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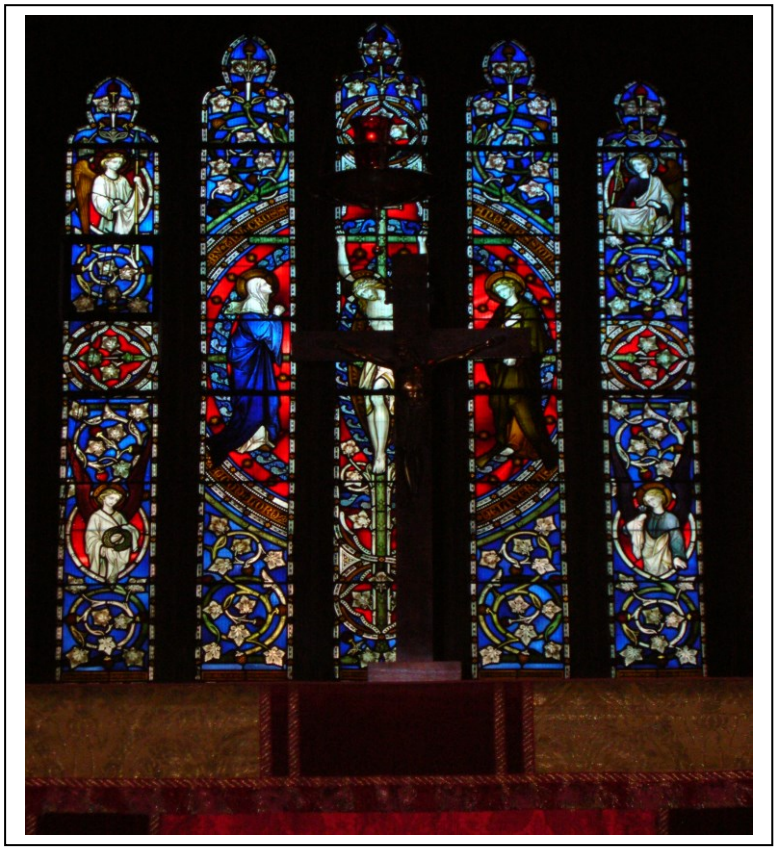

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TREE-RING ANALYSIS OF TIMBERS FROM THE CHURCH OF S
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SUMMARY

Tree-ring analysis of 16 oak samples from Melbourne parish church indicates that a majority of the principal or main beams of the chancel roof are formed from trees likely to have been felled sometime between 1683 and 1692. This, and other inscriptional evidence, would suggest that a major programme of alterations to the church took place in the late-seventeenth and early-eighteenth centuries.

Although not dated by tree-ring analysis, it is likely, given their very straight and clean edges, the clarity of the laying-out lines, and the regularity of the circular saw marks to their surfaces, that the smaller timbers of this roof (the common rafters in particular), are later replacements, possibly of nineteenth (or even twentieth) century date.

The felling date of the small amount of timber sampled in the north east chapel roof cannot be determined with precision, but it is unlikely to be before, say, 1565.

From the samples analysed, two site chronologies were created. The first, MELCSQ01, comprises 12 samples, all from the chancel roof, and has an overall length of 160 rings. These rings were dated as spanning the years 1509–1668. The second site chronology, MELCSQ02, comprises two samples, both from the roof of the north-east chapel, with an overall length of 122 rings. These rings were dated as spanning the years 1431–1552. Two samples remain undated.

Introduction

At the time of William The Conqueror the Parish of Melbourne lay in the diocese of Lichfield and Coventry. However, Henry I granted the Rectory and Manor to Adelulf, the first Bishop of the new diocese of Carlisle, when that see was created in 1133. It is believed, though there is some debate about this, that when Carlisle was seized by the Scots in 1136, it was to Melbourne that Bishop Adelulf retired (as did later bishops during subsequent boarder raids).

Melbourne Parish church, (Frontispiece), SK 389 250 map, Figure 1, dedicated to St Michael with St Mary is believed to date from the middle of the twelfth century and, both inside and out, it is thought to be still very much as it was at this time. Only the aisle walls (raised, it is believed, after 1400), the central Norman tower (originally low and square but raised in the early-seventeenth century), and some parts of the east end are of later date (the chancel was originally of two storeys with an apsed

end and there were apsidal chapels to the east side of the transepts as well). Thus, while the original stylistic evidence might place the construction of the church to between 1130 and 1160, its plan form appears to be older and might suggest that it is either slightly earlier than thought or there is a connexion with the Rhineland and Lower Saxony from whence the plan originated. A view of St Michael's is given in Figure 2. A recent guide and description of the church is available (Barman, 1974).

Between the time of its construction and the early-sixteenth century little other work was undertaken at the church. During the Reformation, however, a great deal of destruction took place, with various chapels and chantries being destroyed at this time and church lands dispersed. It may be of interest to note that Thomas Cromwell leased the Rectory in 1530 from the Bishop 'at a rent of £10, the Bishop to find timber for repairs'. Subsequent rebuilding of the church included the blocking of the east walls of the transepts where the apses had been, this believed to have been done c 1550–59. The apsed east end of the chancel may have been made square at this time too, a drawing of *c* 1602 appearing to show the original central Norman tower plus a now square-ended, two-story, chancel. It is likely, therefore, that the present tower was built after 1602 and before 1610, when the first of the modern bells was hung.

It is not certain when the roofs of the chancel and transepts were lowered. Given that they appear at their original height in the drawing of 1602 it must be after this date, but, on the evidence of an inscription in the south transept recording the relaying of the lead to the present lower roof, before 1711. The roof of the chancel is formed of four tiebeams with shallow cambers supporting a ridge and single purlins to each slope. The purlins in turn support common rafters to each of the three bays. The form if the roof has traditionally been tentatively dated to the late-sixteenth century.

Sampling

There have been two episodes of sampling at the Church of St Michael at Melbourne in Derbyshire. It is believed that the first episode was undertaken on an opportunistic basis in 1979, a time when tree-ring dating in Britain was still at an experimental and theoretical stage, and when the methodological processes of recording timber details and sample location was not fully developed. It is believed that minor repairs were being carried out to the roofs of the chancel and the north-east chapel at this time, necessitating the removal by the building contractors of short lengths of decayed timber to allow the splicing-in of new pieces. As a consequence, although the general location of the sampled timber as to a particular roof is thought to be correct, it is not certain. The exact original location of the individual timbers within the roofs is not known.

The samples obtained in 1979 were retrieved at the time of these works as nine sliced radii, seven from the chancel roof and two from the roof of the north-east chapel, not only to provide regional tree-ring data for research, but also in an attempt to show that the dating of timbers from building archaeology situations could be routinely undertaken. The results of this early analysis showed that the timbers, wherever their original location in the church, were derived from trees felled some time in the seventeenth century.

A further episode of sampling, this time by coring, of the timbers of the chancel roof was undertaken in October 2007, on this occasion the timbers being accessed from a light-weight scaffold tower. A description of the sampled timbers was made and their locations carefully recorded. The purpose of this work, commissioned by Philip Heath, and generously funded by South Derbyshire District Council, was to establish with greater reliability the felling date of the timbers used for the chancel roof.

Thus, from the timbers available a total of seven core samples was obtained, each sample from a different timber. Each sample was given the code MEL-C (for Melbourne Church) and, allowing for the samples obtained in 1979, were numbered 11–17. The positions of these samples have been marked on a simple schematic sketch plan made at the time of sampling, this being reproduced here

as Figure 3. Details of the samples are given in Table 1. In this Table, and on the plan, all trusses and the individual timbers have been numbered and/or identified on a north–south, or east–west basis, as appropriate.

Although additional main beams were in theory available for sampling, it was seen that such timbers, although large, were derived from fast grown trees. As such it was felt unlikely that they would have sufficient rings for reliable analysis. Very many of the smaller beams, that is the common rafters and possibly one or two of the purlins, appeared to be very straight and even, and to have none of the warping, twisting, and varying degrees of surface decay associated with older timbers. Many of these smaller timbers also showed very clear laying-out lines associated with the cutting of chamfers and stops, and some showed clear evidence of having been trimmed with a modern circular saw. It was believed that such timbers represent either nineteenth or even twentieth century repairs. It may be possible to determine the precise date of these repairs from the documentary sources.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank the incumbent of St Michael's Church, the Reverend John Davies, for his help and cooperation during sampling, and for his forbearance during the erection and removal of the scaffold tower. The Laboratory would also like to thank Philip Heath, for arranging access and for help with the interpretation of this building, and South Derbyshire District Council for funding this programme of analysis.

Tree-ring dating

Tree-ring dating relies on a few simple, but quite fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees, the most frequently used building timber in England) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March – September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically influenced pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way.

Secondly, because the weather over any number of consecutive years is unique, so too is the growth-ring pattern of the tree. The pattern of a short period of growth, 20, 30 or even 40 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 54 years or so. In essence, a short period of growth, anything less than 54 rings, is not reliable, and the longer the period of time under comparison the better.

The third principle of tree-ring dating is that, until the early- to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland, or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimeter. The growth patterns of these samples of unknown date are then compared with a series

of reference patterns or chronologies, the date of each ring of which *is* known. When the growth-ring sequence of a sample "cross-matches" repeatedly at the same date span against a series of different relevant reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference, is denoted by a "*t*-value"; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of samples and references have been produced by growing under the same conditions *at the same time*. The statistically accepted fully reliable minimum *t*-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phase of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a "site chronology". As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for reliable dating.

Having obtained a date for the site chronology as a whole, the date spans of the constituent individual samples can then be found, and from this the felling date of the trees represented may be calculated. Where a sample retains complete sapwood, that is, it has the last or outermost ring produced by the tree before it was cut, the last measured ring date is the felling date of the tree.

Where the sapwood is not complete it is necessary to estimate the likely felling date of the tree. Such an estimate can be made with a high degree of reliability because oak trees generally have between 15 to 40 sapwood rings. For example, if a sample with, say, 12 sapwood rings has a last sapwood ring date of 1400, it is 95% certain that the tree represented was felled sometime between 1403 (1400+3 sapwood rings (12+3=15)) and 1428 (1400+28 sapwood rings (12+28=40)).

Given that in a timber-framed building the trees required for each phase are almost certainly to have been cut in a single felling operation especially for that building, it is usual to calculate the average date of the heartwood/sapwood boundary of *all* the dated samples from each phase of a building and add 15 to 40 rings to get the overall likely felling date of the group.

Analysis

All 16 samples obtained from both episodes of sampling were prepared by sanding and polishing and their annual growth-ring widths were measured. The annual growth-ring widths of these 16 samples were then compared with each other.

At a minimum value of *t*=4.5 two group of cross-matching samples could be formed. The first group, comprising 12 samples, cross-matching with each other at the positions indicated in the bar diagram Figure 4 and all believed (certainly those most recently obtained) to be from the timbers of the chancel roof, were combined at these indicated off-set positions to form MELCSQ01, a site chronology of 160 rings. Site chronology MELCSQ01 was then satisfactorily dated by repeated and consistent comparison with a number of relevant reference chronologies for oak as spanning the years 1509 to 1668. The evidence for this dating is given in the *t*-values of Table 2.

The second group comprises two samples, cross-matching with each other at the positions indicated in the bar diagram Figure 5. Both samples are believed to be from timbers of the north-east chapel (though no record of the samples having been made in 1979). These two samples were combined at their indicated off-set positions to form MELCSQ02, a site chronology of 122 rings. Site chronology MELCSQ02 was then satisfactorily dated by repeated and consistent comparison with a number of relevant reference chronologies for oak as spanning the years 1431 to 1552. The evidence for this dating is given in the *t*-values of Table 3.

Both site chronologies, MELCSQ01 and SQ02, were then compared with the two remaining ungrouped samples, MEL-C15 and C16, both from the chancel roof, but there was no further satisfactory cross-matching. These two single samples were then compared individually with the full range of reference chronologies but there was, again, no further cross-matching and they must, therefore, remain undated.

Interpretation

Analysis by dendrochronology of 16 samples obtained from two roofs at St Michael's Church has resulted in 14 of them being combined to form two site chronologies, MELCSQ01 comprising 12 samples from the chancel roof and MELCSQ02 comprising 2 samples from the roof of the north-east chapel.

None of the samples in these two dated site chronologies retains complete sapwood and it is thus not possible to determine the exact felling date of any of the timbers represented with reliable precision. Two samples, MEL-C12 and C13, both from the chancel roof, do, however, retain at least the heartwood/sapwood boundary, the boundary date on both being the same at 1652. Allowing for a minimum of 15 sapwood rings the timbers are likely to have had and a maximum of 40 (now lost through decay or removal by the original carpenters), it is possible that the timbers were felled sometime between 1667 and 1692. It is very likely that the majority of other main timbers in the chancel roof were also cut during this time period, and that all such timbers represent a single programme of felling.

The possible exception to this single phase of felling of timbers of the chancel roof may be represented by sample MEL-C17, from a ridge beam. This sample has a last measured ring date of 1668. The sample does not, however, have any sapwood or the heartwood/sapwood boundary and it is thus not possible to determine a felling date for the timber. It is unlikely, however, to have been felled before 1683 (allowing for a minimum of 15 sapwood rings that it might have had if the first missing ring on the sample were to have been at the heartwood/sapwood transition). Although it may have been possible to insert a ridge beam made from timber felled later than the late-seventeenth century, this is unlikely, and there appear to be no records of subsequent work to the chancel roof. The dating of this timber, therefore, could potentially suggest that all the chancel roof timbers were felled in the period 1683–92.
Two other samples, MEL-C06 and C07, both from the roof of the north-east chapel have last heartwood ring dates of 1552 and 1550 respectively. Again, neither of them has any sapwood or the heartwood/sapwood boundary and again it is not possible to determine a felling date for the timber. It is unlikely, however, that they were felled before 1567 and 1565 respectively (again allowing for a minimum of 15 sapwood rings that it might have had if the next ring on the samples were to be at the heartwood/sapwood transition).

Conclusion

The results of dating by tree-ring analysis would thus show that the timbers used for a number of the main beams of the chancel roof date to the late-seventeenth century, possibly all being felled between 1684 and 1692. It would appear likely, therefore, that the chancel was reduced from two-

stories to one story in the late-seventeenth century, and given a less steeply pitched roof than before, and that the transepts were reduced in height slightly later.

The felling date of two timbers from the roof of the north-east chapel cannot be deduced with reliable precision, but it is unlikely to be before 1567. It is possibly that they relate to post-Reformation period repairs and restoration.

Judging by the degree of cross-matching between some of the samples, it is probable that some beams have been derived from the same tree. The two timbers represented by samples MEL-C02 and C03, for example, cross-matching with a value of *t*=14.0, may represent one tree split in half. Other beams may be from trees that were growing close to each other in the same copse or stand of woodland, those represented by samples MEL-C06 and C07, which cross-match with a value of *t*=8.9. The other samples represent trees growing further apart, indeed, possibly from different woodlands.

It is likely that these source woodlands, while possibly varied, were all relatively local, with, possibly, a tendency to lie towards the south and east in Leicestershire. As may be seen from Tables 2 and 3, which show the reference chronologies against which site chronologies MELCSQ01 and SQ02 have been dated, whilst the locations of the reference chronologies used is varied (reflecting the varied source of the timber used at Melbourne), the best cross-matches, those with the highest *t*-values, are found with reference data from other nearby sites in Leicestershire and Derbyshire.

Despite having sufficient rings for reliable cross-matching and dating, two samples, MEL-C15 and C16, respectively from the north and south purlins of the chancel roof, remain undated. It is noticeable that both samples contain bands of narrow rings and it is possible that these represent periods of stressed growth which cloud the climatic signal by which the samples would normally be dated. All attempts to date the samples by excluding the disturbed sections failed.

Bibliography

Arnold, A J, Howard, R E, Litton, C D, and Dawson, G, 2005 – The Tree-ring Dating of a Number of Bellframes in Leicestershire, Centre for Archaeol Rep **5/2005**

Arnold, A J and Howard, R E, 2007 unpubl, Nottingham Tree-ring Dating Laboratory, unpublished computer file for Wakelyn Old Hall, Main Street, Hilton, Derby, *HLTBSQ01*

Arnold, A J, and Howard, R E, 2007 unpubl, Nottingham Tree-ring Dating Laboratory, unpublished computer file for Lodge Farm, Staunton Harold, Leics, *STHDSQ01*

Arnold, A J, and Howard, R E, 2007 unpubl, Nottingham Tree-ring Dating Laboratory, unpublished computer file for Hilltop Farm, Staunton Harold, Leics, *STHESQ01*

Arnold, A J, and Howard, R E, 2007 unpubl, Nottingham Tree-ring Dating Laboratory, unpublished computer file for Tean Hall, High Street, Upper Tean, Checkley, Staffs, *TNEASQ01*

Barman, R J, 1974 *A History and Guide to The Parish Church of Melbourne, Derbyshire*, Royden Greene Ltd, Derby

Esling, J, Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1989 List 29 no 6b - Nottingham University Tree-ring Dating Laboratory Results: general list, *Vernacular Architect*, **20**, 39–43

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1992 List 44 nos 12, 18, Nottingham University Tree-Ring Dating Laboratory: results, *Vernacular Architect,* **23**, 51–6

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1994 List 57 no 1 - Nottingham University Tree-Ring Dating Laboratory: results, *Vernacular Architect,* **25**, 36–40

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1995 List 60 no 6 - Nottingham University Tree-Ring Dating Laboratory: results, *Vernacular Architect,* **26**, 47–53

Howard, R E, Laxton, R R, and Litton, C D, 1996 List 65 no 5 - Nottingham University Tree-Ring Dating Laboratory: results, *Vernacular Architect,* **27**, 78–81

Howard, R E, Laxton, R R, and Litton, C D, 2000, *Tree-ring analysis of timbers from Stoneleigh Abbey, Stoneleigh, Warwickshire*, Anc Mon Lab Rep, **80/2000**

Laxton, R R, and Litton, C D, 1988 An East Midlands master tree-ring chronology and its use for dating vernacular buildings, University of Nottingham, Dept of Classical and Archaeol Studies, Monograph Series, **III**

Tyers, I, 1997 *Tree-ring Analysis of Timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/1997**

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date	Last heartwood ring date	Last measured ring date
	1979 sampling					
MEL-C01	Chancel wall plate – original location uncertain	106	no h/s	1533	------	1638
MEL-C02	Chancel wall plate – original location uncertain	128	no h/s	1511	------	1638
MEL-C03	Chancel wall plate – original location uncertain	129	no h/s	1509	------	1637
MEL-C04	Chancel wall plate – original location uncertain	105	no h/s	1528	------	1632
MEL-C05	Chancel wall plate – original location uncertain	90	no h/s	1537	------	1626
MEL-C06	North-east chapel, ridge or wallplate	122	no h/s	1431	------	1552
MEL-C07	North-east chapel, ridge or wallplate	109	no h/s	1442	------	1550
MEL-C08	Chancel wall plate – original location uncertain	87	no h/s	1530	------	1616
MEL-C09	Chancel wall plate – original location uncertain	72	no h/s	1557	------	1628
	2007 sampling					
MEL-C11	Tiebeam truss 1 (east-most)	100	no h/s	1529	------	1628
MEL-C12	Tiebeam truss 2	122	h/s	1531	1652	1652
MEL-C13	Tiebeam truss 3	110	h/s	1543	1652	1652
MEL-C14	Tiebeam truss 4	103	no h/s	1537	------	1639
MEL-C15	North purlin, bay 1(east-most)	86	no h/s	------	------	------
MEL-C16	South purlin, bay 1	70	no h/s	------	------	------
MEL-C17	Ridge plate, bay 1	97	no h/s	1572		1668

*h/s = the last ring on the sample is the heartwood/sapwood boundary

Reference chronology	Span of chronology	*t*-value	
Lodge Farm, Staunton Harold, Leics	1533 – 1647	8.6	(Arnold and Howard 2007 unpubl)
East Midlands Master Chronology	882 – 1981	8.1	(Laxton and Litton 1988)
Church of St Andrew, Welham, Leics	1443 – 1633	7.8	(Arnold *et al* 2005)
Stoneleigh Abbey, Warwicks	1398 – 1658	7.4	(Howard *et al* 2000)
Hilltop Farm, Staunton Harold, Leics	1483 – 1628	7.0	(Arnold and Howard 2007 unpubl)
Chapel of the Holy Trinity, Staunton Harold, Leics	1508 – 1661	6.8	(Howard *et al* 1996)
St John The Baptist, Muston, Leics	1437 – 1611	6.7	(Arnold *et al* 2005)
Moor Farm Cottage (north) Shardlow, Derbys	1437 – 1616	6.6	(Howard *et al* 1994)

Reference chronology	Span of chronology	*t*-value	
Donington-le-Heath Manor House, Leics	1411 – 1618	8.0	(Esling *et al* 1989)
10 Loughborough Rd, Walton-on-Wolds, Leics	1400 – 1580	7.6	(Howard *et al* 1992)
Tean Hall, Tean, Staffs	1373 – 1613	7.5	(Arnold and Howard 2007 unpubl)
Wakelyn Old Hall, Hilton, Derbys	1415 – 1573	7.5	(Arnold and Howard 2007 unpubl)
East Midlands Master Chronology	882 – 1981	7.3	(Laxton and Litton 1988)
Ford Green Hall, Stoke on Trent, Staffs	1436 – 1623	6.8	(Howard *et al* 1992)
St Peter's Church, Saltby, Leics	1446 – 1625	6.5	(Howard *et al* 1995)
Sinai Park, Burton on Trent, Staffs	1227 – 1750	6.2	(Tyers 1997)

Figure 1: Map to show general location of Melbourne Parish Church

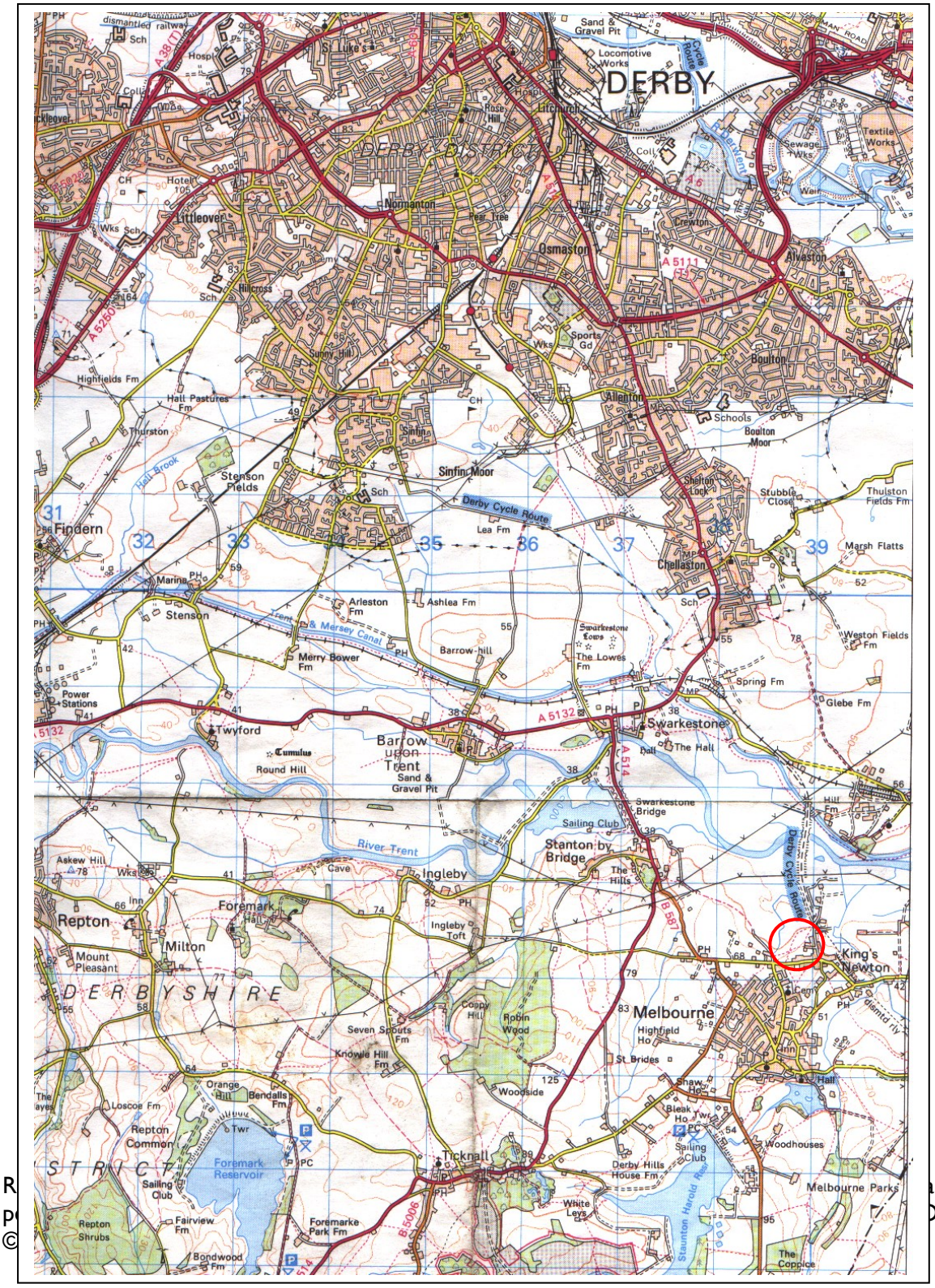

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Figure 2: View of Melbourne Parish Church from the south-east showing the single-storied, square-ended chancel with its later shallow-pitch roof.
The height and pitch of the former roofs to the chancel and the south aisle may be seen as scars on the remaining stonework of the tower

Figure 3: Plan of the chancel roof (viewed from above looking down) to show sampled timbers
(samples obtained in 1979 (MEL-C01-05 and MEL-C08-09) not shown)
(samples from roof of north-east chapel (MEL-C06 and C07) not shown)

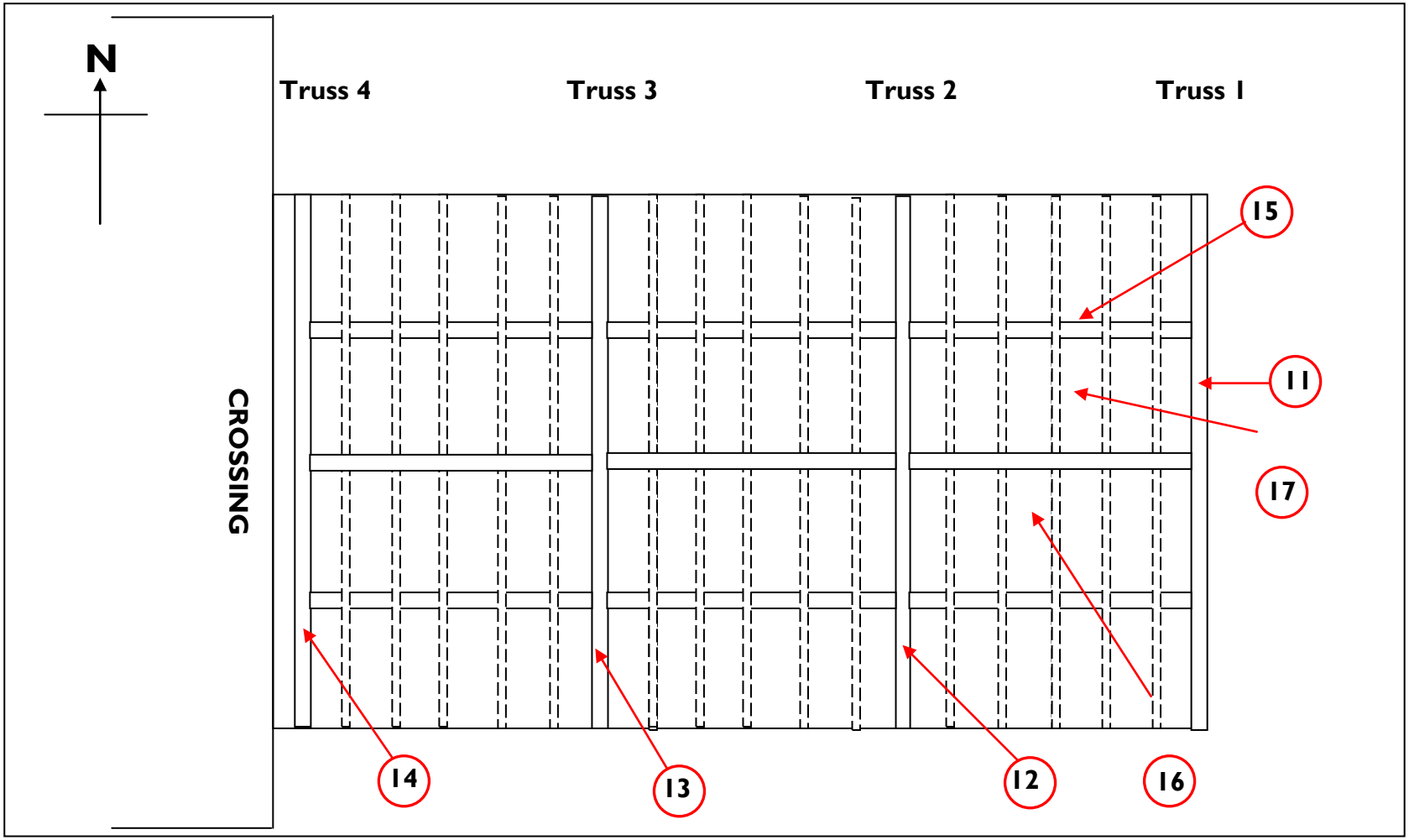
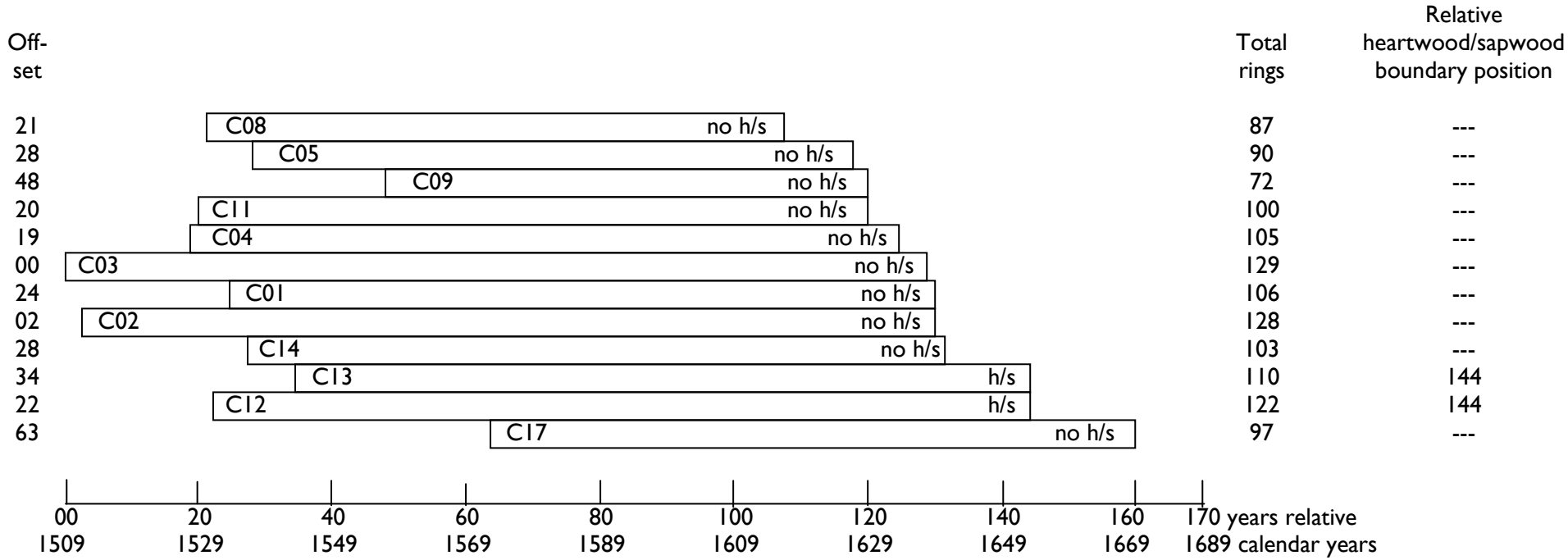


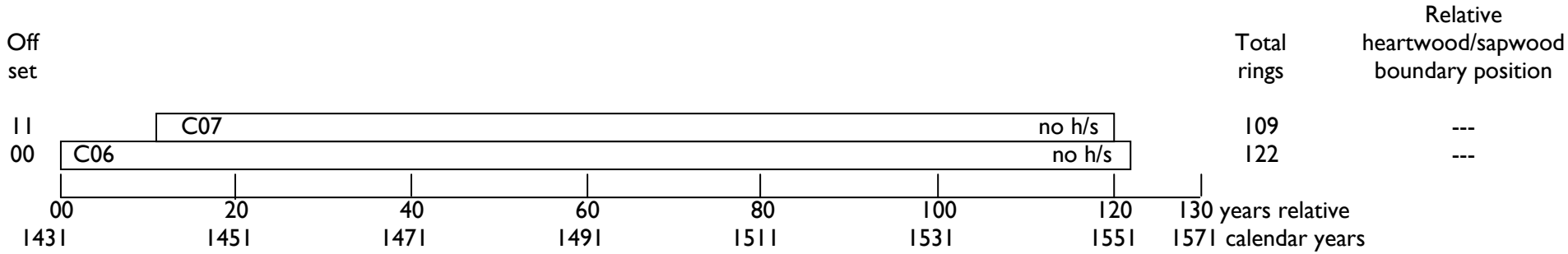
Figure 4: Bar diagram of the samples in site chronology MELCSQ01



White bars = heartwood rings

h/s = heartwood/sapwood boundary

Figure 5: Bar diagram of the samples in site chronology MELCSQ02



White bars = heartwood rings
h/s = heartwood/sapwood boundary

Frontispiece: The interior of St Michael with St Mary, viewed from the west end