Research Department Report 044-2006

Dendrochronological Analysis of the Doom Panel at the Church of St James the Great, Dauntsey, Wiltshire

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Summary

A tree-ring dating programme was commissioned on timbers from the Doom panel, Dauntsey Church, Wiltshire, by English Heritage in AD 2005. The results identify that boards in the panel were probably felled in the final third of the fourteenth century.

Keywords

Dendrochronology

Doom Panel

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from the Doom, or Last Judgement, panel from the Church of St James the Great, Dauntsey, Wiltshire (NGR ST 979 824). It is beyond the dendrochronological brief to describe the panel in detail or to undertake the production of detailed drawings. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication, or an archive deposition, on the object.

Dauntsey is *c* 18km west of Swindon and *c* 20km south of Cirencester (Fig 1). The church is just to the east of the river Avon, standing adjacent to Dauntsey House (Fig 2).

The Doom panel at Dauntsey Church is one of only a handful of such objects that have survived. There are reputed to be only four other painted Doom scenes on panels in England. These are at: Wenhaston, Suffolk; Mitcheldean, Gloucestershire; St Albans, Hertfordshire, and Penn, Buckinghamshire. The last is the only other one of them to have been tree-ring dated (Tyers 2002), yielding a date for the boards in the first half of the fifteenth century. The Dauntsey Doom panel (Fig 3) consists of two rows of vertical boards originally forming a tympanum over the rood screen. This arrangement of boards contrasts with the other surviving Doom panels. The one at Wenhaston, for example, uses boards that are horizontal, and the Penn version consists of a single row of vertical boards. There are several other examples of painted tympana in England, but these usually portray the Crucifixion.

The Dauntsey upper panel portrays Christ in the centre with St Peter receiving the saved to the left, with the procession of the damned to the right. The lower panel also portrays the saved to the left whilst the damned to the right are entering the jaws of Hell. There were originally 20 or so boards. Some are lost and several have split vertically (boards 14 and 15 are two halves of the same original board, as are 16 and 17, and 19 and 20, and 23 and 24; in contrast, board 18 is also one half of a board but the other part is lost). At the time of the analysis there were 25 separate boards or part-boards (Fig 3). The boards are oak, and each is a fairly crudely sawn tangential board. The paint layer was applied to the sawn surface without any further smoothing of the surface with a tool such as a shave, which would be typical on fine art-historical objects of this period. In each case the centreline of the tree is within the board. The boards are not particularly straight-grained, and this characteristic has led to the twisting and splitting apparent on several of the boards. This uneven grain and tangential conversion is also why the material has had a tendency to split into two halves. The bottom row boards vary from *c* 0.95 to *c* 1.19m in height, are *c* 0.36 to *c* 0.49m in width, and are *c* 21-29mm thick. These boards are rectangular or nearly so, with the right hand

boards shorter than those to the left. The upper row boards are more obviously shaped to fit the original shape of the arched roof where the panel was originally housed. The boards of this row are all roughly flat at the bottom, and they have curved top edges. The outer pair are *c* 0.8m in height whilst the innermost are *c* 1.7m in height. Most of the boards have a relatively smooth bevelled upper end, and a rather rougher lower end. It seems possible that these are respectively the original ends, and secondary surfaces made whilst cutting the boards out of their original location. There are traces of nails and other attachments that appear to relate to battens on the backs at some stage in their somewhat chequered past.

The material has such twisty grain that it is possible by simple visual inspection to match the knots and centrelines of several pairs of boards to demonstrate they were derived from the same log (for example boards 6 and 10, see Fig 4). Examining the surfaces of the boards with raking light reveals that many of the boards have a distinctive change of direction in the saw cuts. These angles and their changes suggest these boards were originally trestle sawn (Fig 5). Trestle sawing is normally undertaken on quite long trunks, with the cross-over or snap-off point appearing half way down the stem as the baulk is adjusted on the trestle. With the Dauntsey boards the preponderance of short lengths with the cross-over points present may imply that another technique is being used to convert the boards.

The panel has been undergoing an extensive programme of restoration for a number of years. Tree-ring analysis of the boards prior to the return of the panel to an inaccessible position up in the chancel arch was commissioned by Arnold Root, the local English Heritage Historic Buildings Inspector, to aid the interpretation of this important object.

Methodology

The working methods used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The methodology used for this item was as follows.

The church was initially visited in November 2005 in the company of Andrew Townsend, Project Architect, and John Meadows, English Heritage Scientific Dating Section. An assessment of the dendrochronological potential of individual disarticulated timbers from the panel was undertaken. This assessment aimed to identify whether oak boards with sufficient numbers of rings for analysis existed in the panel. This assessment concluded that several of the timbers in the panel were suitable. At the time of the assessment and analysis the boards were stored in a purpose-built container, locked in the vestry of the church. The assessment further considered the practical aspects of any potential analysis. Discussion with Andrew Townsend concluded that the material could not be temporarily transferred to the laboratory

in Sheffield and that instead any analytical work would have to be undertaken somewhere in the church. Subsequent discussions with Arnold Root identified the degree of intervention on the board edges that were considered acceptable in principle. One of the boards (board 3, see Fig 6) retained complete sapwood and bark-edge, although this was not exposed at either the upper or lower edge of the board.

A selection of the boards was analysed during a subsequent two day visit also in November 2005. The boards selected for analysis were prepared for measurement by removing the dust and grime from the selected radii with a motorised soft brush and then if necessary paring the back edge of the board until each ring boundary could be successfully distinguished. A single radius was prepared on each selected board. The accessible sequences of growth rings in the selected boards were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition a cross-correlation algorithm (Baillie and Pilcher 1973) was employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

The sequences obtained from the selected boards were compared with each other and any found to cross-match were combined to form a site master curve. This, and any other remaining unmatched ring sequences, were tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring sequence.

The tree-ring dates produced by this process initially only date the rings present in the measured section of each successfully matched board. The interpretation of these dates relies upon the nature of the final rings in the measured sequence as well as estimates of the presence of further rings within the boards that are not expressed at the measured edge. These estimates were made by tracing the last measured ring boundary up the back face of the panel and counting the additional ring boundaries, if any were present. Subsequently if the board ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the estimated number of unmeasured rings and then the addition of the minimum expected number of sapwood

rings which are missing. This *tpq* may be many decades prior to the felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the board, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range (Tyers 1998). These figures are applicable to oaks from England and Wales. Alternatively, if bark edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the boards. It is necessary to incorporate other specialist evidence concerning the seasoning or reuse of these timbers before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of the panel.

Results

Twenty-five separate boards or part boards survive from the panel. These were numbered **1**–**25** (Table 1; Fig 3). All of these timbers are oak (*Quercus* spp.).

Fourteen of the boards were found to be unsuitable for analysis. This was for a variety of reasons. Many of the boards were of a highly tangential conversion, and for these too few rings were in the boards for analysis to be considered suitable. Some other boards had fragile or damaged edges that could not be prepared without risking the integrity of the paint layer. Finally a group of eleven boards was identified with the same distinctive sequence that contained a series of irresolvable bands of narrow rings. All but one of these boards were from the upper row, but whereas board 1 from the lower row contained this sequence at its outermost edge, it also contained a relatively straightforward inner sequence that made this board suitable for measurement. The tree-ring series from the inner part of board 1 and a further 10 boards, comprising eight boards from the bottom row and two boards from the upper row, were measured, and the resultant series were then compared with each other.

Nine of these series, eight from the bottom row and one from the top row, were found to match together to form a single group (Table 2). A mean chronology was calculated from these at their synchronised positions. This chronology and the unmatched series were then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well-correlated position was identified for the composite sequence. Table 3 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for each component sample of this sequence by this process and their interpretation. Figure 7 shows the chronological

position identified for each component sample, with interpretations based on maximum and minimum likely sapwood values.

Interpretation and discussion

The 196-year chronology constructed from the 9 cross-matched boards from the Doom panel is dated AD 1154 to AD 1349 inclusive. Statistical and visual comparison demonstrates that four of these were derived from a single tree. Although none of the measured sequences contain sapwood, one of the dated boards was complete to its heartwood/sapwood boundary, with another possibly so. For each of these, an offset between the end of the measurable sequence and the heartwood/sapwood boundary was estimated by counting the visible ring boundaries along the back surface of the board between the measured section and the area retaining the heartwood/sapwood boundary. Adding the minimum and maximum expected number of sapwood rings to the estimated date of the heartwood/sapwood boundary on these two boards, and assuming that they and the others are contemporaneous, suggests they were felled between AD 1369 and AD 1399 (Fig 7; Table 1). The other material all appears to be co-eval. The nine dated timbers comprise boards from both rows, and the same distinctive but unmeasurable sequence of narrow rings was observed in board 1 in the lower row and 10 of the boards (originally 7 different boards) in the upper row. These observations strongly suggest that there is no difference in date between the upper and lower parts of the panel. Assuming the timbers were felled for immediate usage, which was normal practice in this period (Charles and Charles 1995), then this panel dates from between AD 1369 and AD 1399. Board 3 contains sapwood and bark, but it is on the radius of the board that was too fragmented to measure, and the sapwood is not exposed at a measurable location (Fig 6); hence it has not been possible to estimate an appropriate offset for the numbers of rings in the sapwood on this board.

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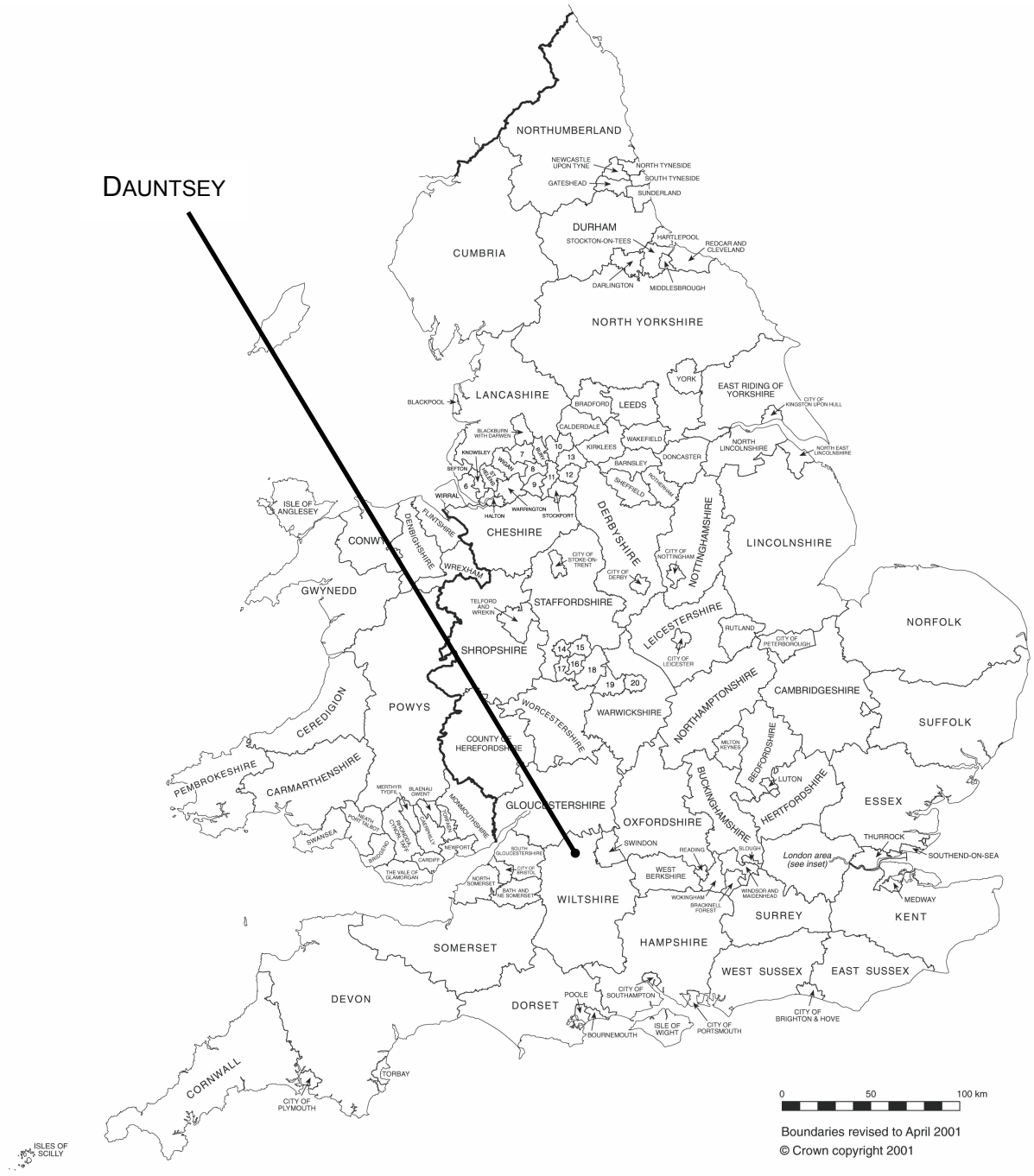

Figure 1 Location of Dauntsey, Wiltshire, within England and Wales.

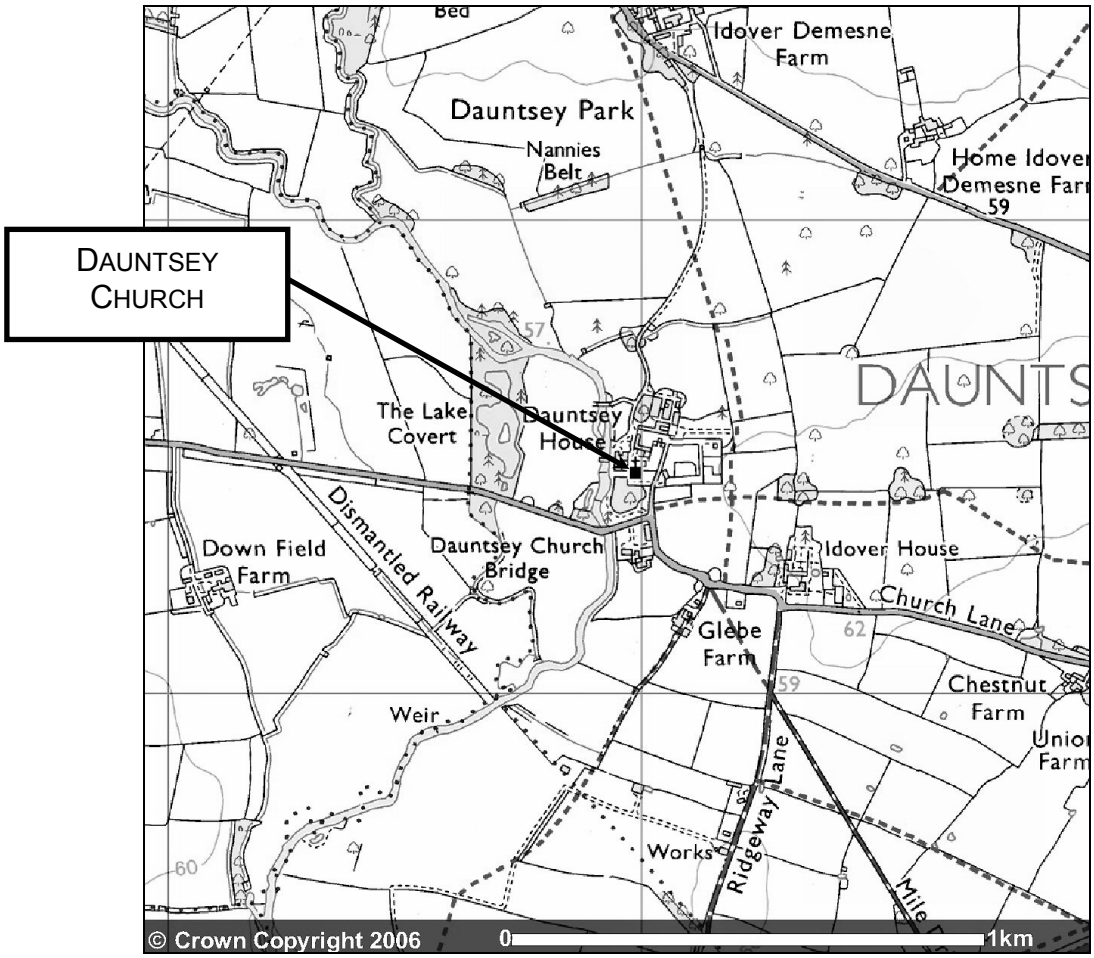

Figure 2 Location of Dauntsey Church, Wiltshire

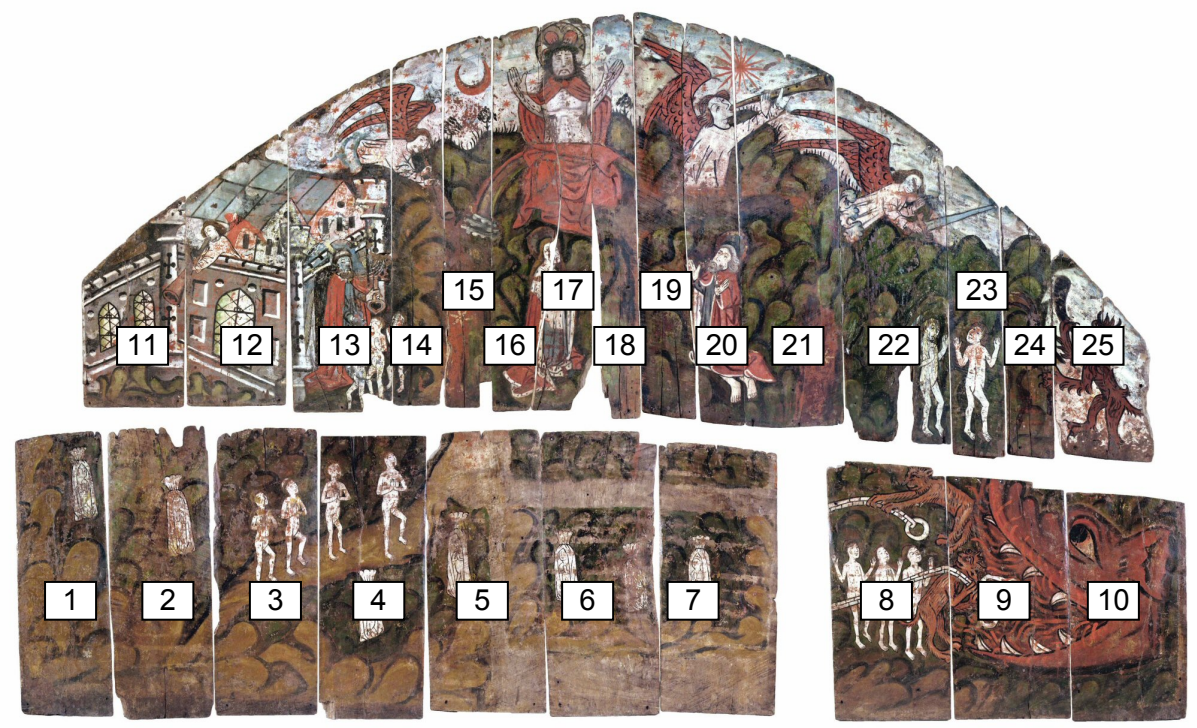

Figure 3 The Doom panel, Dauntsey Church, Wiltshire showing the board numbering scheme used in this report (rectified photograph from the English Heritage Metric Survey Team).

Figure 4 Reverse side of boards 6 (left) and 10 (right) from the Doom panel, Dauntsey Church, Wiltshire. The same knot pattern, the same kink in the centreline, and the same alignment of the grain indicates these were derived from the same length of a single trunk. The exceptionally high t-value between these sequences (t = 18.58) confirms this observation. * marks the measured and dated radii (photographs from the English Heritage Metric Survey Team)

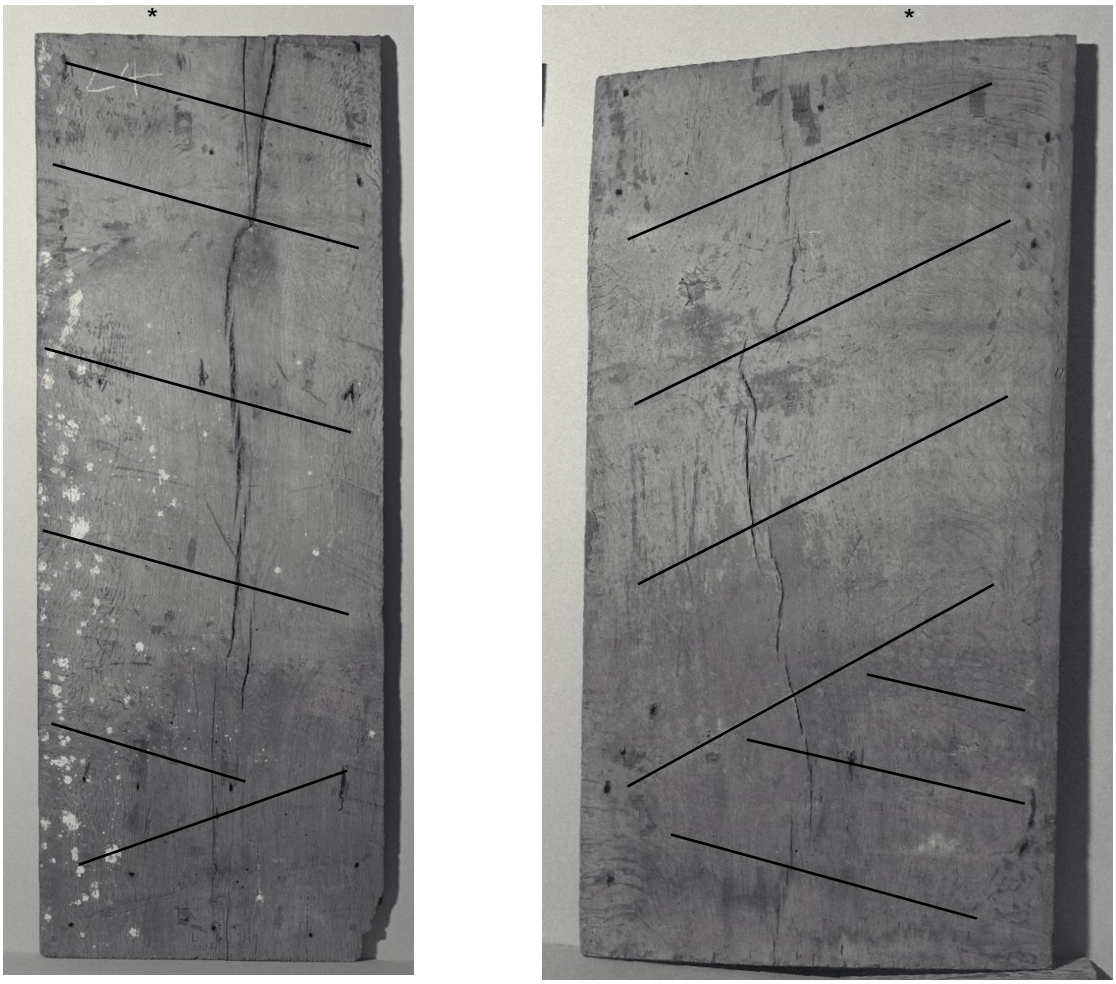

Figure 5 Reverse side of boards 4 (left) and 10 (right) from the Doom panel, Dauntsey Church, Wiltshire. Examination with raking light shows these boards were sawn at an angle and then adjusted to be sawn from the other end at the reciprocal angle. This is usually indicative of trestle sawing, rather than pit sawing. The superimposed lines illustrate the angle of the sawing on these two boards and the adjustment in the alignment as the baulk was turned on the trestle. * marks the measured and dated radii (photographs from the English Heritage Metric Survey Team)

Figure 6 Reverse side of board 3 from the Doom panel, Dauntsey Church, Wiltshire, showing the area of sapwood and bark. The superimposed lines illustrate the angle of the sawing on this board and the adjustment in the alignment as the baulk was turned on the trestle. * marks the measured and dated radius (photographs from the English Heritage Metric Survey Team)

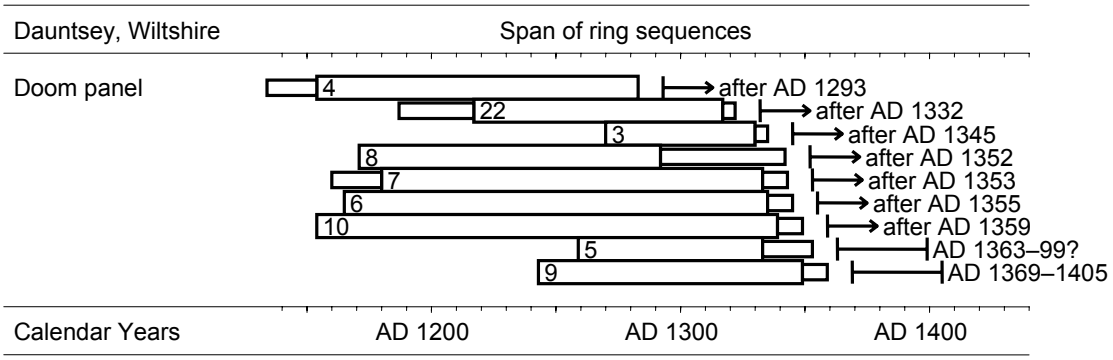

Figure 7 Bar diagram showing the chronological positions of the dated boards from the Doom panel, Dauntsey Church, Wiltshire. White bars represent heartwood, narrow white bars represent unmeasured heartwood rings. The estimated felling periods are also shown, based upon maximum and minimum likely sapwood values

Table 1 The boards in the Doom panel, Dauntsey Church, Wiltshire

Ref	Comments	Size (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
1	Measured *	1185 x 365 x 21	57	-	2.20	undated	-
2	Not measured	*c* 1210 x 417	-	-	-	-	-
3	Measured	1178 x 430 x 23	61+*5*	-	1.78	AD 1270–1330	after AD 1345
4	Measured	1175 x 438 x 21	*20*+130	-	1.59	AD 1154–1283	after AD 1293
5	Measured	1170 x 485 x 25	*75*+*20*	?H/S	1.53	AD 1259–1333	AD 1363–99?
6	Measured [1]	1004 x 488 x 24	171+*10*	-	1.61	AD 1165–1335	after AD 1355
7	Measured [1]	1115 x 489 x 24	*20*+154+*10*	-	1.52	AD 1180–1333	after AD 1353
8	Measured [1]	1070 x 487 x 25	122+*50*	-	1.84	AD 1171–1292	after AD 1352
9	Measured	1170 x 482 x 29	107+*10*	H/S	1.62	AD 1243–1349	AD 1369–1405
10	Measured [1]	944 x 489 x 25	186+*10*	-	1.59	AD 1154–1339	after AD 1359
11	Not measured *	*c* 885 x 422	-	-	-	-	-
12	Measured	1143 x 423 x 25	52	-	2.57	undated	-
13	Not measured *	*c* 1450 x 418	-	-	-	-	-
14	Not measured * [2]	*c* 1522 x 245	-	-	-	-	-
15	Not measured * [2]	*c* 1578 x 185	-	-	-	-	-
16	Not measured * [3]	*c* 1742 x 310	-	-	-	-	-
17	Not measured * [3]	*c* 1700 x 245	-	-	-	-	-
18	Not measured *	*c* 1715 x 177	-	-	-	-	-
19	Not measured [4]	*c* 1716 x 231	-	-	-	-	-
20	Not measured [4]	*c* 1688 x 220	-	-	-	-	-
21	Not measured	*c* 1647 x 424	-	-	-	-	-
22	Measured	1490 x 438 x 21	*30*+101+*5*	-	2.49	AD 1217–1317	after AD 1332
23	Not measured * [5]	*c* 1210 x 222	-	-	-	-	-
24	Not measured * [5]	*c* 1050 x 207	-	-	-	-	-
25	Not measured *	*c* 800 x 410	-	-	-	-	-

KEY for Table 1 See Fig 3 for board numbers. Total rings = measured rings, with values in italics indicating additional rings present on the boards that could not be measured. H/S = heartwood/sapwood boundary. ARW = average ring width of the measured rings. Felling period calculated using 10–46 year sapwood estimate. * = visual inspection suggests these are derived from a single tree, [1] = tree-ring data indicates these are derived from a single tree. [2 3 4 5] broken halves of the same original boards

Table 2

t-value matrix for the timbers forming the Dauntsey Doom panel chronology. - = values less than 3.0, \ = short or no overlap. Values in bold: boards derived from the same parent tree

	4	**5**	**6**	**7**	**8**	**9**	**10**	**22**
3	\	5.37	3.41	-	\	4.24	-	-
4		\	6.08	6.42	5.38	-	6.24	5.68
5			4.81	4.35	3.44	7.93	4.45	-
6				**14.34**	**15.28**	6.35	**18.58**	-
7					**12.98**	7.20	**13.13**	3.07
8						4.66	**16.39**	4.16
9							5.82	-
10								-

Table 3

Dating the Dauntsey Doom mean sequence constructed from the matched samples, AD 1154–1349 inclusive. Example *t*-values with independent reference chronologies

Reference chronology	***t*-value**
Bedfordshire, Chicksands Priory (Howard *et al* 1998a)	9.97
Devon, Bradworthy Church (Tyers 2003)	7.97
Devon, Bury Barton Lapford (Groves 2005)	8.96
Hampshire, Old Church House Odiham (Miles *et al* 1996)	7.77
Nottinghamshire etc, East Midlands Master (Laxton and Litton 1988)	8.70
Somerset, Abbey Barn Glastonbury (Bridge 2001)	11.67
Somerset, Muchelney Abbey (Bridge 2002)	7.93
Staffordshire, Burton Abbey Green (Howard *et al* 1998b)	9.23
Wiltshire, Bradford on Avon Barn (Groves and Hillam 1994)	8.22
Worcestershire, Droitwich Upwich (Groves and Hillam 1997)	8.79

Appendix 1 Ring width data from the measured boards of the Doom panel, Dauntsey Church, Wiltshire, 100 = 1mm

dcdp01

355	396	229	282	239	226	314	570	552	391
407	409	306	380	446	299	455	596	432	369
293	391	320	200	164	182	163	116	113	133
99	116	129	175	187	157	137	83	121	85
148	185	132	155	127	106	68	41	45	67
117	98	78	42	41	44	39			

dcdp03

230	235	210	228	268	79	69	151	164	146
146	129	127	206	179	219	268	172	204	194
282	181	309	318	303	124	93	101	134	127
227	189	173	143	135	114	293	291	247	168
121	111	111	132	182	237	218	212	157	230
163	148	173	189	166	108	113	131	97	149
147									

dcdp04

327	313	363	442	267	497	524	261	366	291
330	496	226	221	264	328	178	265	149	138
207	133	107	49	49	59	59	64	128	87
55	61	60	285	82	105	74	74	61	100
122	116	101	112	74	66	55	112	154	93
128	128	110	76	77	93	107	105	93	134
139	142	135	69	104	177	115	115	54	53
82	103	188	117	216	278	106	97	55	154
150	229	124	254	211	242	165	155	125	279
195	123	162	173	98	69	89	64	101	163
119	153	125	108	93	121	149	119	134	148
168	159	198	145	110	135	137	308	227	256
174	176	203	143	136	192	132	184	194	216

dcdp05

166	145	155	158	140	89	87	156	102	136
97	108	153	188	204	187	117	93	127	155
191	249	176	208	183	162	158	223	171	179
210	236	209	343	344	284	171	205	112	95
88	149	155	206	176	115	92	148	149	176
146	113	121	113	125	150	209	169	170	106
142	89	133	123	117	107	98	90	134	150
130	109	88	100	139					

dcdp06

494 284 255 399 676 318 608 450 339 373
319 355 200 277 194 126 196 356 243 105
154 208 284 132 249 446 198 185 264 125
99 89 91 98 78 151 290 187 117 88
95 145 111 136 116 186 128 99 149 178
218 196 241 124 154 177 231 116 88 91
110 151 223 318 263 162 113 60 96 86
188 112 209 218 225 221 75 58 171 187
151 196 298 82 106 143 155 159 217 158
326 101 119 127 128 128 136 147 63 117
120 113 121 89 81 56 112 114 205 110
92 91 108 126 151 184 120 159 179 180
154 174 119 115 168 182 121 349 185 202
123 136 58 69 79 126 113 160 137 142
93 141 158 185 113 98 91 65 41 55
58 72 74 50 67 66 64 57 58 47
56 56 79 84 97 129 87 97 107 176
169

dcdp07

293 382 711 400 121 171 382 412 174 280
450 254 180 236 173 106 106 108 115 90
98 158 134 86 102 86 139 79 88 96
144 116 111 240 276 281 308 236 142 164
224 259 155 122 105 117 143 154 249 308
215 132 82 64 65 119 72 134 231 189
194 105 69 169 169 178 203 315 117 110
110 136 127 142 103 162 116 115 116 114
104 101 93 94 82 101 121 92 121 86
124 155 173 220 106 102 122 136 173 218
173 173 163 147 168 143 180 127 153 158
166 133 185 190 139 117 142 77 66 78
97 149 191 132 160 133 144 147 154 136
116 108 67 101 99 141 189 111 79 101
96 74 76 84 41 59 60 90 83 125
111 106 120 113

dcdp08

655 535 371 362 499 661 441 559 354 178
147 208 157 88 134 214 353 163 276 393
259 189 245 156 163 122 151 178 121 207
346 183 100 84 95 233 89 161 132 227
145 86 145 219 256 200 270 144 152 206
186 167 127 119 150 201 199 260 260 155
114 89 91 117 223 110 231 277 242 202
78 103 203 192 138 156 226 119 84 125
130 124 198 119 220 121 143 116 118 140
144 114 99 116 95 108 92 104 58 64
98 133 161 142 93 86 94 132 151 174
146 130 148 160 166 173 114 92 166 111
136 214

dcdp09

244 197 197 182 173 91 80 101 91 117
168 123 198 143 141 195 152 211 200 179
157 138 140 133 102 153 124 126 129 136
167 151 129 137 142 227 242 306 205 189
231 206 240 433 368 296 283 285 204 325
282 315 157 171 111 83 97 128 157 198
151 142 121 160 184 180 160 120 148 96
130 190 226 251 227 116 190 144 168 182
153 100 96 93 150 150 190 120 98 128
126 118 117 127 150 156 154 122 169 70
94 60 62 50 51 74 85

dcdp10

203 141 182 230 336 420 430 386 397 285
381 391 307 237 364 515 305 401 372 321
324 266 305 179 241 176 106 165 329 204
105 166 205 349 143 277 332 145 134 180
138 89 98 75 107 72 156 342 177 99
70 84 193 89 133 118 189 129 89 178
195 230 196 228 110 178 172 226 171 118
103 113 212 244 346 261 133 81 66 54
61 90 74 244 218 204 160 66 34 120
153 115 110 164 77 72 88 115 143 209
115 298 138 130 155 114 146 134 131 95
130 151 120 111 99 64 54 125 114 195
111 101 86 110 166 179 146 142 173 193
185 144 194 132 133 204 235 145 342 188
175 118 114 52 40 50 93 113 163 77
81 77 111 139 144 94 90 86 94 55
71 80 72 47 68 84 68 70 69 55
53 55 107 72 85 93 73 92 96 171
145 96 84 91 110 109

dcdp12

695 646 679 630 544 602 705 456 706 625
497 376 375 438 309 198 157 180 212 221
163 220 185 200 218 248 214 189 96 86
83 85 89 170 159 133 140 119 107 61
41 77 176 194 146 70 87 44 72 59
85 74

dcdp22

271 151 250 302 373 179 190 232 258 346
294 333 449 338 324 350 681 513 513 259
482 394 368 454 289 328 357 296 226 486
364 367 496 448 438 352 455 390 384 287
262 188 186 280 171 207 174 157 166 195
137 150 126 133 267 320 225 314 170 220
147 192 209 189 175 182 229 277 295 207
191 173 316 227 215 165 123 138 137 133
114 126 87 115 116 125 90 110 165 148
195 210 141 158 117 115 172 148 117 191
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