two sawed cross-sections from the propylon in which the longest radii for measurement could be selected, all other samples were cores. Since it was not possible to drill core samples from each beam from all four corners, we may not have obtained the longest ring sequence from each timber sampled.

the naos flank walls in which they are imbedded. The beam is part of the interlocking original cribbing used to stabilize the columns and to contain the lateral thrust of the arches arising from them during construction, and it must also have been installed in an early stage of construction. The last preserved ring of Sample 4 is dated 1314. The coincidence of this date with the last year of Niphon's reign is accidental and of no significance. Only five sapwood rings are preserved in the sample, and if this were the full number in the living tree from which it came, it would be a botanical anomaly. We estimate that beyond the five preserved in this sample no less than 13 and probably about 20 additional sapwood rings were lost in the process of squaring the log.

The same reasoning applies to all other samples except that for those preserving no sapwood the addition of a sapwood estimation value to the date of their last preserved ring will give only the *terminus post quem* for probable felling year, not the year itself. Thus when the dendrochronological evidence is examined in terms of structural context we are again led ineluctably to conclude not only that the 1329 date of the last preserved ring of Sample 2 is very close to the year of construction but that the felling year of at least the six most recent samples, including three from core contexts, occurred well after the end of Niphon's reign.

Consequences of the construction date: This is not the place to consider the broad and, in many respects, problematic consequences of advancing the original date of construction of the Holy Apostles by at least fifteen years to 1329 or shortly thereafter. The most immediate problem is to explain the meaning of the founder's inscriptions: how Niphon can be mentioned three times as both *ktitor* and patriarch fifteen years or more after his fall from grace and abdication of the latter office. Among the issues to be explored further is the nature of Niphon's rehabilitation following the ascent to the throne in 1328 of the emperor Andronicos III and the possible significance this may have had for the erection of the church. Related to this is the role of Paul as *deuteros ktitor*.

There are also many problems raised by this in the history of architecture and painting, for the redating reverses the accepted relative chronology for both the architecture and the decoration of the Holy Apostles and hence their primacy vis-à-vis buildings and decoration presumed to be later than it both in Constantinople and the Balkans. The relation to the Palaeologue restoration of the Church of St. Savior in the Chora in Constantinople is but one case in point.[15]

The Byzantine Architectural Evidence: Core and Periphery

In this and the following section we present our observations relating first to the question of the relative date of construction of the core and peripheral structures and then to the reconstruction of the primary Byzantine building phase.

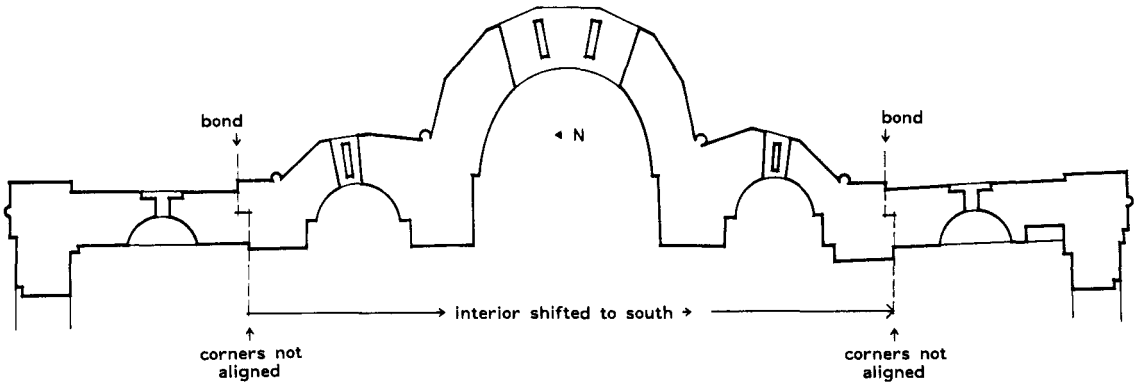
Bonding: The most obvious place where walls from the core adjoin those from the periphery is in the east apse wall of the church (Fig. 7). Here, on the exterior, the masonry is exposed and has been continuously visible, at least since the time of Texier's drawing of 1864.[16] A determination of whether the peripheral structures to the north and south of the pastophoria abut or are in bond with the adjoining core structure is the self-evident, most conclusive basis for determining whether these two parts of the church were built simultaneously or not. In view of this, it is surprising that the matter has been treated in desultory fashion by some, and that agreement has failed to be reached by the few others who have examined the two places carefully. Ćurčić, the most recent scholar to examine these places with any care, concluded that the joints did not bond.[17]

In 1979, we made a course-by-course examination of

[15] For a summary of the general historical cirumstances see D. Nicol, *The Last Centuries of Byzantium 1261–1453*, London, 1972, pp. 159ff. For Niphon's rehabilitation see U. V. Bosch, *Kaiser Andronikos III. Palaiologos*, Amsterdam, 1965, pp. 174–175. A recent analysis of the mosaics and frescoes and their relation to other programs in terms of the heretofore accepted date is given by Stephan, *passim*.

[16] C. F. M. Texier and R. P. Pullan, *Byzantine Architecture*, London, 1864, pl. 46.

[17] *Loc. cit.*, subsequently doubted by P. L. Vocotopoulos, "The Role of Constantinopolitan Architecture during the Middle and Late Byzantine Period," *Jahrbuch der Österreichischen Byzantinistik [XVI. Internationaler Byzantinistenkongress, Akten I/2]*, 31/2 (1981), p. 561 n. 43.



7. Plan of east wall showing disalignment between exterior and interior articulation (drawing: D. K. McCoubrey based on Tanoulas)

the two junctures; and, while admitting that modern pointing grout obscures much of the evidence, we were able to poke a thin wire probe at several points in the junctures (e. g., on the north side, the 22nd course from the bottom). This revealed conclusively that bricks from the periphery penetrate and bond with the adjoining walls of the core. We will return below to the question of bonding at these points.

Outer corners of the pastophoria: Any hypothesis proposing two Byzantine phases of construction must be supported by an adequate account of how the church appeared in its primary phase before the addition of the exonarthex and parecclesia. And any features indicating that the core might not have been a complete, normal, and autonomous church require explanation. Here and in the following two sections we consider the consequences of this.

The accuracy of the Tanoulas plan[18] makes possible for the first time a detailed examination of the relationship of wall members to one another, clearly revealing a feature that bears on the question of internal chronology. According to a two-phase hypothesis, the points of juncture that we have just considered on the east facade would have marked the outer eastern corners of the pastophoria in the first phase, subsequently obscured in the second phase by the addition of the north parecclesion and skeuophylakion (Fig. 7).

But the plan shows clearly that the external return angles of these corners are not in alignment with their internal counterparts as would have been necessary had these been the external corners of the pastophoria in the first phase. Indeed, it is impossible to devise a reconstruction of how these corners originally would have appeared, taking into account the disalignment. Moreover, the disalignment is not bilaterally symmetrical. The internal wall arrangement in this zone is shifted about 20 cm to the south with respect to the external wall articulation and has the further anomaly of a double setback in the south side of the diaconicon. It follows necessarily from this that the full facade, including the east walls of the north parecclesion and skeuophylakion, was designed as a whole, in terms only of its external aspect, and independent of regard for exact internal correspondence. Even if no other evidence were available, this disalignment of external and internal features, and the resulting impossibility of providing a reasonable reconstruction of the external corners of the pastophoria as freestanding, is proof alone that the east wall of the church was constructed as a continuous wall in masonry bond.

Esonarthex tribeloi: Others[19] have observed correctly that the east-west tie-beams spanning the outer arches of the esonarthex have two approximately equally-spaced trenches on their undersides; and that the exposed remains of a triple arcade above the northern beam makes evident that the flanking ends of the esonarthex were screened by tribeloi. But the tie-beams, and the significance of the tribeloi of which they were a part, repay more careful consideration than has been given them to determine whether they

[18] Nikonanos, *op. cit.*, pl. 1.

[19] E. g., Ćurčić, p. 72; Rautmann, pp. 104–105 & 108.

were originally open or closed-off by windows in the arcades. For if the naos and esonarthex were originally part of a freestanding, autonomous church, their flanks must have been closed, exterior walls with windows in the tribeloi.

Close inspection of the tie-beams reveals that they are decorated with the same painted ornamental motifs that survive on some of the tie-beams elsewhere in the building. The vertical sides have a row of stylized ivy-like vegetal motifs. Our concern, however, is with the undersides, on which is painted a rectilinear meander in black and red filling the full width and running the full length of the beam, interrupted only by the aforementioned trenches. The meander motif can be read as a whole, as is now possible, only if the soffits of the beams and the triple arcades below were unobscured and undivided by windows. To dispel the notion that this decor might have been added after a hypothetical addition of the periphery around the core and the removal of windows, we took particular care to examine the lower and upper surfaces of both beams for traces of nails, plaster, other attachments, or discoloration indicating that windows were once attached below or above the beams. All surfaces are pristine in this respect. The only nails are those associated with modern electrical wiring. We conclude from this that the arcades were originally open, at least above the level of hypothetical dado-height closure slabs. The tribeloi were part of an original interior arrangement permitting visual, and probably physical communication between the esonarthex and flanking parecclesia.

Bemata doors: Similar questions to those asked about the tribeloi must be raised in connection with the doors connecting the outer walls of the pastophoria with the parecclesia, at the north to the open eastern bay, and at the south to the enclosed skeuophylakion. Since the possibility of doors originally opening directly to the exterior from prothesis and diaconicon must be excluded, a two-phase hypothesis would require these doors to have been broken through subsequently at the time of the addition of the peripheral structures.

There are now no tie-beams across these doors, the presence of which would indicate the doors to be part of the original construction. To the south, in the door between the diaconicon and skeuophylakion, the possible existence of a tie-beam cannot be determined since the door reveals at impost level are blocked by masonry fill above the low, marble-enframed door.

While at the time of our original study no tie-beam was visible in the corresponding north door connecting prothesis and north parecclesion, we had established the presence of hidden tie-beam stumps in the reveals by tapping across the plaster. The recent work of the Ephoreia of Byzantine Antiquities has now exposed these stumps, leaving no doubt as to the originality of this door. In addition, this work has exposed the fresco remains of a standing deacon on the prothesis side of the door whose figure is cut by the now open door.[20] This indicates the existence of an unexpected second Byzantine phase in which the door was blocked and frescoed over, subsequently to be reopened at the time of the transformation to a mosque. Evidence for this secondary Byzantine phase was, as we shall see, also found elsewhere in the building.

Tie-Beams of the parecclesia and exonarthex: If the parecclesia and exonarthex were added to an already standing, or even partially standing church, we should be able to reconstruct in some detail the construction procedures necessary to accomplish this, including how the new structure was attached to the old; and we should be able to explain the structural reasons for these procedures.

In the parecclesia and exonarthex, the most important static problem to be dealt with by the builders was to provide tensile spans across each of the open arches defining the bays in order to contain the predominantly outward thrust during construction and in the long period thereafter needed for the mortar to cure and the masonry to stiffen. The same problem exists whether the periphery was built at the same time or later than the core; and this was the purpose of the twelve tie-beams that originally crossed these spaces, eight of which survive in the parecclesia, a normal feature of Byzantine arch and vault construction.

[20] Prior to our recent visit to the building, information on recent work of the Ephoreia of Byzantine Antiquities cited throughout this paper was kindly provided us by George Velenis.

From evidence in other buildings, we know that Byzantine builders were aware of the magnitude of these tensile forces and took great care to anchor firmly the ends of beams in the masonry at the impost. In larger spans, usual procedure was to secure the beam ends with transverse or vertical anchors within the masonry, a straightforward operation when done in the course of new construction. But it was another matter to anchor a beam securely in an existing masonry face. At St. Eirene in Istanbul, the rebuilders of the ground story nave arcade found it necessary to dismantle the outer side aisles down to impost level to install vertical anchors, and the increase of the number of aisle bays from three to five was probably to provide additional tensile spans.[21] Here the beam anchors held fast with the only splay occurring above them in the haunch zone. At the Kariye Camii in Istanbul, the later south parecclesion was built with a new north bearing wall into which the tie-beams, visible in old photographs, could be easily anchored.[22]

There can, in short, be no doubt that when vaulted peripheral structures were added to an earlier building, they required either autonomous and self-sufficient new walls or major intervention in the earlier building to anchor tie-beams; and in such cases the evidence is almost always visible. At the Holy Apostles, the addition of the periphery to a preexisting core would have been a major and precarious operation, the more so since the impost level of the periphery is more than a meter below that of the naos requiring deep excavation into bearing walls. That no trace of such a procedure may be found is, in our opinion, further evidence for simultaneous construction of core and periphery. Further verification of this is treated in the next section.

Quadratura: One of the reasons that so much attention has been paid to the chronological relationship between the core and peripheral parts of the Holy Apostles is an opinion, first expressed by Diehl and recently reiterated by Ćurčić, that "the planning of the Holy Apostles reveals a lack of integration between the core and the envelope, an aspect characteristic of all two phase solutions."[23] Our purpose here is not to take issue with this contention, but rather to show that even if such matters as spatial design and composition were concerns of the Byzantine builders, the analysis of them must follow, not precede, the systematic collection and analysis of physical and other verifiable evidence. A case in point is the matter of planning and design at the Holy Apostles.

Some years ago Hans Buchwald showed that Church E at Sardis was laid out using a simple method of *quadratura*; and he suggested, correctly in our opinion, that the use of this method was probably widespread in Byzantine architecture and worthy of further investigation.[24] The problem in pursuing such an inquiry is the unreliability of most survey plans for this purpose, and the necessity even when good large-scale surveys exist, to verify measurements from the working masonry with precise instruments, taking into account such potentially misleading features as the thickness of marble revetment or plaster.

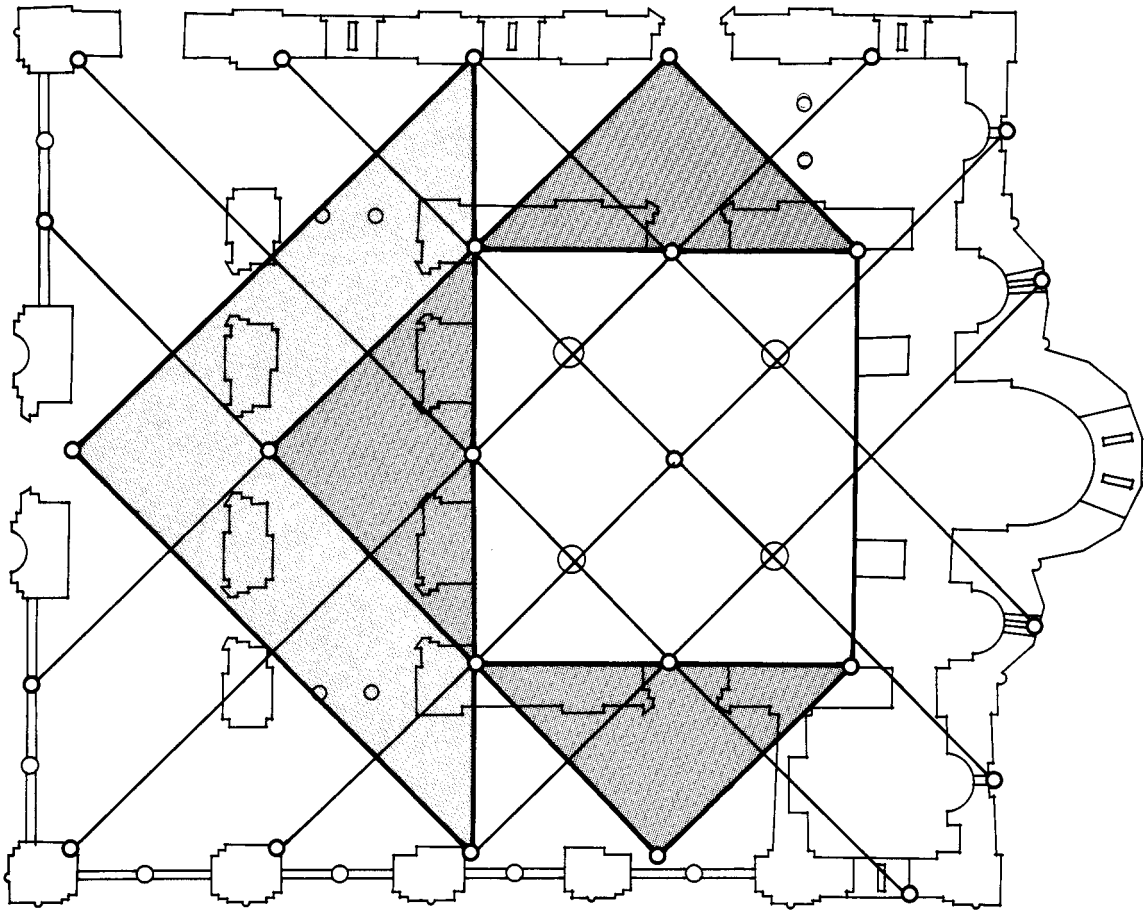
Mindful of this limitation, we nevertheless tested the method using the excellent, but unverified Tanoulas plan. In our experiment (Fig. 8), heavy lines define the most obvious relationships: the rectangular perimeter of the interior of the naos used at its north, south, and west sides to find the widths of the parecclesia and esonarthex (dark shading), and the west base line extended the full width of the interior to find the width of the exonarthex (light shading). Lighter lines define a series of further possible relationships. By moving the apex of a 90° triangle along the central east-west axis of the building, many points of correspondence were

[21] See P. I. Kuniholm & C. L. Striker, "The Tie-Beam System in the Nave Arcade of St. Eirene: Structure and Dendrochronology," in U. Peschlow, *Die Irenenkirche in Istanbul* (Istanbuler Mitteilungen, Beiheft 18), Tübingen, 1977, pp. 232–235. For tie-beams in general see, W. Haas, "Hölzerne und eiserne Anker an mittelalterlichen Kirchenbauten," *Architectura*, 13 (1983), pp. 136–151. R. P. Wilcox, *Timber and Iron Reinforcement in Early Buildings*, London, 1981, is so error-ridden as to be useless.

[22] See R. Ousterhout, *The Architecture of the Kariye Camii in Istanbul* (Dumbarton Oaks Studies 25), Washington, 1987, pp. 54ff. For the appearance of the parecclesion before restoration with one original tie-beam in situ see P. Underwood, "First Preliminary Report on the Restoration of the Frescoes in the Kariye Camii," *Dumbarton Oaks Papers*, 9/10 (1956), pl. 61.

[23] Diehl, pp. 191–192; Ćurčić, p. 73 n. 15 and p. 84.

[24] H. Buchwald, "Sardis Church E – A Preliminary Report," *Jahrbuch der Österreichischen Byzantinistik*, 26 (1977), pp. 271–272 and fig. 7.



8. Plan showing quadratura (drawing: D. K. McCoubrey based on Tanoulas)

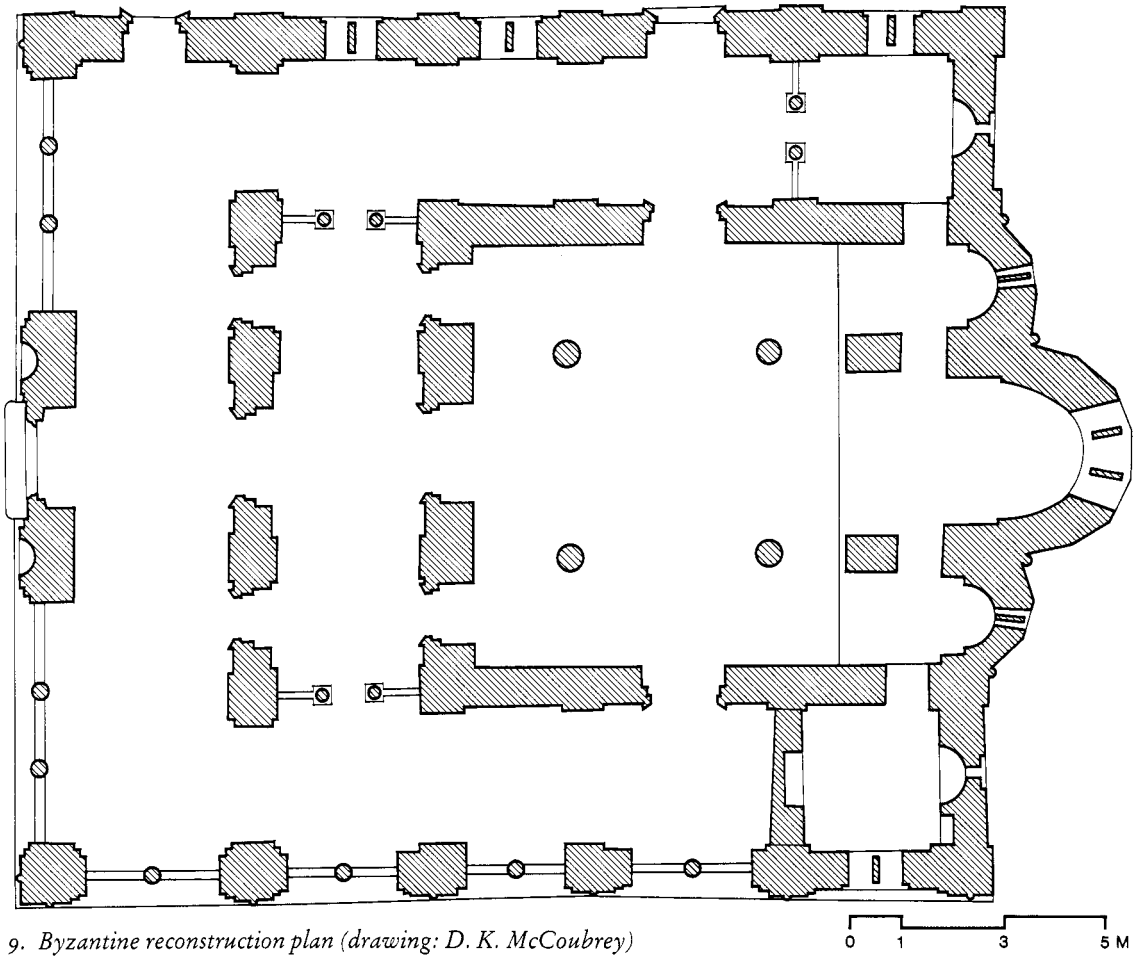
revealed, among which we have shown a selection connecting the core with the peripheral areas.[25] The significance of this for our purpose is not so much that the design of the plan is governed by an underlying set of simple geometric relationships, but rather that the entire plan could be laid out simply and practically at the building site using no more than L-square, plumb bob, and string. Of course this presupposes that the plan of the entire building was laid out and built at one time. For while it would have been theoretically possible to add the peripheral structures using geometric relationships generated from an already standing core, once sight-lines were obscured by preexisting standing structure, this would have been a tedious and useless exercise.

The Byzantine Architectural Evidence: Reconstruction

Our reconstruction of the appearance of the Holy Apostles in what we believe to have shown was a single primary Byzantine phase (Fig. 9) differs in some respects from other recent reconstructions. To observations we have already made, we add the following.

Exterior north and south facades: The outer flank walls of the parecclesia were both modified in Ottoman times and partially restored to their Byzantine

[25] The fact that the naos is rectangular rather than square imposes no limitation on the application of *quadratura*, since the proportional relationships are generated by laying out isosceles right triangles on an existing hypotenuse, in this case, e. g., the naos flank walls, the west wall, etc.

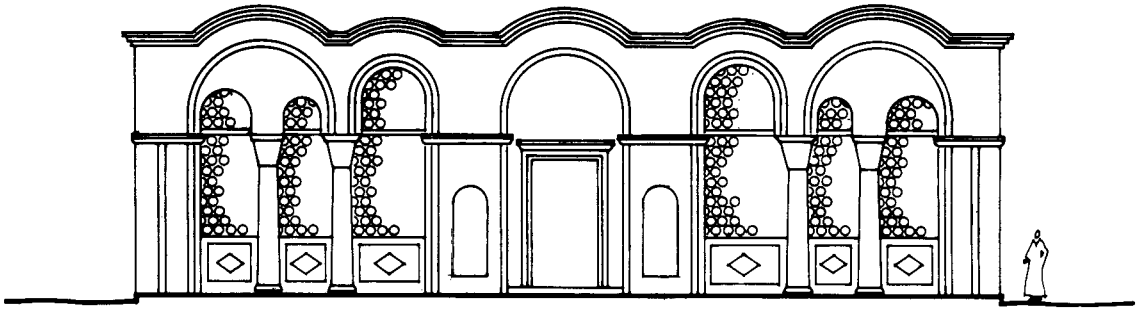


9. Byzantine reconstruction plan (drawing: D. K. McCoubrey)

form following the retransformation of the building to a church. But evidence is adequate to obtain an accurate picture of their original external appearance. Both facades are defined by six blind arches. Their spans differ both from bay to bay within each facade and between some of the corresponding bays on north and south, depending on the arrangement of doors, windows, and internal divisions. On the south facade, engaged brick colonnettes articulate each of the pilasters, rising from ground level to impost where they terminated with a chamfered marble cornice. The spandrels above this level had decorated brickwork with X-shaped motifs predominating.

On the north facade there were no colonnettes on the pilasters. As we shall see, the masonry in the center of each pilasters where they might have existed was subsequently disturbed. But proof that they never existed is to be found at the base of each pilaster where original masonry courses through, uninterrupted by vertical trim bricks that characteristically frame the existing colonnettes elsewhere on the facades.

Following the transformation of the building to a mosque, the roof drainage system was modified to carry the runoff along the north and west facades beyond the limits of the Ottoman porch. Vertical drain-pipes were installed below the Byzantine scuppers by cutting deep trenches down the center of each pilaster from the existing roof line to slightly above ground level. The trenches were then walled over flush with the facade surface in irregular horizontal brickwork. The lower mouths of the drain-pipes are still visible on both facades.



10. Reconstruction elevation of Byzantine west facade (drawing: D. K. McCoubrey)

The original fenestration of the north facade, consisting of small, undifferentiated bifora windows below surmounted by narrow, single-light windows above, was restored to its original form following the modern retransformation of the building to a church. On the south, the same original arrangement survives only in the eastern bay, corresponding to the skeuophylakion within. The four remaining bays to the west had large, double-arcade windows over marble screens and divided by columns, not unlike the present west facade. This arrangement is clearly visible in the masonry and has been correctly observed by others. The windows of both facades were undoubtedly glazed creating fully-enclosed spaces within.

Exterior west facade: The west facade preserves most of its original features below the window arches. The modern cement screens and metal lattice windows had Byzantine counterparts, probably in marble and plaster, fully enclosing the exonarthex (Fig. 10). By contrast, the center bay of the west facade, with its flanking niches, marble-enframed portal surmounted by double segmental relieving arches, and rectangular panel, has been extensively modified making an accurate reconstruction very difficult (Fig. 11).

Both of the niches flanking the door show clearly the walled-over vertical trenches cut up their back walls for roof drain-pipes in the same procedure just described on the north facade. Here, at the bottom, the trenches cut through the bases of the niches to bring the lower mouths of the drain-pipe, still visible, below the level of the Turkish porch (see Turkish reconstruction below). Above, the trenches cut through the heads of the niches and continued first vertically upward, and then diagonally outward through the spandrels in the direction of the scuppers. In this process the niche heads were crudely rebuilt possibly accounting for the marked difference between their construction and the refined Byzantine masonry elsewhere in the building.

The evidence for the original arrangement in the zone above the niches is particularly obscure. Since the drain pipe trenches rise diagonally outward when they reach the spandrels they bypass the vertical projections that were interpreted by Velenis to be the cut-back skewbacks of arches supporting a bell tower.[26] Accordingly, they offer no apparent evidence one way or the other for the validity of this hypothesis. But since it has not been possible to define the limits of rebuilding of the zone above the center door, which we shall see is demonstrably Ottoman, and since this rebuilding may include the anomalous vertical projections, we believe that the question of a bell tower is still open.[27]

The rectangular recessed panel above the door, unique in Byzantine architecture, undoubtedly originally enframed the Ottoman founder's inscription and is treated below in the Turkish reconstruction. Originally in its place was probably a stilted lunette, with an arcuated eaves line above (Fig. 10). While such an

[26] G. Velenis, "Οι Αγιοι Απόστολοι Θεσσαλονίκης και η σχολη της Κωνσταντινούπολης," *Jahrbuch der Österreichischen Byzantinistik [XVI. Internationaler Byzantinistenkongress, Akten*, II/4], 32/4 (1982), pp. 457–467.

[27] Rautman (pp. 221–223, note 66) offers objections to a bell tower, but none that are conclusive. We can offer no conclusive alternative to Velenis' interpretation of the rough cuttings on the marble foundation course below the niches as evidence for a bell tower, *loc. cit*, pp. 458–459 & fig. 4, but these can be read equally well as cut-backs to permit horizontal drain-pipes connected to the vertical roof drains to pass over.

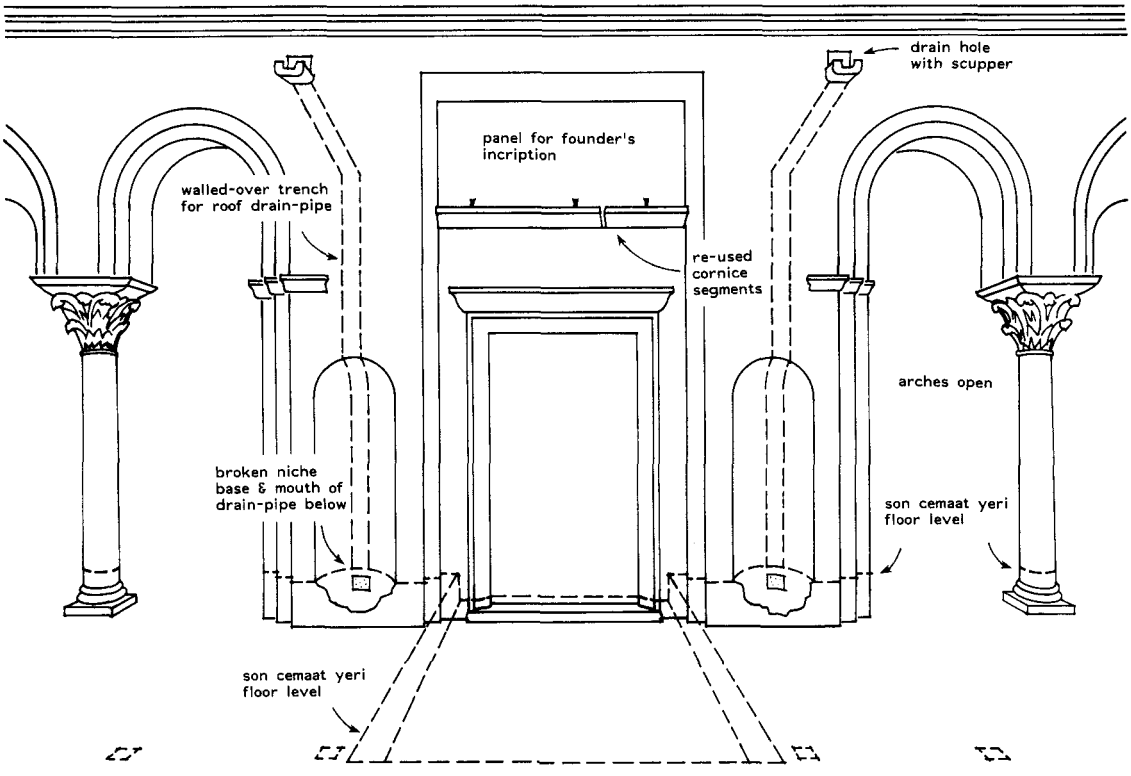
11. a) West facade showing Turkish modifications

arrangement is already reasonably shown in Le Tourneau's rendering and Papagiorgiou's sketch of this zone, both must be hypothetical reconstructions.[28]

Exonarthex east wall: Three doors originally connected the two narthexes, the center higher than the two flanking. We were unable to remove the modern boxing of the tie-beams of the flanking doors for the purpose of sampling, but the presence of beams within leaves no question that these originally were doors, undoubtedly marble enframed like those elsewhere.[29] Their subsequent history is complex. The aforementioned recent work of the Ephoreia of Byzantine Antiquities has exposed the fresco remains of standing figures on this wall that are cut by the flanking doors

[28] Diehl, pl. 63.1, and Papageorgiou, *loc. cit.* pl. 4, fig. 19. See also note 40 below.

[29] The issue of the number of doors here and correspondingly in the esonarthex west wall is clouded in recent published reconstruction plans of the building. The plan (by Ćurčić) in R. Krautheimer, *Early Christian and Byzantine Architecture*, 2nd ed., Harmondsworth, Baltimore & Ringwood, 1975, p. 455, fig. 388, proposes originally only one door in each of these walls. Later, Ćurčić, accepting our findings on this point, reconstructs three doors in each of these walls in his revised plan, fig. 103. But the plan (also by Ćurčić) in the 4th revised edition of Krautheimer, 1986, *op. cit.*, p. 430, fig. 388, shows the two flanking doors between the esonarthex and naos as Turkish. Rautman, fig. 5, reproduced by Ousterhout, *op. cit.*, fig. 166, reconstructs three doors between esonarthex and naos, but only one connecting the two narthexes. His argument, pp. 102–104, that Byzantine fresco is interrupted by the flanking door openings, refers to a meander frieze above, not to the recently discovered figures. It fails to take account of the fact that the flanking doors were lower than the center, and leaves unexplained the presence of tie-beams in them. Velenis' plans, *op. cit.*, p. 467, figs. 6 & 7, reprinted slightly modified by P. L. Vocotopoulos, "Church Architecture in Thessaloniki in the 14th Century, Remarks on the Typology," *L'Art de Thessalonique et des pays balkaniques et les courants spirituels au XIVe siècle*, Belgrade, 1987, p. 108, fig. 1, reflects the recent fresco findings but leaves in doubt whether the flanking doors were originally present. A correct reconstruction plan is given in *Thessaloniki and its Monuments, op. cit.*, p. 101.



11. b) West facade showing Turkish modifications (drawing: D. K. McCoubrey)

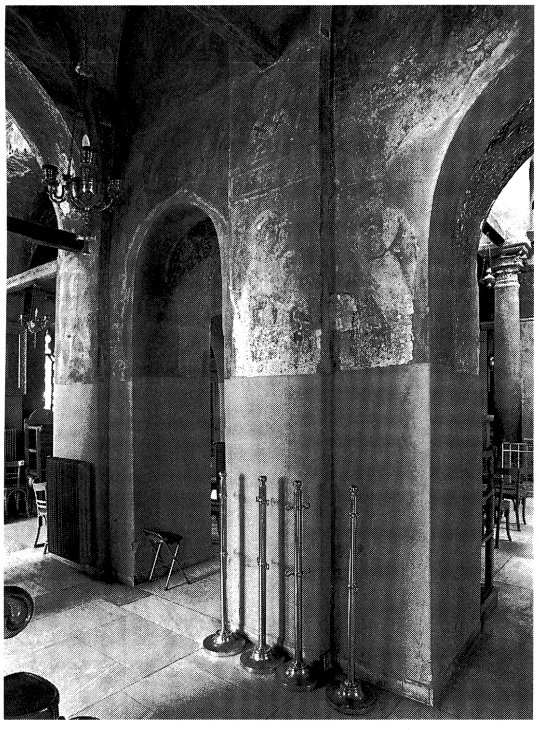
indicating that here, as well, the doors were blocked and frescoed over in a second Byzantine phase. Further modification of these doors is treated below in the Turkish reconstruction.

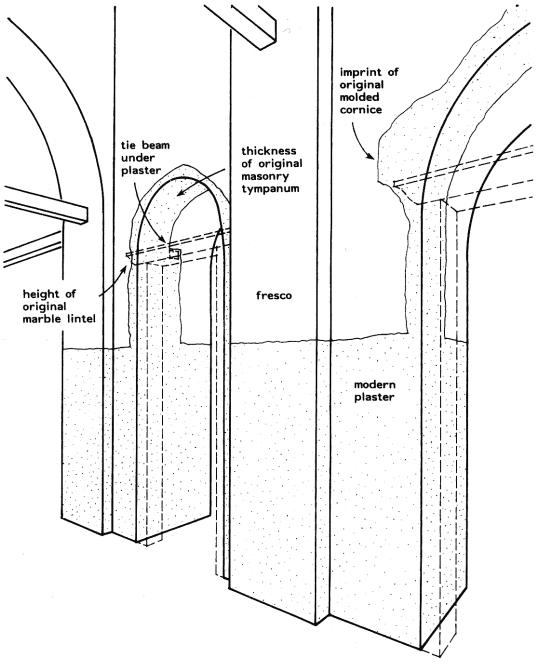
Esonarthex east wall: Originally, there were three doors, as well, leading from the esonarthex into the naos, in this case leaving clear evidence for their reconstruction (Fig. 12). The presence of stumps of sawed-off tie-beams, concealed by modern plaster, may be verified by tapping across the modern plaster, and the shadows of the stumps are visible on the plaster surface. Moreover, the border between surviving Byzantine fresco and modern plaster traces the contour of the marble jambs and lintels originally surrounding the door. The reason for their removal is treated below.

Esonarthex tribeloi: In our discussion above of the tribeloi flanking the esonarthex, we left open the question of whether passage was possible through them into the parecclesia. In the absence of physical evidence or a clear indication from comparable arrangements elsewhere, we believe that the issue must remain open.

North parecclesion partitions: Recent work of the Ephoreia of Byzantine Antiquities has exposed evidence in the north parecclesion for a transverse partition wall, undoubtedly with door, in alignment with the west wall of the naos and separating the third and fourth bays. While the partition must have been in place before the aforementioned painted decoration of the tie-beams, we have no evidence indicating whether this was part of a primary or secondary Byzantine decoration. Thus, while provisionally accepting Velenis' assignment of this partition to the primary phase, we have not included it in our reconstruction plan, Figure 9.

On the other hand the recent removal of plaster at the east end of the parecclesion reveals that the eastern bay was originally screened off by a tribelon similar to those flanking the esonarthex with a tympanum above bonded to the transverse arch defining this bay. Im-





12. a) and b) North and center doors of esonarthex east wall showing evidence for original marble door frames (drawing: D. K. McCoubrey)

prints were also exposed on the working masonry indicating the presence of an epistyle and of marble screens below, undoubtedly flanking a center door. This resolves uncertainty about the original arrangement on the north side, and, as we shall see, has bearing on questions about the south side as well.

Skeuophylakion west wall: The wall closing off the east bay of the south parecclesion and forming a square skeuophylakion accessible only from the diaconicon, has perplexed scholars as to its purpose and originality. Le Tourneau, apparently considering it to be Turkish, went so far as to exclude it from his plan, although in fairness to him it should be noted that the Byzantine fresco program covering its west side was not visible at the time of his survey.

Our examination of the vertical crack in the west face of this wall at its north corner where it adjoins the pilaster of the parecclesion north wall indicated that it was not bonded to the pilaster. We also concluded that a horizontal wood tie-beam, identical to the others spanning the bays to the west, was undoubtedly imbedded in this wall, its position indicated by a horizontal crack. Velenis and Rautman concurred that this wall was not bonded to the surrounding structure, and this was recently confirmed by examination of the joints from the interior of the skeuophylakion by the Ephoreia of Byzantine Antiquities. Velenis and Rautman concluded that the wall was inserted in a second Byzantine phase, and Velenis used this to support his hypothesis that the present skeuophylakion bay was originally open and continuous with the remainder of the south parecclesion, that a wall originally closed off the corresponding bay in the north parecclesion, and that this was subsequently removed and replaced by the existing one at the south.[30]

With regard to the north parecclesion, this hypothesis can now be corrected by the aforementioned new evidence. We also believe there to be a more probable interpretation of the evidence on the south

[30] Velenis, *op. cit.*, and personal communication; Rautman, pp. 148–149.

Holy Apostles Turkish phase compared to four-building dated master

Distribution of t-value (t)

t	number	%
0.0 - 0.5	315	67.0
0.6 - 1.0	70	14.9
1.1 - 1.5	45	9.6
1.6 - 2.0	23	4.9
2.1 - 2.5	12	2.6
2.6 - 3.0	3	0.6
3.1 - 3.5	1	0.2
3.6 - 6.0	-	-
6.1 - 6.5	1	0.2

t = 6.06 at 1490

Distribution of trend coefficient (TC)

TC	number	%
0.0 - 50.	264	56.2
50.1 - 52.	89	18.9
52.1 - 54.	74	15.7
54.1 - 56.	21	4.5
56.1 - 58.	15	3.2
58.1 - 60.	3	0.6
60.1 - 62.	2	0.4
62.1 - 64.	1	0.2
64.1 - 66.	1	0.2

TC = 63.37 at 1490

Distribution of dating index (D)

D	number	%
0 - 10	454	96.6
11 - 20	13	2.8
21 - 30	1	0.2
31 - 40	0	0.0
41 - 50	1	0.2
51 - 80	-	-
81 - 90	1	0.2

D = 81.01 at 1490

13. Distribution of statistical values for cross-dating Turkish phase

side. The joints where the transverse wall abuts the surrounding construction are more likely construction rather than phase joints. In the normal sequence of construction the south parecclesion would first have been built up in working masonry as a continuous space, with the now imbedded tie-beam between the two eastern bays, and undoubtedly with wood centering to support the vaulting. Only after the masonry had stiffened and the centering had been removed, would the partitions, such as this wall, have been inserted. The external fenestration of the south flank, with the clear distinction between the small window of the skeuophylakion and large windows further to the west, also indicates that the internal partition between the two eastern bays was originally intended.

Despite its importance for understanding how the skeuophylakion was originally intended to function, the question of when the door in its west wall was blocked and frescoed over on its west side must, in the absence of evidence for determining this, remain moot.

Turkish Chronological Problems

Most aspects of the history of the Church of the Holy Apostles in the Turkish period have been ignored. And in light of the use of the building as a mosque half again longer over its lifespan than as a church, this chapter of its history is worthy of further inquiry, not only for its own sake, but for the light that this might shed on its Byzantine phase.

Uncertainty as to when the building was transformed into a mosque may now be put to rest. It was founded by Cesari-zade Koca Kasim Paşa, the military governor *(sanjak beyi)* of Thessaloniki from 1520 to 1530, who gave his name both to the mosque and to the quarter of the city *(mahalle)* where it was located, newly founded at the same time.[31] The inconclusive and varying prior opinions on this question resulted from the erroneous assumption that the transformation must have occurred shortly after the Turkish conquest of the city in 1430, as well as from futile searches for reference to the building under its late, vernacular name, Soğuk Su Camii (Cold Water Mosque, from the nearby fountain) rather than associating the name of the mosque and its date of transformation with the name of the founder of the quarter and its foundation date.

Turkish Dendrochronological Evidence

Wood samples from the Turkish period came from the south facade and from squared Turkish windows in the drums of the eastern domes of the parecclesia left unmodified in the modern retransformation to a church. While samples from the windows in the south facade and parecclesia domes had short ring sequences, all under 50, the door lintel (Sample 21) yielded a 229-ring sequence with which several sequences from the south facade windows (Samples 22, 23, and 24) could

[31] See V. Demetriadis, Τοπογραφία της Θεσσαλονίκης κατα την εποχη της Τουρκοκρατίας, Thessaloniki, 1983, pp. 307–308.

be cross-dated and merged, giving a 245-year sequence. And when this was compared to the aforementioned four-building dated master, a secure cross-date was obtained at 1490 for the last preserved ring of the Turkish sequence (Fig. 13). Notwithstanding the fact that the trend coefficient is only second highest at this date, the *t* and D-values are widely separated from the next lowest values.

Since no sapwood is preserved on any of the samples we are unable to estimate the felling year for the set. However, our estimate of 26 ± 9 sapwood rings for Aegean oak added to the date of the last preserved ring of 1490 gives the estimated date of 1516 with the range 1507–1525 for one standard deviation for the probable *terminus post quem* for the felling year for the set. Thus, while the absence of sapwood limits our felling year estimate only to a *terminus post quem*, that date is fully consistent with the date for transformation in the 1520s known from historical evidence, and it provides the first independent confirmation of it.[32]

Turkish Reconstruction

No attempts have been made, to our knowledge, to consider the architecture of the Holy Apostles in terms of its function as a mosque. From photographs and drawings of the building made before its retransformation into a church, we are able to obtain a quite complete picture of its appearance and to understand a number of otherwise anomalous features as normal and coherent modifications to adapt the building from Christian to Islamic use (Fig. 14).

Son cemaat yeri and narthexes: The conventional Ottoman mosque was always preceded by a portico or porch, generally single but occasionally double, called the *son cemaat yeri* (lit.: last or late congregation place) where late-comers could pray and the coffins of the dead were placed during funeral services.[33] From here, one normally entered directly into the prayer hall; and the functional division between these two spaces is reflected in clear division in the building design. In adapting the Byzantine narthex or narthexes to Islamic use, this creates a problem; for the narthex, when there is but one, or exonarthex, where there are two, is a space more enclosed toward the western exterior then toward the interior naos, the reverse, in other words, of the *son cemaat yeri* that is always clearly segregated from the prayer hall. Moreover, when a second narthex is present, there is the additional problem of another intermediate room between exterior and the prayer hall within.

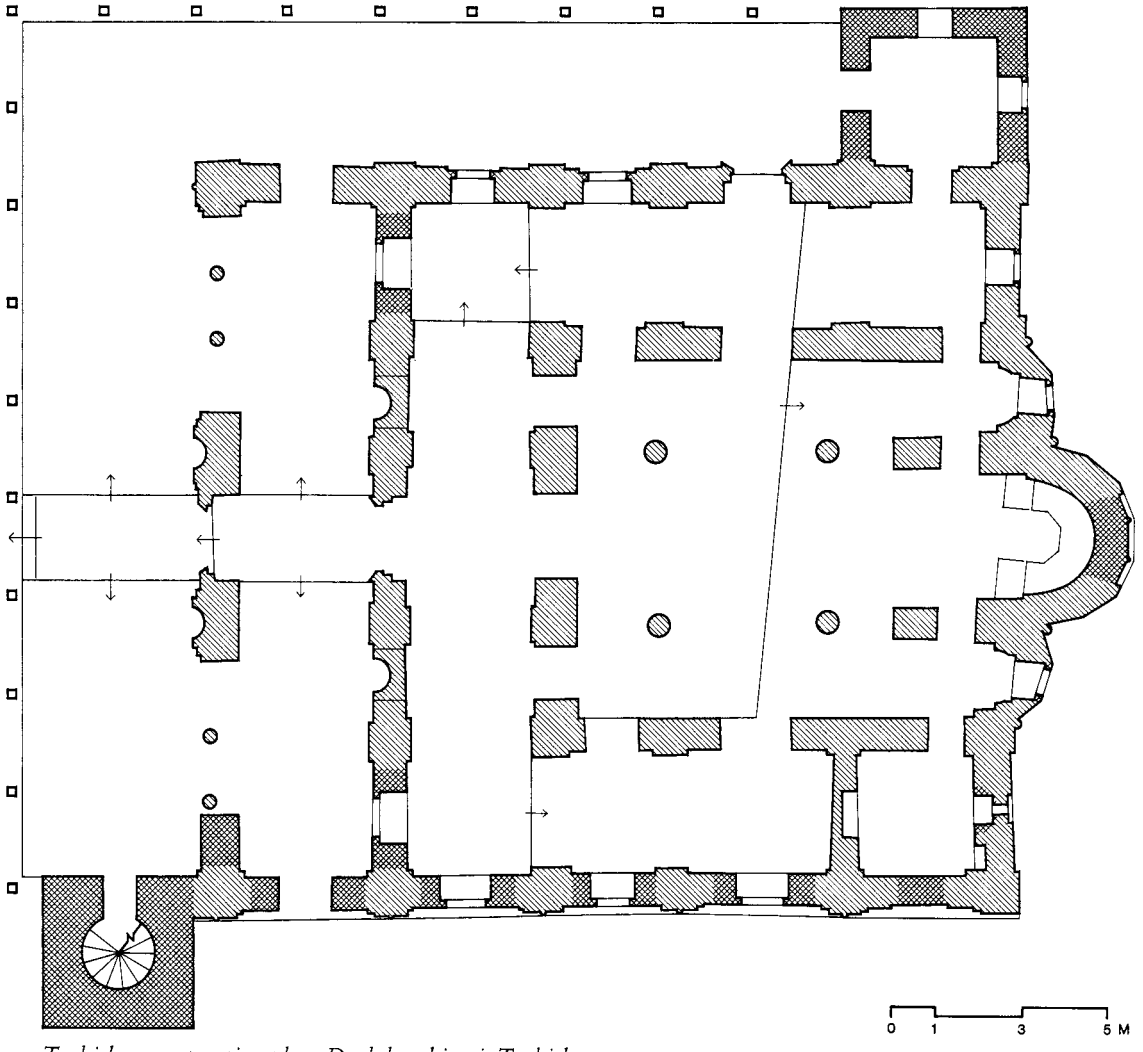
The solution at the Holy Apostles was to make the exonarthex part of the *son cemaat yeri* and the esonarthex and west bays of the parecclesia part of the prayer hall; and all changes here follow logically from this. The two doors that originally flanked the center door between the two narthexes had already been blocked in a secondary Byzantine phase, and the only change here was to cut *mihrab* niches on their western sides. At the two end bays of the exonarthex, partitions with low, square windows, now removed, were inserted between these bays and the western bays of the parecclesia. If the partition in the north parecclesion aligned with the west wall of the naos had still been present, this would undoubtedly have been removed at this time. The intent, in short, was to close up passage all along the axis of the naos west wall making it into the west wall of the prayer hall and keeping only the central door with its marble frame intact as access. All of these features are shown in the Le Tourneau drawings made while the building was still in use as a mosque.[34]

In this procedure it was normal that external *mihrab* niches be provided in the east wall or walls of the *son cemaat yeri* to orient the faithful who could not see the main *mihrab* on the *kible* wall within the prayer hall. Hence the aforementioned niches in the blocked doors

[32] Despite our care in pointing out that in the absence of bark or the terminal growth ring the date of the last preserved ring of 1455 (now corrected to 1490) is only the *terminus post quem*, Rautman, p. 59, note 4, misinterprets this to signify the date of transformation.

[33] For the suggestion that double *son cemaat yeri* found in some newly-built mosques of the early 16th century may have been a passing fashion for mosques of vezirs see G. Goodwin, *A History of Ottoman Architecture*, London, 1971, p. 214. Dr. Machiel Kiel kindly advises us that the term for these porticoes may be an intentional play on words reflecting their double function for late comers and as final resting place.

[34] Diehl, pls. 62, 63.1, and 66.2



14. Turkish reconstruction plan. Dark hatching is Turkish (drawing: D. K. McCoubrey based on Tanoulas and Le Tourneau)

between the former narthexes. On the west facade, the Byzantine niches flanking the center door were conveniently adapted to *mihrab* niches, and, as we shall see in our consideration of the Turkish floor levels, their bases, again conveniently, determined the floor level of the *son cemaat yeri* (Fig. 11). The resulting ensemble was that of a normal *son cemaat yeri*, raised on a platform and transected by a lower entrance corridor on the main axis.

At the same time, and consistent with these changes, the exterior wall of the exonarthex was opened up by removing what we believe to have been enclosing marble slabs with windows above in the triple arcades flanking the main entry. This arrangement, clearly shown in the Le Tourneau drawings, is confirmed by the accompanying photograph[35], and was reversed as well in the modern retransformation to a church.

Drawings and photographs from the late 19th and early 20th century show a portico with tile-covered, lean-to roof supported by wooden posts enclosing the north and west side of the building (Fig. 15). While there is no direct evidence for when it occurred, the

[35] Diehl, *ibid.* and p. 90, fig. 82.

porch roof in this final form was a modification of the original Ottoman arrangement. The aforementioned drain pipes that had carried the roof run-off within the outer north and west walls and under the floor of the outer *son cemaat yeri* were suppressed beneath a continuous roof that carried the run-off over both porticoes to the building perimeter.

Minaret: Old photographs (Fig. 15) also show the minaret at the southwest corner of the building, a type known from the early 16th century. It is structurally logical and evident from photographs that the square base of the minaret was an autonomous structure, built against, but not including the southwest corner pier of the building as is misleadingly suggested in the Le Tourneau plan.[36]

Windows in the flanks and east facade: In addition to serving as place of prayer, another important function of the mosque is for reading and instruction in the Koran; and this required more daylight near ground level than was available in Byzantine churches. To provide for this, it was usual practice to replace with low, square, large-light windows the other types of Byzantine fenestration that admitted very little light even at waist level.[37] This modification is still visible along the south flank, where the Turkish changes were not reversed in the modern retransformation. Square windows, since removed, were also installed along the north flank, in the aforementioned west wall of the prayer hall, and in the apses of the pastophoria. Windows in the main apse were blocked, since the *kible* wall and *mihrab* occupied the full east part of the apse in the interior.

Prayer hall: Few changes were necessary to modify the naos, esonarthex, and remaining bays of the parecclesia for use as prayer hall. Here the requirement was to create as much unobstructed space as possible from what had been segregated areas by opening up the divisions between them. This was accomplished by dismantling the tribeloi at the ends of the esonarthex, removing the three marble frames from the doors in the west wall of the naos and from the single doors in each of its flanks, and by cutting new doors through the same flanks immediately to the west of the existing ones. The secondary Byzantine blocking of the north door of the prothesis was also probably reopened at this time. These measures facilitated circulation and increased the area in which sightlines by the faithful were possible to the *mihrab* or to the *imam*, the leader of the congregation.

Photographs of the naos interior made while the building was still a mosque[38] show a customary wooden women's gallery *(kadın mahfili)* spanning the west side of the naos. While this may not be original, such a gallery would have originally existed.

Floor levels: Le Tourneau's survey of the building before its modern retransformation for Orthodox use records sufficient information for the reconstruction of the floor levels in the mosque phase, shedding light on some otherwise anomalous surviving features.

The western exterior grade, now lowered to the probable original Byzantine level, was at the time of Le Tourneau's survey about 90 cm. above the interior Byzantine floor level (Figs. 11 and 14). From here, two steps led down ca. 60 cm. into the outer *son cemaat yeri* through an axial entrance corridor flanked on each side by the slightly raised floor of the *son cemaat yeri* proper.[39] Another step down along the entrance corridor and through the main portal led into the inner *son cemaat yeri* (exonarthex). Here the floor of the corridor was at the original Byzantine level, while that of the flanking *son cemaat yeri* was characteristically some 50 cm. higher.

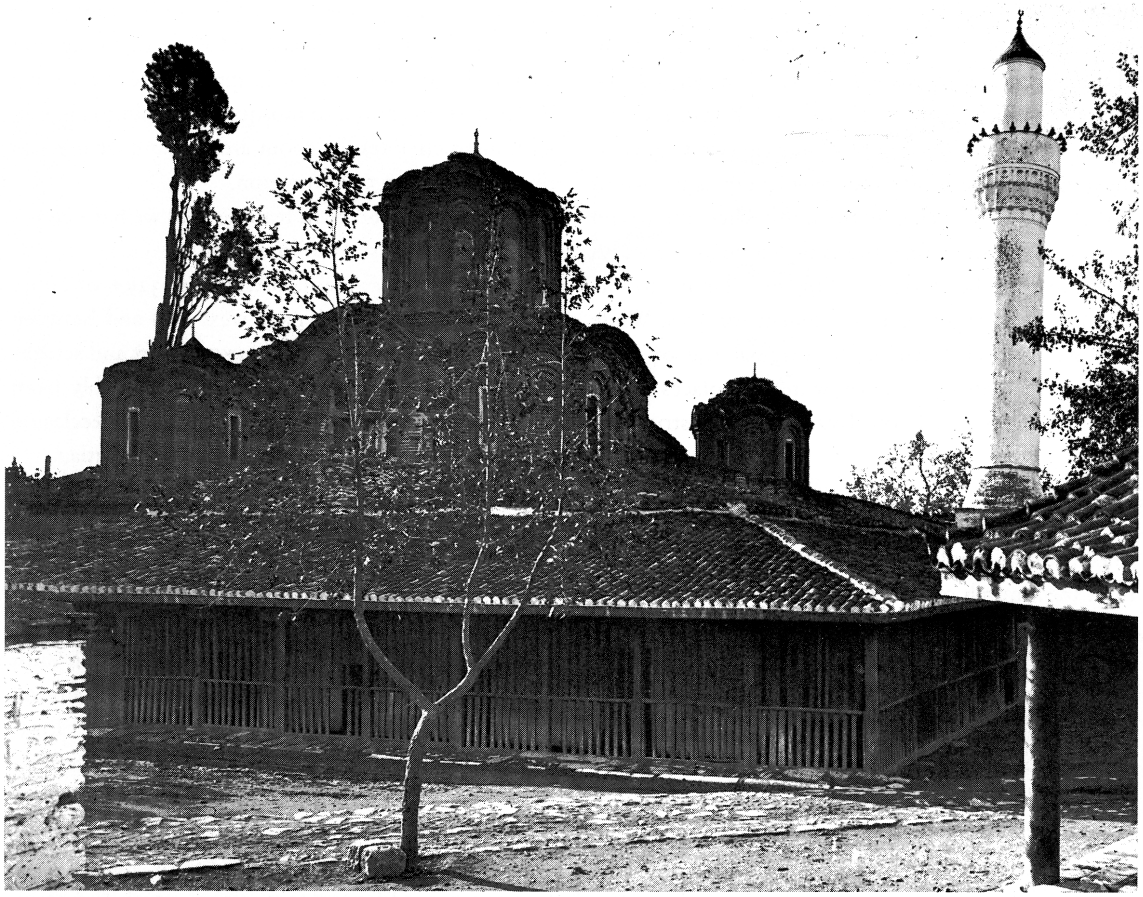
Within the eastern part of prayer hall a step running slightly diagonally to the transverse axis of the building but parallel to the *kible* wall raised the east bay of the north parecclesion and the eastern part of the naos and bema above ground level. This made the *mihrab*

[36] Photograph and plan, respectively Diehl, pls. 64 and 62. For the minaret type see S. Eyice, "Istanbul Minareleri," *Türk San'atı Tarihi Araştırma ve Incelemeleri*, 1 (1963), pp. 31–132.

[37] Rautman's failure to recognize the purpose of these Turkish modifications here and elsewhere, and his apparent misconception of the form of Middle and Late Byzantine windows leads him to the opposite conclusion, p. 144, that, "In its original state the south ambulatory was the best illuminated part of the church," and that, "The present Turkish windows effectively dull what once must have appeared as a spacious and light vessel." Modern wooden pews blocking much of each window opening are the cause of the present dim lighting in this space.

[38] Diehl, p. 195, fig. 85.

[39] Diehl, p. 190, fig. 82 and pl. 66.2.



15. View of building from northwest ca. 1900 (courtesy British School at Athens)

and *imam* more easily visible from the remainder of the prayer hall, and by obscuring the original bemata steps corrected the orientation of the congregation toward Mecca. The two eastern bays of the original south parecclesion and the northwest bay of the prayer hall in the north parecclesion were also raised one step bringing these areas closer to window sill level and providing better light for Koran reading.

Rectangular panel over main door: In our discussion above of the reconstruction of the west facade in its Byzantine phase, we noted that the rectangular panel over the main door (Fig. 11), considered Byzantine by some, was anomalous, indeed unique, in Byzantine architecture. But it is perfectly normal in Ottoman architecture as the place and shape of the founder's inscription *(kitabe)*, usually a marble plaque with raised inscription against a recessed field.[40] The bottom of the now empty panel has a sill made of reused

[40] The rectangular frame is homogeneous in construction with no evidence of modification and its outline is shown schematically in Texier's drawing of 1864 and Papageorgiou's sketch. But it is omitted in Le Tourneau's drawing; and the arch above it in both Le Tourneau and Papageorgiou was certainly invented, probably to look more Byzantine (see note 28 above). The actual inscription panel must have been removed from this location (and possibly placed elsewhere in the building) prior to Diehl's ca. 1909 photograph of the zone (p. 190, fig. 82). The latest this could have occurred was during construction or reconstruction of the outer *son cemaat yeri* visible in late photographs, in the course of which a range of horizontal tiebeams was crudely inserted across the entire west facade, three of them penetrating the rectangular panel. The positions of the insertion holes, blocked in the modern restoration, are still visible.

marble cornice, and the three iron nails, still leaded into it, probably secured in typical fashion the bottom of the inscription plaque. We observe further that the sill has the same chamfered profile as Byzantine cornices elsewhere in the building and is in two segments: the longer northern one, the same length as the width of the pier directly below to the south where there is no cornice; the shorter one, the same length as the width remaining in the corresponding pier below to the north where a short cornice segment survives. While this may be coincidental, the original use of these cornice segments directly below in these places on the west facade fits exactly our Byzantine reconstruction.

Summary

The dendrochronological analysis of 45 wood samples from the Church of the Holy Apostles revealed some surprising information about the date of the original construction of the Byzantine church, moving it to 1329 or slightly later, at least 15 years after the inferred date from the founder's inscription. It also added further confirmation to the hypothesis that the Byzantine church was constructed in one phase. Finally, it provided the first independent confirmation for recent opinion based on historical information that its transformation to a mosque occurred not, as had been generally assumed, shortly after the final Turkish conquest of the city in 1430, but almost a century later in the 1520s.

The initial inconclusiveness of the dendrochronological results led to a reexamination of the fabric of the building resulting in the revision of a number of points regarding its Byzantine reconstruction, and the recognition of conclusive evidence for its construction in one phase. In addition, the reconstruction of the appearance of the building during its use as a mosque in the Turkish period is considered for the first time, and analyzed in terms of double adaptive reuse of the same building from church to mosque and again to church, with instructive results about architectural changes in response to changes in function.

We summarize the main features that we have considered in each phase as follows:

Byzantine 1: Original construction 1329+ of entire church. Three doors in naos west wall and between narthexes. Tribeloi at flanks of exonarthex and screening off east bay of north parecclesion. Possibly from this phase, transverse partition in north parecclesion aligned with naos west wall. Bell tower uncertian.

Byzantine 2: Date unknown. Door from prothesis to north skeuophylakion and flanking doors between narthexes blocked and frescoed over.

Ottoman 1: Transformation to mosque in 1520s. Founder's inscription *(kitabe)* in rectangular frame over main door. Niches in piers flanking main door adapted to *mihrab* niches. *Mihrab* niches in already blocked flanking doors between narthexes. Low, square windows throughout ground story. Apse windows blocked. Cross-arm attic tympana and dome windows replaced. Door at south end of exonarthex. Archways through west flanks of naos. Marble door frames removed from doors in naos north and south walls and from flanking doors in naos west wall. Tribeloi flanking esonarthex and in north parecclesion removed. Partitions in north and south parecclesia aligned with wall between narthexes. Blocked door between prothesis and north parecclesion opened. Minaret and *son cemaat yeri.*

Ottoman 2: Date unknown. Roof drain drainage system modified.

Photos: 1, 9, 11b, 12b D. K. McCoubrey. – 2, 7, 8 D. K. McCoubrey based on Tanoulas. – 14 D. K. McCoubrey based on Tanoulas and Le Tourneau. – 15 courtesy British School at Athens.