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CHURCH OF SAINT ANDREW, WHITESTAUNTON, SOMERSET
TREE-RING ANALYSIS OF TIMBERS FROM THE BELLFRAME AND FOUNDATION BEAMS

SCIENTIFIC DATING REPORT

Martin Bridge

INTERVENTION AND ANALYSIS

ENGLISH HERITAGE

Research Report Series 33-2014

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SUMMARY
Samples were taken from two foundation beams supporting the bell-chamber floor and from 13 timbers in the bellframe itself. Neither of the foundation beams dated but 11 of the timbers from the bellframe were dated. Two site chronologies were formed which, although of similar date, may represent two slightly different felling events. The 138-year sequence comprises two timbers with a likely empirically derived combined felling date range of AD 1654–86 (*95% confidence*)or a Bayesian based *combined felling date range* of *AD 1658–94 (95% probability)*. The 95-year sequence comprises nine timbers with a likely empirically derived combined felling date range of AD 1681–1712 (*95% confidence*)or a Bayesian based *combined felling date range* of *AD 1687–96 (95% probability)*.

CONTRIBUTORS
Dr M C Bridge

ACKNOWLEDGEMENTS
I am grateful to Shahina Farid, English Heritage Scientific Dating Team, for commissioning this study. The Churchwarden, Robert Kemp, was most helpful in providing access and practical help, as well as hospitality, during my visits to the site. I am grateful to Chris Pickford for making available his report, the sample location illustrations in this report were based on his original drawings. Cathy Tyers, English Heritage Scientific Dating Team, made useful comments on earlier drafts of this report.

ARCHIVE LOCATION
Somerset Historic Environment Record
Somerset Heritage Centre
Brunel Way
Norton Fitzwarren
Taunton
TA2 6SF

DATE OF INVESTIGATION
2013

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INTRODUCTION

The Church of St Andrew is Grade I listed, and lies at the heart of the village of Whitestaunton, some 5km west of the town of Chard (Figs 1 and 2). Whilst the church has Norman origins, most of the present fabric is of thirteenth- to sixteenth-century origin, although there was a major refurbishment of the building in AD 1882–3. The west tower is in the late Perpendicular style, and is stylistically dated to the early sixteenth century. The medieval church evidently possessed bells, but there are no records of how many or of what size they were. It is thought there were three bells here in the mid-sixteenth century, of which one remains and one was removed in AD 1908. Dendrochronological dating of the bellframe and associated foundation beams and floor was requested by Jenny Chesher, the English Heritage Inspector of Buildings and Areas, in order to add to the overall understanding of the historic development of the tower, and hence the significance of the bellframe and bell-chamber floor.

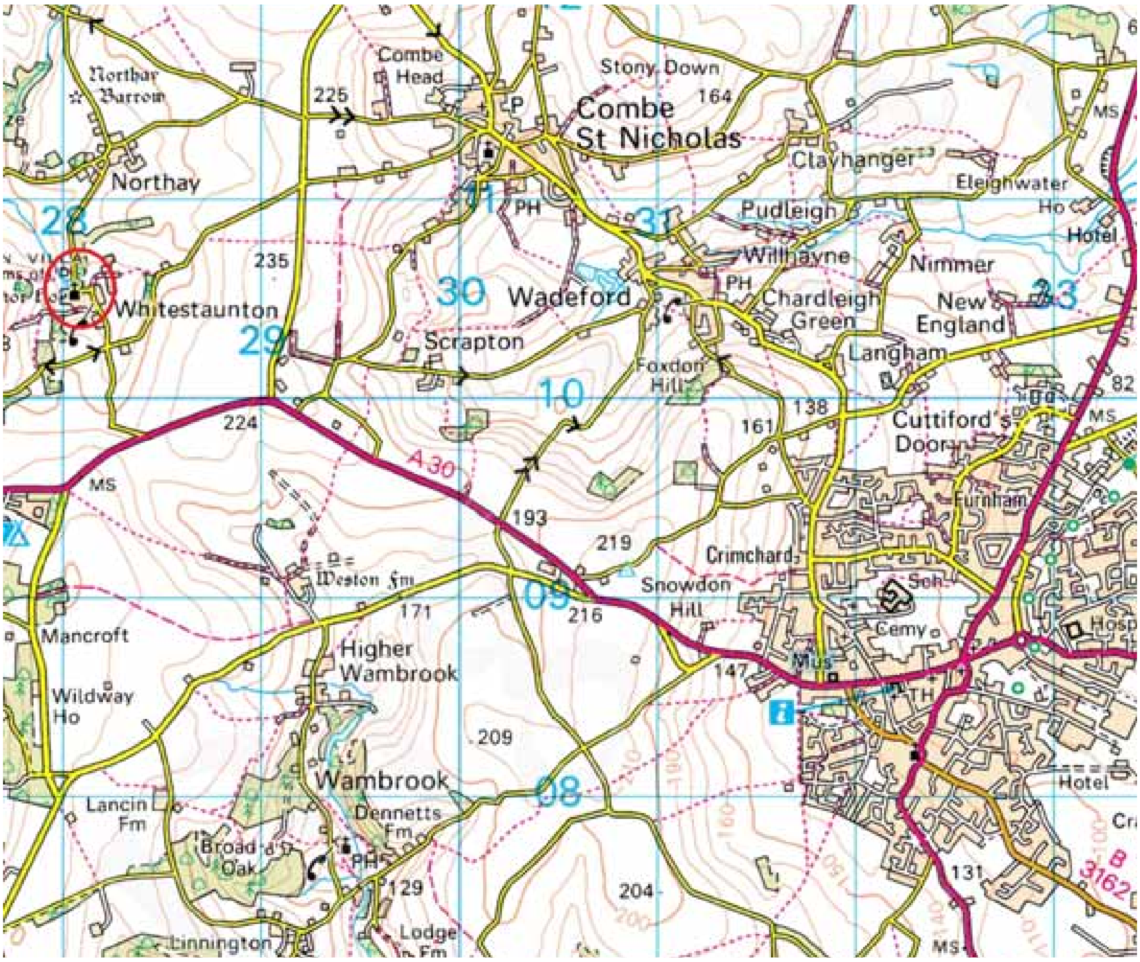

Figure 1. Map showing the location of the Church of St Andrew, Whitestaunton (circled on the left side of the map) in relation to Chard (the town in the lower right of the map). © Crown Copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100024900

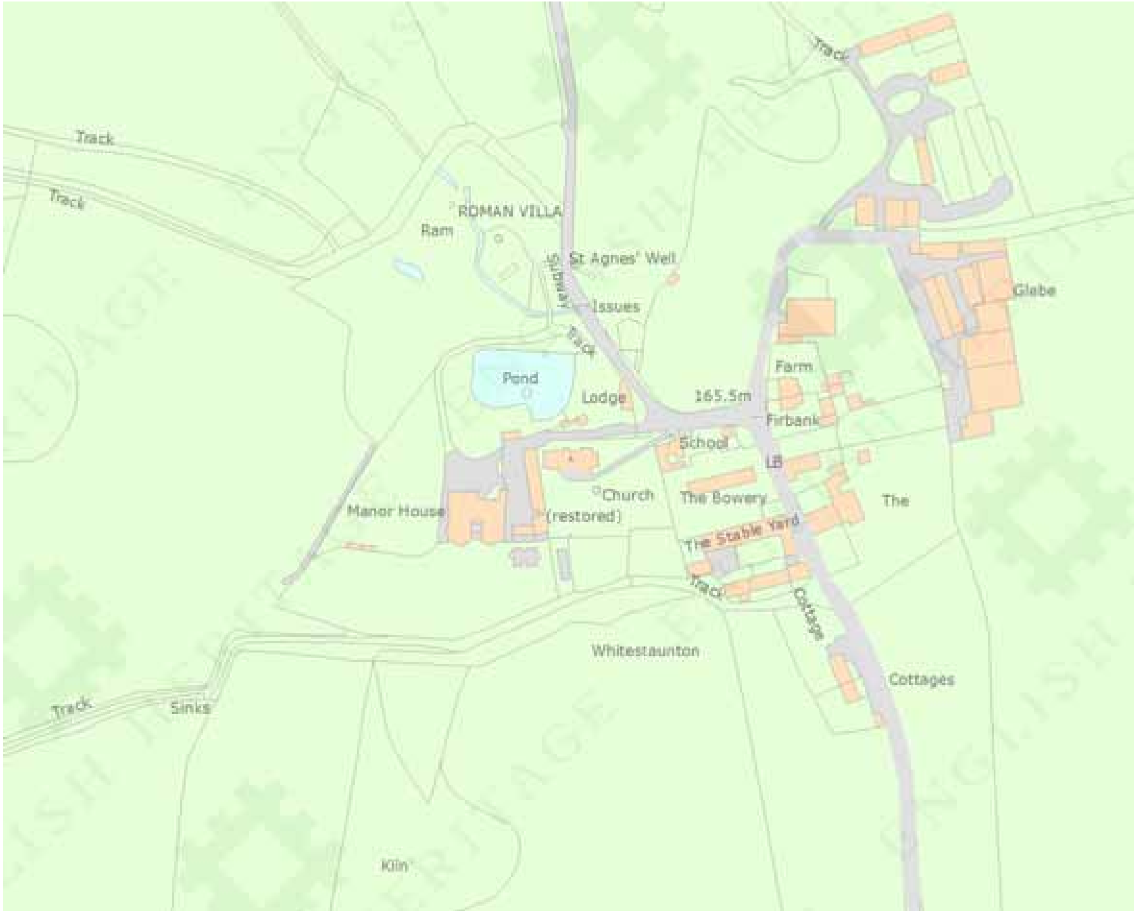

Figure 2. Map showing the position of the Church of St Andrew within Whitestaunton. © Crown Copyright and database right 2014. All rights reserved. Ordnance Survey Licence number 100024900

Pickford (2013) describes the frame trusses in the parallel pits as of similar construction throughout, having sills, diagonal main braces, long frame heads, and end-posts. The end-posts are shaped and stand a little within the overall length of the truss. The diagonal main braces are butted together at the apex. Some of his drawings are used as the basis for figures in this report, showing the locations of the samples taken (Figs 3–5). Pickford contends that the king-posts in the tenor pit do not indicate a different period of construction. The braces are at a shallower angle and the king-posts were included to provide added strength below the bearings. The main braces are butted as in the other trusses. Pickford also points out that the western return section of the frame is different, and may be of later date than the rest of the frame, and proposes that the frame may have been originally built with open-ended pits on the west (ie no lateral bracing above the sills).

The survey by Pickford (2013) points out that various dates have been suggested for the Church of St Andrew's bellframe. Massey (2011, 736) suggests that it *"probably dates from the 18th or early 19th century"* and recent reports have tended to follow this view.

Another plausible suggestion has been that the frame might date from AD 1763 when the tower roof was renewed. It has also been claimed that the frame is of mixed dates and that the eastern pit (containing the tenor) is an add-on. Pickford (2013) however favoured a late seventeenth-century origin, probably associated with the addition of new bells in AD 1696/7, and he also proposes that it was most likely built by a specialist bellframer, rather than a local carpenter. A letter from Robert Parker (2013), church bellhanger, to the churchwarden, also supports this view of a late seventeenth-century origin, but suggests that the whole frame was rebuilt, utilising these old timbers and incorporating others, in AD 1763.

METHODOLOGY

Fieldwork for the present study was carried out in May 2013, following an initial assessment of the potential for dating some weeks beforehand. In the initial assessment accessible oak timbers with more than 50 rings and possible traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. Those timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared statistically for cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same tree derivation.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring (ie if it has only the spring vessels or early wood formed, or the latewood or summer growth) a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic timbers has shown that an empirically based sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9–41 rings (Miles 1997a).

However, an alternative method of estimating felling date ranges has recently been developed (Miles 2005) which runs as a function implemented in OxCal (Bronk Ramsey 2009; Miles 2006). Following the methodology set out by Millard (2002), Bayesian statistical models are used to produce individual sapwood estimates for samples using the variables of number of heartwood rings present, the mean ring-width of those heartwood rings, the heartwood/sapwood boundary date, and the number of any surviving sapwood rings or a count of those lost in sampling. These individual probability distributions for the felling dates (expressed at the 95% probability level) may then be combined to produce a highest probability density estimate for the *combined felling date range*. When a timber in a group has no heartwood-sapwood boundary present, but finishes later than the heartwood-sapwood boundary dates of other timbers in the group, this information may be used to truncate the earlier end of the combined sapwood dates used. When carried out within OxCal, this uses a sapwood model that has to be defined. Miles (2005) suggested several such models, of which the one that has been deemed appropriate to apply to the timbers in this case is that for 'England and Wales AD'. This model is based on timbers from throughout England and Wales, with a bias to those in the most densely-dated counties of Shropshire, Somerset, Hampshire, Oxfordshire, and Kent, and is thus appropriate for these timbers. Although it has been found that some samples do not fit this particular model well (Tyers 2008), the timbers from this site were considered suitable.

It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study. Thus the dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the reuse of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965; Miles 2005).

RESULTS AND DISCUSSION

Samples were taken from what were considered to be the primary phase bellframe timbers, as well as from some suitable timbers in the category of those considered to be secondary or later repair timbers, although some of this latter category were either of small scantling or were fast-grown and had too few rings, making them unsuitable for sampling. The initial assessment concluded that fewer of the timbers previously considered to be likely later insertions or repairs were actually of a different age, based on the overall appearance and ring characteristics of the assemblage.

Of the four foundation beams supporting the bell-chamber floor, the northernmost was found to be of elm (*Ulmus* spp) and hence unsuitable for analysis, whilst the southernmost had obviously suffered from severe woodworm infestation and access was such that it could not be sampled at a suitable angle. Of the two central foundation beams, the northern one was assessed as probably having just too few rings, but it was nevertheless sampled because of the potential importance of obtaining dating evidence for this floor, whilst the southern one clearly did have sufficient rings to warrant sampling. The floorboards of the bell-chamber floor were assessed, but were considered mostly too decayed to sample, and those that could be seen more clearly were thought anyway to contain too few rings to be useful.

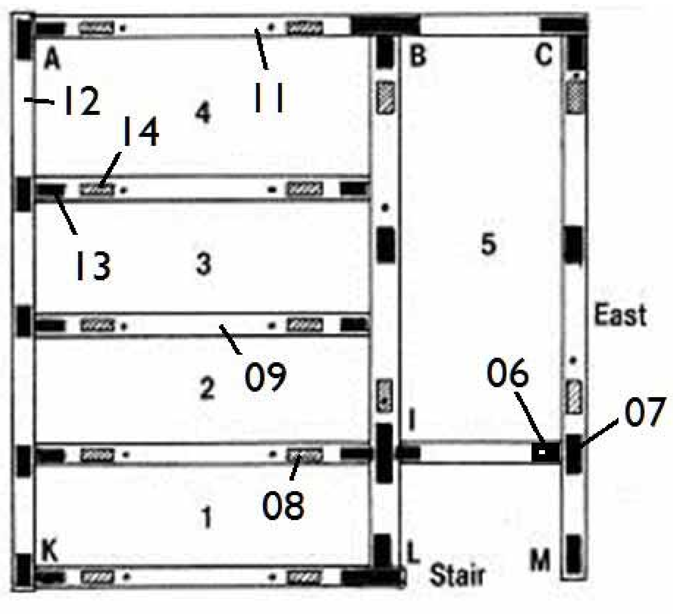

Figure 3. Plan of the bellframe showing the locations of some of the samples taken for dendrochronological analysis, adapted from original drawings by Pickford (2013)

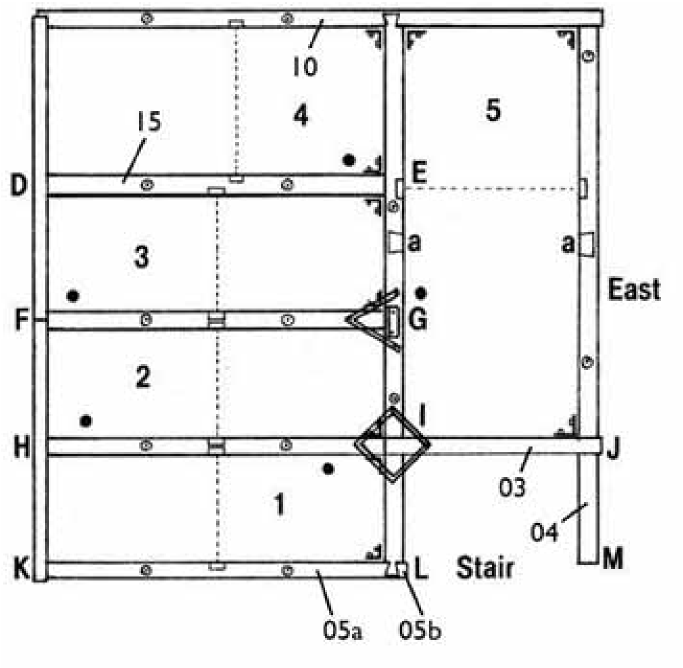

Figure 4. Plan of the upper rails of the bellframe showing the locations of some of the samples taken for dendrochronological analysis, adapted from original drawings by Pickford (2013)

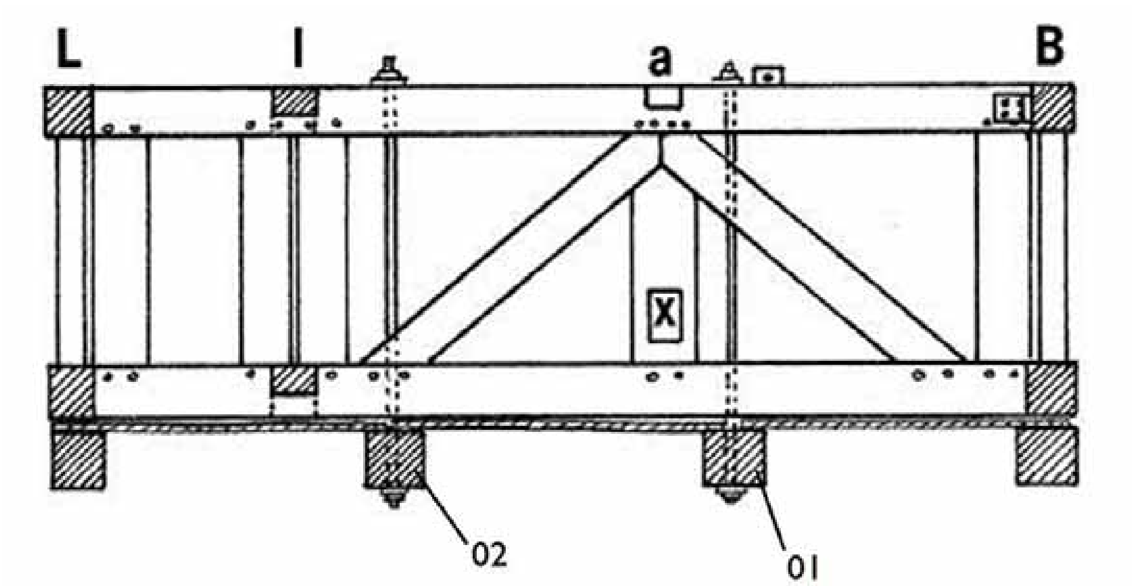

Figure 5. Drawing of one of the cross frames of bellframe showing its form, and also the foundation beams sampled for dendrochronology, adapted from original drawings by Pickford (2013)

Basic information about the samples taken is given in Table 1. Two samples were taken from the top plate on the south side of the frame (aws05a and aws05b), because the first sample had too few rings to be useful, sample 05a was therefore not analysed further. Two other samples, aws01 and aws13 also had too few rings to be further analysed. One of these (aws13) had a chiselled assembly mark, and was noted at the time of sampling as possibly being either reused or a replacement timber not associated with the main construction of the bellframe. The raw ring-width data for the measured samples is given in the appendix.

Neither of the two foundation beams could be dated, the first sampled having too few rings (aws01) and the second (aws02) failing to cross-match with other samples from the site and not matching independently.

Comparison of the bellframe samples (Table 2) revealed that two samples, aws05b and aws11, matched each other well, but did not match the other nine measured samples. These two series were therefore combined to form a 138-year long site series aws511m for subsequent analysis, whilst the remaining nine series were averaged together to form a 95-year long site chronology, WHTSTNBF. The dating evidence for these two series is given in Tables 3a and 3b. This group includes sample aws12, which is the sole plate to the western frame, suggesting that this frame is indeed contemporaneous with the rest of the bellframe, and not an addition, as had been suggested by Pickford (2013).

The conventional empirically derived sapwood estimate produces felling dates for the timbers forming the main site chronology, WHTSTNBF, which indicate that the trees used were most likely felled at the same time (Table 1; Fig 1). Using a mean heartwood-sapwood boundary date for these nine timbers of AD 1671 gives a likely combined felling date range of AD 1681–1712 (*95% confidence*), taking into account the unmeasured sapwood rings present on sample aws14.

This group of timbers appears to be an ideal candidate for the application of the Bayesian modelling technique, being a group of timbers likely to have all been felled at the same time, and with none of the timbers showing unusual characteristics. They are also within the geographical range of the data used to create the sapwood model used within OxCal (England and Wales AD) developed by Miles (2005), and being composed of young relatively fast-grown timbers are more likely to give accurate results (Tyers 2008).

OxCal v4.2.3 (Bronk Ramsey 2014) was used to produce the sapwood estimates for each of the eight tree series in the site chronology with a heartwood-sapwood boundary. (Table 1; Fig 7). As the group had similar individual sapwood ranges a Bayesian approach to combining individual sapwood estimates following the methodology of Millard (2002), was used to derive the likely *combined felling date range* (Fig 7). The combined index agreement for this group (A_{comb} 131.2%, A_n=25 %, n=8) shows this to be a coherent group. This methodology derives a *posterior density estimate* for the *combined felling date range* of *AD 1687–96 (95% probability)* for this group of timbers, and construction is assumed to have taken place within months of the trees being felling. It should be noted that this *posterior density estimate* may vary if a different combination of samples was used, but there is no reason in this case to reject any of the samples.

Examination of the variation in date of the heartwood/sapwood boundaries of all 11 dated timbers from the bellframe (Table 1; Fig 6) suggests that it is possible that the remaining two dated samples, aws05b and aws11, were from trees felled a little earlier than the remaining timbers. Only one of these two timbers retained the heartwood-sapwood boundary and hence, other than the fact that they do not match the remaining assemblage well, there is no clear evidence to support this idea. The empirically derived felling dates for these two timbers are AD 1654–86 (*95% confidence*, aws11) and after AD 1656 (aws05b). Bayesian modelling suggests a likely felling date range of *AD 1659–94 (95% probability)* for aws11 and felling after AD 1659 for sample aws05b. Thus, whilst it is possible that they were felled slightly earlier than the main group of nine timbers, it is also possible that they were felled at the same time. Since one of them is a sole plate, it seems unlikely that it is not part of the original construction, unless of course the whole frame has been reassembled. The dating evidence for series aws511 (Table 3a) also suggests that the source of these timbers may be different to that for the remaining dated timbers, the dating evidence for which is presented in Table 3b. Both groups of timbers do however appear likely to have come from the south-west of England.

The dendrochronological results obtained provide clear dating evidence for the construction of the bellframe and hence address the various dating opinions set out in the introduction of this report. It seems that more of the bellframe structure is a coherent group of contemporaneous timbers than previously interpreted, and that it does indeed date to the late-seventeenth century, as some recent interpretations would have it, but it is slightly later than the re-roofing of the tower in AD 1673, to which some had also linked it.

Table 1. Details of the samples taken from the Church of St Andrew, Whitestaunton

Sample number	Timber and position	Total no of rings	Mean HW ring width (mm)	Dates spanning (AD)	h/s boundary (AD)	No of Sapwood rings	Mean sensitivity	Felling date ranges (AD) *(95% confidence)*	*OxCal-derived felling date range(AD) (95% probability)*
aws01	Northern of two central foundation beams	<40	NM	-	?h/s	-	-	-	-
aws02	Southern of two central foundation beams	65	3.50	-	-	-	0.18	-	-
aws03	Top plate, south end of pit 5	73	1.61	1592–1664	1664	h/s	0.18	1673–1705	*1674–1702*
aws04	Top plate, east side frame	87	1.27	1589–1675	1675	h/s	0.20	1684–1716	*1686–1716*
aws05a	Top plate, south side frame	<40	NM	-	-	-	-	-	-
aws05b	Top plate, south side frame	115	0.93	1533–1647	-	-	0.20	after 1656	*after 1659*
aws06	Post, south-east corner of pit 5, internal	55 *(+7NM)*	1.73	1608–62	-	-	0.23	after 1678	-
aws07	Post on east frame, south end of pit 5	51	2.20	1624–74	1674	h/s	0.18	1683–1715	*1683–1707*
aws08	East diagonal brace, pit 1–2	57	1.50	1616–72	1672	h/s	0.16	1681–1713	*1682–1710*
aws09	Sole plate, pit 2–3	64	1.89	1608–71	1671	h/s	0.24	1680–1712	*1680–1706*
aws10	Top plate, north side frame	90	1.48	1587–1676	1676	h/s	0.18	1685–1717	*1686–1715*
aws11	Sole plate, north side frame	136	0.82	1510–1645	1645	h/s	0.20	1654–86	*1659–94*
aws12	Sole plate, west side frame	81	1.18	1582–1662	1662	h/s	0.17	1671–1703	*1673–1704*
aws13	Vertical post at west end of frame, pit 3–4	<40	NM	-	h/s	-	-	-	-
aws14	West diagonal brace, frame pit 3–4	44 *(+4NM)*	2.19	1633–76	1673	3	0.33	1682–1714	*1682–1705*
aws15	Top plate, pit 3–4	122	0.85	-	-	13	0.19	-	-

HW = heartwood; h/s = heartwood-sapwood boundary; NM = not measured

Table 2. Cross-matching between the dated series from the Church of St Andrew, Whitestaunton. Values of t *greater than 3.5 are statistically significant*

t-values										
Sample	aws04	aws06	aws07	aws08	aws09	aws10	aws12	aws14	aws05	aws11
aws03	4.1	4.3	4.4	2.9	3.9	5.0	3.7	4.4	1.7	2.6
aws04		4.1	3.6	5.7	3.4	9.6	5.2	5.1	0.8	2.1
aws06			5.6	1.8	8.5	4.3	1.6	5.8	0.5	0.6
aws07				1.7	5.4	4.8	2.9	5.7	3.4	0.3
aws08					1.5	6.5	4.4	3.2	0.9	1.8
aws09						4.1	2.1	6.6	-	0.9
aws10							7.1	7.5	1.3	1.1
aws12								3.1	2.8	2.4
aws14									0.8	*
aws05										6.0

* = overlap equal to or less than 15 years, no value calculated; - = *t*-value equal to or less than 0.0

Table 3a. Dating evidence for the site sequence aws511m, AD 1510–1647

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (years)	*t*-value
Regional reference chronologies						
South Central England	South Central England	(Wilson *et al* 2012)	SCENG	663–2009	138	7.4
Wales	Welsh Master Chronology	(Miles 1997b)	WALES97	404–1981	138	7.3
Hampshire	Hampshire Master Chronology	(Miles 2003)	HANTS02	443–1972	138	6.8
Oxfordshire	Oxfordshire Master Chronology	(Haddon-Reece *et al* 1993)	OXON93	632–1987	138	6.6
Somerset	Somerset Master Chronology	(Miles 2004)	SOMRST04	770–1979	138	6.4
Individual site chronologies						
Somerset	8 Market Place, Shepton Mallet	(Miles 2002b)	SHPTNMLT	1518–1677	130	7.9
Wales	Tredegar House, Newport	(Miles and Bridge 2011)	TREDEGR1	1397–1688	138	7.2
London	White Tower, Tower of London	(Miles 2007)	WHTOWR7	1463–1616	107	7.1
Sussex	Warhams, Rudgwick	(Miles *et al* 2009)	WARHAM3	1342–1606	97	7.0
Somerset	St Matthew's Church bellframe, Wookey	(Miles and Bridge 2012)	WOOKEY	1481–1603	94	6.8
Oxfordshire	Wadham College	(Miles and Bridge 2010)	WADHAM	1426–1610	101	6.5
Oxfordshire	Manor Farm, Stanton St John	(Miles and Worthington 1998)	STNSTJN4	1480–1646	137	6.4

Table 3b. Dating evidence for the site chronology WHTSTNBF, AD 1582–1676

Source region:	Chronology name:	Publication reference:	File name:	Span of chronology (AD)	Overlap (years)	*t*-value
Regional reference chronologies						
South Central England	South Central England	(Wilson *et al* 2012)	SCENG	663–2009	95	8.1
Oxfordshire	Oxfordshire Master Chronology	(Haddon-Reece *et al* 1993)	OXON93	632–1987	95	7.1
Hampshire	Hampshire Master Chronology	(Miles 2003)	HANTS02	443–1972	95	6.4
Somerset	Somerset Master Chronology	(Miles 2004)	SOMRST04	770–1979	95	6.2
Individual site chronologies						
Shropshire	Buildwas Abbey	(Miles 2002a)	BUILDWS3	1563–1687	95	7.6
Gloucestershire	100 Church St, Tewkesbury	(Nayling 2000)	TEWKES2	1484–1664	83	7.5
London	Breakspear House, Harefield	(Arnold and Howard 2010)	HFDBSQ01	1574–1694	95	7.5
Dorset	Wolfeton Riding House	(Bridge 2005)	WOLFETN2	1583–1719	94	6.8
Oxfordshire	Old Clarendon Building, Oxford	(Worthington and Miles 2006)	CLRNDNOX	1539–1711	95	6.5
Wiltshire	Salisbury Cathedral	(Miles *et al* 2005)	SARUM12	1556–1703	95	6.3
Berkshire	Maidenhead Bridge	(Miles *et al* 2003)	MDNHEAD2	1605–1750	72	6.2
Hampshire	Gilbert White's House, Selbourne	(Miles *et al* 2004)	SELBRNE2	1620–1722	57	6.1

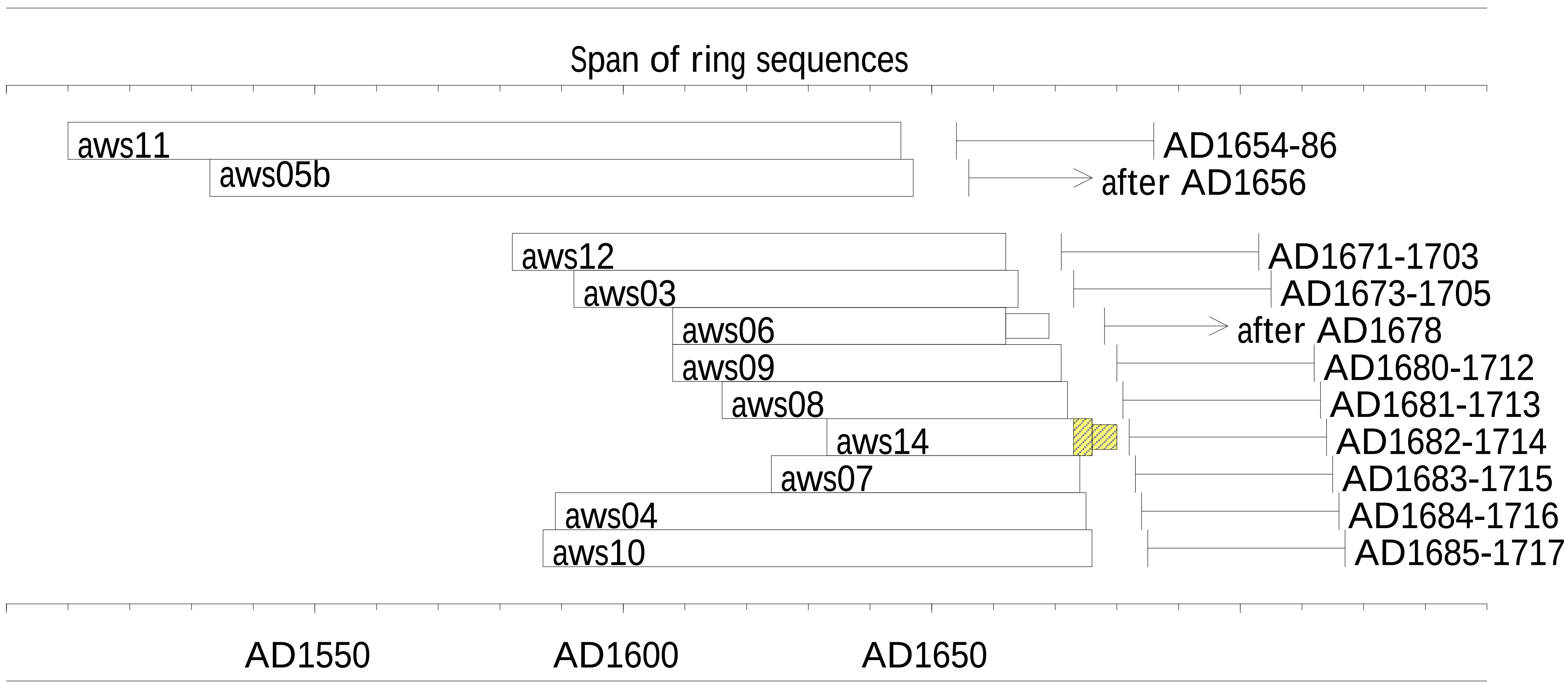

Figure 6. Bar diagram showing the relative positions of overlap and the empirically derived likely felling date ranges for the dated samples from the bellframe of the Church of St Andrew, Whitestaunton, Somerset. White bar – heartwood; yellow hatched bar – sapwood; narrow section of bar – additional unmeasured rings

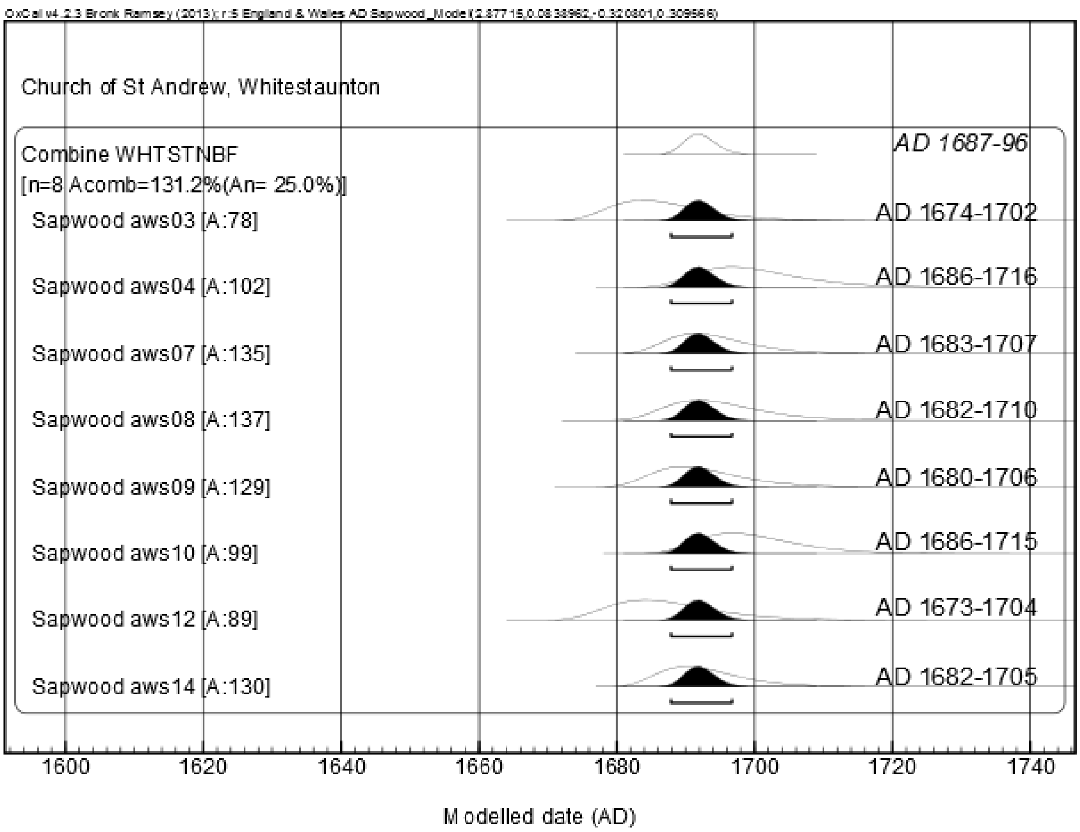

Figure 7. Church of St Andrew, Whitestaunton: combined felling date range and individual felling date distributions for timbers from the bellframe with heartwood-sapwood boundary included in the site chronology WHTSTNBF. Individual felling date distributions are shown in outline and the 95.4% probability individual felling dates ranges are listed. The 95.4% probability combined felling date range is shown in black and italic text

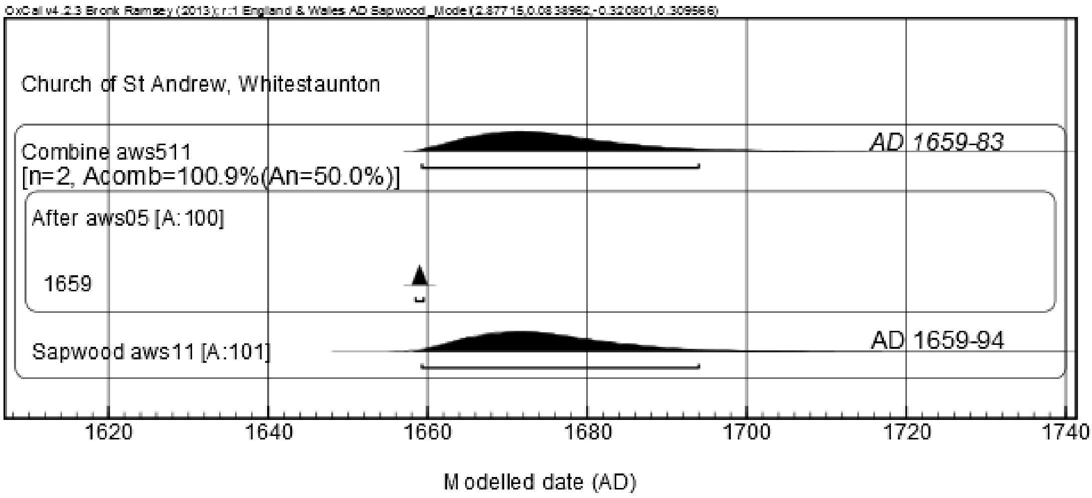

Figure 8. Church of St Andrew, Whitestaunton: combined felling date range and individual felling date distributions for samples aws05 and aws11. Individual felling date distributions are shown in outline and the 95.4% probability individual felling dates ranges are listed. The 95.4% probability combined felling date range is shown in black and italic text

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APPENDIX

Ring width values (0.01mm) for the sequences measured

aws02

538	239	459	543	527	477	414	324	298	300
141	194	115	152	180	146	168	165	169	217
172	164	228	175	212	254	300	275	240	242
361	366	266	309	286	333	337	345	345	400
452	491	562	394	598	478	356	471	385	344
474	635	633	557	512	421	447	493	403	361
380	407	369	375	381					

aws03

231	200	224	190	270	249	253	253	227	386
354	264	313	211	297	250	243	179	200	164
157	147	120	130	125	124	155	143	148	153
158	222	140	130	102	126	133	165	146	140
155	124	84	149	114	171	176	141	169	174
185	110	111	134	126	93	124	108	94	98
75	80	86	114	90	93	129	85	102	112
102	131	93							

aws04

281	196	296	251	211	394	281	253	186	181
174	203	219	189	140	145	116	156	162	128
94	110	101	94	147	99	100	80	68	82
82	78	105	188	168	79	79	81	116	127
107	112	113	133	157	115	136	110	133	166
140	139	144	107	116	121	122	110	95	116
94	109	87	59	71	80	104	66	100	96
74	77	100	105	109	47	51	69	91	123
107	76	72	69	105	72	96			

aws05b

111	109	198	114	110	129	122	136	110	79
115	197	148	100	103	158	186	168	230	140
155	190	209	148	169	170	195	149	127	179
120	164	143	103	71	105	125	133	154	112
100	86	84	68	53	64	83	99	105	61
77	67	93	87	82	80	117	112	144	157
114	112	92	105	84	101	75	56	52	32
62	67	55	58	62	82	64	75	84	80
65	60	65	49	40	57	69	63	69	56
58	44	33	36	49	39	48	48	48	56
49	44	52	41	52	43	36	55	46	41
37	38	33	42	44					

aws06

191	201	259	270	159	404	227	229	301	253
238	215	218	192	198	220	172	229	219	276
213	275	224	245	261	199	89	133	111	170

212	92	113	109	107	120	132	116	104	85
148	130	134	87	77	104	102	204	122	147
122	84	78	94	85					

aws07

150	169	180	209	227	289	268	288	308	285
215	295	238	424	347	239	303	217	236	237
220	212	225	175	208	167	198	186	158	200
191	295	223	186	202	173	204	225	164	223
158	128	141	212	222	250	186	176	172	241
151									

aws08

169	192	210	191	156	186	270	286	198	146
158	171	153	140	186	169	186	188	146	157
166	129	171	161	148	153	150	145	129	136
155	147	182	136	165	142	97	121	115	131
92	101	129	115	115	134	108	109	88	107
93	104	171	183	99	120	140			

aws09

245	187	265	239	161	369	176	217	256	223
234	144	174	224	257	285	167	257	206	220
224	257	257	127	152	147	79	138	148	293
368	167	191	183	210	201	213	184	173	149
208	182	168	130	124	137	150	271	161	146
142	123	166	119	84	140	102	130	151	168
168	189	156	214						

aws10

179	219	209	146	193	220	207	245	239	249
268	244	213	237	294	220	197	211	142	235
211	181	164	195	161	152	181	133	130	121
155	147	124	120	131	165	188	110	88	128
137	124	106	146	124	146	161	119	130	111
152	194	163	191	175	138	136	153	166	136
113	138	117	150	117	78	98	107	169	98
113	113	97	111	113	95	84	60	57	60
90	121	97	80	83	102	165	93	90	76

aws11

123	156	197	181	198	309	165	194	161	257
151	209	183	145	120	117	123	131	91	133
107	156	111	96	116	182	107	97	101	149
118	124	87	101	129	91	69	65	108	135
87	148	127	114	108	126	69	103	107	97
106	85	122	82	120	93	56	68	53	78
61	74	50	52	64	70	71	67	48	51
48	50	50	45	53	72	64	62	51	56
42	53	47	37	38	39	48	46	48	45
34	38	48	46	54	30	55	62	61	50
41	38	39	41	34	45	36	30	48	36
33	38	42	37	40	40	35	42	51	49

45	52	52	63	46	69	56	40	42	28
24	24	28	33	37	35				

aws12

278	246	256	324	194	208	242	290	171	242
233	192	172	186	209	167	167	181	167	235
144	128	117	106	133	165	158	110	134	103
100	74	70	71	64	68	86	80	92	77
121	88	82	68	94	119	99	94	90	72
91	84	63	76	53	72	96	90	95	73
72	74	68	68	67	68	60	57	67	67
48	51	62	72	52	65	72	62	86	66
70									

aws14

222	109	149	109	208	282	158	218	185	221
202	222	273	193	165	291	204	207	188	124
137	135	304	175	242	257	268	335	312	208
371	186	153	174	178	348	252	136	232	166
463	179	192	129						

aws15

158	161	249	264	158	215	156	199	160	126
184	134	166	159	74	73	110	126	186	173
106	100	84	97	92	90	46	57	112	99
92	79	71	60	87	81	84	74	118	110
218	146	115	115	118	134	95	107	91	68
64	55	65	71	45	54	71	96	70	82
84	85	89	82	73	72	57	75	71	99
92	100	90	59	52	53	61	66	64	73
50	59	59	37	51	44	50	49	44	39
47	41	30	25	32	57	52	55	39	39
31	33	36	34	43	51	40	50	46	46
69	49	39	46	56	59	64	64	57	67
59	66								

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