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Tree-Ring Analysis of Timbers from Town Wall Street, Dover

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Summary

Nine samples from timber structures encountered during waterfront excavations were examined. All were oak (*Quercus* spp.) and had sufficient rings for tree-ring dating. The tree-ring width series from four samples cross-matched and were dated against numerous sequences from sites in Roman London covering the period 263 BC-AD 15. It would appear that the timbers were converted from very mature trees which would have been over three centuries old at the time of Roman occupation. As no sapwood survived on any of the dated samples, the dating results are limited to indicating a *terminus post quem* of AD 28 for one of the two waterfront structures encountered. Timbers from the stratigraphically later, and presumably medieval, structure were not dated.

Keywords

Dendrochronology

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Introduction

This document is a technical archive report on the tree-ring analysis of samples from waterlogged timbers from excavations at Town Wall Street, Dover (NGR TR32014137). The samples derive from two waterfront excavations of Roman and medieval date. Analysis of the assemblage was requested by the Canterbury Archaeological Trust.

As part of a multifaceted and multidisciplinary study of the site, 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 building. The conclusions may therefore have to be modified in the light of subsequent work.

Methodology

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (1998). Details of the methods used for the dating of the samples from this site are described below.

The samples, taken on site by the excavators, were supplied as cross-section slices from the parent timbers. These were frozen for 48 hours and then cleaned with a 'Surform' blade, and subsequently razor blades to provide a clear view of the samples' tree-ring sequences.

The complete sequences of growth rings in the samples were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 1997). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were 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 satisfactory visual matching supports these positions. Timbers originally derived from the same parent tree generally have *t*-values greater than 10.0. Lower values from timbers obviously derived from the same parent tree (eg on morphological grounds) are, however, quite common. It is the visual similarity in medium term growth trends of the samples that is the critical factor in determining 'same tree' origin.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These, and any 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 timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample 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 minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, 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. These figures are applicable to oaks from the British Isles (Tyers 1998). 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 structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

All the supplied samples were oak (*Quercus* spp.) and had sufficient rings to merit measurement. (Table 1; Fig 1). All nine samples, four of possible medieval date and five of possible Roman date, were measured and the resultant ring sequences compared. Two of the supposed Roman samples clearly crossmatch and tentative matches were identified for the other three samples from the Roman structure (Table 2). The tentative matches were confirmed during crossdating of the individual samples with reference chronologies. A mean sequence calculated for these matching sequences and the series from unmatched, individual timber measurements were then compared with dated reference chronologies from throughout the British Isles and northern Europe. Table 3 shows the correlation of the mean sequence for samples **43-47** (DS92ROMt5) with dated series at the dating position identified of 263 BC- AD 32. Table 4 lists the dated mean chronology and the relationships between the dated timbers are indicated graphically in Figure 2. None of the medieval samples either crossmatched or could be dated individually. The ring sequences all have recurrent bands of very narrow rings which will adversely affect the chances of obtaining reliable crossmatching.

Interpretation

As neither sapwood nor the heartwood/sapwood boundary was present on any of the dated samples from the Roman harbour wall, only a *terminus post quem* can be given for the felling of the timbers' parent trees. Taking account of a minimum loss of 10 sapwood rings, the parent trees could not have been felled before AD 42. This hardly refines dating available from artefactual and stratigraphic evidence but does highlight the exploitation and conversion of mature trees, some of which must have been growing for three centuries prior to Roman occupation.

Acknowledgements

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Figure 1 Town Wall Street, Dover 1992. Sketch plan of Roman and later timber structures (after Canterbury Archaeological Trust)

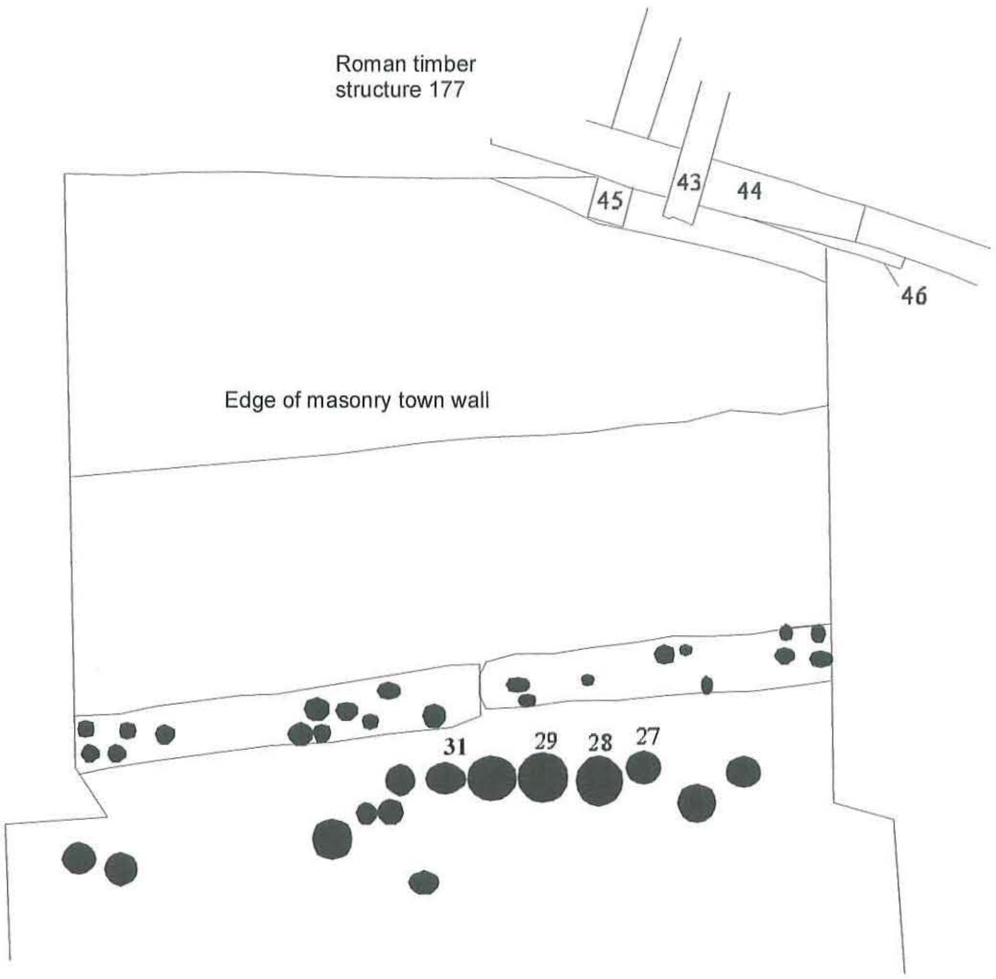

Figure 2 Bar diagram showing the chronological positions of the four dated samples. Dates given are based on current sapwood estimates.

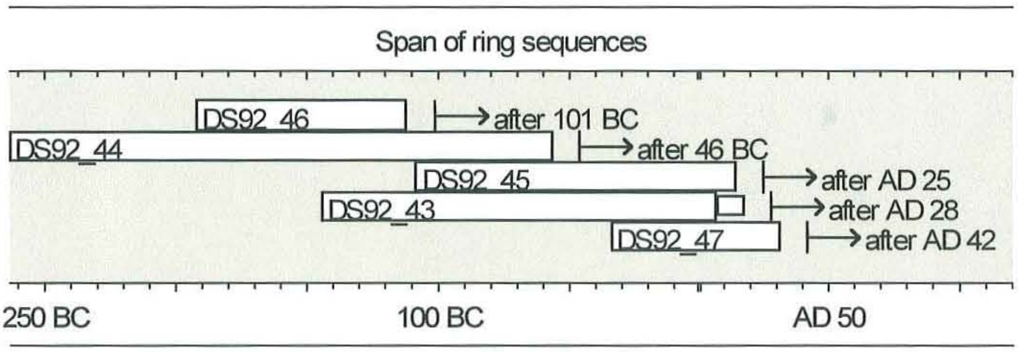

Table 1

List of samples

Sample No	Origin of sample	Cross-section size (mm)	Species	Cross-section of tree	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
27	Pile, medieval revetment	240 x 125	Oak	Half	100	21+?B	1.47	Undated	
28	Pile, medieval revetment	265 x 150	Oak	Half	87	9	1.72	Undated	
29	Pile, medieval revetment	290 x 160	Oak	Half	101	31+?B	1.63	Undated	
31	Pile, medieval revetment	198 x 105	Oak	Half	71	H/S	1.46	Undated	
43	Horizontal cross-timber, Roman harbour wall, context 177	190 x 110	Oak	Radial?	152+10H	-	1.24	144 BC-AD 8	after AD 28
44	Horizontal side-timber, Roman harbour wall, context 177	275 x 90	Oak	Radial?	208	-	1.26	263 BC-56 BC	after 46 BC
45	Horizontal cross-timber, Roman harbour wall, context 177	160 x 150	Oak	Radial?	123	-	1.28	108 BC-AD 15	after AD 25
46	Horizontal side-timber, Roman harbour wall, context 177	95 x 56	Oak	Radial?	82	-	0.68	192 BC-111 BC	after 101 BC
47	Pile, Roman harbour wall, context 177	105 x 95	Oak	Quarter	66	-	2.06	34 BC-AD 32	after AD 42

Total rings = all measured rings, +H value means additional rings were only counted, the felling period column is calculated using these additional rings.
Sapwood rings: H/S = heartwood/sapwood boundary ?B = possible bark edge
ARW = average ring width of the measured rings

Table 2

t-value matrix for samples **43**, **44**, **45**, **46**and **47**. \ = overlap < 15 years, - = t-values less than 3.00

Sample	44	45	46	47
43	3.79	3.76	-	3.42
44	*	-	7.68	\
45	*	*	\	3.05
46				\

Table 3

Dating the mean sequence DS92ROMt5 263 BC- AD 32 inclusive. *t*-values with independent reference chronologies

Reference chronology	*t*-values
Bucklersbury, London (Tyers pers comm)	8.02
Cheapside, London (Tyers pers comm)	9.46
Fleet Valley, London (Tyers pers comm)	8.20
Guildhall Art Gallery, London (Tyers pers comm)	8.72
Miles Lane, London (Tyers pers comm)	7.52
Peninsular House, London (Tyers pers comm)	9.62
Pudding Lane, London (Tyers pers comm)	9.49
Regis House, London (Tyers pers comm)	9.45
Thames St Tunnel, London (Tyers pers comm)	7.26

Table 4

Ring-width data from site master DS92ROMt5, dated to 263 BC- AD 32 inclusive.

Date	Ring widths (0.01mm)										No of samples									
263 BC								181	107	174								1	1	1
-	177	156	88	92	94	104	115	185	180	164	1	1	1	1	1	1	1	1	1	1
250 BC	89	173	257	186	136	176	298	167	146	305	1	1	1	1	1	1	1	1	1	1
-	274	180	241	269	218	162	100	105	85	98	1	1	1	1	1	1	1	1	1	1
-	87	99	118	176	110	246	255	176	139	184	1	1	1	1	1	1	1	1	1	1
-	197	238	316	503	255	257	255	197	239	470	1	1	1	1	1	1	1	1	1	1
-	346	364	205	213	199	125	88	90	103	71	1	1	1	1	1	1	1	1	1	1
200 BC	81	108	133	76	106	83	113	119	79	113	1	1	1	1	1	1	1	1	2	2
-	102	77	69	58	62	59	61	48	45	67	2	2	2	2	2	2	2	2	2	2
-	62	59	65	45	59	68	86	64	52	46	2	2	2	2	2	2	2	2	2	2
-	51	49	57	51	74	84	78	123	94	75	2	2	2	2	2	2	2	2	2	2
-	76	97	90	181	150	103	60	110	95	67	2	2	2	2	2	2	2	2	2	2
150 BC	77	82	129	102	83	44	99	118	102	113	2	2	2	2	2	2	3	3	3	3
-	161	127	145	99	97	145	83	113	127	100	3	3	3	3	3	3	3	3	3	3
-	105	167	108	79	106	81	81	74	93	129	3	3	3	3	3	3	3	3	3	3
-	82	126	105	102	91	85	80	93	113	169	3	3	3	3	3	3	3	3	3	3
-	172	127	197	167	115	203	269	199	188	161	2	2	3	3	3	3	3	3	3	3
100 BC	139	118	145	152	156	159	181	169	116	102	3	3	3	3	3	3	3	3	3	3
-	119	106	133	98	108	118	120	141	101	124	3	3	3	3	3	3	3	3	3	3
-	110	99	77	81	109	96	109	107	121	104	3	3	3	3	3	3	3	3	3	3

Date	Ring widths (0.01mm)										No of samples									
-	111	96	105	94	110	109	125	103	101	118	3	3	3	3	3	3	3	3	3	3
-	109	88	99	91	117	92	77	79	85	89	3	3	3	3	3	2	2	2	2	2
50 BC	96	84	69	106	74	120	119	108	102	89	2	2	2	2	2	2	2	2	2	2
-	99	104	128	103	132	109	191	181	203	202	2	2	2	2	2	2	3	3	3	3
-	159	147	143	168	191	223	180	206	202	137	3	3	3	3	3	3	3	3	3	3
-	151	142	197	177	175	154	164	141	131	121	3	3	3	3	3	3	3	3	3	3
-	204	182	157	133	166	152	140	130	113	105	3	3	3	3	3	3	3	3	3	3
AD 1	108	159	141	89	96	122	110	113	142	137	3	3	3	3	3	3	3	3	2	2
-	127	157	173	163	170	196	174	202	161	181	2	2	2	2	2	1	1	1	1	1
-	175	142	112	130	110	57	126	135	86	115	1	1	1	1	1	1	1	1	1	1
-	94	137									1	1								