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## Church of St Helen, South Wheatley, Nottinghamshire

# Tree-ring Analysis of Timbers from the Bellframe and Supporting Structure

Martin Bridge

Discovery, Innovation and Science in the Historic Environment





CHURCH OF ST HELEN,  
SOUTH WHEATLEY,  
NOTTINGHAMSHIRE

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THE BELLFRAME AND SUPPORTING STRUCTURE

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## **SUMMARY**

Two beams supporting the bellframe were sampled but could not be dated. Nine bellframe timbers were sampled and found to cross-match, with three pairs of timbers each being found to have been derived from an individual parent tree. Thus, six series were combined to form a site chronology that was subsequently dated to the period AD 1579–1665. One timber retained complete sapwood and was found to have come from a tree felled in the summer AD 1666, whilst a second tree had detached sapwood, with very few missing rings, suggesting a felling date in the period *c* AD 1666–70. The other samples have similar likely felling dates and thus appear to be coeval, suggesting construction of the bellframe also occurred in the period AD 1666–70. Fragments of roof timbers and a screen were not sampled as they were found to have too few rings.

## **CONTRIBUTORS**

Dr M C Bridge

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This work was commissioned by Shahina Farid (English Heritage Scientific Dating Team). I would like to acknowledge the kind help of Andrew Walster, who travelled to open up the site and offered hospitality. The data were checked by Cathy Tyers (English Heritage Scientific Dating Team) who made useful comments on earlier drafts of this report.

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## INTRODUCTION

The remains of the Church of St Helen in South Wheatley, Nottinghamshire, are a Scheduled Ancient Monument and Grade I listed building situated on an eminence on the east side of the village of South Wheatley, which itself is about 7km south-west of Gainsborough, Lincolnshire (Fig 1). At the time of sampling, extensive work had just been completed to stabilise and re-roof the tower, which contains the remnants of a three-bell wooden frame that had been exposed to the elements for over a century. Other than the two-stage fifteenth-century Perpendicular tower, all that now remains of the rest of the church is the narrow twelfth-century Norman chancel arch. Dendrochronological dating of the bell frame and its supporting structure was requested by Tim Allen, English Heritage Inspector of Ancient Monuments, in order to enhance understanding of the significance of the remains of this church and hence inform its future management and care. It would also add to the corpus of dendrochronologically-dated bell frames in England.



*Figure 1: Map to show the location of the Church of St Helen © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey Licence number 100024900*

## METHODOLOGY

An initial assessment of the timbers was carried out in May 2013, in which accessible oak timbers with more than 50 rings and, where possible, traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. It was decided that the timbers would be best sampled at the end of the summer, when they might be at their driest, and sampling thus took place in October 2013. 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). The ring widths of the measured Tree-ring series are provided in the Appendix. 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 for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted and compared on the computer monitor. 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 a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 11–41 rings (Miles 1997). 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.

## RESULTS AND DISCUSSION

The brief for the dendrochronological study of the Church of St Helen included some old roof timbers that had collapsed and were resting on the bell frame (Fig 2), as well as a fragment thought to have come from a medieval timber screen (Fig 3). However, the roof timbers were judged to have too few rings and were too degraded to warrant sampling, whereas the screen timber simply contained too few rings to be sampled.



*Figure 2: Photograph of the old roof timbers lying on top of the bellframe (Tim Allen)*



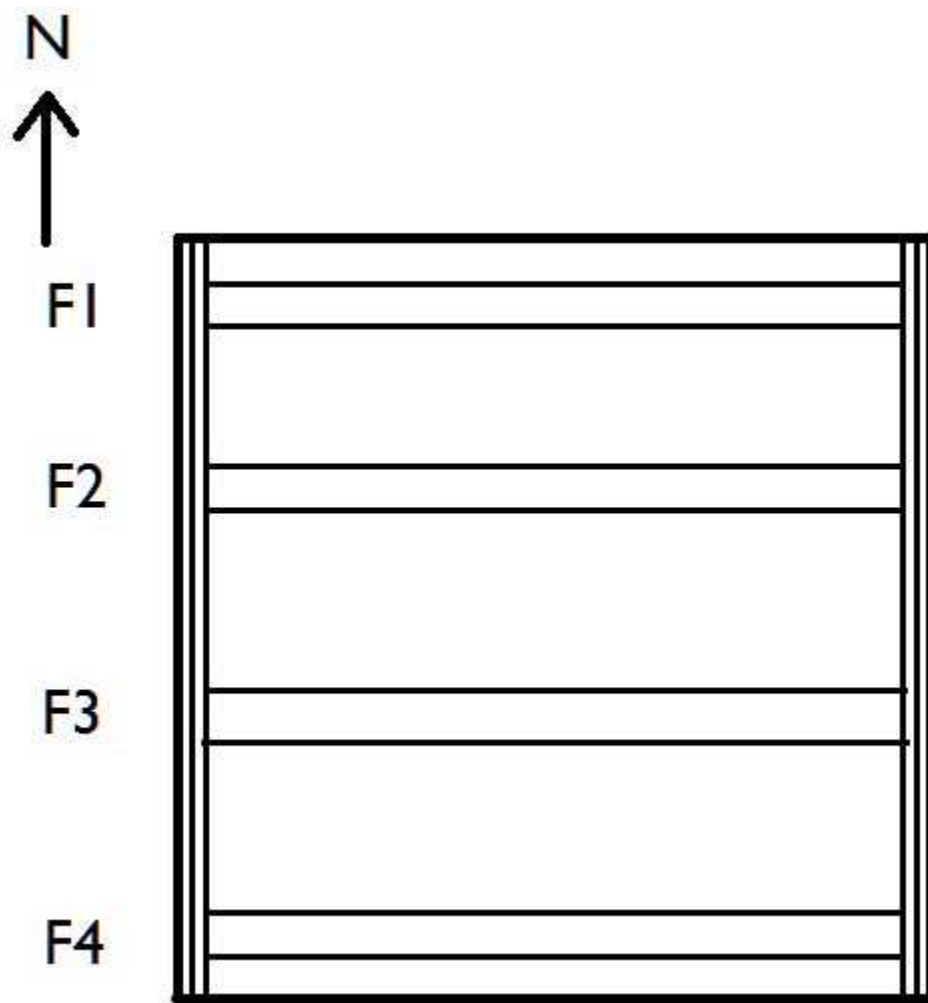


*Figure 3: Fragment, possibly from a medieval timber screen (Tim Allen)*



*Figure 4: Two of the support beams to the bell frame (Tim Allen)*

Two long support beams running north-south were assessed (Fig 4), and the one lying more centrally was sampled, along with a short support bracket lying diagonally across the south-west corner of the tower. Various timbers of the bellframe were assessed as being potentially good for dendrochronological analysis, having sufficient rings and some traces of sapwood, and thus, nine timber elements were sampled. Basic information about the samples taken is presented in Table 1. Figures 5 and 6 show the basic layout of the frame and an indication of the general form of the four cross frames of the bell frame. Sample swbf07 at only 35 years would generally be considered too short for further analysis, however, visual analysis of its ring width pattern, backed up by one strong statistical match (Table 2) meant that it was considered suitable for inclusion on this occasion, and hence all 11 samples were analysed.

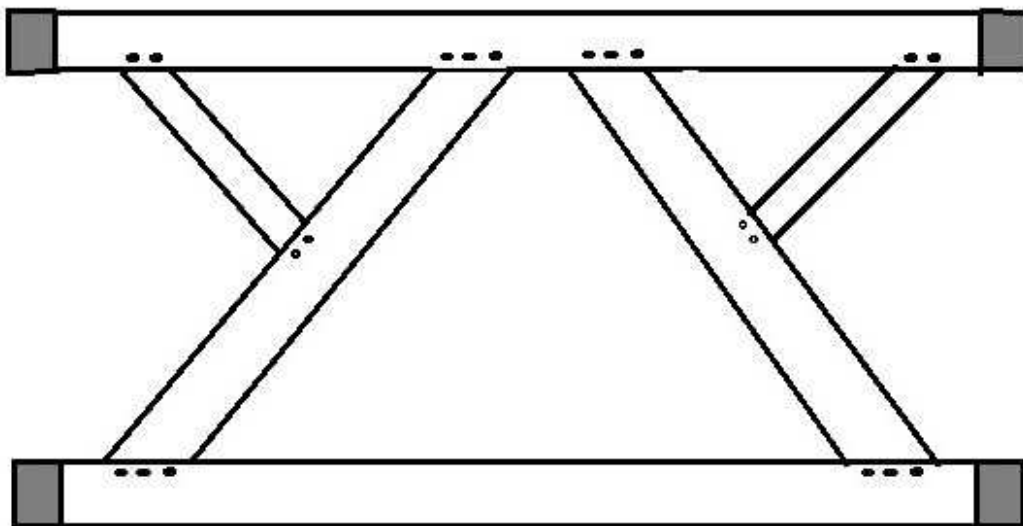


*Figure 5: Sketch plan of the arrangement of frames in the tower*

The two samples from the support beams yielded relatively short sequences that did not cross-match with each other or the sequences from the bellframe itself. They could not be dated independently, and therefore the support frame remains undated.

The cross-matching between the remaining nine sequences, all from the bellframe, is shown in Table 2. Three pairs of timbers potentially derived from the same tree were identified. Each of the three pairs were combined to produce three new tree series for further analysis. These and the three other matching individual series were combined into an 87-year long site chronology, which was subsequently dated to the period AD 1579–1665, the strongest matches being shown in Table 3. One timber (swbf06) retained complete sapwood and was from a tree felled in summer AD 1666. A second timber (swbf07) had complete sapwood but detached from the main core. It was known that only a very few, or no rings had been lost at this break, thus allowing a tight felling date range of *c* AD 1666–70 to be determined. The other dated series had likely felling date ranges in close agreement (Fig 7) suggesting that this is a coeval group. These results strongly suggest construction of the bellframe shortly after felling in the period *c* AD 1666–70.

The cross-matching of the site chronology with dated reference chronologies (Table 3) revealed that the strongest match was with relatively locally derived dated material from Vicars' Court in Lincoln (Hillam and Groves 1996), suggesting a local origin for the timbers from the bellframe, although other good matches were found with sites further afield.



*Figure 6: Sketch of the form of the four cross frames of the bell frame*

**Table 1: Details of samples taken from the Church of St Helen, South Wheatley, Nottinghamshire**

Sample number	Timber and position	No of rings	Mean HW ring width (mm)	Dates spanning (AD)	h/s boundary (AD)	Sapwood rings	Mean sensitivity	Felling dates ranges (AD)
Bellframe								
swbf01	Frame F2, sole plate	56	2.24	1599–1654	1654	h/s	0.17	1665–95
swbf02	Frame F3, sole plate	86	1.83	1579–1664	1653	11	0.23	1665–94
swbf03	Frame F3, east long diagonal brace	67	2.10	1580–1646	1646	h/s	0.23	1657–87
swbf04	Frame F3, west long diagonal brace	60	2.15	1595–1654	1649	5	0.23	1660–90
swbf05	Frame F2, west long diagonal brace	63	2.22	1599–1661	1638	23	0.24	1662–79
swbf06	Frame F2, east long diagonal brace	81	2.41	1585–1665	1641	24½C	0.21	Summer 1666
swbf07	West end frame, sole plate	35	2.65	1617–51	1648	3 + 15CNM	0.23	c1666–70
swbf08	Frame F1, sole plate	59	1.77	1602–60	1654	6	0.26	1665–95
swbf09	East end frame, sole plate	55	3.09	1592–1646	1646	h/s	0.21	1657–87
<i>swbf28m</i>	<i>Mean of 02 and 08</i>	86	1.88	1579–1664	1654	10	0.23	1665–95
<i>swbf34m</i>	<i>Mean of 03 and 04</i>	75	2.15	1580–1654	1648	6	0.23	1659–89
<i>swbf56m</i>	<i>Mean of 05 and 06</i>	81	2.44	1585–1665	1640	25½C	0.23	Summer 1666
Support structure								
swbfS01	South-west corner diagonal support	57	0.48	-	-	12 + c25	0.16	-
swbfS02	Central north-south support	50	1.33	-	-	h/s	-	-

Key: HW = heartwood; h/s = heartwood-sapwood boundary; C = complete sapwood; ½C = complete sapwood, felled the following summer

**Table 2: Cross-matching between the dated sequences. *t*-values over 3.5 are significant. Those highlighted indicate pairs of timbers considered likely to have been derived from the same tree**

Sample number	<i>t</i> -values							
	swbf02	swbf03	swbf04	swbf05	swbf06	swbf07	swbf08	swbf09
swbf01	6.3	5.5	5.6	5.6	4.6	2.8	7.6	5.7
swbf02		9.2	6.5	4.8	4.2	2.7	10.5	5.8
swbf03			9.8	5.9	4.7	2.6	7.9	5.9
swbf04				8.2	6.2	3.6	6.8	6.7
swbf05					13.0	4.3	5.7	6.9
swbf06						2.8	5.0	6.0
swbf07							1.7	6.2
swbf08								4.6

**Table 3: Dating evidence for the site chronology SHWTLY, AD 1579–1665**

County/region:	Chronology name:	Short publication reference:	File name:	Spanning: (yrs AD)	Overlap (yrs)	<i>t</i> -value
Lincolnshire	Vicar's Close, Lincoln	(Hillam and Groves 1996)	LINCVC2	1578–1663	85	7.9
Gloucestershire	5 Barton Street, Tewkesbury	(Miles <i>et al</i> 2007)	TEWKES3	1590–1654	65	6.6
Somerset	St Andrew's Church, Whitestaunton	(Bridge 2014)	WHTSTNBF	1582–1676	84	6.4
Oxfordshire	Old Clarendon Building, Oxford	(Worthington and Miles 2006)	CLRNDNOX	1539–1711	87	6.3
Oxfordshire	Wardington Manor, Wardington	(Miles <i>et al</i> 2006)	WRD-B	1547–1738	87	5.8
Yorkshire	Pontefract Castle	(Arnold <i>et al</i> 2005)	PFCASQ01	1507–1656	78	5.7
London	Breakspeare House, Harefield	(Arnold and Howard 2010)	HFDBSQ01	1574–1694	87	5.7
Wiltshire	Salisbury Cathedral	(Miles <i>et al</i> 2005)	SARUM12	1556–1703	87	5.7
Warwickshire	Middleton Hall	(Arnold <i>et al</i> 2006)	MIDHSQ01	1593–1718	73	5.6

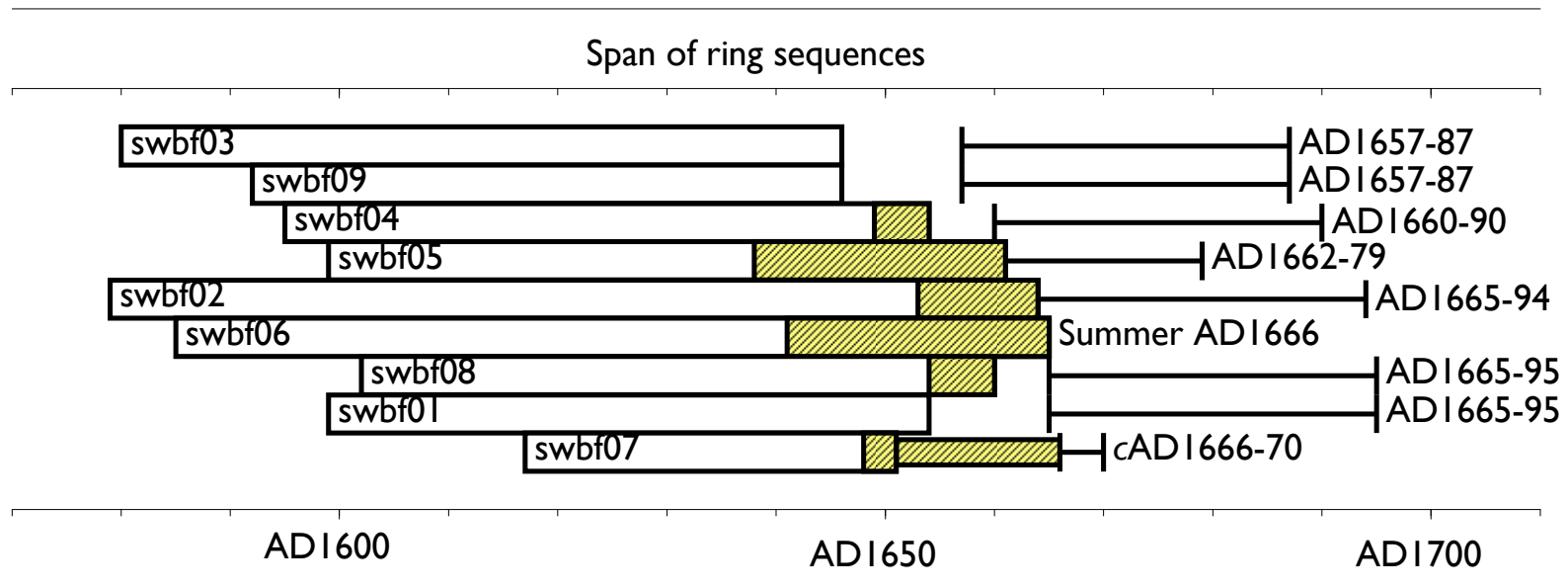


Figure 7: Bar diagram showing the relative positions of overlap and likely felling date ranges for the individual dated samples from the bellframe at the Church of St Helen, South Wheatley. White bars – heartwood; yellow hatched bars – sapwood; narrow section of bar – additional unmeasured rings

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## APPENDIX

Ring width values (0.01 mm) for the dated samples from Church of St Helen, South Wheatley

### swbf01

180	177	172	260	307	328	191	264	256	223
250	299	254	210	289	203	187	271	258	300
256	317	260	298	269	233	204	225	265	274
317	216	216	259	320	190	183	208	210	221
199	233	238	181	192	193	166	208	176	203
180	135	112	91	96	148				

### swbf02

387	279	296	294	204	148	245	268	159	405
245	141	146	141	189	312	254	231	177	186
217	230	211	231	255	170	142	236	266	181
186	196	189	126	196	170	126	162	203	182
180	199	175	240	178	109	130	143	170	180
204	123	185	221	202	113	131	151	129	118
82	138	156	109	142	142	173	198	103	170
135	72	75	73	67	109	112	105	75	91
87	112	113	117	89	79				

### swbf03

327	280	278	208	168	204	217	203	393	338
153	133	111	221	395	362	364	318	319	301
290	271	370	383	299	178	264	308	239	191
244	294	167	279	216	201	227	206	116	110
188	229	228	163	111	112	113	168	174	210
147	165	207	247	133	108	82	83	66	49
135	136	112	167	129	131	128			

### swbf04

340	381	302	361	311	295	284	376	321	349
259	389	361	360	296	285	347	216	331	239
215	294	276	132	91	119	125	182	161	105
106	117	168	167	214	136	182	257	231	146
126	75	77	92	66	147	154	108	148	167
167	198	149	168	173	111	97	71	101	137

### swbf05

243	267	236	283	148	151	107	147	230	263
263	276	336	207	366	206	207	310	230	228
191	274	273	350	287	225	192	152	209	250
261	193	214	275	256	143	129	87	96	103
93	156	150	160	136	157	142	178	126	154
146	126	86	64	73	100	204	126	94	134
88	144	203							



## swbf06

420	313	221	254	446	361	373	316	354	422
280	430	280	350	307	355	295	329	206	167
126	158	223	252	186	218	294	210	287	191
179	253	227	237	182	249	258	293	274	216
159	149	156	176	209	162	181	224	225	141
144	110	175	121	122	149	141	155	126	129
116	152	98	101	95	90	60	51	68	108
156	113	94	108	85	106	105	93	121	116
117									

## swbf07

381	266	216	252	298	380	315	267	215	194
317	256	304	212	281	349	357	205	269	173
150	192	193	221	209	223	232	226	253	394
277	407	197	244	159					

## swbf08

320	344	331	189	325	307	237	211	244	271
181	234	188	162	223	230	208	172	256	200
204	175	95	120	155	223	211	208	122	174
169	207	107	84	120	109	93	99	181	158
93	160	156	177	172	105	151	130	69	68
59	78	121	156	92	69	93	70	120	

## swbf09

168	371	462	395	537	426	476	412	409	360
368	318	323	199	276	343	329	293	323	354
282	358	220	207	273	255	199	217	300	324
346	298	189	192	235	334	327	411	230	285
335	407	205	315	232	184	220	202	256	295
322	275	329	346	458					

## swbfS01

54	60	54	49	39	43	65	56	57	63
75	56	75	61	45	40	38	66	53	55
46	43	57	58	46	44	45	41	42	49
33	38	39	46	40	35	48	41	32	47
46	45	42	36	34	29	32	24	29	35
24	26	31	39	41	28	27			

## swbfS02

368	213	230	218	159	175	147	127	98	166
73	45	40	45	111	119	52	111	95	149
136	161	262	296	230	187	137	118	156	165
92	113	118	144	125	74	59	85	75	135
175	164	144	112	88	55	59	62	79	80



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