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THE BELLFRAME
CHURCH OF ST SWITHIN
KIRKLINGTON
NOTTINGHAMSHIRE

SURVEY, RECORDING AND TREE-RING ANALYSIS OF TIMBERS

Alison Arnold, Robert Howard & George Dawson

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SURVEY, RECORDING AND TREE-RING ANALYSIS OF TIMBERS FROM THE BELLFRAME OF THE CHURCH OF ST SWITHIN, KIRKLINGTON, NOTTINGHAMSHIRE

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SUMMARY

Dendrochronological analysis undertaken on samples taken from timbers of the bellframe at this church resulted in the construction of two site sequences.

Site sequence NBFBSQ01, containing eight samples from primary timbers, spans the period AD 1404–1669. Site sequence NBFBSQ02, contains six samples from later insertions, and spans the period AD 1567–1757.

Interpretation of the sapwood suggests felling of the primary timbers occurred in AD 1661/69 and that of the later beams in AD 1750/57.

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INTRODUCTION

The Grade II* listed Church of St Swithin is located in Kirklington, approximately 15.3km west of Newark (Figs 1 and 2). It consists of nave with south porch, chancel with south vestry, and west tower. Although it is thought to have its origins in the twelfth and thirteenth centurys, the church underwent comprehensive restoration in AD 1847 and then again in AD 1873 and as a result little of the original structure remains; the south doorway and possibly the core of the nave are twelfth century and the south porch is late-thirteenth century. With the exception of a few of the lower, medieval stone courses, the present tower is thought to date to the seventeenth century (http://southwellchurches.nottingham.ac.uk/kirklington/hintro.php)

Bellframe

This oak bellframe for three bells is of king-post design (Pickford Group 5.A) with straight braces (Fig 3). The king post on truss C has a slot for a chiming hammer, now no longer used. There are no cut-outs on the braces of the other trusses, so it is clear that the frame has always had long heads.

There is some later bracing added to each truss consisting of struts from the base of the king-post to the top sills in an attempt to stiffen the frame. The treble bell is late-fourteenth century in date, the second bell dates to the AD 1664, and the third to AD 1759.

It is possible that the frame was installed when the tower was rebuilt in the seventeenth century. It is on the Church Buildings Councils Lists of Bell fittings of Historical Importance.

Bells

Treble. [+ 122] SCA : MARIA : ORA PRO NOBIS : ROBERTVS : WILKINSON : FIERI : FECIT

2. GOD [46] SAVE [46] THE [46] KING [46] 1664[53]

Tenor (i). WILLIAM REDMAN IOHN RENCH C. W. 1759 THOMAS HEDDERLY

(ii). FOUNDER

Badge numbers are taken from the Church Bells of Nottinghamshire.

All three bells retain their canons.

All letter S's on the treble bell are reversed.

The treble was cast by an unknown founder in the late-fourteenth century. The use of the word 'feiri' on it implies that the donor was Robert Wilkinson, whose identity has not been discovered. The bell is otherwise unique. The second bell was cast by George I Oldfield of Nottingham and the tenor is the work of Thomas I Hedderly, also of Nottingham.

The treble bell is on the Church Buildings Councils Lists of Bells of Historical Importance. As such the presumption is of minimal intervention at any restoration.

Physical data:

	Diameter(cm)	Weight (Cwt.Qr.Lbs)	Note
Treble.	25 ½"	c 3 cwt	D# (1268 Hz)
2.	28 ½"	c 4 cwt	C# (1100 Hz)
Tenor.	30"	c 6 cwt	B (1011 Hz)

The clappers of the bells have caused heavy wear on the soundbows of the bells, and there is a strong risk of cracking if further ringing is undertaken.

The bells are not well in tune, with both the treble and tenor being sharp compared to the second bell. To be in tune (using the treble as datum) they should be 1268, 1129 & 1006 Hz respectively. As the second is then flat of what it should be, the only course of action at a restoration and augmentation is some tuning of the historically important treble.

The fittings, headstocks, wheels, gudgeons and bearings appear to be of nineteenth century date.

PRINCIPLES OF TREE-RING DATING

Tree-ring dating relies on a few simple, but fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees) 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 to 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 determined 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 pattern of the tree. The pattern of a short period of growth, 20 or 30 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 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal 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 millimetre. 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 a sample "cross-matches" repeatedly at the same date 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 the 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 phases 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 satisfactory analysis.

SAMPLING STRATEGY

A total of 16 samples were taken from various timber elements of this bellframe with each sample being given the code NBF-B and numbered 01–16. Samples NBF-B01–10 were taken from timbers thought to be primary whilst samples NBF-B11–16 were from those believed to relate to later alterations. The location of all samples was noted at the time of sampling and has been marked on Figures 4–10. Further details can be found in Table 1. .

ANALYSIS & RESULTS

At this stage one of the samples, taken from a primary timber (NBF-A07), was found to have a very compacted growth pattern which would have been impossible to measure accurately. The remaining 15 samples were prepared by sanding and polishing and their growth-ring widths measured. The growth-ring widths were then compared with each other resulting in 14 samples matching to form two groups.

Firstly, eight samples matched each other and were combined to form NBFBSQ01, a site sequence of 266 rings (Fig 11). This site sequence was compared against a series of relevant reference chronologies for oak where it was found to match securely and consistently at a first-ring date of AD 1404 and a last-measured ring date of AD 1669. The evidence for this dating is given by the *t*-values in Table 2.

Secondly, six samples matched each other and were combined to form NBFBSQ02, a site sequence of 191 rings (Fig 12). When this site sequence was compared against the reference chronologies it was found to match consistently and securely to span the period AD 1567–1757 (Table 3).

Attempts to date the remaining ungrouped sample by comparing it against the reference chronologies were unsuccessful and this sample remains undated.

INTERPRETATION

Fourteen samples taken from this bellframe have been successfully dated, eight from primary timbers and six from timbers associated with the later alteration (Fig 13).

Phase 1

Eight of the samples associated with the primary phase have been successfully dated. Sample NBF-B01 has complete sapwood and the last-measured ring date of AD 1660. When this sample is looked at under the microscope it is possible to see the early growth cells for the following year, indicating that the timber represented was felled in AD Spring 1661. Two other samples, NBF-B05 and NBF-B06, match NBF-F01 at *t*=12.3 and *t*=12.9, respectively. This is of a value to suggest that all three beams represented were cut from the same tree, and so these two timbers were also felled in AD Spring 1661.

Sample NBF-B04 also has complete sapwood but with a last-measured ring date of AD 1669 can be seen to have been felled a little later (AD 1669).

Three other timbers have the heartwood/sapwood boundary ring date, which in all cases are broadly contemporary and suggestive of a single felling. The average of these is AD 1653, allowing an estimated felling date to be calculated for the timbers represented to within the range AD 1668–93, consistent with a felling of AD 1669.

The final dated sample (NBF-B10) does not have the heartwood/sapwood boundary and so an estimated felling date cannot be calculated except to say that a last-measured ring date of AD 1543 gives the timber represented a *terminus post quem* felling of AD 1558 and so it could have been felled in either AD 1661 or AD 1669.

Phase II

All six samples taken from the secondary phase have been dated. Three of these samples, NBF-B11, NBF-B13, and NBF-B16) have complete sapwood. Samples NBF-B11 and NBF-B13 have the last-measured ring date of AD 1750, the felling date of the two timbers represented. Additionally, sample NBF-B11 matches one of the other samples (NBF-B12) at the very high value of *t*=16.3, indicating that both timbers were almost certainly cut from the same tree and thus demonstrating a felling of AD 1750 for NBF-B12 too. Sample NBF-B16 also has complete sapwood but with the slightly later felling date of AD 1757. The final two dated samples within this site sequence do not have the heartwood/sapwood boundary ring date but with last-measured heartwood dates of AD 1650 (NBF-B14) and AD 1700 (NBF-B15), these two timbers could have been felled in either AD 1750 or AD 1757. However, the *t*-value evidence (Table 4) does suggest that both are more likely to have been felled in AD 1750 with contemporary with NBF-B11, NBF-B12, and NBF-B13.

DISCUSSION

Prior to tree-ring dating being undertaken on the timbers of this bellframe it had been thought that the frame might date to the seventeenth century. A number of primary timbers have now been dated to AD 1661 and AD 1669, suggesting pointing to a construction date in the second half of the seventeenth century. The tower is also thought to have been rebuilt in the seventeenth century, with completion of it possibly commemorated by the AD 1664 bell. These results would suggest that the frame was built for the new tower.

Phase II also utilises timber of slightly differing dates, with five of the six timbers thought likely to have been felled in AD 1750 with the sixth, slightly later in AD 1757. These dates suggest the use of stockpiled timber with construction occurring in the mid-eighteenth century, and possibly coinciding with the casting of one of the bells in AD 1759.

The intra-site matching of samples in site sequence NBFBSQ01 is generally very good with a number of same tree matches noted (Table 4). This suggests a single woodland source was utilised, despite timbers being of slightly different dates. There is also some good matching between NBFBSQ02 but perhaps not so consistently. Despite the two site sequences overlapping by just over 100 years there is no matching between the two groups which may suggest a different woodland source for the timbers used for the eighteenth century modification. Indeed, when one looks at the reference chronologies against which each site sequence matches most highly (Tables 2 and 3) it is clear that the

source for LBFBSQ01, matches sites very local to Kirklington, all north Nottinghamshire whilst those against which LBFBSQ02 matches most highly are slightly more disparate.

It can be seen (Table 1) that the trees utilised in the phase I construction were extremely long lived, with the majority likely to have been more than 200 years old at felling. Those trees representing the second phase with the bellframe, although not particularly short lived, can be seen to be somewhat younger at felling.

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Table 1: Details of samples taken from the bellframe at the Church of St Swithin, Kirklington, Nottinghamshire

Sample number	Sample location	*Total rings	**Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
Phase 1						
NBF-B01	Top cill, truss 1	233	18C	1428	1642	1660
NBF-B02	Top cill, truss 2	199	h/s	1458	1656	1656
NBF-B03	Top cill, truss 3	221	03	1440	1657	1660
NBF-B04	Top cill, truss 4	197	22C	1473	1647	1669
NBF-B05	Top cill, east end frame	209	h/s	1432	1640	1640
NBF-B06	Top cill, west end frame	238	h/s	1404	1641	1641
NBF-B07	North brace, west end frame	NM	--	----	----	----
NBF-B08	East post, truss 4	184	h/s	1462	1645	1645
NBF-B09	East post, truss 1	75	h/s	----	----	----
NBF-B10	King post, truss 3	76	--	1468	----	1543
Phase II						
NBF-B11	West strut, truss 1	170	47C	1581	1703	1750
NBF-B12	East strut, truss 1	146	18	1575	1702	1720
NBF-B13	West strut, truss 2	110	18C	1641	1732	1750
NBF-B14	West strut, truss 3	84	--	1567	----	1650
NBF-B15	East strut, truss 3	82	--	1619	----	1700
NBF-B16	East strut, truss 4	98	24C	1660	1733	1757

*NM = not measured

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

C = complete sapwood retained on sample, last-measured ring is the felling date s

Table.2: Results of the cross-matching of site sequence NBFBSQ01 and relevant reference chronologies when the first-measured ring date is AD 1473 and the last-measured ring date is AD 1669

Reference chronology	*t*-value	Span of chronology	Reference
Langford by Holme, Nottinghamshire	15.3	AD 1451–1608	Howard *et al* 1995
21 Church Street, Mansfield, Nottinghamshire	11.6	AD 1439–1584	Howard *et al* 1994
Langford Manor, Nottinghamshire	11.3	AD 1467–1632	Howard *et al* 1989
Manor House, Sutton in Ashfield, Nottinghamshire	11.2	AD 1441–1656	Howard *et al* 1996
Sherwood Trees, Sherwood Forest, Nottinghamshire	11.2	AD 1426–1981	Laxton and Litton, 1988
Yew Tree Farm, Kirton, Nottinghamshire	10.7	AD 1443–1688	Arnold *et al* 2001
5 Church Street, Newark-on-Trent, Nottinghamshire	10.6	AD 1403–1655	Arnold *et al* 2002

Table 3: Results of the cross-matching of site sequence NBFBSQ02 and relevant reference chronologies when the first-ring date is AD 1567 and the last-measured ring date is AD 1757

Reference chronology	*t*-value	Span of chronology	Reference
Wren Wing, Easton Neston, Northamptonshire	8.0	AD 1468–1686	Arnold *et al* 2008
Bolsover Castle (Riding House), Derbyshire	7.9	AD 1494–1744	Howard *et al* 2005
Bentley Hall, Hungry Bentley, Derbyshire	6.9	AD 1444–1675	Arnold and Howard 2009
Kibworth Harcourt Mill, Leicestershire	6.9	AD 1582–1773	Arnold *et al* 2004
St Firmin Church, Thurlby, Lincolnshire	6.6	AD 1599–1792	Arnold and Howard 2010
Bolsover (Little Castle), Derbyshire	6.6	AD 1532–1749	Arnold *et al* 2003
Pitchforks, Norwell, Nottinghamshire	6.6	AD 1624–1747	Hurford *et al* 2010

Table 4: Matrix of intra-site matching of all dated samples, the higher the level, the greater the similarity between samples; black box = phase I timbers, green box = phase II timbers

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
NBF-B01	1	***	-30	-12	-45	-4	24	-34	-40	42	56	-37	-72	-108	-87
NBF-B02	2	**4.9**	***	18	-15	26	54	-4	-10	-115	59	-7	-75	-119	-93
NBF-B03	3	**5.3**	**11.0**	***	-33	8	36	-22	-28	-30	-68	63	-2	-103	-93
NBF-B04	4	**5.5**	**4.7**	**5.0**	***	41	69	11	5	114	96	-75	-51	-41	-94
NBF-B05	5	**12.3**	**5.8**	**7.2**	3.5	***	28	-30	-36	-149	-143	36	-74	-152	-41
NBF-B06	6	**12.9**	**7.0**	**6.6**	**5.0**	**11.9**	***	-58	-64	-177	-83	-43	-163	-181	-163
NBF-B08	7	**5.2**	**7.6**	**9.7**	**4.5**	**5.4**	**7.6**	***	-6	-74	-68	-105	20	30	20
NBF-B10	8	**4.4**	3.8	**4.9**	**5.9**	**4.9**	**4.6**	**5.6**	***	120	61	60	2	-24	41
NBF-B11	9	3.4	3.6	3.0	**4.7**	3.7	3.1	3.6	3.4	***	6	-60	14	-38	-125
NBF-B12	10	2.6	3.3	3.0	3.7	**4.1**	2.7	3.0	2.6	**16.3**	***	-43	8	-44	1
NBF-B13	11	2.3	2.9	3.7	3.3	3.5	3.7	3.5	3.1	**4.2**	3.1	***	-1	22	-19
NBF-B14	12	3.4	3.3	2.5	3.2	**4.0**	3.2	**4.6**	2.5	**8.6**	**8.2**	2.5	***	-36	-7
NBF-B15	13	2.9	3.6	2.8	3.8	2.6	3.3	**4.2**	2.9	**4.1**	3.5	**9.6**	3.8	***	26
NBF-B16	14	3.8	2.5	3.0	**4.9**	3.5	3.5	3.7	2.9	**4.3**	2.6	**8.1**	3.1	2.6	***

Figure 1: Map to show the general location of Kirklington, circled (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

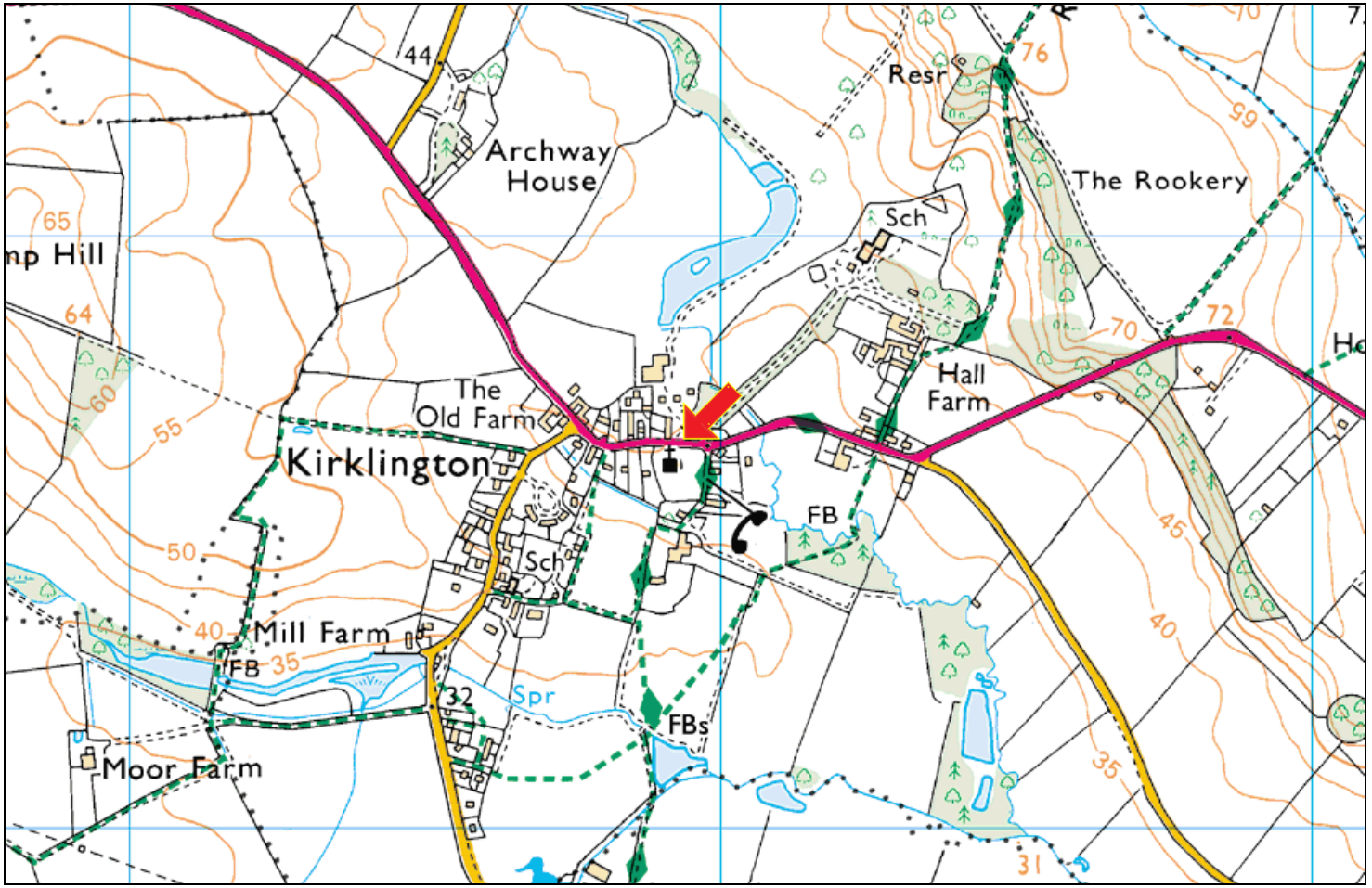

Figure 2: Map to show the location of the Church of St Swithin, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Figure 3: The bellframe, photograph taken from above

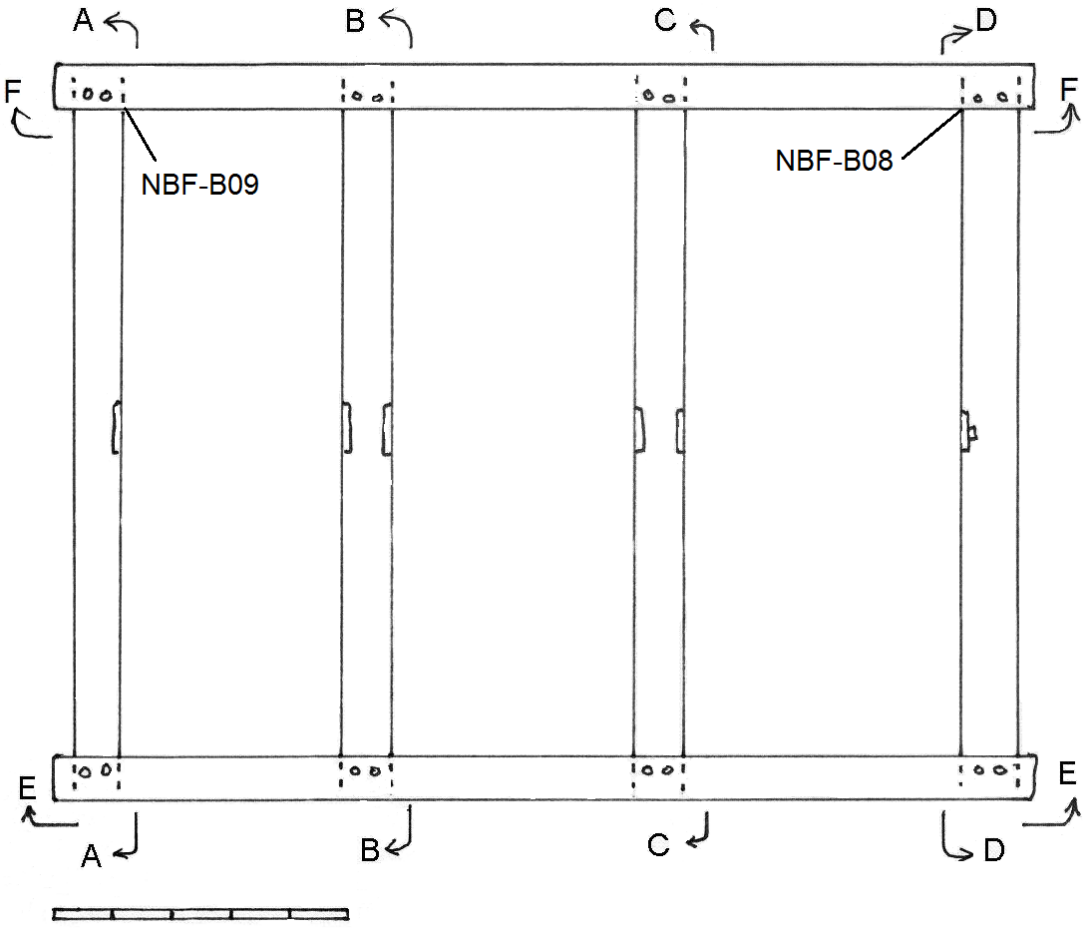

Figure 4: Plan, showing truss labelling and the location of samples NBF-B08 and NBF-B09 (George Dawson)

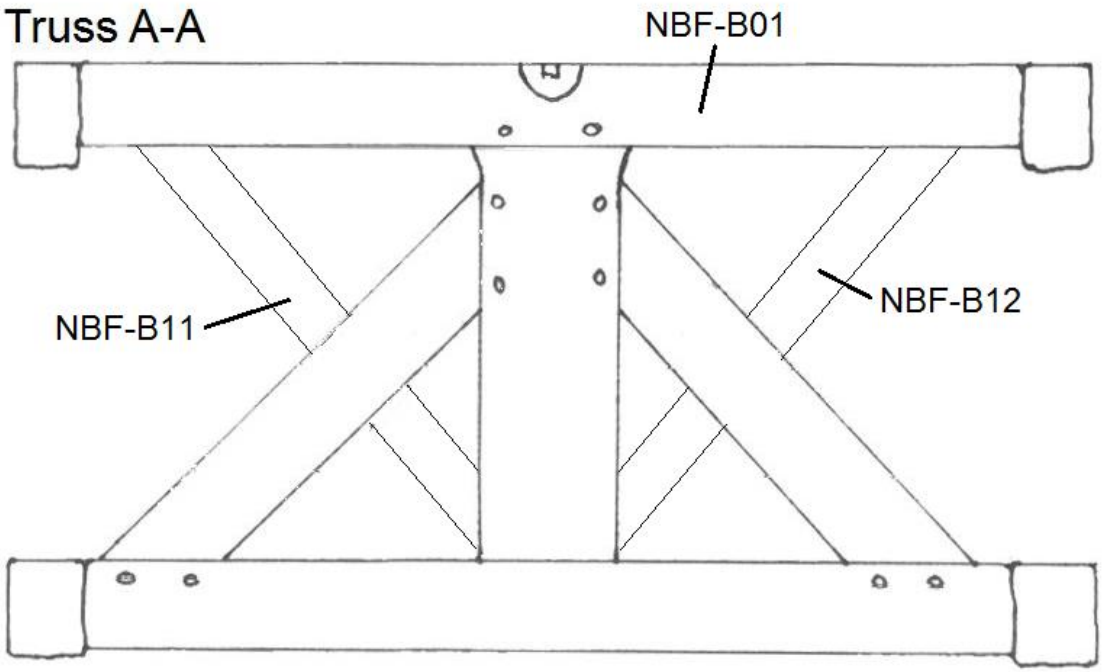

Figure 5: Truss A, showing the location of samples NBF-B01, NBF-B11, and NBF-B12 (after George Dawson)

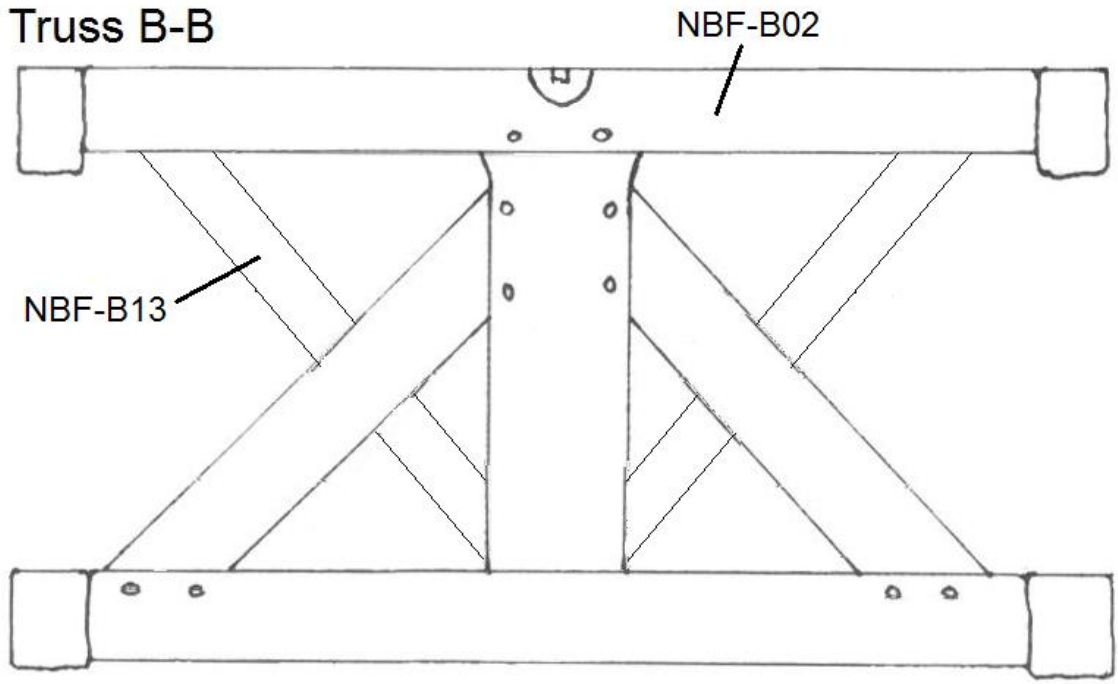

Figure 6: Truss B, showing the location of samples NBF-B02 and NBF-B13 (after George Dawson)

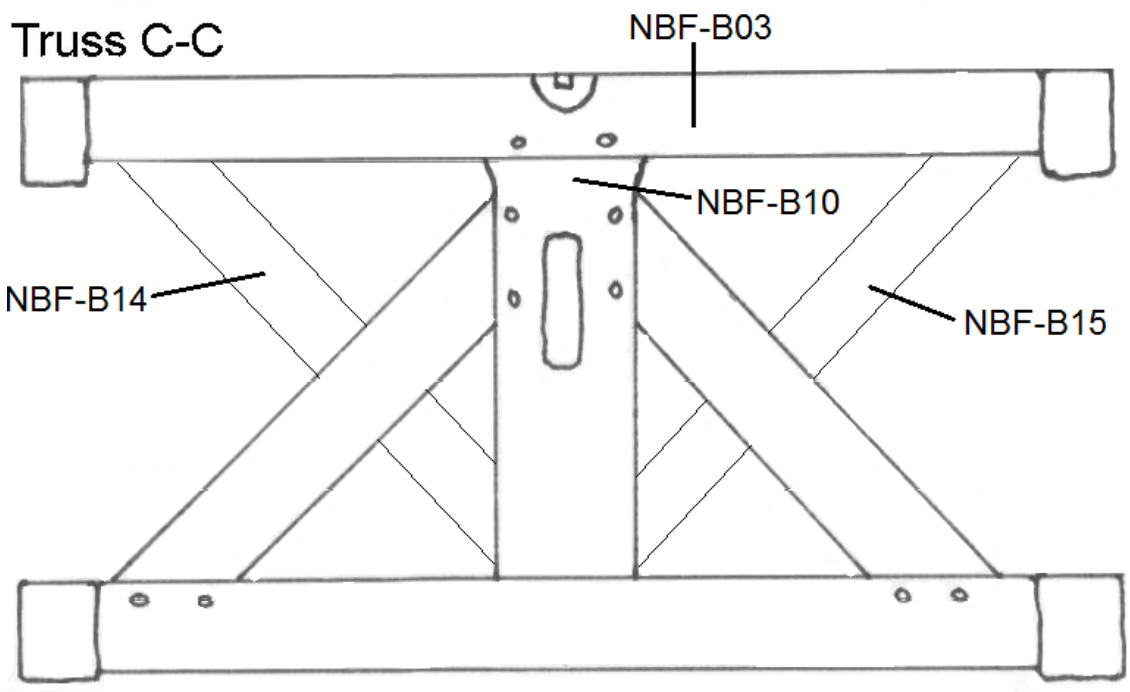

Figure 7: Truss C, showing the location of samples NBF-B03, NBF-B10, and NBF-B14-15 (after George Dawson)

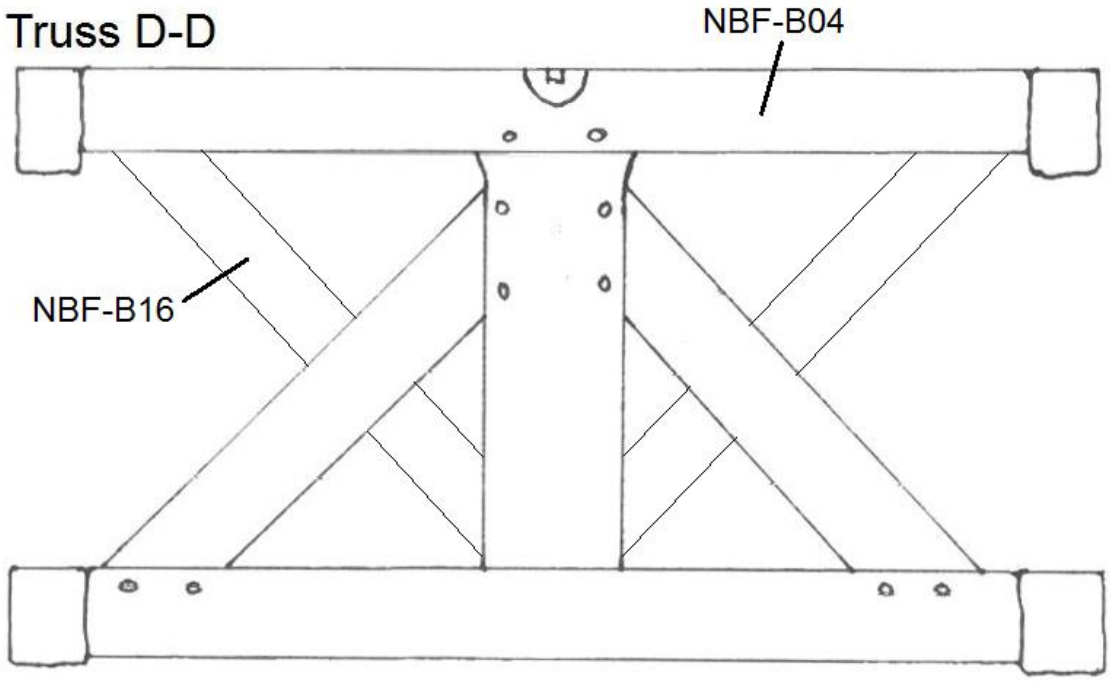

Figure 8: Truss D, showing the location of samples NBF-B04 and NBF-B16 (after George Dawson)

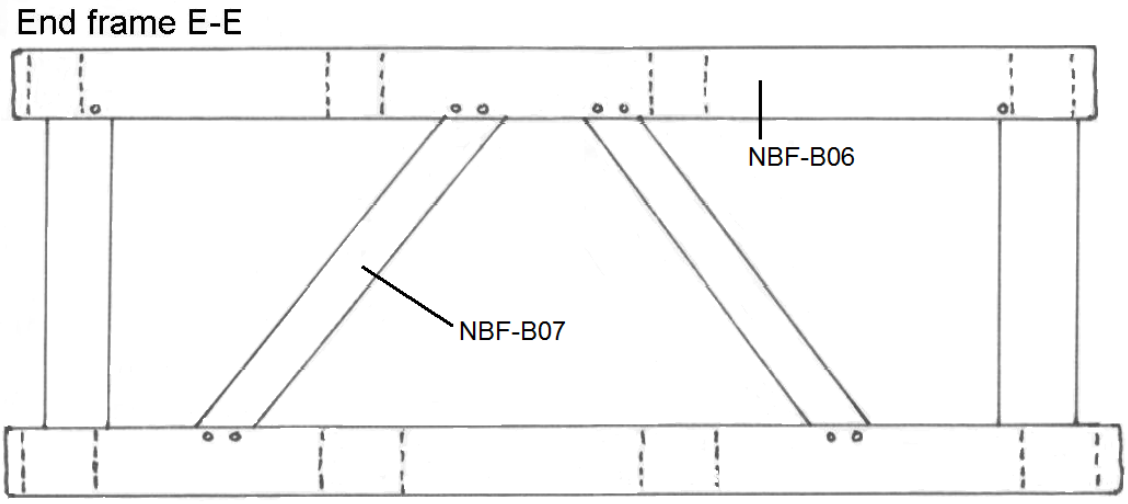

Figure 9: Endframe E, showing the location of samples NBF-B06 and NBF-B07 (George Dawson)

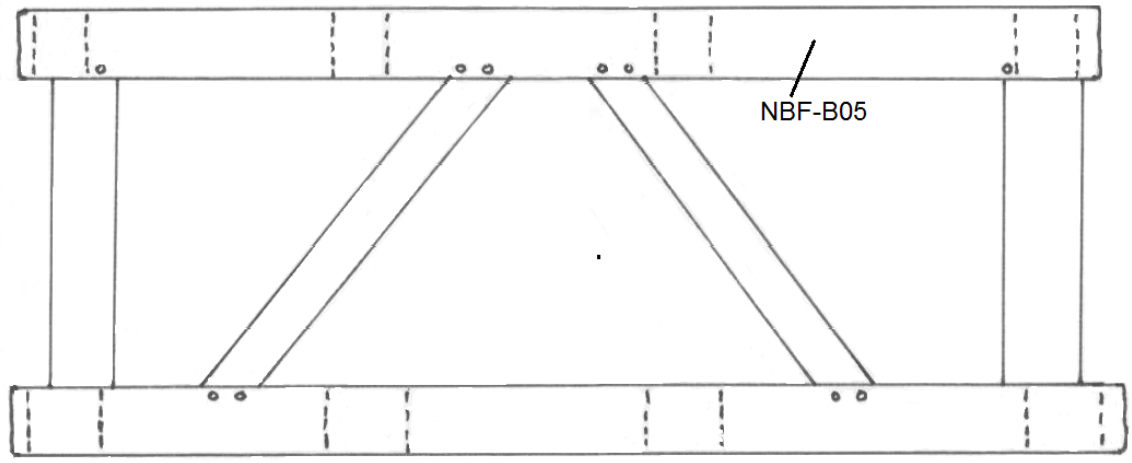

Figure 10: Endframe F (based on endframe E), showing the location of sample NBF-B05 (George Dawson)

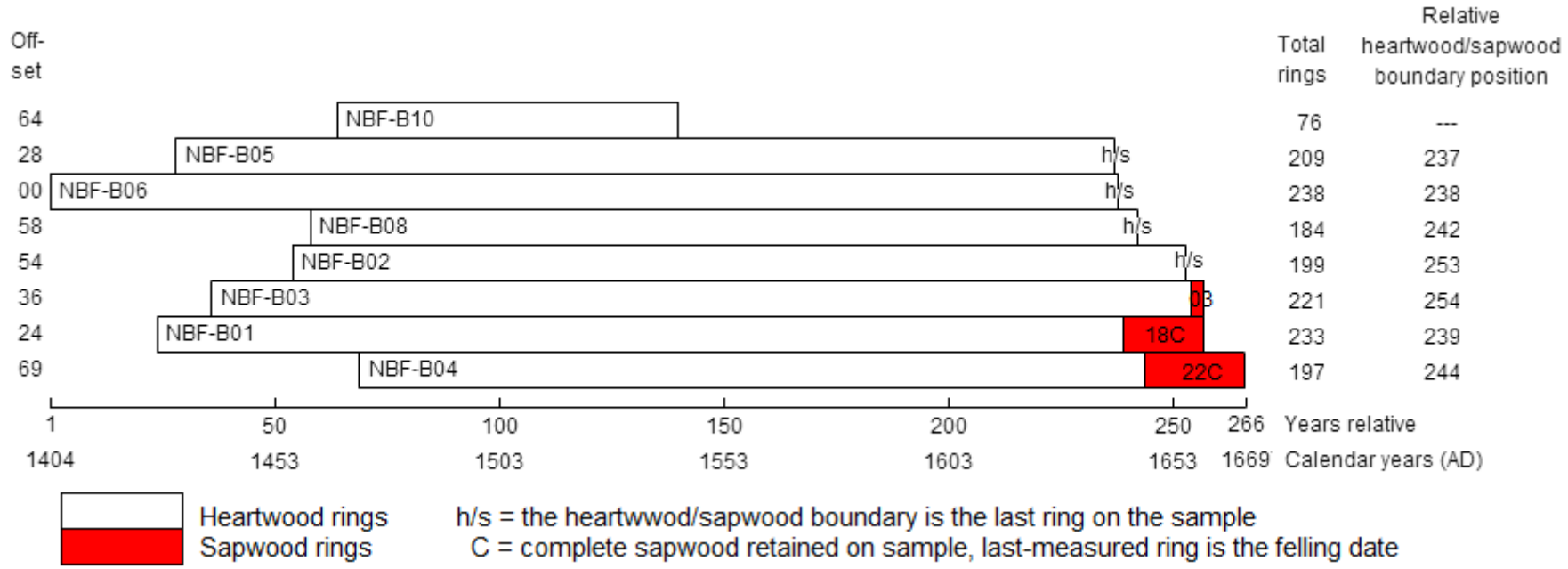

Figure 11: Bar diagram to show the position of samples in site sequence NBFASQ01

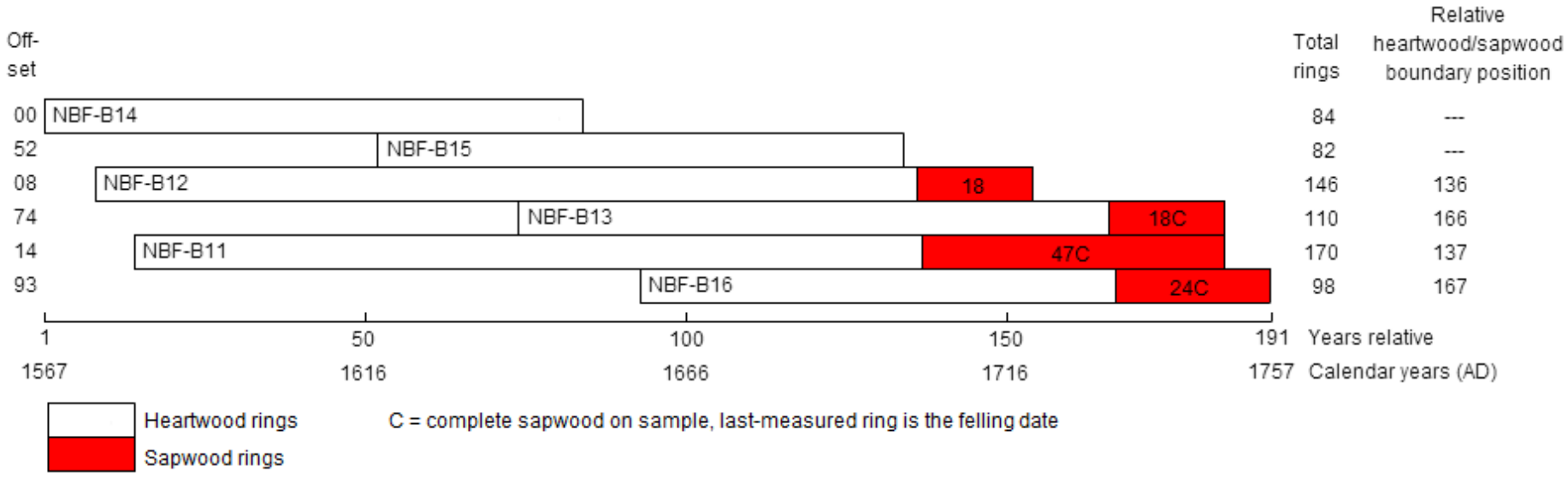

Figure 12: Bar diagram of samples in site sequence NBFBSQ02

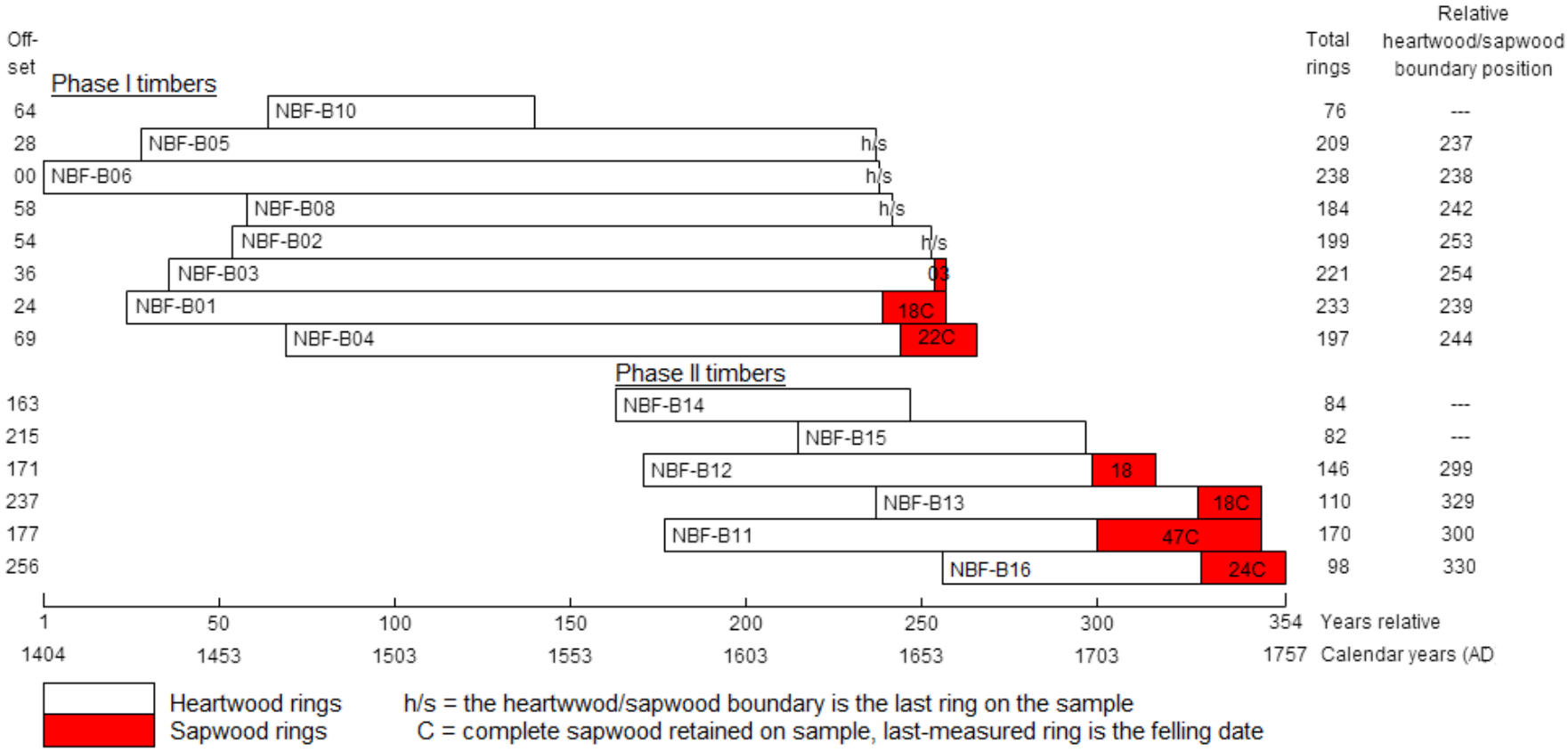

Figure 13: Bar diagram of all dated samples

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

NBF-B01A 233
255 251 202 205 241 248 227 185 97 94 53 39 56 134 103 169 199 205 135
118 131 181 167 200 179 154 200 212 250 213 128 82 88 80 113 93 97 81 77
90 130 148 169 132 123 106 100 118 100 90 74 84 93 103 93 81 66 70 63
95 64 63 67 85 77 96 75 103 113 99 97 108 109 104 115 98 104 120 144
89 70 63 61 65 82 67 69 61 63 56 60 60 51 50 71 57 55 59 59
40 47 51 46 52 62 73 63 71 62 75 67 75 94 90 77 93 112 81 85
50 74 97 91 105 86 80 61 60 46 71 73 74 59 71 106 67 83 53 57
67 75 95 110 112 100 99 86 78 78 104 99 123 125 134 90 106 120 104 116
113 85 99 70 84 105 111 120 109 106 72 74 62 55 65 74 73 105 78 87
120 75 69 79 88 78 91 81 74 95 66 86 88 89 87 90 88 74 57 71
84 59 56 55 45 55 42 44 38 44 38 46 53 57 61 45 54 52 36 58
49 56 63 52 46 74 46 53 58 47 61 62 55 55
NBF-B01B 233
259 258 199 197 248 250 217 180 105 89 53 43 63 136 121 168 201 198 137
110 132 183 188 198 184 154 206 215 239 214 135 78 90 79 110 103 84 91 70
106 115 149 168 141 122 105 96 125 97 94 72 97 88 105 85 84 61 77 65
97 64 66 76 78 82 94 71 105 116 93 101 106 107 109 110 100 100 121 145
86 72 62 64 60 80 71 65 61 65 54 59 62 49 57 71 51 59 61 50
42 51 50 49 51 63 72 67 63 60 73 70 83 87 92 76 98 107 81 83
57 66 97 87 102 91 89 53 67 45 64 81 77 58 79 107 69 81 56 56
73 76 99 108 108 100 98 90 79 76 101 95 125 129 130 96 101 122 107 110
109 87 97 72 81 101 122 126 114 103 79 76 52 60 64 73 70 108 77 85
125 74 65 81 86 78 91 80 80 89 69 83 89 92 87 89 92 69 59 74
79 63 60 53 52 54 42 43 37 45 38 47 51 57 58 52 51 49 44 54
47 57 63 56 43 70 53 49 60 45 63 74 53 58
NBF-B02A 199
137 112 103 137 150 130 100 100 64 85 98 91 121 92 104 101 99 163 164 141
133 218 120 181 148 132 140 149 140 164 134 89 126 119 146 149 187 208 184 151
116 92 78 65 58 79 62 93 98 87 62 61 52 52 77 68 80 87 103 80
70 82 98 114 113 71 106 68 120 132 111 135 107 118 118 113 110 124 86 66
48 90 120 76 81 91 84 62 67 43 61 86 84 113 88 72 59 63 35 44
67 60 45 37 47 46 40 29 31 46 39 56 65 48 76 77 57 52 52 60
56 57 70 74 51 48 51 52 69 58 35 28 26 36 27 35 41 45 30 22
24 29 19 19 21 25 25 25 23 22 31 30 22 34 67 73 70 75 49 50
71 76 83 67 103 75 71 62 45 73 82 82 75 60 87 59 57 66 48 48
57 47 67 103 76 85 63 69 82 70 86 77 85 80 64 61 76 85 83
NBF-B02B 199
140 102 106 134 148 132 103 96 68 82 100 91 108 104 88 109 103 154 168 140
132 217 129 188 150 123 142 147 148 167 134 75 133 117 157 140 191 206 184 148
109 100 72 75 57 71 75 91 103 78 64 64 45 54 78 63 85 83 106 77
77 75 104 108 110 80 101 68 122 135 109 132 112 113 117 116 112 121 88 70

53 80 118 86 87 90 84 68 54 45 67 90 86 104 86 73 57 60 39 42
63 67 48 46 35 42 32 39 33 40 42 68 58 51 68 76 58 59 46 57
56 54 73 75 48 47 61 50 66 69 38 31 26 34 32 37 35 45 26 24
28 26 22 16 25 32 26 21 24 23 32 22 30 35 60 71 71 71 56 49
71 75 79 73 95 76 73 59 53 69 74 85 77 60 85 61 62 56 58 48
51 54 73 79 88 82 68 66 84 63 79 81 79 80 64 64 75 84 84
NBF-B03A 221
221 238 221 166 196 153 116 94 122 148 123 135 108 103 97 109 158 168 87 70
76 81 107 84 67 62 44 57 61 64 75 64 51 71 79 101 97 71 69 121
65 107 70 68 82 98 85 123 64 55 77 72 86 77 95 109 110 80 59 60
58 44 40 50 57 60 65 60 40 37 35 56 56 48 53 58 53 44 45 44
65 68 67 46 52 38 71 75 75 68 65 70 61 62 60 78 61 50 51 66
62 47 47 50 43 43 38 39 48 51 57 56 53 50 39 37 37 28 39 41
41 40 52 41 36 38 32 37 45 66 57 56 62 56 55 47 40 54 46 72
50 60 45 50 59 66 69 63 58 36 46 53 61 61 92 98 86 65 57 51
48 51 56 64 37 40 47 45 41 53 66 86 79 82 69 71 64 64 85 87
116 110 119 82 84 73 76 68 110 115 85 78 108 91 78 73 66 50 62 54
77 94 125 106 99 91 151 183 220 210 164 155 140 122 120 173 186 201 223 194
272
NBF-B03B 221
216 244 213 162 200 151 118 96 122 149 122 137 107 103 95 111 155 168 88 70
73 81 103 87 62 70 46 55 63 62 74 65 54 70 75 105 91 68 69 123
65 111 71 66 85 97 87 121 56 60 86 77 77 81 93 103 119 86 62 63
62 39 39 49 59 61 66 58 40 36 41 53 52 52 54 50 62 48 43 45
62 68 67 50 43 41 70 74 73 73 60 71 64 60 64 73 60 54 50 70
62 45 43 58 46 40 40 32 50 50 53 65 47 45 47 39 39 24 35 43
35 40 43 50 35 31 37 31 46 63 61 57 66 60 56 49 36 52 54 63
53 60 49 50 61 63 74 69 53 39 45 55 61 61 90 96 84 68 53 57
42 54 57 58 42 43 45 39 48 51 64 90 81 79 68 73 60 70 86 84
115 106 117 86 85 71 57 90 102 116 86 76 105 100 70 71 59 53 60 59
76 97 123 108 96 96 149 185 222 207 157 163 139 118 115 179 189 197 223 199
261
NBF-B04A 173
107 161 196 165 70 72 101 106 89 64 56 68 80 64 78 50 40 36 51 42
53 61 71 60 42 35 37 26 25 33 20 34 40 26 36 25 34 31 31 35
41 37 36 32 28 31 24 25 33 30 32 23 24 28 27 23 27 32 42 35
45 38 41 51 41 34 49 75 92 41 55 47 33 51 37 37 56 58 50 51
41 40 40 31 56 43 54 41 46 48 31 38 32 26 36 51 64 63 47 53
46 34 28 30 34 33 41 46 55 47 35 48 57 47 48 35 34 31 22 44
49 51 70 58 40 45 38 38 38 44 71 77 48 66 40 28 24 20 28 32
30 28 37 24 27 33 35 44 33 42 36 37 32 24 21 27 33 23 42 36
33 31 32 43 37 45 59 60 56 53 43 46 40
NBF-B04B 197
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55 61 70 58 46 31 35 25 26 33 25 31 37 30 38 26 31 30 28 35
40 44 27 37 29 33 24 22 33 30 33 27 25 26 23 23 29 32 43 34

43 40 44 49 38 36 55 68 98 42 50 43 41 51 33 38 56 57 52 49
44 34 39 37 52 43 55 43 46 43 34 38 34 25 32 51 67 68 47 56
45 30 32 26 38 31 41 44 57 44 35 50 60 44 50 31 36 27 26 43
48 59 61 56 39 32 39 36 46 45 63 67 54 62 37 26 19 25 36 27
29 31 33 27 22 34 32 43 36 39 36 41 33 26 23 24 30 29 37 38
33 31 29 33 35 42 57 63 54 56 55 40 53 55 59 57 56 41 44 51
48 40 48 50 55 52 47 51 55 52 63 53 56 60 28 46 53

NBF-B05A 209

194 168 228 164 111 86 52 43 80 190 130 191 234 205 119 100 131 151 144 187
109 100 119 142 153 149 78 53 74 74 88 100 87 75 73 125 142 140 114 114
55 69 77 96 93 66 49 60 60 75 44 53 48 48 48 83 42 44 60 64
57 105 68 98 88 84 69 87 89 111 77 73 93 106 139 84 48 55 61 52
69 65 60 64 55 48 49 50 41 84 77 60 63 60 56 49 67 59 65 83
84 86 71 103 70 68 82 106 123 89 102 92 88 118 82 52 83 116 117 127
70 58 52 42 41 41 46 81 62 73 66 49 48 40 52 60 48 62 56 112
99 92 83 65 64 80 62 81 127 88 94 74 82 88 97 85 60 42 35 63
80 92 89 120 84 81 65 38 49 42 51 82 95 68 75 99 73 62 81 87
82 110 77 76 80 55 87 82 90 83 97 77 65 53 51 86 54 37 29 23
48 36 32 41 35 37 48 51 53

NBF-B05B 209

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115 103 115 137 154 150 85 57 68 77 89 99 87 77 70 111 148 141 121 105
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64 105 60 97 89 80 76 82 85 112 80 69 94 111 128 83 46 54 56 51
78 56 60 63 58 45 54 47 36 95 78 52 68 54 54 48 72 65 67 80
74 86 74 102 68 73 79 107 128 87 102 93 86 116 83 47 88 116 119 129
69 60 49 48 35 41 50 77 65 74 77 51 53 42 52 55 54 62 57 115
93 95 83 64 65 82 56 85 135 82 91 75 81 86 101 88 59 39 34 65
80 92 90 117 86 83 65 42 47 43 53 79 91 69 79 101 64 62 84 88
82 110 76 80 76 51 91 82 87 85 97 89 57 56 54 78 60 30 27 33
48 33 33 42 31 43 62 51 48

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265 208 143 128 145 171 165 144 142 109 144 145 163 177 100 77 101 101 117 87
84 79 63 108 143 134 156 102 89 102 98 148 110 83 58 60 70 80 67 57
45 52 55 67 63 51 53 54 72 59 58 91 116 66 63 76 86 78 72 68
66 69 105 65 42 39 35 28 51 44 50 43 51 45 42 48 49 56 51 48
50 41 49 55 63 57 60 62 51 63 52 67 64 63 69 67 88 68 62 57
67 72 62 49 74 107 95 107 65 60 40 49 44 61 58 67 67 62 84 66
57 52 47 54 60 63 72 73 79 76 65 76 60 79 67 82 97 84 78 73
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NBF-B06B 238

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263 209 144 129 149 173 152 162 135 110 141 141 165 175 105 71 98 102 117 90
90 77 66 105 142 135 160 109 87 97 97 147 110 84 56 65 65 84 65 57
48 48 57 61 66 50 58 52 71 66 56 93 114 62 71 69 90 78 72 63
68 79 94 69 38 51 33 32 55 46 49 42 41 45 44 50 41 54 64 43
45 45 49 46 61 62 63 53 64 53 53 70 64 56 79 70 102 65 75 62
68 87 55 53 76 117 93 102 66 70 42 53 39 57 60 58 68 71 80 63
58 48 51 50 63 77 65 74 68 79 67 68 71 78 73 92 96 89 80 65
77 80 90 88 54 69 43 56 79 70 98 97 80 56 60 42 40 37 41 47
58 52 41 47 39 40 42 44 52 49 52 53 46 38 46 42 53 66 59 57
47 40 35 39 59 50 37 39 19 36 22 29 36 31 33 37 38 47

NBF-B08A 184

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65 90 94 126 173 120 68 47 46 85 103 78 71 63 85 49 49 56 81 67
68 66 43 27 50 59 93 71 51 93 81 92 69 103 78 86 77 105 151 133
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52 41 31 40

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65 57 53 39 46 49 88 71 60 92 81 93 69 105 76 87 77 105 151 138
122 166 132 70 52 52 60 85 75 122 77 97 75 68 58 69 87 99 123 103
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45 29 32 45

NBF-B09A 75

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87 100 105 116 73 59 59 127 135 188 165 104 85 99 89

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141 124 109 204 173 118 80 75 113 146 139 162 117 76 105 87 129 141 66 82
93 94 110 114 74 57 57 120 138 182 164 106 79 98 79

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122 132 230 270 198 274 285 128 114 150 93 92 69 85 118 154 143 148 98 186
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144 167 134 66 110 114 135 170 154 110 102 129 105 63 76 115 88 121 97 79
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61 73 58 59 66 58 27 45 38 56 27 47 39 42 42 35 51 51 39 30
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123 127 154 146 116 214 146 161 136 61 120 101 144 164 149 94 99 137 90 78
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93 122 74 68 92 97 97 107 108 93 62 58 85 59 66 94 80 92 92 91
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91 125 112 91 85 98 92 74 100 131 131 164 137 123 168 112 144 159 126 174
125 141 105 134
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91 123 125 87 76 112 86 80 88 126 138 165 135 124 170 122 137 151 127 171
129 143 114 119
NBF-B15A 82
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97 135 141 109 82 129 156 139 105 128 102 79 70 60 65 103 142 93 89 88
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114 108 69 116 65 65 60 82 90 111 86 69 47 58 89 71 60 88 81 100
77 100
NBF-B15B 82
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102 134 137 99 84 135 152 140 104 124 106 76 71 60 59 105 117 90 97 83
73 71 60 123 96 109 87 110 112 130 121 113 77 69 59 64 65 62 123 106
113 112 65 117 62 66 58 83 91 111 83 69 65 55 85 62 67 82 80 94
73 95
NBF-B16A 98
67 70 106 96 105 75 105 113 130 100 125 69 99 51 59 57 63 123 142 103
136 79 147 85 71 85 106 115 134 169 90 79 49 124 90 58 99 122 115 89
105 85 70 76 79 81 84 89 87 73 40 50 92 103 83 109 63 94 99 67
76 82 119 62 110 83 105 95 89 103 68 64 76 69 70 60 62 62 86 94
64 54 53 37 61 62 74 72 66 79 76 78 79 59 53 60 55 59
NBF-B16B 98
68 78 105 104 101 76 96 113 151 113 113 72 78 55 63 55 62 135 156 102
141 90 144 78 83 94 116 100 136 153 78 75 61 112 91 71 83 112 119 92
108 80 72 76 82 71 92 86 86 68 43 56 88 92 77 94 74 85 98 69
77 83 124 65 106 80 107 100 85 95 65 56 78 65 72 59 61 61 97 98
63 54 52 42 56 74 68 71 64 78 79 80 73 55 54 69 49 57