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FAIRFIELD HOUSE, STOGURSEY, SOMERSET
TREE-RING ANALYSIS OF TIMBERS

SCIENTIFIC DATING REPORT

Alison Arnold and Robert Howard

INTERVENTION
AND ANALYSIS

ENGLISH HERITAGE

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SUMMARY

Dendrochronological analysis undertaken on timbers from a series of roofs and two newel post caps resulted in the dating of three site sequences with a further five site sequences remaining undated. Site sequence FRFDSQ01 contains eight samples and spans the period AD 1389–1507, FRFDSQ02 contains 18 samples and spans the period AD 1525–1713 and FRFDSQ03 contains seven samples and spans the period AD 1682–1778. The earliest timbers identified felled in AD 1508–28, were from the West range roof making construction of this roof slightly later than previously thought. The East range roof contains timbers felled in AD 1627–52, whilst the Connecting range roof utilises timber of AD 1630 demonstrating that these roofs are broadly contemporary, both dating to the second quarter of the seventeenth century. The East and West range roof hips contain timbers felled in spring AD 1779 and AD 1777–96 respectively, though earlier reused timber was identified within these hips.

CONTRIBUTORS

Alison Arnold and Robert Howard

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ARCHIVE LOCATION

Somerset Historic Environment Record
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DATE OF INVESTIGATION

2011–13

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CONTENTS

INTRODUCTION

Fairfield House is a Grade II* listed manor house located just to the west of the village of Stogursey in Somerset (Figs 1 and 2; ST 1876 4298). The house is believed to have had its origins in the medieval period but underwent substantial remodelling in the late-sixteenth century, giving it a classic E-shape plan (Fig 3). This remodelling work is thought to have been started during the ownership of Elizabeth Verney (died AD 1592) and continued by her son Thomas Palmer (died AD 1605) and grandson William (died AD 1652). William Palmer was succeeded by his brother Peregrine (died AD 1684), who in turn was followed by his son Nathaniel Palmer (died AD 1718). Internal modifications, including new staircases within each wing have been attributed to either Nathaniel or his son Thomas (died AD 1734). Later, under the ownership of Sir John Acland, further extensive alterations were undertaken including the reconstruction of some roofs in *c* AD 1780 and *c* AD 1815 (www.british-history.ac.uk).

West range

The roof over this range consists of seven trusses of principal rafters, collars, and the remains of carved and decorated arch-braces. Some windbraces survive and there is a ridge and three sets of moulded purlins to each slope (Fig 4). This range is believed to be the oldest surviving part of the building, with the roof thought to date to the late-fifteenth century. The southern hipped end is a later modification, undertaken some time after the early eighteenth century as paintings of the house from this period still show the original gable end.

East range

The roof over this range is of six trusses consisting of principal rafters and two collars, with ridge and three sets of purlins to each slope (Fig 5). It is thought to date to the sixteenth century. A later modification was made to a hip at the southern end of this roof.

Connecting (or north) range

The roof of this range has nine trusses of principal rafters and single collar, with ridge and three sets of purlins to each slope (Fig 6). It is possible that this roof might be of two phases which is suggested by a division within the lower walls. The date of this range is however, uncertain.

Staircase

The dog-leg with half-landing staircase within this connecting range rises from ground floor to attic level. It has turned balusters, square section newel posts with framed and planted detailing and ramped handrail rising to merge with the newel caps (Fig 7). It is thought to date to remodelling work carried out in the eighteenth century.

SAMPLING

Sampling was requested by Jenny Chesher, English Heritage Inspector of Historic Buildings and Areas, to complete a programme of investigative work undertaken on the building by Stuart Blaylock. It was hoped that tree-ring dating would enhance the understanding of the chronological development of this building that has been in receipt of English Heritage grant-aid and is part of a long-standing community archaeology project.

A total of 57 timbers was sampled by coring and additionally, two newel caps of the staircase (Fig 7) in the Connecting range were measured *in situ* using a graticule. Each sample was given the code FRF-D (for Fairfield) and numbered 01–59. Nineteen of these were from the East range roof (FRF-D01–19), 18 from the West range roof (FRF-D20–37), 20 from the Connecting range roof (FRF-D38–57), and the two sets of in situ measurements from the staircase newel posts (FRF-D58–9). The location of samples was noted at the time of sampling and where possible, is shown on Figures 8–29. Further details relating to the samples can be found in Table 1.

ANALYSIS AND RESULTS

Ten of the samples, five from the East range and five from the Connecting range were found to have too few rings for secure dating and so were discarded prior to analysis. The remaining 47 samples were prepared by sanding and polishing and their growth-ring widths measured; the data of these measurements are given at the end of the report. These samples and the two sets of measurements taken from the staircase newel caps were then compared with each other by the Litton/Zainodin grouping procedure (see Appendix), resulting in 45 samples matching to form eight groups.

Firstly, eight samples from the West range roof matched each other to form FRFDSQ01, a site sequence of 119 rings (Fig 30). This site sequence was compared against a series of relevant reference chronologies where it was found to match consistently and securely at a first-ring date of AD 1389 and a last-measured ring date of AD 1507. The evidence for this dating is given by the *t*-values in Table 2.

Next, 18 samples (eight from the East range, eight from the Connecting range, and one each from the East and West range hips) grouped and were combined at the relevant offset position to form FRFDSQ02, a site sequence of 189 rings (Fig 31). This was found to span the period AD 1525–1713. The evidence for this dating is given by the *t*-values in Table 3.

Seven samples (three from the East and four from the West range hips) matched and were again combined at the relevant offset positions to form FRFDSQ03, a site sequence of 97 rings (Fig 32). This site sequence was found to match against the reference chronologies at a first-ring date of AD 1682 and a last-measured ring date of AD 1778. The evidence for this dating is given by the *t*-values in Table 4.

A further five site sequences were constructed (Figs 33–37). These site sequences contained a maximum of four samples and ranged in length from 70 to 105 rings. They were compared against the reference chronologies but could not be securely matched and are undated. Attempts to date the remaining ungrouped samples were unsuccessful and these are also undated.

INTERPRETATION

Tree-ring analysis has resulted in the successful dating of three site sequences which together contain 33 samples. To aid interpretation, samples from each area have been dealt with separately (Fig 38).

West range

Eight timbers, all principal rafters from trusses 1–4, were successfully dated from this roof. All of these had the heartwood/sapwood boundary which was broadly contemporary varying by only eight years. This suggests that the dated timbers are part of a single felling programme. The average heartwood/sapwood boundary ring date is AD 1488, allowing an estimated felling date range to be calculated for the timbers represented of AD 1508–28. This takes into account sample FRF-D23 having a last-measured ring date with incomplete sapwood of AD 1507.

East range

Eight of the timbers from this roof have been dated, these representing five principal rafters, two collars, and a purlin. All of these had the heartwood/sapwood boundary ring which in all cases is broadly contemporary, varying by 11 years and consistent with a single felling. The average heartwood/sapwood boundary ring date is AD 1612, allowing an estimated felling date range of AD 1627–52 to be calculated for the eight timbers represented.

Hip ends

Nine of the timbers of the hip ends have been dated, five from the West range and four from the East range. One of these samples (FRF-D13), taken from the East range hip, has complete sapwood and the last-measured ring of AD 1778. Furthermore, the spring growth cells of the following year can be seen, giving the timber represented a felling of spring AD 1779. Six of the remaining eight dated timbers have broadly contemporary heartwood/sapwood boundary ring dates which suggest a single felling. The average of these is AD 1758, allowing an estimated felling date range to be calculated for the timbers represented of AD 1777–98, allowing for the outermost measured sapwood ring present on FRF-D37. This is clearly consistent with these timbers also having been felled in spring AD 1779. The remaining two samples are clearly earlier. Sample FRF-D15 has a heartwood/sapwood boundary ring date of AD 1613, allowing an estimated felling date range to be calculated for the timber represented of AD 1628–53. Sample FRF-D36 has a heartwood/sapwood boundary ring date of AD 1713, giving an estimated felling date within the range AD 1728–53.

Connecting range

Eight of the timbers, four principal rafters and four purlins from this roof have been dated. One of these has complete sapwood and the last-measured ring date of AD 1630, the felling date of the timber represented. The other seven dated timbers from this range all have broadly contemporary heartwood/sapwood boundary ring dates. The average of these is AD 1608, allowing an estimated felling date range to be calculated for the seven timbers of AD 1623–48, consistent with these timbers also having been felled in AD 1630.

All felling date ranges have been calculated using the estimation that mature oak trees in this region have between 15 and 40 sapwood rings.

DISCUSSION

The earliest timbers identified by the tree-ring analysis are those used within the construction of the West range roof. Eight of the principal rafters, all from trusses 1–4, utilised within this roof have now been dated to AD 1508–28. This indicates that the roof is slightly later than the late fifteenth-century date previously assigned to it. The early sixteenth-century date does however suggest that the construction of the roof is associated with Robert Verney who died in AD 1547.

The East range roof is now known to contain timbers which were felled in AD 1627–52. These results demonstrate a construction date in the second quarter of the seventeenth century rather than the sixteenth-century date expected.

The roof over the range which connects the East and West ranges is now known to have been constructed using timber which was felled in AD 1630 and hence is also seventeenth century in date. Timbers were dated along the length of this roof and there is no evidence to suggest that construction is not of a single phase.

These results demonstrate that that the East range and Connecting range roofs are broadly contemporary, both dating to the second quarter of the seventeenth century, being part of the works undertaken by William Palmer. These therefore post-date

Elizabeth Verney's ownership during which it was thought that the substantial remodelling of the medieval building was started.

The latest timbers dated are those from the hip ends of the East and West range roofs. It is thought likely that the modifications to create the hips were coeval and hence that all of the dated timbers may well have been felled in, or around AD 1779. This demonstrates that these are part of the alterations known to have been undertaken by Sir John Acland. However both hips have at least one reused timber present. A single timber from the East range hip has been dated to AD 1628–53. Given the similarity to the felling date range for the timbers of the main body of this roof (AD 1627–52) it is likely that this timber (a purlin) represents a beam from the original roof, either in its primary position or reused within the new hip. In the West range hip another purlin has been dated to AD 1728–53, and appears likely to represent timber reused from earlier eighteenth-century works.

Documentary sources state new staircases were inserted in all ranges by Nathaniel Palmer or his son Thomas. Tentative dating identified for the site sequence (FRFDSQ04) containing the two newel post caps from the Connecting range staircase, which would broadly concur with this could not be verified, despite the efforts of various colleagues from England and elsewhere in Europe. Unfortunately, with the site sequence being undated it is still not possible to determine who actually undertook this work.

The four matched but undated samples forming FRFDSQ05 are all from the West range and represent two principal rafters, a collar, and an arch brace from trusses 1, 3, 5 and 6. They are clearly coeval but their dating potential may be hampered by periodic occurrences of growth retardation events shown in their ring sequences.

The remaining three undated site sequences all consist of only two samples: a pair of dormer rafters (FRFDSQ06), one from the East range hip and one from the West range hip, both of which appear likely to be contemporary; a principal rafter and collar (FRFDSQ07), both from truss 13 in the Connecting range, are clearly coeval; as are purlin and a collar (FRFDSQ08) also from the Connecting range. These latter three site sequences are all relatively short and poorly replicated which will have reduced the chances of successful dating.

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TABLES

Table 1: Details of tree-ring samples from Fairfield House, Stogursey, Somerset

Sample number	Sample location	Total rings	Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
East range						
FRF-D01	Upper collar, truss 21	60	h/s	1554	1613	1613
FRF-D02	Upper collar, truss 20	51	h/s	1555	1605	1605
FRF-D03	West principal rafter, truss 20	NM	--	----	----	----
FRF-D04	East principal rafter, truss 19	59	h/s	1558	1616	1616
FRF-D05	West principal rafter, truss 19	NM	--	----	----	----
FRF-D06	West principal rafter, truss 18	58	h/s	1551	1608	1608
FRF-D07	East principal rafter, truss 17	65	h/s	1549	1613	1613
FRF-D08	West principal rafter, truss 17	50	h/s	1562	1611	1611
FRF-D09	East principal rafter, truss 22	59	h/s	1553	1611	1611
FRF-D10	West upper purlin, truss 20–21	NM	--	----	----	----
FRF-D11	West middle purlin, truss 17–18	69	h/s	1547	1615	1615
FRF-D12	West upper purlin, truss 17–18	NM	--	----	----	----
Hip end						
FRF-D13	East lower purlin, truss 21-hip	67	24C	1712	1754	1778
FRF-D14	West middle purlin, truss 21-hip	52	h/s	----	----	----
FRF-D15	West lower purlin, truss 21-hip	59	h/s	1555	1613	1613
FRF-D16	East dormer rafter	NM	--	----	----	----
FRF-D17	West dormer rafter	45	h/s	----	----	----
FRF-D18	East hip rafter	56	10	1720	1765	1775
FRF-D19	West hip rafter	67	h/s	1695	1761	1761
West range						
FRF-D20	East principal rafter, truss 1	90	h/s	1396	1485	1485
FRF-D21	West principal rafter, truss 1	84	h/s	1400	1483	1483
FRF-D22	Collar, truss 1	101	h/s	----	----	----
FRF-D23	East principal rafter, truss 2	110	16	1398	1491	1507
FRF-D24	West principal rafter, truss 2	98	h/s	1394	1491	1491
FRF-D25	East principal rafter, truss 3	89	h/s	1399	1487	1487
FRF-D26	West principal rafter, truss 3	83	h/s	1405	1487	1487
FRF-D27	West archbrace, truss 3	75	--	----	----	----
FRF-D28	East principal rafter, truss 4	84	h/s	1402	1485	1485
FRF-D29	West principal rafter, truss 4	103	h/s	1389	1491	1491
FRF-D30	East principal rafter, truss 5	99	h/s	----	----	----
FRF-D31	East principal rafter, truss 6	103	h/s	----	----	----
Hip end						
FRF-D32	East dormer rafter	86	27C	----	----	----
FRF-D33	West dormer rafter	50	h/s	1697	1746	1746
FRF-D34	East hip rafter	61	h/s	1707	1767	1767
FRF-D35	West hip rafter	65	h/s	1682	1746	1746
FRF-D36	East upper purlin, south hip	156	h/s	1558	1713	1713
FRF-D37	East middle purlin, truss 1-south hip	47	13	1730	1763	1776
Connecting range						
FRF-D38	North principal rafter, truss 16	NM	--	----	----	----
FRF-D39	South principal rafter, truss 16	NM	--	----	----	----
FRF-D40	North purlin, truss 15–16	84	h/s	1525	1608	1608
FRF-D41	South purlin, truss 14–15	49	01	1571	1618	1619
FRF-D42	North principal rafter, truss 13	73	h/s	----	----	----
FRF-D43	Collar, truss 13	74	h/s	----	----	----
FRF-D44	North purlin, truss 12–13	53	03	1554	1603	1606
FRF-D45	North principal rafter, truss 12	56	09	1562	1608	1617
FRF-D46	Collar, truss 12	NM	--	----	----	----
FRF-D47	South principal rafter, truss 11	NM	--	----	----	----
FRF-D48	North purlin, truss 10–11	57	h/s	----	----	----
FRF-D49	South purlin, truss 10–11	65	h/s	1549	1613	1613
FRF-D50	North principal rafter, truss 10	90	26C	1541	1604	1630
FRF-D51	South principal rafter, truss 10	66	14	1564	1615	1629
FRF-D52	North purlin, truss 9–10	72		----	----	----
FRF-D53	North principal rafter, truss 9	62	h/s	----	----	----
FRF-D54	South principal rafter, truss 9	58	h/s	1537	1594	1594
FRF-D55	Collar, truss 9	70	h/s	----	----	----
FRF-D56	South purlin, truss 8–9	NM	--	----	----	----
FRF-D57	South principal rafter, truss 8	NM	--	----	----	----
Staircase						
FRF-D58	Newel post cap	94	--	----	----	----
FRF-D59	Newel post cap	96	--	----	----	----

NM = not measured
h/s = the heartwood/sapwood boundary is the last ring on the sample
C = complete sapwood retained on sample, last measured ring is the felling date

Table 2: Results of the cross-matching of site sequence FRFDSQ01 and relevant reference chronologies when the first ring date is AD 1389 and the last-ring date is AD 1507

Reference chronology	*t*-value	Span of chronology	Reference
Chalgrove Manor, Chalgrove, Oxfordshire	8.6	AD 1355–1503	Arnold *et al* 2008a
London Charterhouse	7.6	AD 1382–1545	Howard *et al* 1997
Badge Court, Elmbridge, Worcestershire	7.6	AD 1418–1578	Bridge 2002
Roscarrock, St Endellion, Cornwall	7.5	AD 1373–1500	Tyers 2004a
Manor Farm, Ickenham, Middlesex	6.9	AD 1374–1483	Arnold *et al* 2005a
Warleigh House, Tamerton Foliot, Devon	6.8	AD 1367–1539	Howard *et al* 2006
Holy Cross Church, Crediton, Devon	6.8	AD 1317–1536	Tyers 2004b

Table 3: Results of the cross-matching of site sequence FRFDSQ02 and relevant reference chronologies when the first ring date is AD 1525 and the last-ring date is AD 1713

Reference chronology	*t*-value	Span of chronology	Reference
Bolsover Castle (Riding House), Bolsover, Derbyshire	8.1	AD 1494–1744	Howard *et al* 2005
1-5 Bridge Street, Bideford, Devon	7.7	AD 1484–1706	Arnold and Howard 2012 unpubl
Bradenham Manor, Buckinghamshire	7.3	AD 1553–1652	Miles and Worthington 1998
Salisbury Cathedral nave, Wiltshire	7.1	AD 1556–1703	Miles 2005
The Market House, Ledbury, Herefordshire	7.0	AD 1485–1617	Arnold *et al* 2008b
Sinai Park, Burton-on-Trent, Staffordshire	6.5	AD 1227–1750	Tyers 1997
Worcester Cathedral, Worcestershire	6.4	AD 1484–1772	Arnold *et al* 2003
Poltimore House, Devon	6.2	AD 1534–1725	Arnold *et al* 2005b

Table 4: Results of the cross-matching of site sequence FRFDSQ03 and relevant reference chronologies when the first ring date is AD 1682 and the last-ring date is AD 1778

Reference chronology	*t*-value	Span of chronology	Reference
Exeter Cathedral, Devon	8.6	AD 1659–1787	Mills 1988
Widhayes, Uplowman, Devon	7.6	AD 1631–1786	Tyers *et al* forthcoming
Green 's Mill, Sneinton, Nottinghamshire	7.3	AD 1664–1787	Laxton *et al* 1982
Exeter Cathedral St John the Baptist Chapel roof, Devon	7.0	AD 1698–1805	Arnold *et al* 2006
Bradgate trees, Leicestershire	6.1	AD 1595–1975	Laxton and Litton 1988
Stoneleigh Abbey, Stoneleigh, Warwickshire	5.9	AD 1646–1813	Howard *et al* 2000
Buckland, Yelverton, Devon	5.9	AD 1677–1799	Morgan pers comm
'Parkers Field', North Petherton, Somerset	5.7	AD 1692–1796	Arnold and Howard 2011

FIGURES

Figure 1: General location of Stogursey, Somerset, circled (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright and database right 2013. All rights reserved. Ordnance Survey Licence number 100024900.)

Figure 2: General location of Stogursey, Somerset, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright and database right 2013. All rights reserved. Ordnance Survey Licence number 100024900.)

Figure 3: Fairfield House, showing the areas under investigation; East range (hashed green), West range (hashed blue), and Connecting range (hashed red, based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright and database right 2013. All rights reserved. Ordnance Survey Licence number 100024900.)

Figure 4: West range roof; truss 3 in the foreground, photograph taken from the south-east (Robert Howard)

Figure 5: East range roof; truss 19 in the foreground, photograph taken from the south-east (Robert Howard)

Figure 6: Connecting range roof; truss 15 in the foreground, photograph taken from the north-east (Robert Howard)

Figure 7: Connecting range; staircase, photograph taken from the first floor (Robert Howard)

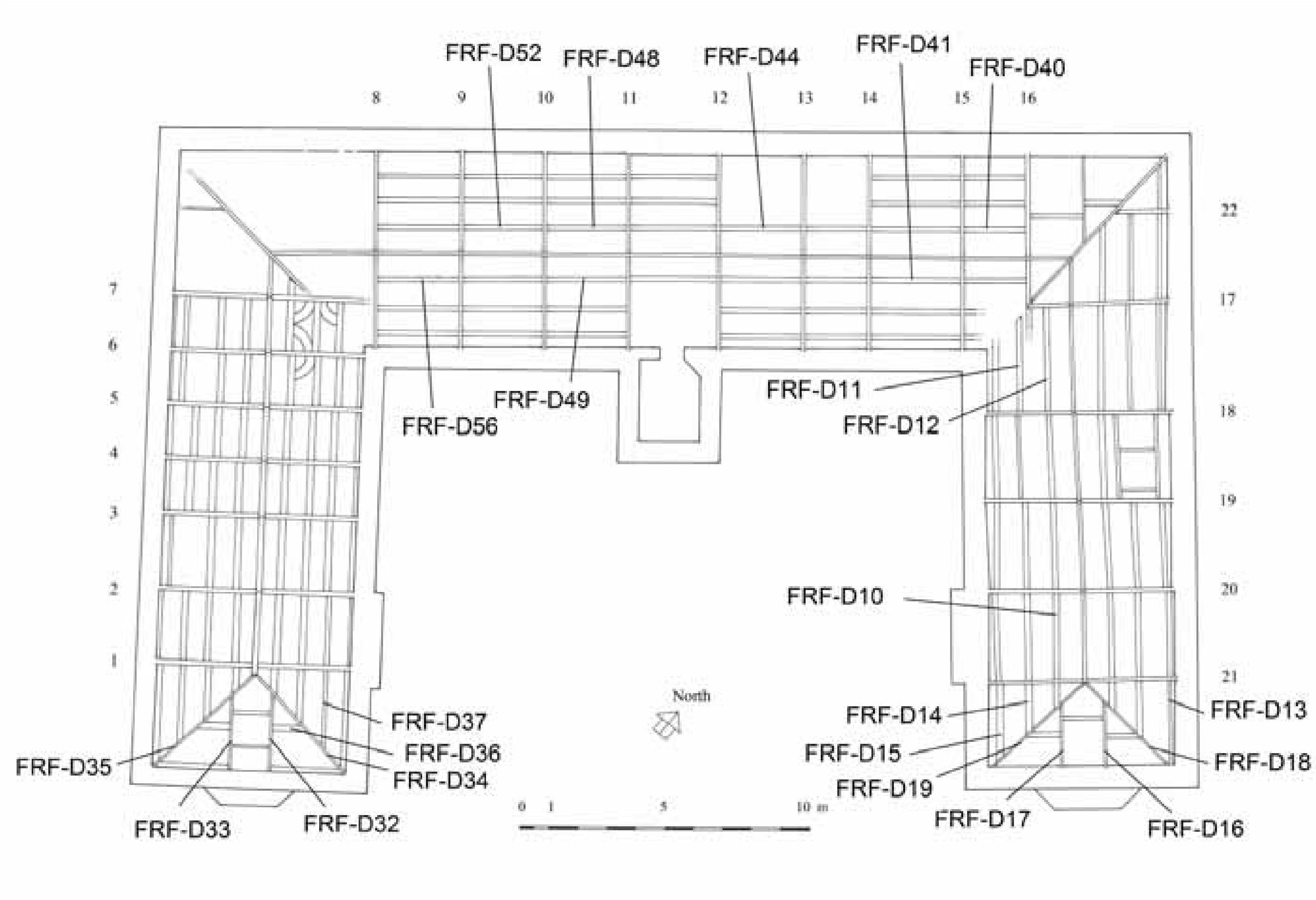

Figure 8: Attic plan, showing truss numbering and the location of samples FRF-D10–19, FRF-D32–7, FRF-D40–41, FRF-D44, FRF-D48–9, FRF-D52, and FRF-D56 (after Alan Graham)

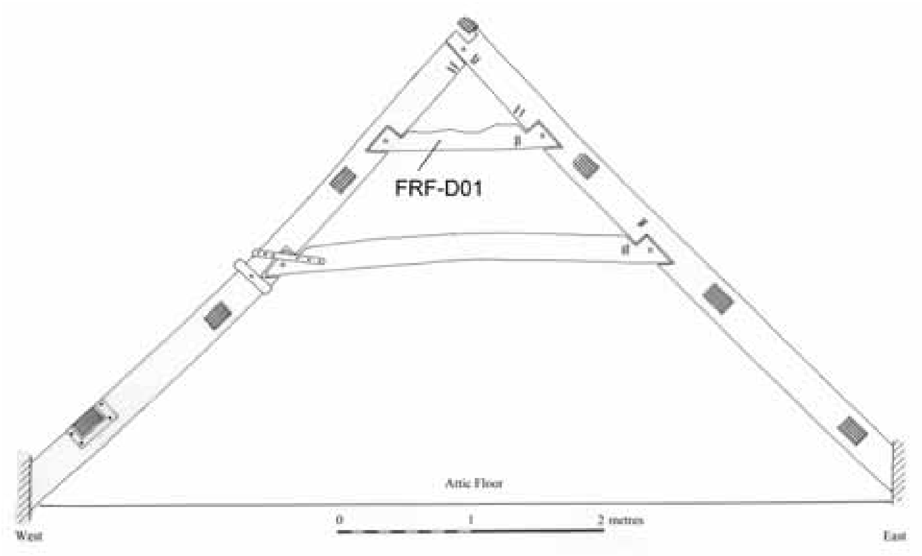

Figure 9: East range; truss 21, showing the location of sample FRF-D01 (Alan Graham)

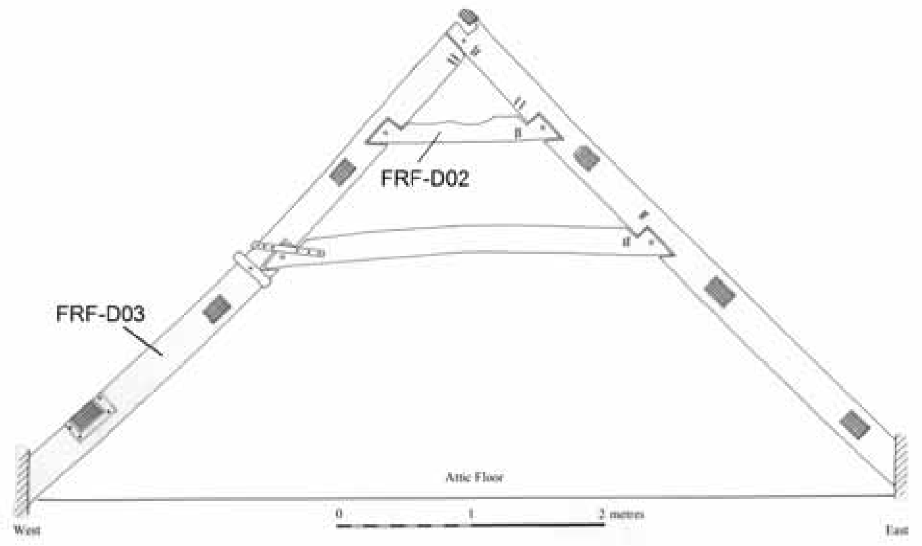

Figure 10: East range; truss 20, showing the location of samples FRF-D02 and FRF-D03 (Alan Graham)

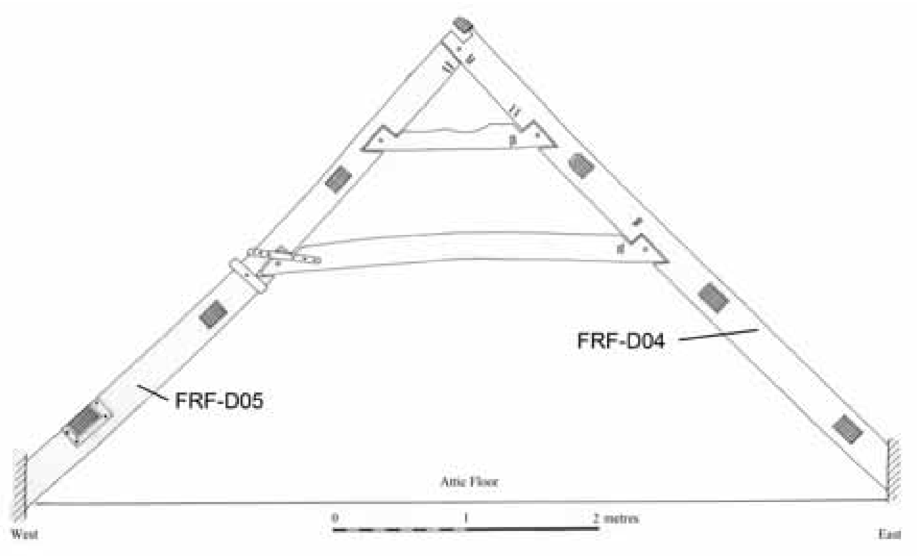

Figure 11: East Range; truss 19, showing the location of samples FRF-D04 and FRF-D05 (Alan Graham)

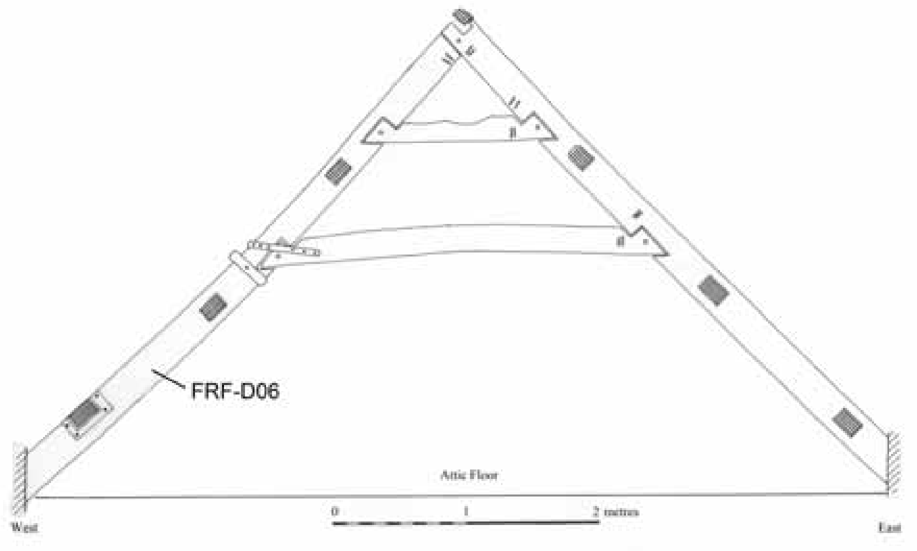

Figure 12: East range; truss 18, showing the location of sample FRF-D06 (Alan Graham)

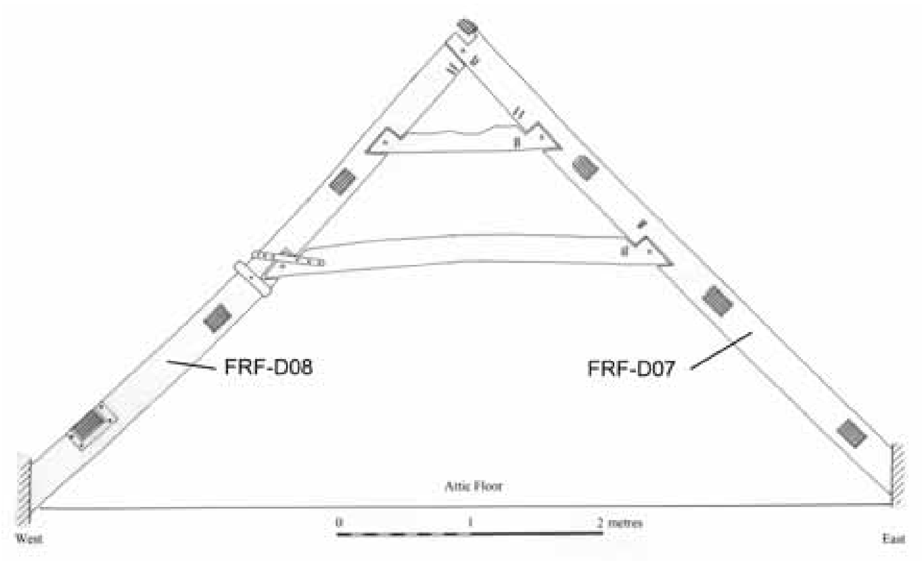

Figure 13: East range; truss 17, showing the location of samples FRF-D07 and FRF-D08 (Alan Graham)

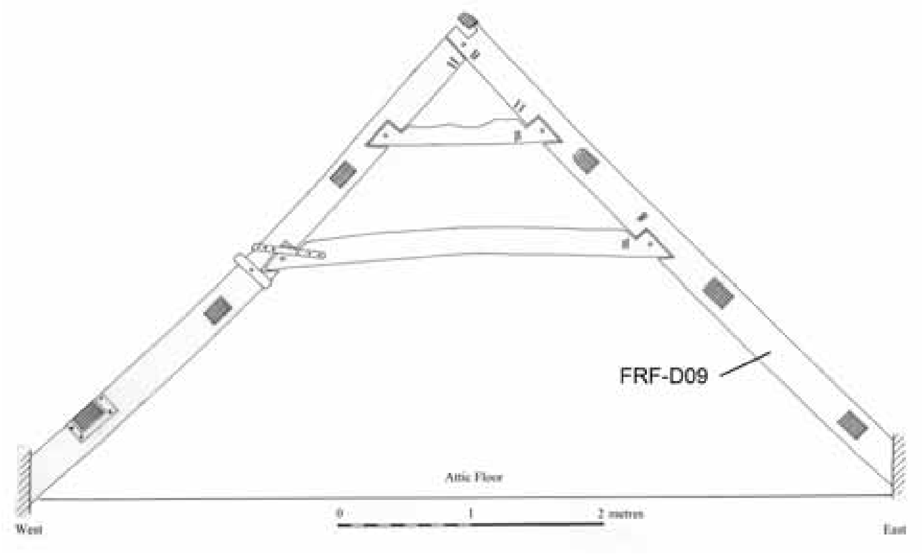

Figure 14: East range; truss 22, showing the location of sample FRF-D09 (Alan Graham)

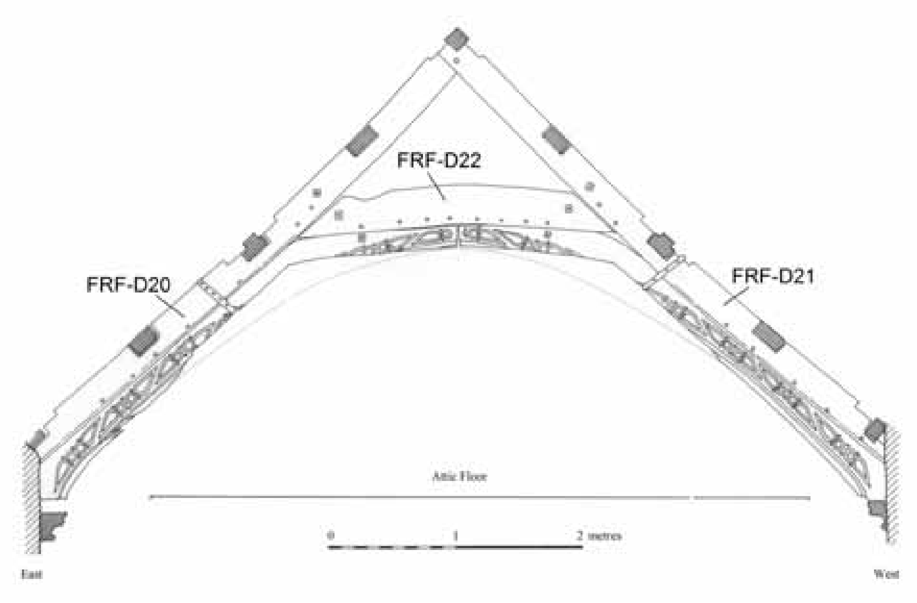

Figure 15: West range; truss 1, showing the location of samples FRF-D20-2 (Alan Graham)

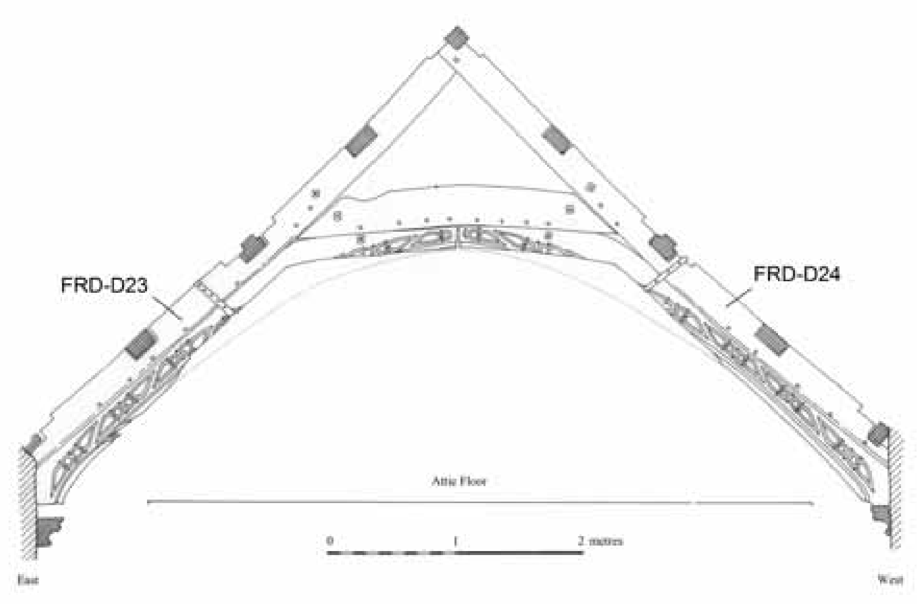

Figure 16: West range; truss 2, showing the location of samples FRF-D23-4 (Alan Graham)

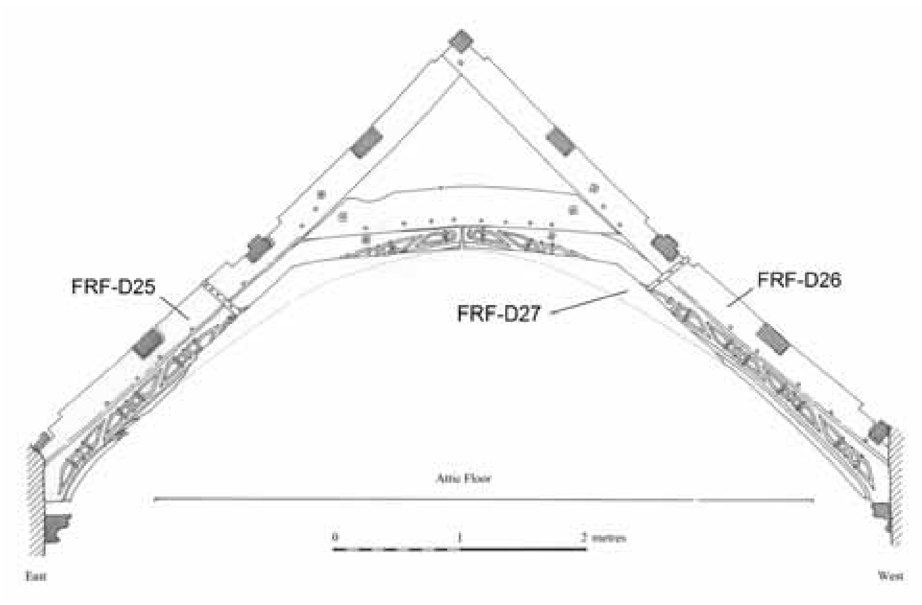

Figure 17: West range; truss 3, showing the location of samples FRF-D25-7 (Alan Graham)

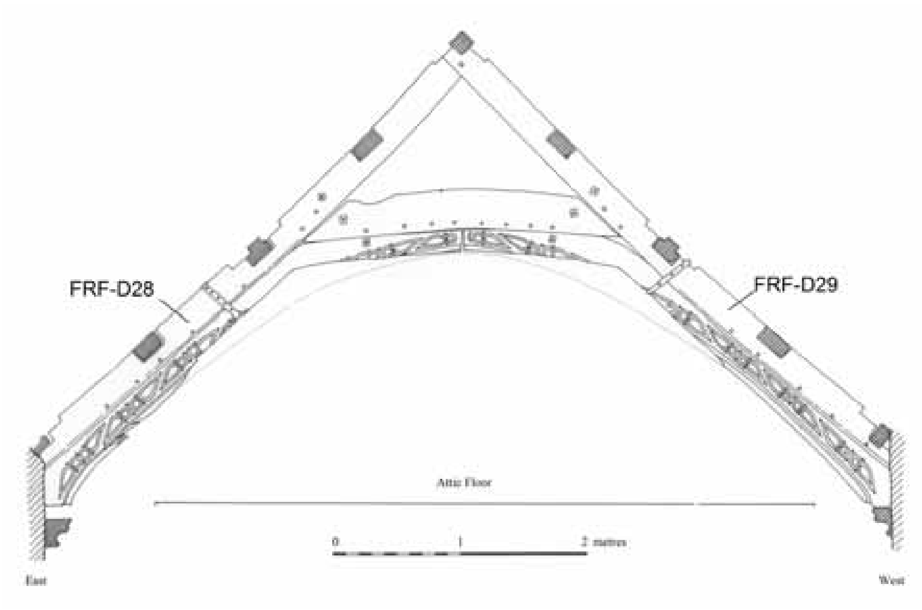

Figure 18: West range; truss 4, showing the location of samples FRF-D28 and FRF-D29 (Alan Graham)

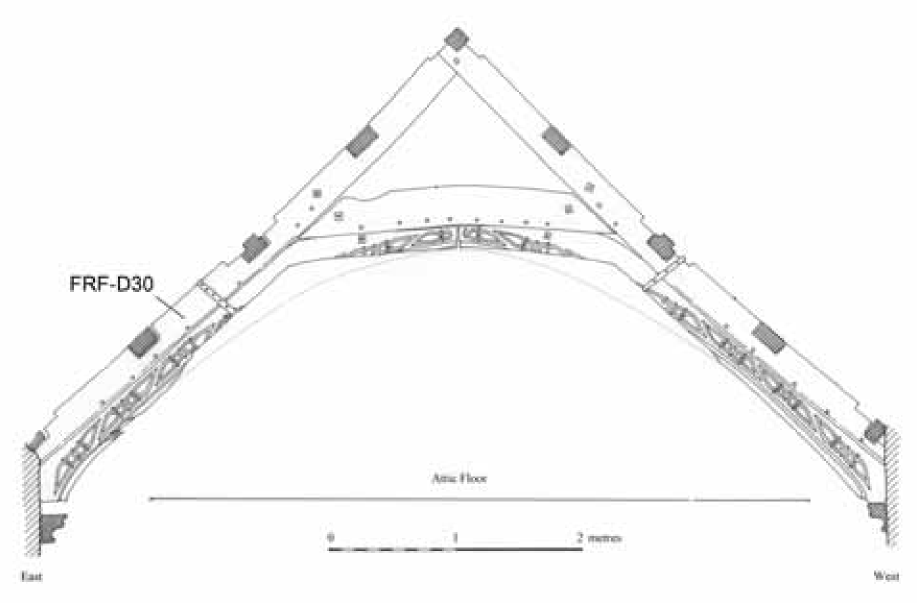

Figure 19: West range; truss 5, showing the location of sample FRF-D30 (Alan Graham)

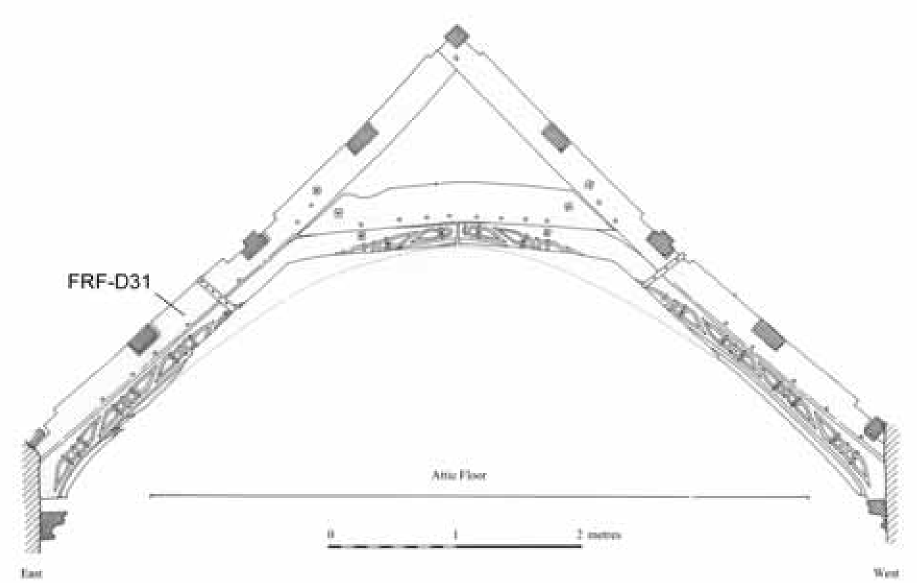

Figure 20: West range; truss 6, showing the location of sample FRF-D31 (Alan Graham)

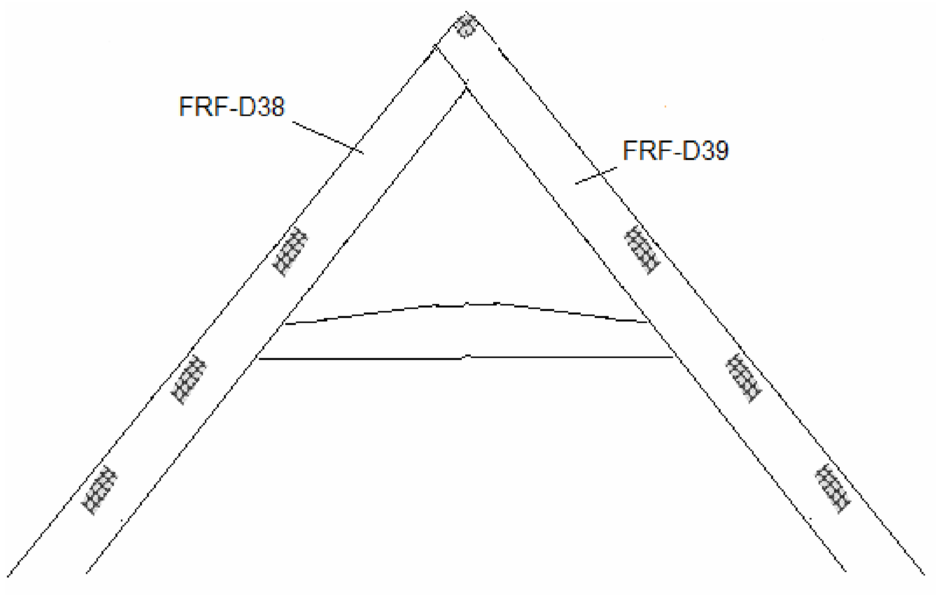

Figure 21: Connecting range; sketch of truss 16, showing the location of samples FRF-D38 and FRF-D39

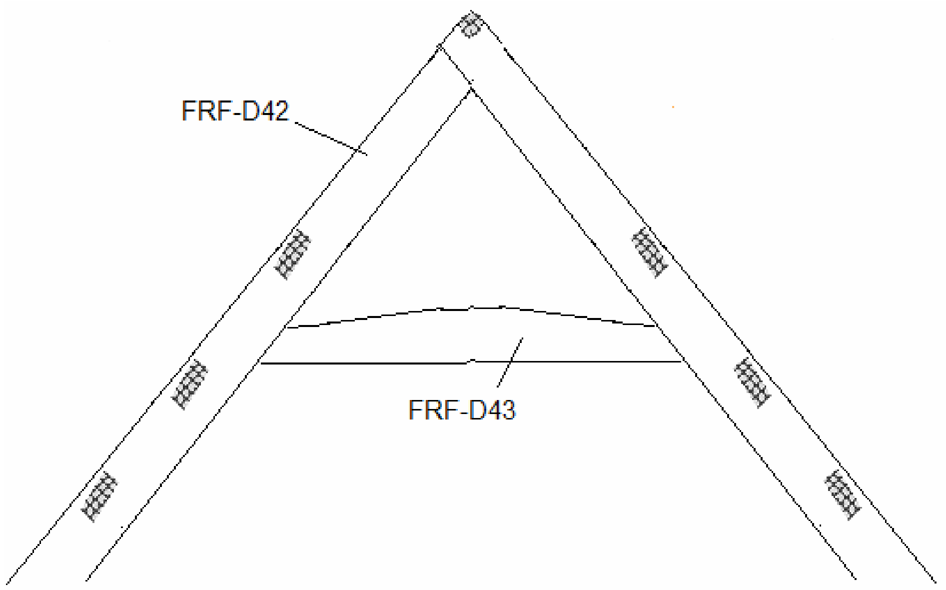

Figure 22: Connecting range; sketch of truss 13, showing the location of samples FRF-D42 and FRF-D43

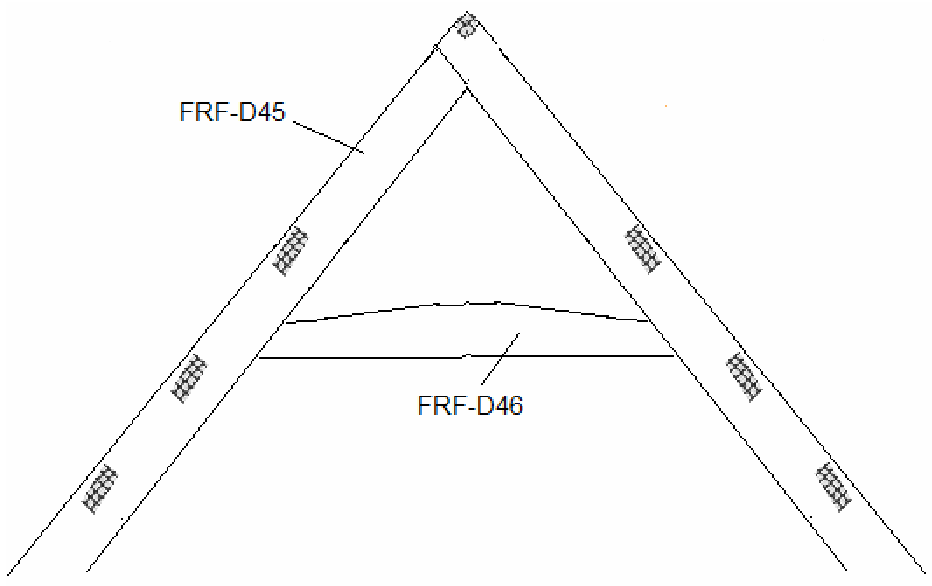

Figure 23: Connecting range; sketch of truss 12, showing the location of samples FRF-D45 and FRF-D46

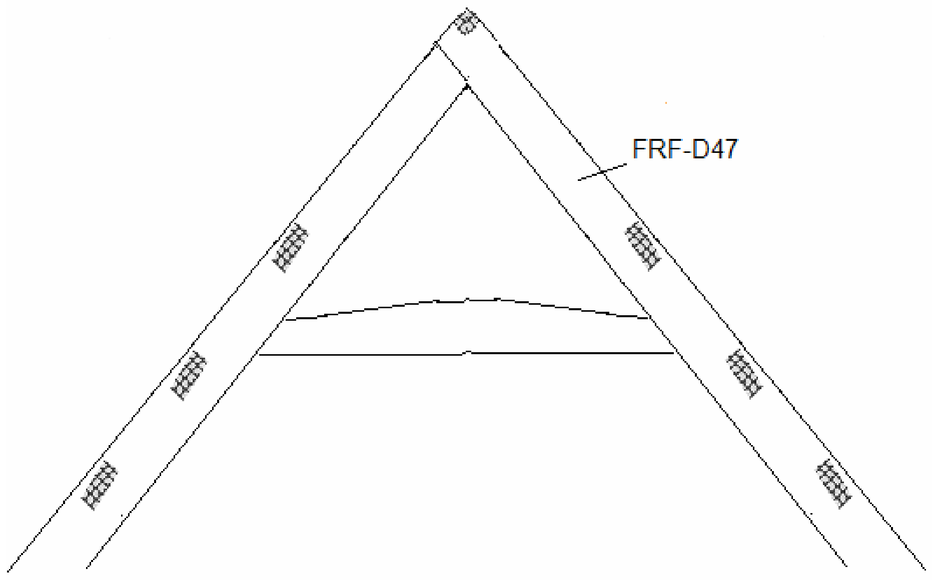

Figure 24: Connecting range; sketch of truss 11, showing the location of sample FRF-D47

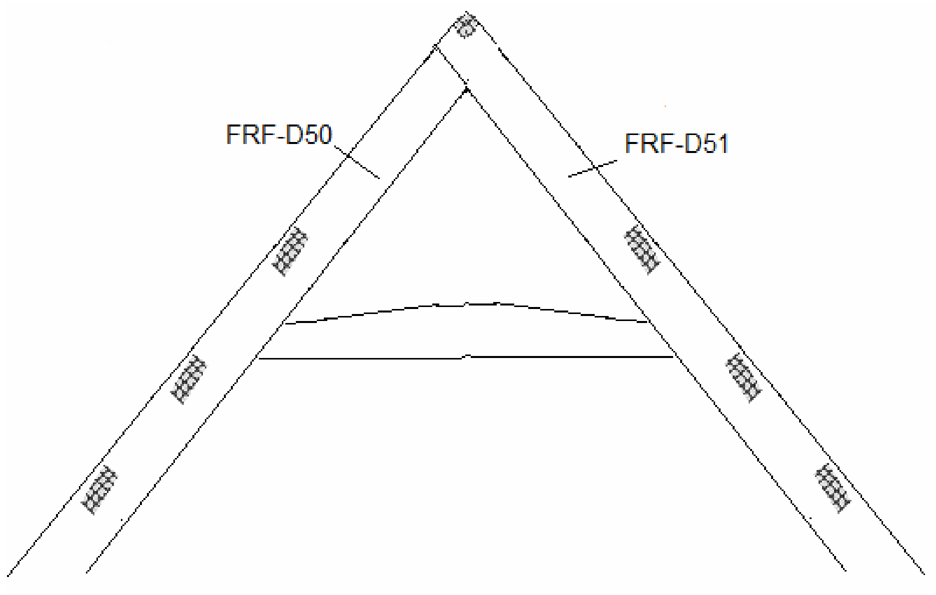

Figure 25: Connecting range; sketch of truss 10, showing the location of samples FRF-D50 and FRF-D51

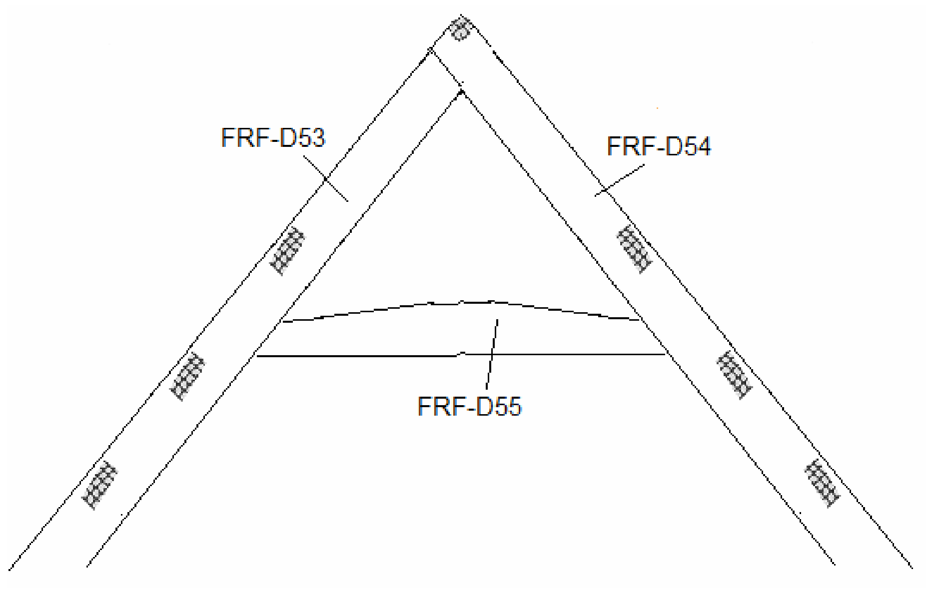

Figure 26: Connecting range; sketch of truss 9, showing the location of samples FRF-D53-5

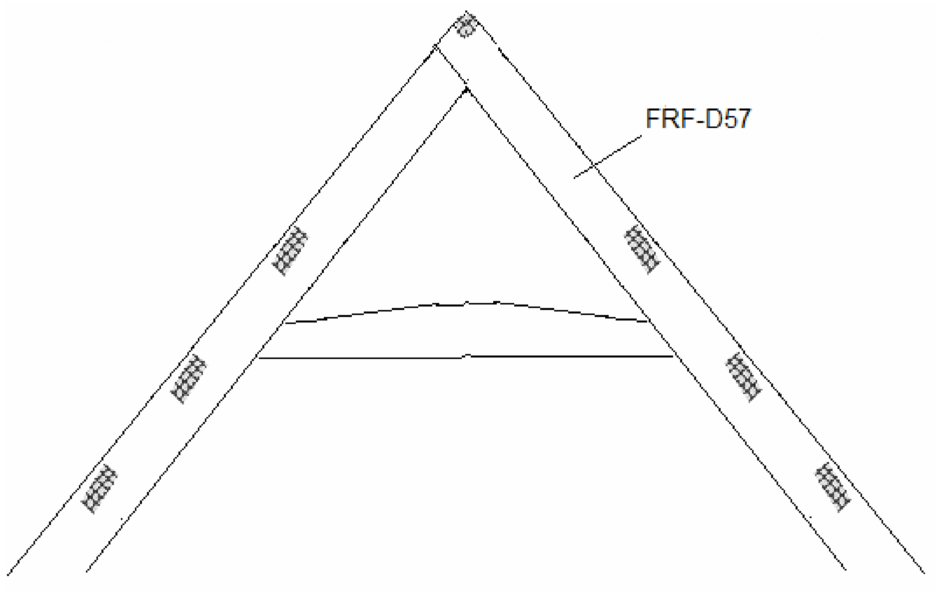

Figure 27: Connecting range; sketch of truss 8, showing the location of sample FRF-D57

Figure 28: Photograph of first-floor newel post cap, showing the location of sample FRF-D58 in the Connecting range (RobertHoward)

Figure 29: Photograph of the mid-landing newel post cap, showing the location of sample FRF-D59 in the Connecting range (Robert Howard)

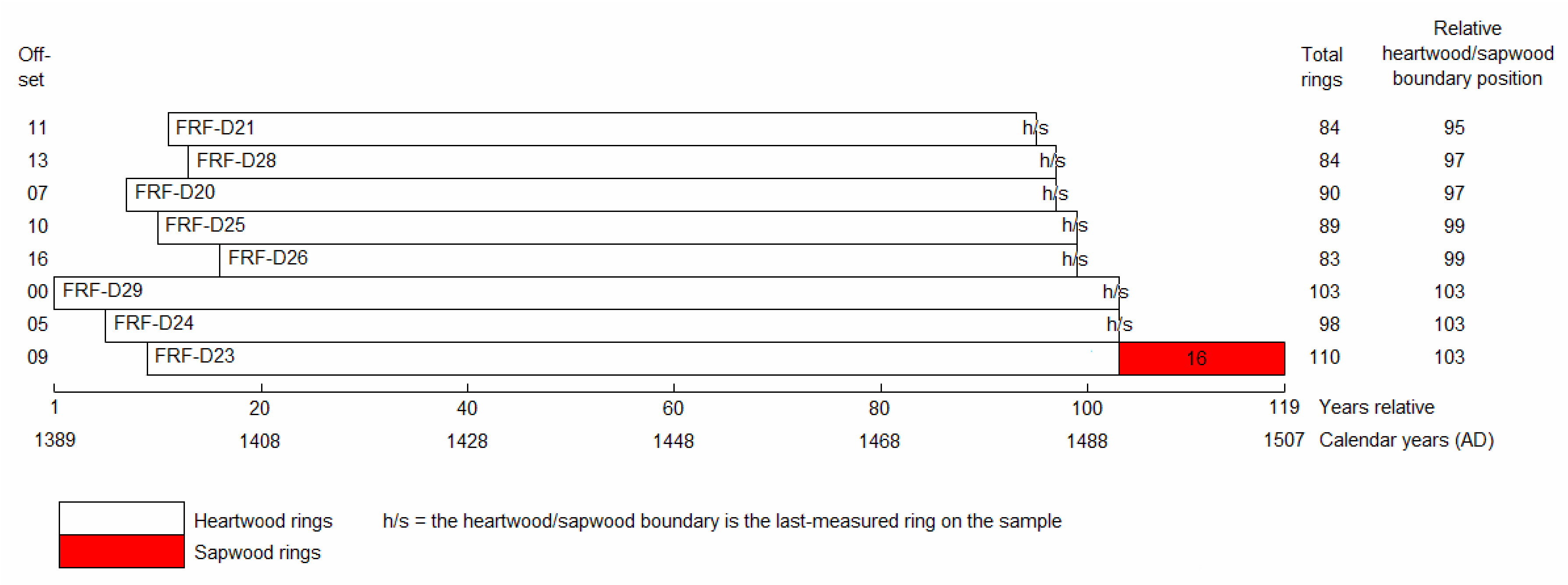

Figure 30: Bar diagram of samples in site sequence FRFDSQ01

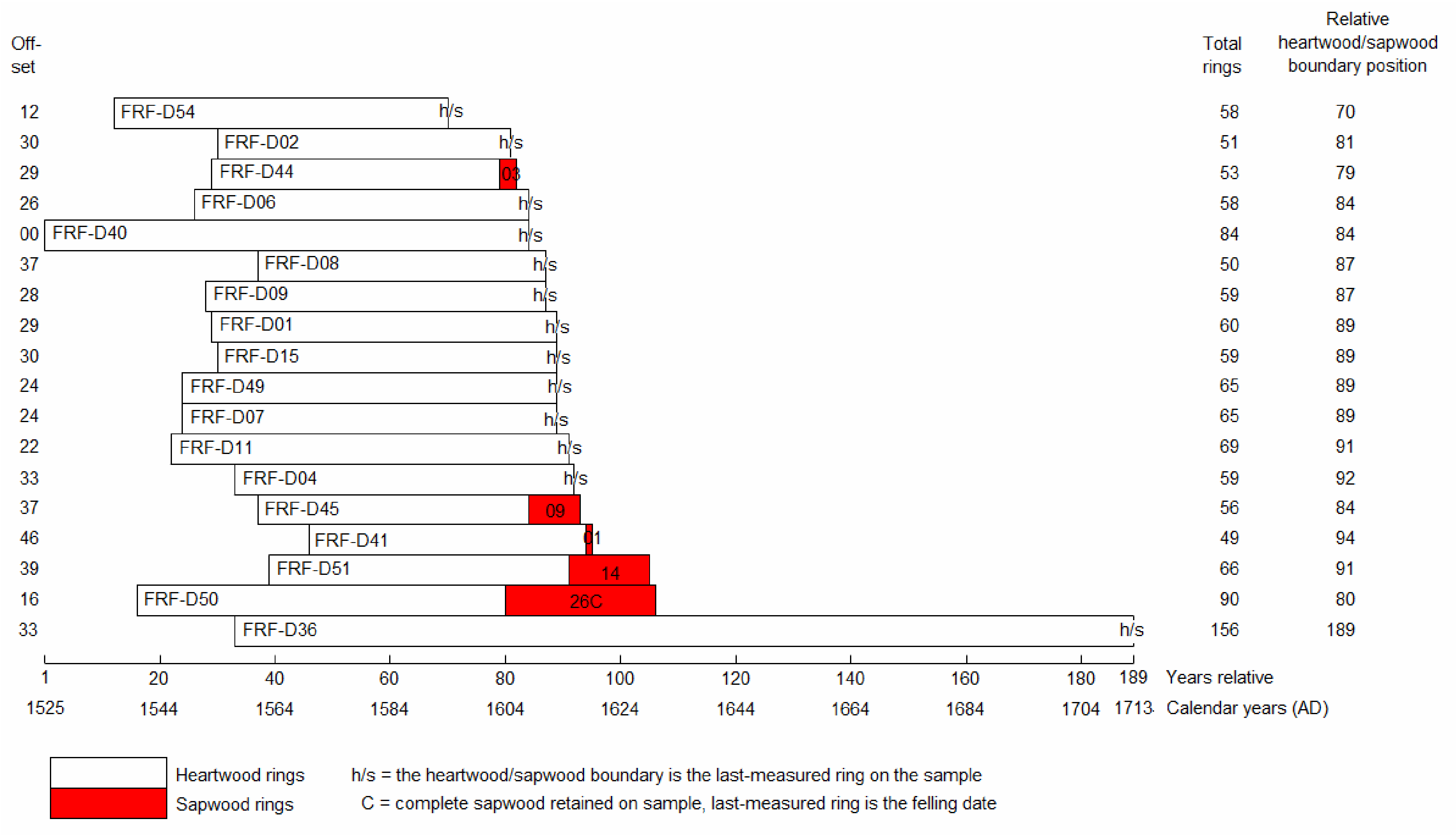

Figure 31: Bar diagram of samples in site sequence FRFDSQ02

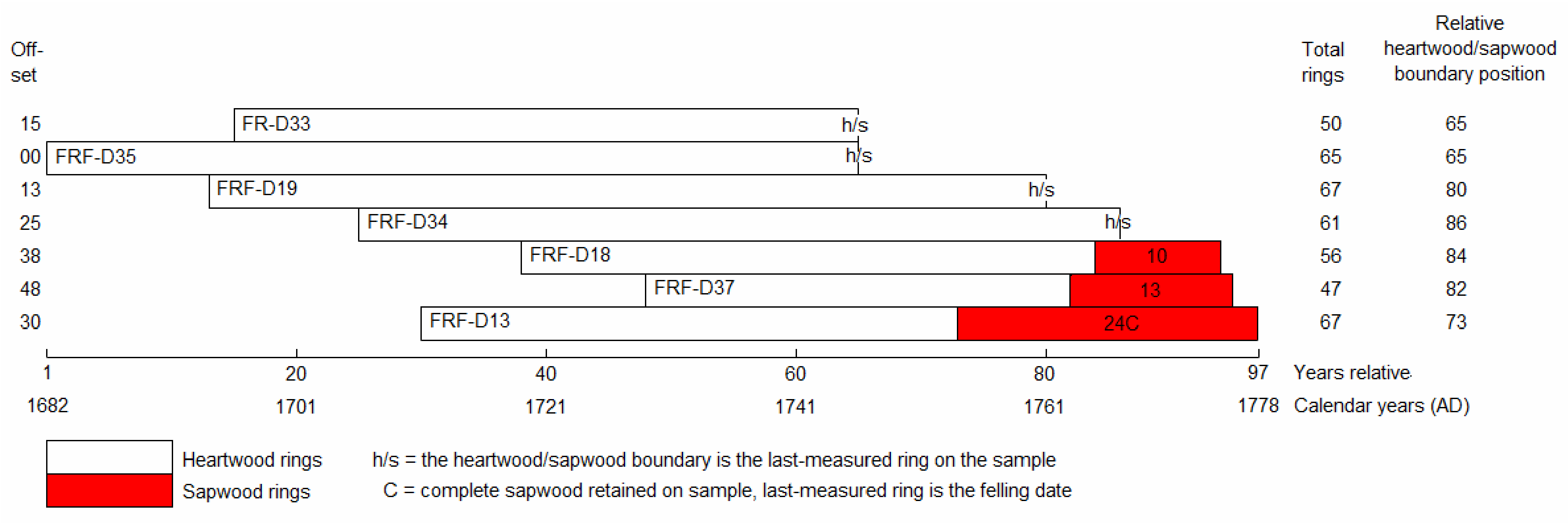

Figure 32: Bar diagram of samples in site sequence FRFDSQ03

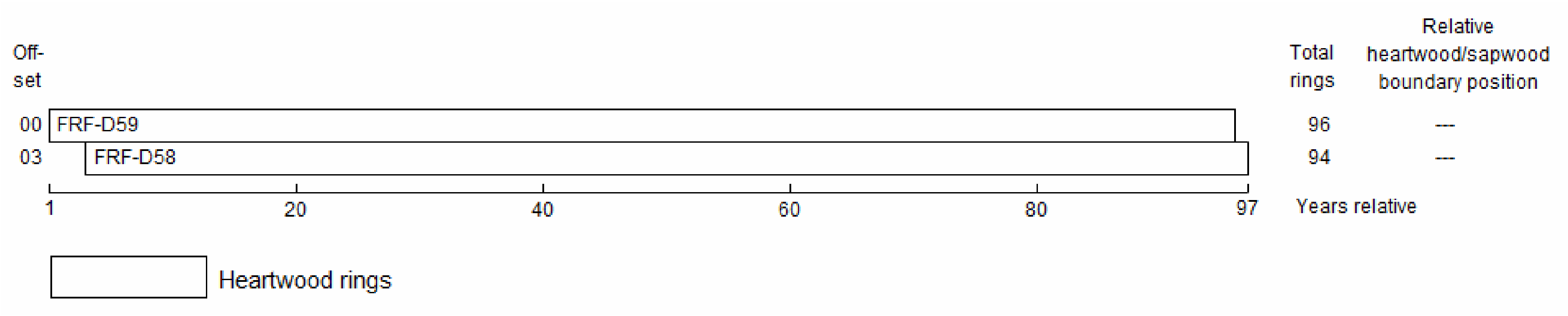

Figure 33: Bar diagram of samples in undated site sequence FRFDSQ04

Figure 34: Bar diagram of samples in undated site sequence FRFDSQ05

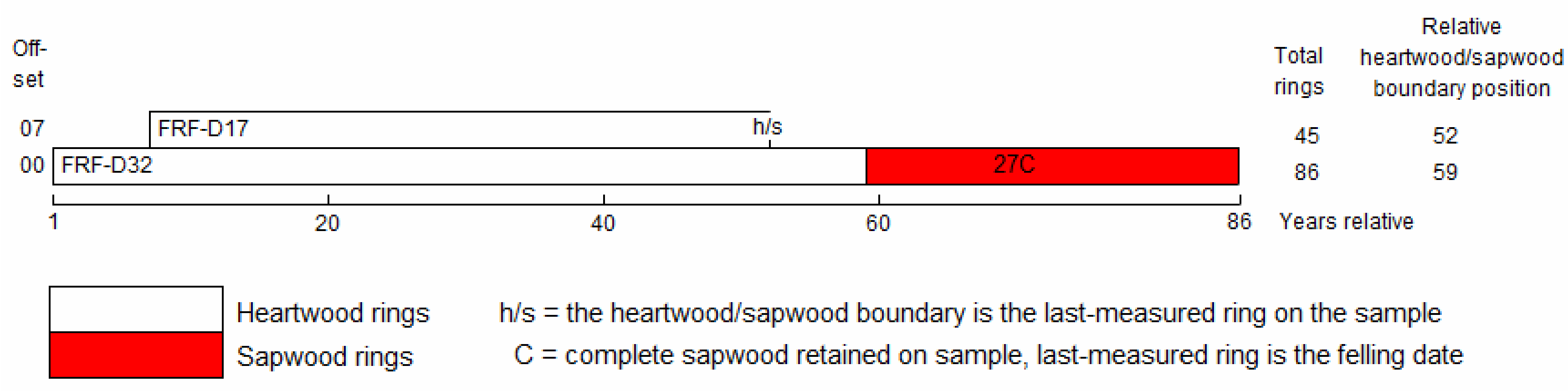

Figure 35: Bar diagram of samples in site sequence FRFDSQ06

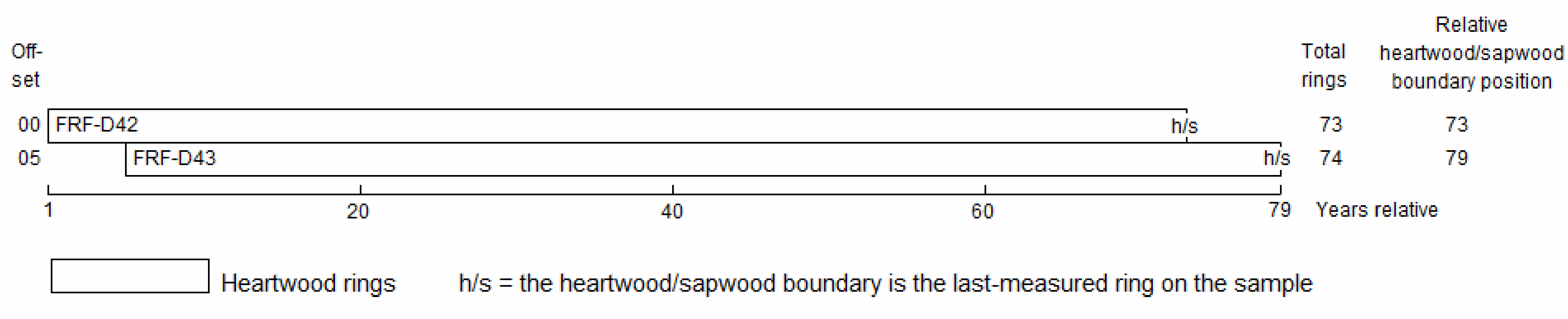

Figure 36: Bar diagram of samples in undated site sequence FRFDSQ07

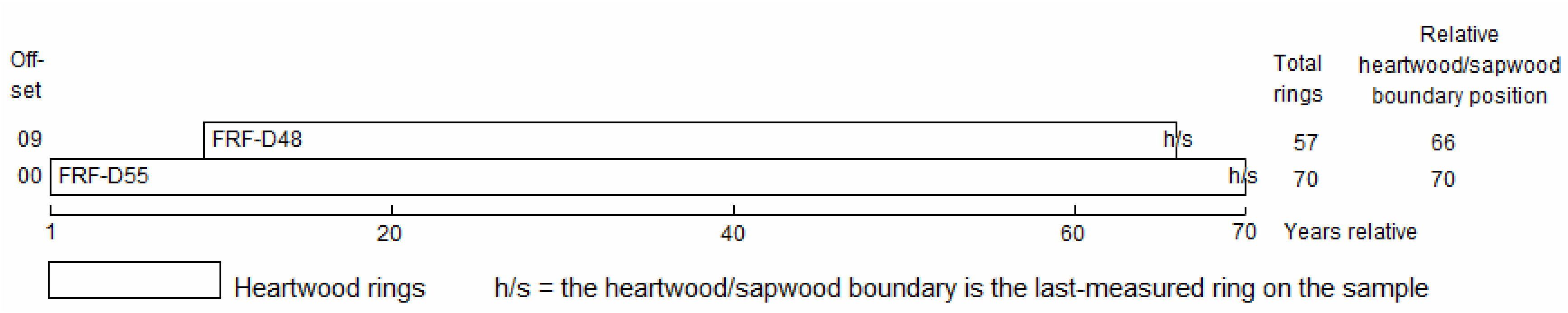

Figure 37: Bar diagram of samples in undated site sequence FRFDSQ08

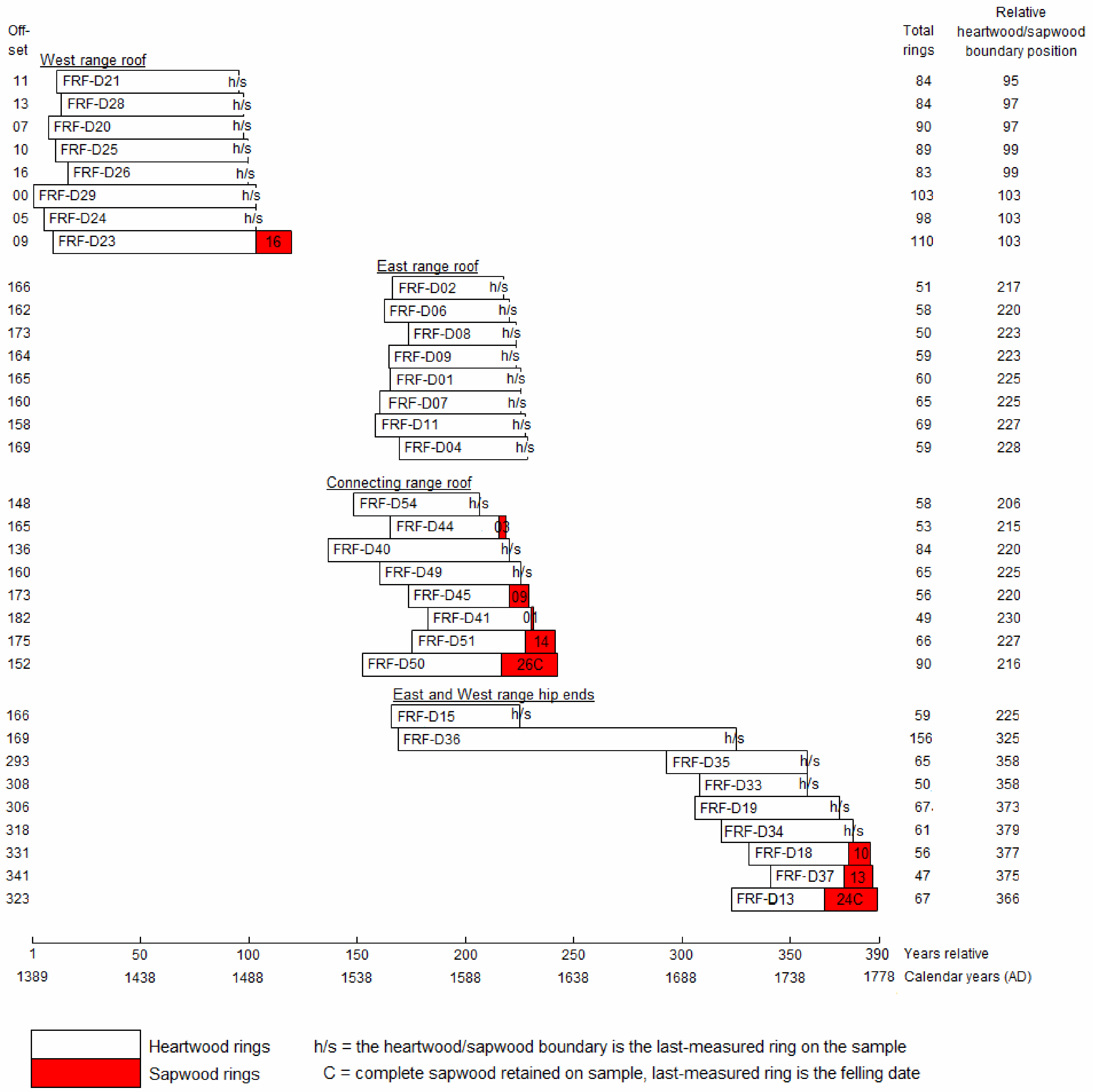

Figure 38: Bar diagram of dated samples, sorted by area

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

FRF-D01A 60
180 222 171 296 552 613 587 450 508 350 468 249 127 255 230 313 420 344 248 279
361 327 242 271 281 176 241 223 179 187 211 192 148 161 146 230 161 134 175 153
181 182 207 165 129 146 118 93 128 126 211 112 171 142 147 137 158 99 87 75
FRF-D01B 60
156 233 168 262 539 610 599 521 510 329 469 248 133 247 234 310 418 351 244 281
362 327 240 285 282 180 238 222 181 182 214 192 153 166 140 230 167 104 189 159
193 174 203 167 126 144 123 94 127 128 206 117 176 137 146 139 147 109 89 86
FRF-D02A 51
183 392 434 676 713 727 622 586 374 650 257 190 566 377 414 514 347 257 340 484
331 290 386 303 257 282 243 219 240 270 295 175 137 143 198 130 188 226 148 238
213 165 136 177 171 154 111 179 176 268 188
FRF-D02B 51
183 401 444 691 731 738 636 592 366 634 267 203 587 382 410 531 354 248 343 489
336 291 390 307 253 284 242 193 235 269 293 173 138 135 192 136 194 233 147 240
214 166 141 184 172 151 112 179 175 274 174
FRF-D04A 59
318 338 422 285 260 195 276 136 84 337 308 325 284 270 213 302 284 300 191 194
220 317 412 333 299 346 326 370 325 272 177 390 236 239 373 341 298 324 330 296
270 226 370 334 275 306 295 297 340 233 280 289 253 280 192 288 190 231 219
FRF-D04B 59
390 321 407 278 259 197 279 134 83 337 305 335 277 246 205 256 290 308 196 186
218 307 398 329 304 333 315 367 330 279 209 385 236 261 359 350 283 332 355 309
268 246 357 309 270 314 291 286 329 250 290 288 246 289 182 288 196 236 188
FRF-D06A 58
476 433 348 722 696 516 491 774 861 712 690 511 341 380 330 205 482 288 283 329
277 266 297 424 362 364 445 383 362 292 302 218 239 238 320 284 254 218 314 246
196 158 114 79 136 133 149 114 161 123 123 87 136 127 87 79 81 90
FRF-D06B 58
492 434 348 668 641 546 509 834 796 692 689 503 344 375 333 195 509 309 291 326
282 266 301 408 371 357 430 373 329 301 311 221 260 240 343 281 260 223 309 235
186 152 117 80 145 130 158 114 152 127 128 85 121 130 89 78 82 63
FRF-D07A 65
140 293 304 260 341 267 225 137 200 207 280 308 246 417 250 217 248 158 275 343
463 368 377 222 247 313 282 266 169 163 252 179 167 182 144 164 159 168 168 105
152 138 124 160 163 161 176 173 120 159 149 127 105 92 125 146 134 140 112 162
142 152 113 134 93
FRF-D07B 65
143 300 294 248 345 270 219 146 195 203 277 309 251 410 230 225 235 163 264 363
479 333 375 236 245 327 273 268 183 162 238 180 171 190 133 158 166 164 170 112
151 131 129 168 163 167 174 171 127 159 147 130 114 86 134 129 124 129 104 150
125 149 119 120 92
FRF-D08A 50
491 320 443 292 201 356 371 381 455 435 327 326 482 442 652 643 428 491 537 407
387 411 380 374 397 403 310 390 339 340 437 453 440 422 377 373 414 217 330 321
289 351 405 256 378 298 438 530 274 328
FRF-D08B 50
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383 409 382 369 413 390 312 415 338 344 419 442 434 414 387 366 421 226 339 331
294 335 384 253 378 302 456 473 292 324
FRF-D09A 59
590 684 661 424 298 306 344 276 354 337 255 367 389 145 267 321 315 302 254 231
203 213 320 173 179 147 171 155 189 138 179 198 285 273 287 287 312 199 288 228
226 194 240 217 184 198 168 160 155 210 244 237 185 221 170 207 267 285 175
FRF-D09B 59
552 686 657 424 311 310 348 260 347 347 251 381 377 150 280 304 354 309 255 234
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237 204 249 231 191 189 191 166 159 191 244 223 166 208 172 210 271 293 163
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269 205 410 375 381 357 298 312 271 274 252 163 130 106 158 97 180 305 202 210
213 174 125 96 161 128 297 223 175
FRF-D11B 69
329 247 447 421 282 250 309 245 187 100 129 180 384 642 538 751 455 581 211 143
236 250 381 566 526 195 98 165 269 413 455 302 312 290 281 269 328 389 399 326
265 200 398 404 381 352 300 319 266 272 261 162 139 104 153 95 184 298 199 206
214 170 137 114 126 136 311 224 186
FRF-D13A 67
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73 113 146 109 48 79 87 148 69 62 53 101 102 74 64 62 91 68 89 71
74 123 197 149 114 71 54
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120 110 101 145 197 117 109 106 109 94 91 140 96 109 95 75 66 87 92 148
74 111 149 95 53 90 85 156 67 62 53 100 102 75 71 57 94 65 92 70
69 120 207 165 119 69 55
FRF-D14A 52
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312 427 399 485 309 305 121 232 178 187 187 173
FRF-D14B 52
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322 413 426 475 296 308 123 258 159 197 181 176
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386 283 258 281 369 431 323 301 268 335 314 294 279 180 198 178 169 181 218 206
252 223 211 249 178 181 153 152 210 172 141 164 222 256 273 225 232 215 178
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231 207 207 259 199 180 164 168 199 186 138 162 208 283 271 226 235 213 181
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153 146 244 215 158
FRF-D17B 45
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155 145 248 224 140
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176 146 145 192 216 151 190 201 252 217 279 125 125 142 135 182
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278 306 284 193 241 153 117 123 210 307 224 230 257 251 188 270 185 175 150 273
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166 156 144 186 231 150 210 181 258 210 282 127 136 149 120 163
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286 233 171 158 510 407 302 181 479 446 252 186 137 68 44 142 293 143 141 96
98 86 130 192 209 155 104
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292 271 243 209 421 484 373 387 304 174 75 90 84 147 235 248 317 315 371 310
282 234 131 123 483 399 296 189 463 452 268 199 136 68 39 139 282 126 138 87
95 91 129 191 209 147 98
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132 139 186 110 161 150 167 182 119 207 216 148 93 100 72 114 69 93 98 142
129 107 95 98 93 180 121 116 143 123
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292 175 271 274 190 250 200 212 177 126 95 129 196 147 44 59 125 85 72 153
128 169 154 100 147 226 157 167 132 108 149 151 152 161 120 123 90 85 103 124
137 132 191 108 162 151 165 191 113 203 210 142 96 97 95 97 74 88 98 143
130 105 90 96 97 180 126 117 133 126
FRF-D21A 84
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265 191 177 194 155 167 238 160 132 130 177 184 152 113 85 83 143 117 110 123
115 151 157 121
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382 402 370 360 484 463 596 404 443 392 341 355 423 323 458 354 295 253 378 302
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326 537 448 437 460 510 469 442 381 385 536 366 297 390 415 464 408 448 386 341
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132 113 104 111 129 166 168 145 160 257 299 242 227 136 190 214 234 159 59 63
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187
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114 163 175 131 117 111 140 109 110 121 122 125 147 189 85 60 88 103 103 81
127 145 116 81 81 97 103 96 97 85 135 112 62 87 128 71 93 73 80 92
115 133 123
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112 128 128
FRF-D27A 75
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296 227 255 226 195 187 232 228 226 231 153 151 164 160 150 158 143 177 289 204
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142 135 112 100 168 118 127 115 110 130 105 117 122 105 146
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286 235 252 228 201 177 236 219 232 225 151 152 161 152 151 156 142 186 281 195
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50 70 108 113
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53 72 104 120
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326 272 239 152 149 190 199 238 213 102 67 119 158 160 333 178 393 347 262 236
196 239 206 258 210 219 218 172 137 141 204 108 97 106 127 166 223 189 204 171
164 191 201
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325 267 255 157 160 187 211 239 204 113 61 107 163 167 330 180 387 351 251 246
189 245 212 267 207 215 213 158 146 134 206 111 82 87 107 168 214 205 201 167
163 197 178
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389 510 314 268 253 255 151 187 173 191 223 131 130 284 247 311 352 314 316 268
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124 152 161 143 179 143 130 101 143 190 157 283 180 165 143 205 204 150 110 167
216 196 183 175 162 207 183 266 251 247 112 60 38 48 51 50 57 80 57 110
139 133 137 123 126 138 182 172 175 188 168 90 54 77 73 87 56 68 105
FRF-D30B 99
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246 190 115 59 72 89 116 160 83 54 71 62 58 48 135 121 111 201 200 148
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APPENDIX: TREE-RING DATING

The Principles of Tree-Ring Dating

Tree-ring dating, or dendrochronology as it is known, is discussed in some detail in the Laboratory's Monograph, An East Midlands Master Tree-Ring Chronology and its uses for dating Vernacular Building (Laxton and Litton 1988) and Dendrochronology: Guidelines on Producing and Interpreting Dendrochronological Dates (English Heritage 1998). Here we will give the bare outlines. Each year an oak tree grows an extra ring on the outside of its trunk and all its branches just inside its bark. The width of this annual ring depends largely on the weather during the growing season, about April to October, and possibly also on the weather during the previous year. Good growing seasons give rise to relatively wide rings, poor ones to very narrow rings and average ones to relatively average ring widths. Since the climate is so variable from year to year, almost random-like, the widths of these rings will also appear random-like in sequence, reflecting the seasons. This is illustrated in Figure A1 where, for example, the widest rings appear at irregular intervals. This is the key to dating by tree rings, or rather, by their widths. Records of the average ring widths for oaks, one for each year for the last 1000 years or more, are available for different areas. These are called master chronologies. Because of the random-like nature of these sequences of widths, there is usually only one position at which a sequence of ring widths from a sample of oak timber with at least 70 rings will match a master. This will date the timber and, in particular, the last ring.

If the bark is still on the sample, as in Figure A1, then the date of the last ring will be the date of felling of the oak from which it was cut. There is much evidence that in medieval times oaks cut down for building purposes were used almost immediately, usually within the year or so (Rackham 1976). Hence if bark is present on several main timbers in a building, none of which appear reused or are later insertions, and if they all have the same date for their last ring, then we can be quite confident that this is the date of construction or soon after. If there is no bark on the sample, then we have to make an estimate of the felling date; how this is done is explained below.

The Practice of Tree-Ring Dating at the Nottingham Tree-Ring Dating Laboratory

1. Inspecting the Building and Sampling the Timbers. Together with a building historian the timbers in a building are inspected to try to ensure that those sampled are not reused or later insertions. Sampling is almost always done by coring into the timber, which has the great advantage that we can sample in situ timbers and those judged best to give the date of construction, or phase of construction if there is more than one in the building. The timbers to be sampled are also inspected to see how many rings they have. We normally look for timbers with at least 70 rings, and preferably more. With fewer rings than this, 50 for example, sequences of widths become difficult to match to a unique

position within a master sequence of ring widths and so are difficult to date (Litton and Zainodin 1991). The cross-section of the rafter shown in Figure A2 has about 120 rings; about 20 of which are sapwood rings – the lighter rings on the outside. Similarly the core has just over 100 rings with a few sapwood rings.

To ensure that we are getting the date of the building as a whole, or the whole of a phase of construction if there is more than one, about 8–10 samples per phase are usually taken. Sometimes we take many more, especially if the construction is complicated. One reason for taking so many samples is that, in general, some will fail to give a date. There may be many reasons why a particular sequence of ring widths from a sample of timber fails to give a date even though others from the same building do. For example, a particular tree may have grown in an odd ecological niche, so odd indeed that the widths of its rings were determined by factors other than the local climate! In such circumstances it will be impossible to date a timber from this tree using the master sequence whose widths, we can assume, were predominantly determined by the local climate at the time.

Sampling is done by coring into the timber with a hollow corer attached to an electric drill and usually from its outer rings inwards towards where the centre of the tree, the pith, is judged to be. An illustration of a core is shown in Figure A2; it is about 150mm long and 10mm diameter. Great care has to be taken to ensure that as few as possible of the outer rings are lost in coring. This can be difficult as these outer rings are often very soft (see below on sapwood). Each sample is given a code which identifies uniquely which timber it comes from, which building it is from and where the building is located. For example, CRO-A06 is the sixth core taken from the first building (A) sampled by the Laboratory in Cropwell Bishop. Where it came from in that building will be shown in the sampling records and drawings. No structural damage is done to any timbers by coring, nor does it weaken them.

During the initial inspection of the building and its timbers the dendrochronologist may come to the conclusion that, as far as can be judged, none of the timbers have sufficient rings in them for dating purposes and may advise against sampling to save further unwarranted expense.

All sampling by the Laboratory is undertaken according to current Health and Safety Standards. The Laboratory's dendrochronologists are insured.

Figure A1: A wedge of oak from a tree felled in 1976. It shows the annual growth rings, one for each year from the innermost ring to the last ring on the outside just inside the bark. The year of each ring can be determined by counting back from the outside ring, which grew in 1976

Figure A2: Cross-section of a rafter, showing sapwood rings in the left-hand corner, the arrow points to the heartwood/sapwood boundary (H/S); and a core with sapwood; again the arrow is pointing to the H/S. The core is about the size of a pencil

Figure A3: Measuring ring widths under a microscope. The microscope is fixed while the sample is on a moving platform. The total sequence of widths is measured twice to ensure that an error has not been made. This type of apparatus is needed to process a large number of samples on a regular basis

Figure A4: Three cores from timbers in a building. They come from trees growing at the same time. Notice that, although the sequences of widths look similar, they are not identical. This is typical

2. Measuring Ring Widths. Each core is sanded down with a belt sander using medium-grit paper and then finished by hand with flourgrade-grit paper. The rings are then clearly visible and differentiated from each other with a result very much like that shown in Figure A2. The core is then mounted on a movable table below a microscope and the ring-widths measured individually from the innermost ring to the outermost. The widths are automatically recorded in a computer file as they are measured (see Fig A3).

3. Cross-Matching and Dating the Samples. Because of the factors besides the local climate which may determine the annual widths of a tree's rings, no two sequences of ring widths from different oaks growing at the same time are exactly alike (Fig A4). Indeed, the sequences may not be exactly alike even when the trees are growing near to each other. Consequently, in the Laboratory we do not attempt to match two sequences of ring widths by eye, or graphically, or by any other subjective method. Instead, it is done objectively (ie statistically) on a computer by a process called cross-matching. The output from the computer tells us the extent of correlation between two sample sequences of widths or, if we are dating, between a sample sequence of widths and the master, at each relative position of one to the other (offsets). The extent of the correlation at an offset is determined by the t-value (defined in almost any introductory book on statistics). That offset with the maximum t-value among the t-values at all the offsets will be the best candidate for dating one sequence relative to the other. If one of these is a master chronology, then this will date the other. Experiments carried out in the past with sequences from oaks of known date suggest that a t-value of at least 4.5, and preferably at least 5.0, is usually adequate for the dating to be accepted with reasonable confidence (Laxton and Litton 1988; Laxton et al 1988; Howard et al 1984–1995).

This is illustrated in Figure A5 with timbers from one of the roofs of Lincoln Cathedral. Here four sequences of ring widths, LIN-C04, 05, 08, and 45, have been cross-matched with each other. The ring widths themselves have been omitted in the bar diagram, as is usual, but the offsets at which they best cross-match each other are shown; eg the sequence of ring widths of C08 matches the sequence of ring widths of C45 best when it is at a position starting 20 rings after the first ring of C45, and similarly for the others. The actual t-values between the four at these offsets of best correlations are in the matrix. Thus at the offset of +20 rings, the t-value between C45 and C08 is 5.6 and is the maximum found between these two among all the positions of one sequence relative to the other.

It is standard practice in our Laboratory first to cross-match as many as possible of the ring-width sequences of the samples in a building and then to form an average from them. This average is called a site sequence of the building being dated and is illustrated in Figure A5. The fifth bar at the bottom is a site sequence for a roof at Lincoln Cathedral and is constructed from the matching sequences of the four timbers. The site sequence width for each year is the average of the widths in each of the sample sequences which has a width for that year. Thus in Fig A5 if the widths shown are 0.8mm for C45, 0.2mm for C08, 0.7mm for C05, and 0.3mm for C04, then the corresponding width of the site sequence is the average of these, 0.55mm. The actual sequence of widths of this site sequence is stored on the computer. The reason for creating site sequences is that it is usually easier to date an average sequence of ring widths with a master sequence than it is to date the individual component sample sequences separately.

The straightforward method of cross-matching several sample sequences with each other one at a time is called the 'maximal t-value' method. The actual method of cross-matching a group of sequences of ring-widths used in the Laboratory involves grouping and averaging the ring-width sequences and is called the 'Litton-Zainodin Grouping Procedure'. It is a modification of the straightforward method and was successfully developed and tested in the Laboratory and has been published (Litton and Zainodin 1991; Laxton et al 1988).

4. Estimating the Felling Date. As mentioned above, if the bark is present on a sample, then the date of its last ring is the date of the felling of its tree (or the last full year before felling, if it was felled in the first three months of the following calendar year, before any new growth had started, but this is not too important a consideration in most cases). The actual bark may not be present on a timber in a building, though the dendrochronologist who is sampling can often see from its surface that only the bark is missing. In these cases the date of the last ring is still the date of felling.

Quite often some, though not all, of the original outer rings are missing on a timber. The outer rings on an oak, called sapwood rings, are usually lighter than the inner rings, the heartwood, and so are relatively easy to identify. For example, sapwood can be seen in the corner of the rafter and at the outer end of the core in Figure A2, both indicated by arrows. More importantly for dendrochronology, the sapwood is relatively soft and so liable to insect attack and wear and tear. The builder, therefore, may remove some of the sapwood for precisely these reasons. Nevertheless, if at least some of the sapwood rings are left on a sample, we will know that not too many rings have been lost since felling so that the date of the last ring on the sample is only a few years before the date of the original last ring on the tree, and so to the date of felling.

Various estimates have been made and used for the average number of sapwood rings in mature oak trees (English Heritage 1998). A fairly conservative range is between 15 and 50 and that this holds for 95% of mature oaks. This means, of course, that in a small number of cases there could be fewer than 15 and more than 50 sapwood rings. For example, the core CRO-A06 has only 9 sapwood rings and some have obviously been lost over time – either they were removed originally by the carpenter and/or they rotted away in the building and/or they were lost in the coring. It is not known exactly how many sapwood rings are missing, but using the above range the Laboratory would estimate between a minimum of 6 (=15-9) and a maximum of 41 (=50-9). If the last ring of CRO-A06 has been dated to 1500, say, then the estimated felling-date range for the tree from which it came originally would be between 1506 and 1541. The Laboratory uses this estimate for sapwood in areas of England where it has no prior information. It also uses it when dealing with samples with very many rings, about 120 to the last heartwood ring. But in other areas of England where the Laboratory has accumulated a number of samples with complete sapwood, that is, no sapwood lost since felling, other estimates in place of the conservative range of 15 to 50 are used. In the East Midlands (Laxton et al 2001) and the east to the south down to Kent (Pearson 1995) where it has sampled extensively in the past, the Laboratory uses the shorter estimate of 15 to 35 sapwood rings in 95% of mature oaks growing in these parts. Since the sample CRO-A06 comes from a house in Cropwell Bishop in the East Midlands, a better estimate of sapwood rings lost since felling is between a minimum of 6 (=15-9) and 26 (=35-9) and the felling would be estimated to have taken place between 1506 and 1526, a shorter period than before. Oak boards quite often come from the Baltic region and in these cases the 95% confidence limits for sapwood are 9 to 36 (Howard et al 1992, 56).

Even more precise estimates of the felling date and range can often be obtained using knowledge of a particular case and information gathered at the time of sampling. For example, at the time of sampling the dendrochronologist may have noted that the timber from which the core of Figure A2 was taken still had complete sapwood but that some of the soft sapwood rings were lost in coring. By measuring into the timber the depth of sapwood lost, say 20mm, a reasonable estimate can be made of the number of sapwood rings lost, say 12 to 15 rings in this case. By adding on 12 to 15 years to the date of the last ring on the sample a good tight estimate for the range of the felling date can be obtained, which is often better than the 15 to 35 years later we would have estimated without this observation. In the example, the felling is now estimated to have taken place between AD 1512 and 1515, which is much more precise than without this extra information.

Even if all the sapwood rings are missing on a sample, but none of the heartwood rings are, then an estimate of the felling-date range is possible by adding on the full compliment of, say, 15 to 35 years to the date of the last heartwood ring (called the heartwood/ sapwood boundary or transition ring and denoted H/S). Fortunately it is often easy for a trained dendrochronologist to identify this boundary on a timber. If a timber does not have its heartwood/sapwood boundary, then only a post quem date for felling is possible.

5. Estimating the Date of Construction. There is a considerable body of evidence collected by dendrochronologists over the years that oak timbers used in buildings were not seasoned in medieval or early modern times (English Heritage 1998; Miles 1997, 50–5). Hence, provided that all the samples in a building have estimated felling-date ranges broadly in agreement with each other, so that they appear to have been felled as a group, then this should give an accurate estimate of the period when the structure was built, or soon after (Laxton et al 2001, fig 8; 34–5, where 'associated groups of fellings' are discussed in detail). However, if there is any evidence of storage before use, or if there is evidence the oak came from abroad (eg Baltic boards), then some allowance has to be made for this.

6. Master Chronological Sequences. Ultimately, to date a sequence of ring widths, or a site sequence, we need a master sequence of dated ring widths with which to cross-match it, a Master Chronology. To construct such a sequence we have to start with a sequence of widths whose dates are known and this means beginning with a sequence from an oak tree whose date of felling is known. In Figure A6 such a sequence is SHE-T, which came from a tree in Sherwood Forest which was blown down in a recent gale. After this other sequences which cross-match with it are added and gradually the sequence is 'pushed back in time' as far as the age of samples will allow. This process is illustrated in Figure A6. We have a master chronological sequence of widths for Nottinghamshire and East Midlands oak for each year from AD 882 to 1981. It is described in great detail in Laxton and Litton (1988), but the components it contains are shown here in the form of a bar diagram. As can be seen, it is well replicated in that for each year in this period there are several sample sequences having widths for that year. The master is the average of these. This master can now be used to date oak from this area and from the surrounding areas where the climate is very similar to that in the East Midlands. The Laboratory has also constructed a master for Kent (Laxton and Litton 1989). The method the Laboratory uses to construct a master sequence, such as the East Midlands and Kent, is completely objective and uses the Litton-Zainodin grouping procedure (Laxton et al 1988). Other laboratories and individuals have constructed masters for other areas and have made them available. As well as these masters, local (dated) site chronologies can be used to date other buildings from nearby. The Laboratory has hundreds of these site sequences from many parts of England and Wales covering many short periods.

7. Ring-Width Indices. Tree-ring dating can be done by cross-matching the ring widths themselves, as described above. However, it is advantageous to modify the widths first. Because different trees grow at different rates and because a young oak grows in a different way from an older oak, irrespective of the climate, the widths are first standardized before any matching between them is attempted. These standard widths are known as ring-width indices and were first used in dendrochronology by Baillie and Pilcher (1973). The exact form they take is explained in this paper and in the appendix of Laxton and Litton (1988) and is illustrated in the graphs in Figure A7. Here ring-widths are plotted vertically, one for each year of growth. In the upper sequence of (a), the generally large early growth after 1810 is very apparent as is the smaller later growth from about 1900 onwards when the tree is maturing. A similar phenomenon can be observed in the lower sequence of (a) starting in 1835. In both the widths are also changing rapidly from year to year. The peaks are the wide rings and the troughs are the narrow rings corresponding to good and poor growing seasons, respectively. The two corresponding sequence of Baillie-Pilcher indices are plotted in (b) where the differences in the immature and mature growths have been removed and only the rapidly changing peaks and troughs remain, that are associated with the common climatic signal. This makes cross-matching easier.

t-value/offset Matrix

	C45	C08	C05	C04
C45		+20	+37	+47
C08	5.6		+17	+27
C05	5.2	10.4		+10
C04	5.9	3.7	5.1	

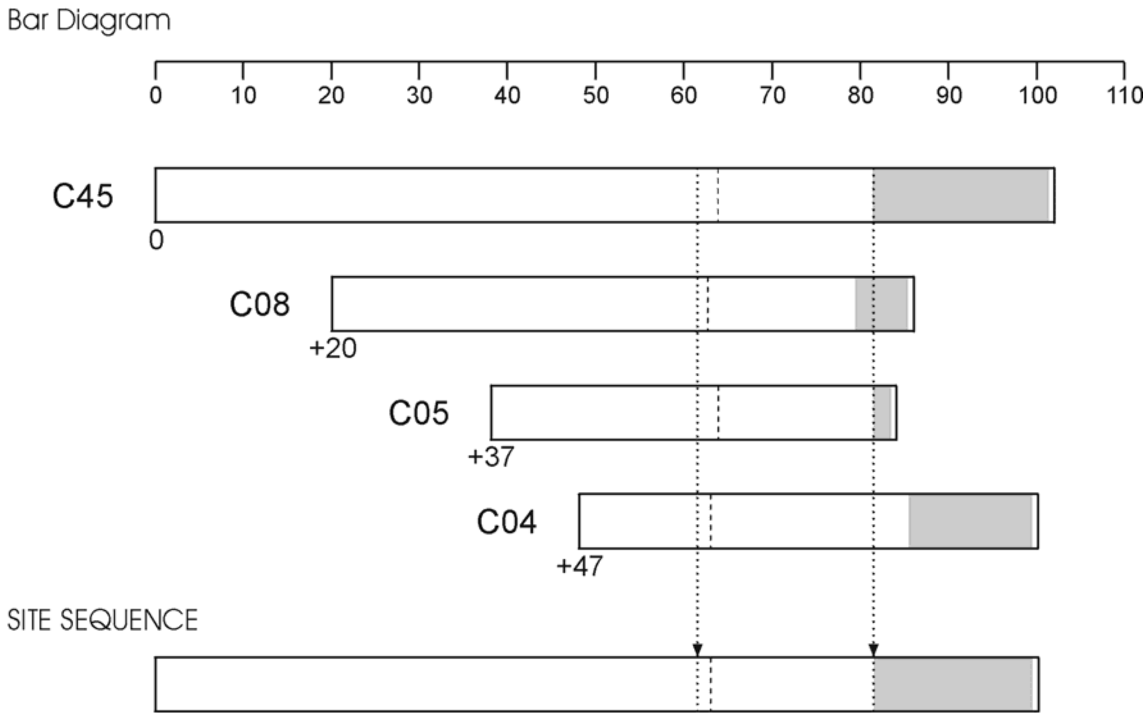


Figure A5: Cross-matching of four sequences from a Lincoln Cathedral roof and the formation of a site sequence from them

The bar diagram represents these sequences without the rings themselves. The length of the bar is proportional to the number of rings in the sequence. Here the four sequences are set at relative positions (offsets) to each other at which they have maximum correlation as measured by the t-values. The t-value/offset matrix contains the maximum t-values below the diagonal and the offsets above it. Thus, the maximum t-value between C08 and C45 occurs at the offset of +20 rings and the t-value is then 5.6. The site sequence is composed of the average of the corresponding widths, as illustrated with one width.

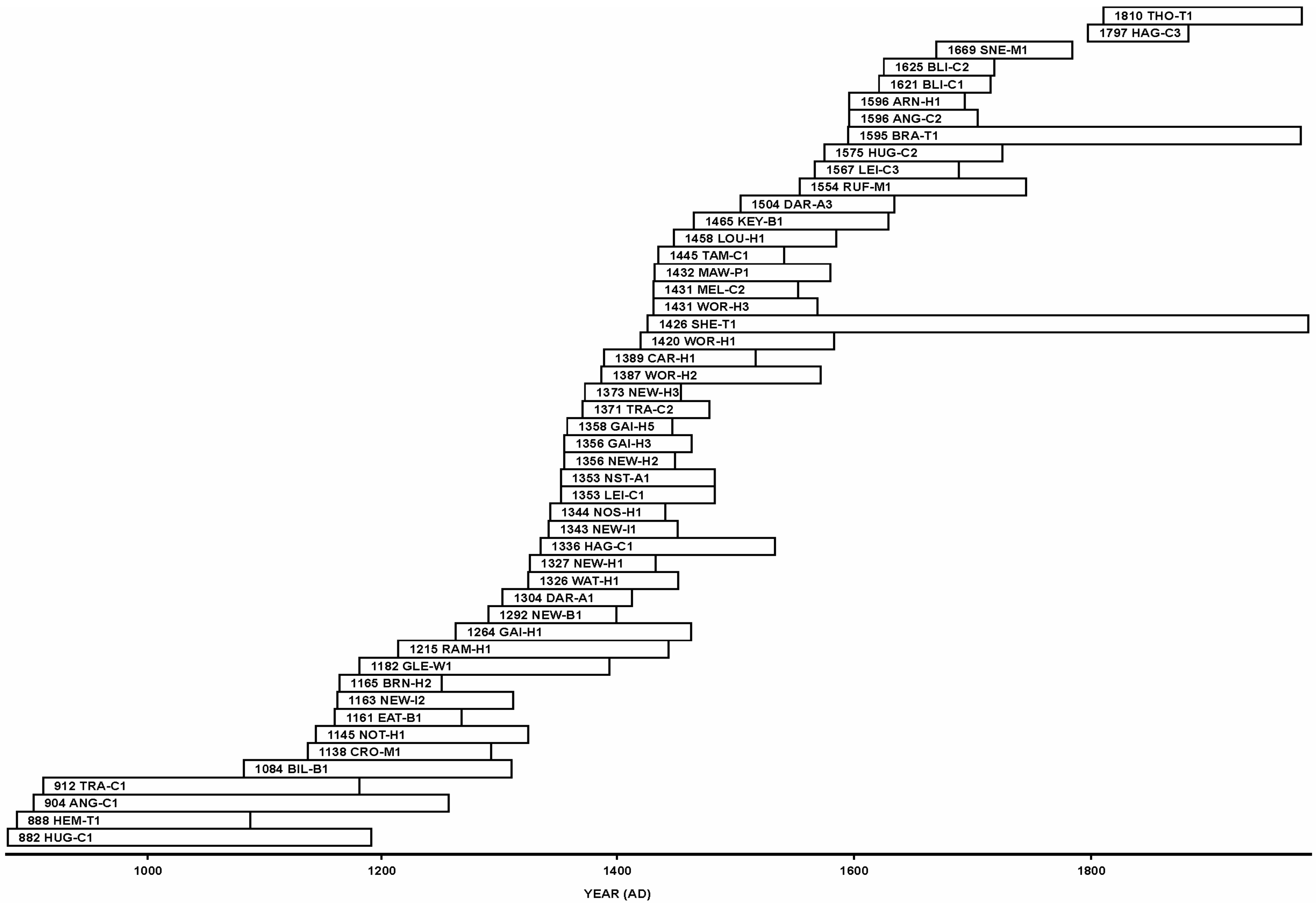
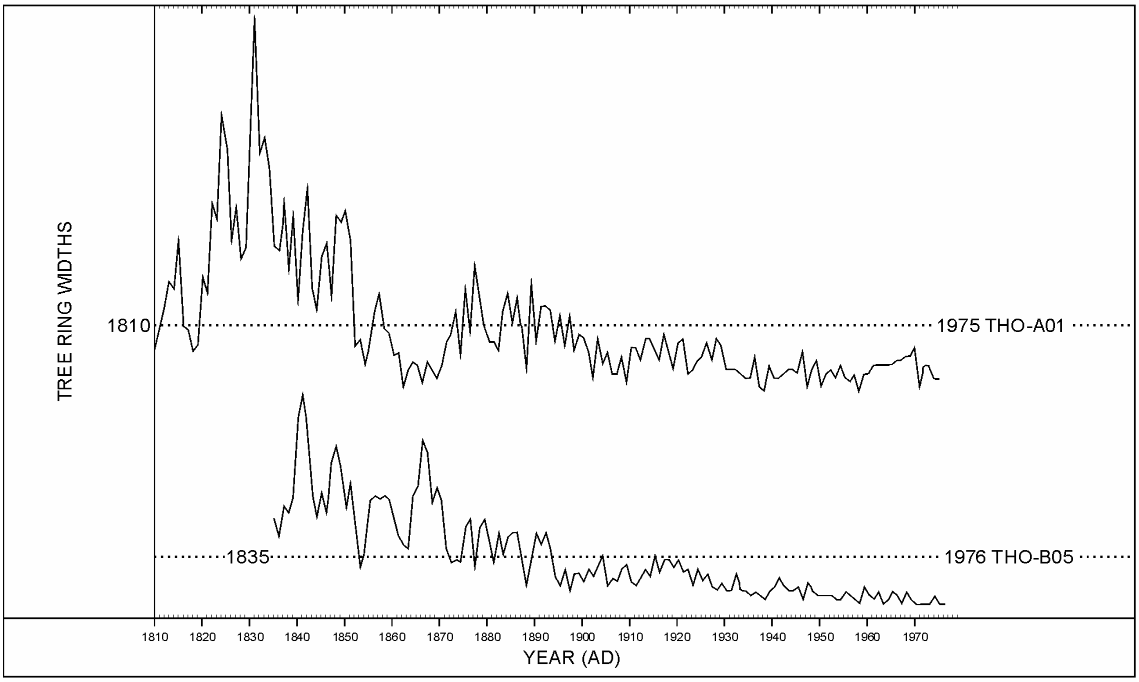


Figure A6: Bar diagram showing the relative positions and dates of the first rings of the component site sequences in the East Midlands Master Dendrochronological Sequence, EM08/87

(a)



(b)

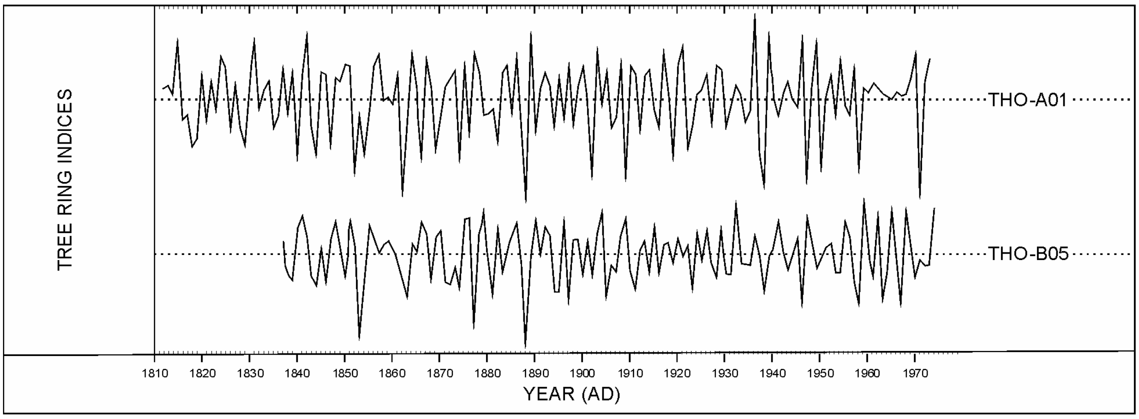


Figure A7 (a): The raw ring-widths of two samples, THO-A01 and THO-B05, whose felling dates are known

Here the ring widths are plotted vertically, one for each year, so that peaks represent wide rings and troughs narrow ones. Notice the growth-trends in each; on average the earlier rings of the young tree are wider than the later ones of the older tree in both sequences

Figure A7 (b): The Baillie-Pilcher indices of the above widths

The growth trends have been removed completely

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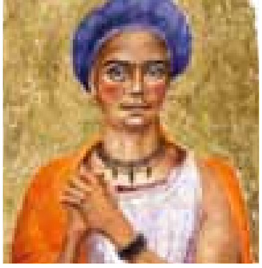


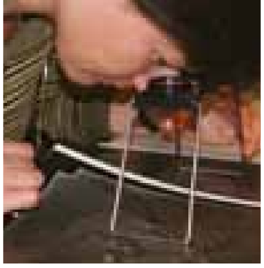


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