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18 NORTH STREET, EXETER, DEVON DENDROCHRONOLOGICAL ANALYSIS OF OAK PANELS

SCIENTIFIC DATING REPORT

Ian Tyers

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18 NORTH STREET
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DEVON

DENDROCHRONOLOGICAL ANALYSIS OF OAK PANELS

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SUMMARY

A tree-ring dating programme was commissioned on panelling from 18 North Street, Exeter. The results identified that one board was datable by tree-ring dating techniques, with this board felled in either the late-sixteenth century or early seventeenth century. This dating programme was commissioned during the conservation of the panelling, and prior to its re-installation in 18 North Street. This report archives the dendrochronological results.

CONTRIBUTORS

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ACKNOWLEDGEMENTS

The assessment and analysis of the panels from 18 North Street, Exeter, was funded by English Heritage (EH), at the request of Francis Kelly, Historic Buildings Inspector, South West Region (EH), Hugh Harrison, Steve Bellamy, Cameron Stewart provided practical assistance during the analysis, and Andy Pye (Exeter City Council) kindly drove me around during the assessment trip.

ARCHIVE LOCATION

Exeter City Historic Environment Record
Planning Services
Exeter City Council
Civic Centre
Paris Street
Exeter EX1 1NN

DATE OF INVESTIGATION

2009

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INTRODUCTION

This document is a technical archive report on the tree-ring analysis of oak panelling from 18 North Street, Exeter, Devon. It is beyond the dendrochronological brief to describe the panels 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 material.

18 North Street, Exeter (NGR SX 9182 9263, Fig 1) is a four-storey house with a cellar. It contains extensive sixteenth- or seventeenth-century timber framing, including a two-storey timber-framed gallery connecting with a demolished kitchen wing. A fire in 1995 exposed internal panelling with two painted decorative schemes. This material was examined whilst undergoing restoration prior to re-installation in the property, currently 'The Conservatory Restaurant'.

METHODOLOGY

Tree-ring dating employs the patterns of tree-growth to determine the calendar dates for the period during which the sampled trees were alive. The amount of wood laid down in any one year by most trees is determined by the climate and other environmental factors. Trees over relatively wide geographical areas can exhibit similar patterns of growth, and this enables dendrochronologists to assign dates to some samples by matching the growth pattern with other ring-sequences that have already been linked together to form reference chronologies.

The panelling was assessed in February 2009. At that stage it was distributed between a museum storeroom in Exeter, and a timber restoration workshop and an art restoration studio, both near Honiton. An assessment of the dendrochronological potential of all the available timbers had been requested by Francis Kelly, HBI South-West Region EH. This assessment aimed to identify whether panels, or other elements of the panelling structure had sufficient numbers of rings for analysis to be considered suitable. This assessment identified that two groups of panels were present: *c* 27 panels were softwood boards, with softwood muntins and rails, and *c* 35 panels, and a six-panel door, contained oak boards. Some of these latter boards were associated with oak muntins and rails, whilst some of which were articulated with the softwood boards. The softwood boards were tangentially sawn boards derived from *c* 30 year-old softwood trees. These boards and the rest of the softwood material all had too few rings for analysis. None of the oak muntins and rails were suitable either, as they also contained too few rings for analysis. Many of the oak boards appeared from external examination to be timbers suitable for analysis; these were, however, part of fully articulated frames, and only a few of the boards around the edges of the frames could be removed for analysis without disfiguring the panels and their paint scheme. It was concluded that the material was of low potential for analysis.

The analysis of the limited number of accessible oak boards was commissioned and this analysis took place during July 2009. The disarticulated oak boards were analysed by taking direct measurement series from along the edges of the boards. These ring sequences were revealed by cleaning the board ends with brushes, and the discreet use of surgical scalpels. The edges where these interventions were made were subsequently hidden when the board groups were re-assembled.

This preparation revealed the width of each successive annual tree ring. Each prepared board edge could then be accurately assessed for the number of rings it contained, and at this stage it was also possible to determine whether the sequence of ring widths within it could be reliably resolved. Dendrochronological samples need to be free of aberrant anatomical features, such as those caused by physical damage to the tree, which may prevent or significantly reduce the chances of successful dating.

Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to each suitable edge of each suitable board. Sequences of the annual growth rings in the suitable boards were measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequences of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition, cross-correlation algorithms (eg Baillie and Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. Highly correlated positions were checked using the graphs and, if any of these were satisfactory, new composite sequences were constructed from the synchronised sequences. Any *t*-values reported below were 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 need to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

Not every tree can be correlated by the statistical tools or the visual examination of the graphs. There are thought to be a number of reasons for this: genetic variations; site-specific issues (for example, a tree growing in a stream bed will be less responsive to rainfall); or some traumatic experience in the tree's lifetime, such as injury by pollarding, defoliation events by caterpillars, or similar. These could each produce a sequence dominated by a non-climatic signal. Experimental work with modern trees shows that 5–20% of all oak trees cannot be reliably cross-matched, even when enough rings are obtained.

Converting the date obtained for a tree-ring sequence into a useful date requires a record of the nature of the outermost rings of the sample. If bark or bark-edge survives, a felling date precise to the year or season can be obtained. If no sapwood survives, the date obtained from the sample gives a *terminus post quem* for its use. If some sapwood survives, an estimate for the number of missing rings can be applied to the end-date of the heartwood. This estimate is quite broad and varies by region. This report uses a

minimum of 10 rings and a maximum of 46 rings as a sapwood estimate (see eg English Heritage 1998, 10–11).

Where bark-edge or bark survives, the season of felling can be determined by examining the completeness or otherwise of the terminal ring lying directly under the bark. Complete material can be divided into three major categories:

- 'early spring', where only the initial cells of the new growth have begun – this is equivalent to a period in March/April, when the oaks begin leaf-bud formation;
- 'later spring/summer' where the early wood is evidently complete but the late wood is evidently incomplete, which is equivalent to May-through-September of a normal year, and
- 'winter' where the latewood is evidently complete and this is roughly equivalent to September-to-March (of the following year) since the tree is dormant throughout this period and there is no additional growth put on the trunk.

These categories can overlap as, for example, not all oaks simultaneously initiate leaf-bud formation. It should also be noted that slow growing or compressed material cannot always be safely categorised.

Timber technology studies demonstrate that many of the tool marks recorded on ancient timbers can only have been done on green timber. There is little evidence for long-term storage of timber or of widespread use of seasoned, rather than green, timber in the medieval period (see eg English Heritage 1998, 11–12).

Reused timbers can only provide tree-ring dates for the original usage date, not their reuse. Identifying reused timbers requires careful timber recording which notes the presence of features which are not functional in the structure. It is always possible that some timbers exhibit no evidence of earlier usage, and are thus 'hidden reused' timbers. The dendrochronological impact of this problem is particularly acute where only single timbers have been dated from a structure.

The analysis may highlight potential same-tree identifications if two or more tree-ring sequences are obtained that are exceptionally highly correlated. Such pairs, or sometimes more, are then used as a same-tree group and each can be given the interpreted date of the most complete of the samples. They are most useful where several timbers date but only one has any sapwood or where same-tree identifications yield linkages between different areas.

RESULTS

In July 2008 eight disarticulated oak boards from the 18 North Street panelling were examined at Steve Bellamy's workshop at Feniton. Two of the boards retained labels from a recording system relating to their salvage after the fire, boards 22 and 31. Arbitrary

labels, A–F, were assigned to the rest of the examined boards (Fig 2). Each board was assessed for the wood type, the number of rings it contained, and whether the sequence of ring widths could be reliably resolved. This assessment confirmed that all the boards were oak (*Quercus* spp.) and that three were suitable for dendrochronological analysis. The other five examined boards had either too few rings for analysis or had particularly awkward anatomical problems that could not be resolved along the narrow board edges. There was some survival of sapwood on two of the suitable boards. The details of the eight examined boards are provided in Table 1.

Full or partial edges of each suitable board were prepared for analysis, three board edges were measured and the resultant ring series were compared with each other. The three series were not found to cross-match each other. Each board sequence was then compared with medieval and later tree-ring data from throughout the British Isles and central and northern Europe. The series from board E was found to cross-match against data from sites in the South-West, and West Midlands regions (Table 2). This cross-matching provided consistent calendar dates for the sequence. A summary of the results for this board are provided in Table 1 and Figure 3. The other two individual series failed to provide any consistent dating evidence. The measurement data for the measured boards is listed in Appendix 1.

DISCUSSION

The dated board is derived from the edge of one of the main sections of panelling, from the south wall of the building (Fig 2). A 88-year sequence was obtained from the lower edge of this board. This sequence was dated AD 1476 to AD 1563 inclusive. The correct interpretation of the date relies upon the characteristics of the final rings in the board. No bark-edge survived on this board, but the heartwood/sapwood edge did survive. Making allowance for minimum and maximum likely amounts of missing sapwood provides a felling date range for this board of AD 1573–1609. Figure 3 and Table 1 includes this interpreted felling date range.

The saw marks on the reverse of this board are identical to those on the backs of the eight oak boards on each of the top two rows of this section of panelling. Hence it is quite likely that all of these boards were cut at the same time, and possible that they were derived from a single tree. The building is thought to date from *c* 1600 (Andy Pye pers comm). The date obtained from this board suggests it is reasonable to conclude that this section of panelling was part of the original structure. Furthermore, it is likely that the arabesque paint scheme is also contemporary with the original building. The later botanical paint scheme is thought to date from the later seventeenth century.

All the oak boards are tangentially sawn, relatively fast grown, and exhibit quite twisted grain. These characteristics are typical of English-sourced material, and strongly contrast with the regular straight growth encountered in contemporary groups of imported oak boards.

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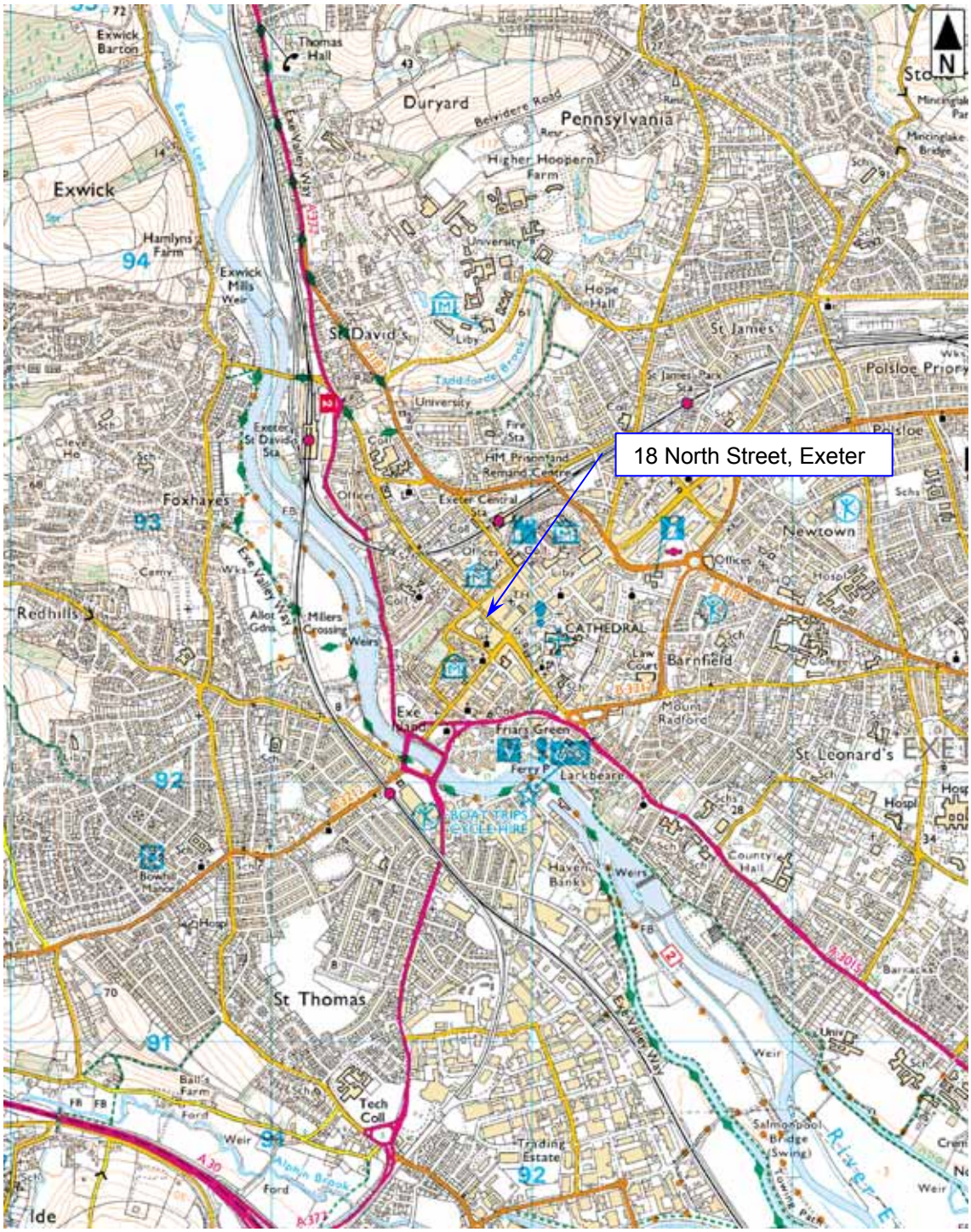

Figure 1. Location of 18 North Street, Exeter. © Crown Copyright. All rights reserved. English Heritage 100019088. 2010

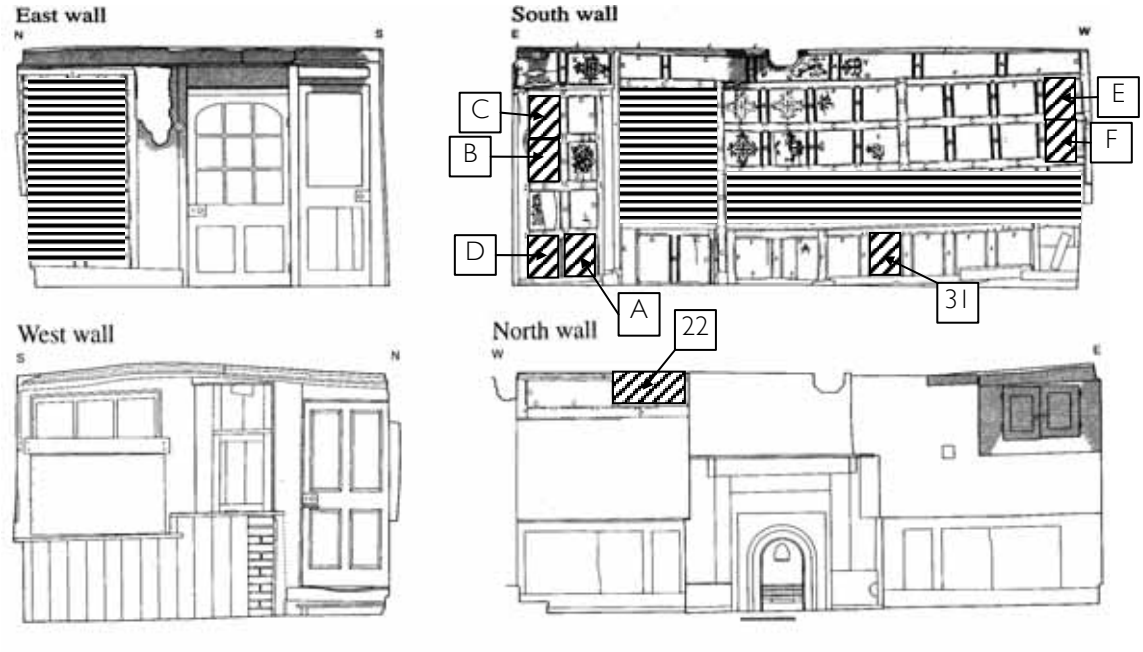

Figure 2. Panels at 18 North Street, Exeter showing the eight accessible oak panels (diagonal stripes), inaccessible oaks (no stripes) and the softwood panels (horizontal stripes); based on drawings by Exeter Archaeology

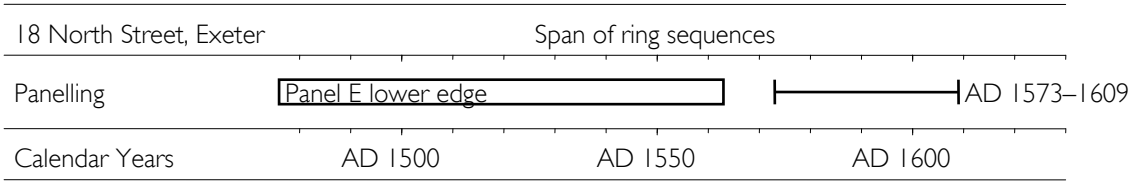

Figure 3. Bar diagram showing the absolute dating position of the dated tree-ring sequence from 18 North Street, Exeter. The interpreted felling date range is also shown

KEY White bar is oak heartwood

Table 1. Details of the accessible oak panels from 18 North Street, Exeter.

Panel	Location	Rings	Sap	Date of measured sequence	Interpreted result
22	North Wall	-	-	not analysed	-
31	South Wall	67	4	not dated	-
A	South Wall Door	-	-	not analysed	-
B	South Wall Door	110	-	not dated	-
C	South Wall Door	-	-	not analysed	-
D	South Wall Door	-	-	not analysed	-
E	South Wall	88	H/S	AD 1476–AD 1563	AD 1573–1609
F	South Wall	-	-	not analysed	-

KEY For locations see Figure 2. H/S is heartwood/sapwood edge.

Table 2. Showing example t-values (Baillie and Pilcher 1973) between the sequence from Panel E from 18 North Street, Exeter and oak reference data.

Reference chronology	18 North St Panel E AD 1476–1563
Avon, Bristol Red Lodge (Tyers 2008a)	5.38
Devon, Berry Pomeroy Castle (Groves and Hillam 1993)	4.98
Devon, Warleigh House Tamerton Foliot (Howard *et al* 2006)	5.10
Gloucestershire, Naas House Lydney (Howard *et al* 1998)	5.00
Herefordshire, The Mynde Much Dewchurch (Nayling 2001)	5.10
Oxfordshire, Upper House Farm Nuffield (Haddon-Reece *et al* 1989)	5.28
Worcestershire, Droitwich Upwich (Groves and Hillam 1997)	5.67
Worcestershire, Hoarstone Farm (Tyers 2008b)	5.02

APPENDIX 1

exp31

115	120	169	325	229	188	232	274	304	411
219	198	291	240	182	212	200	261	350	197
219	198	161	279	219	201	195	172	203	122
110	161	180	168	126	175	205	227	217	178
220	236	266	249	333	274	299	278	227	306
362	379	385	296	314	247	324	290	289	310
329	233	293	184	246	192	164			

exp_B

409	208	315	264	382	250	318	338	273	141
115	134	216	180	179	194	196	145	174	195
223	170	142	194	141	139	173	194	220	189
234	159	172	162	139	151	149	146	209	161
178	106	81	112	110	68	103	115	133	110
149	143	136	220	261	264	259	278	351	426
483	316	320	236	236	193	233	244	358	348
335	314	435	252	349	425	354	374	283	465
270	330	357	284	337	231	238	169	135	114
128	109	154	232	248	168	258	185	237	249
306	409	520	507	388	382	444	261	436	462

exp_E

151	125	114	146	138	161	154	209	247	177
200	190	149	178	294	240	212	318	271	190
364	298	232	152	185	210	277	303	340	277
176	210	233	171	136	148	180	187	314	219
158	141	136	235	159	250	238	224	239	159
227	171	272	229	153	324	227	157	118	233
195	211	283	220	229	275	169	193	152	141
114	120	129	224	239	220	193	156	164	257
149	204	277	193	250	237	302	244		






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