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ABBEY HOUSE, WHITBY ABBEY, WHITBY, NORTH YORKSHIRE

TREE-RING ANALYSIS OF TIMBERS

SCIENTIFIC DATING REPORT

Alison Arnold, Robert Howard, Cliff Litton and Cathy Tyers

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Alison Arnold, Robert Howard, Cliff Litton, and Cathy Tyers

Summary

A total of 27 cores samples was obtained from timbers of Abbey House at Whitby Abbey, North Yorkshire. Twelve of these samples were from pine timbers forming the roof of the main range, while a further ten samples came from pine timbers forming the roof of a short connecting range between the main range and the Banqueting Hall. Five samples were obtained from oak timbers in the ground floor of the main range.

The analysis of these samples produced four pine site chronologies, comprising one group of seven samples and three groups of two samples each. These site chronologies range in length from 63 rings to 135 rings. Despite being compared to an extensive range of reference chronologies for pine none of the pine site chronologies could be dated.

There was no cross-matching between any of the oak samples and attempts to cross-match them individually with oak reference chronologies produced no satisfactory results. This analysis forms part of the on-going dendrochronological research programme on conifer timbers funded by English Heritage.

Keywords

Dendrochronology
Standing Building

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Introduction

The Abbey at Whitby, built, it is believed, upon the site of a possible Roman signal station, was founded in AD 657 by St Hilda, abbess of Hartlepool, following a vow by King Oswy after his victory over Penda, King of Mercia in AD 655. The abbey, which was for men as well as women, soon gained an international reputation, and it was here in AD 664 that the Synod was held at which the two branches of early English Christianity, the Celtic and Roman churches, debated the dating of Easter. The Synod decided in favour of the Roman tradition. This first abbey was destroyed by Danish raiders in AD 867.

The re-establishment of an abbey at Whitby, along with its monastic building, was undertaken in the late-eleventh century during the pilgrimage of Aldwin of Winchcombe, and of Elfwy and Reinfred from Evesham. So great were the numbers of pilgrims visiting the abbey that by the early-thirteenth century the Romanesque church had become inadequate and the building of a new abbey was started. It is the remains of this abbey that now stand as a spectacular ruin, imposing and stark, on its windswept hilltop overlooking the town at the mouth of the river Esk and North Sea below.

Although mostly ruinous, there are a few intact buildings remaining within the abbey grounds. In particular a group to the south-east of the Abbey form what is known as 'Abbey House', which stands, supposedly, on the site of the prior's kitchen (NZ 903 112, Figures 1 and 2). This substantial range was built after the Dissolution of the monasteries by Richard Chomley, between AD 1583 – 93, and rebuilt or remodelled by the first Sir Hugh Chomley between AD 1633 – 6. Between AD 1672 – 82 the second Sir Hugh Chomley added the large Banqueting Hall in front of, or to the north of, the original range. Some time later, the exact date is uncertain, a short cross-wing range was built connecting the original and later buildings at their western ends. Abbey House is Grade I listed building.

Sampling

Sampling and analysis by tree-ring dating of timbers from two ranges of Abbey House were commissioned by English Heritage, the initial purpose of this being to inform listed building consent. These parts of the building have until recently been used by Countrywide Holidays and were undergoing archaeological recording as part of a lottery bid to convert the building into a youth hostel. There are no plans under this scheme for any works to the Banqueting Hall range, and thus no request for tree-ring sampling of timbers in this area. The assessment ascertained that the timbers associated with the roofs of these two ranges were conifers. An English Heritage funded research project is currently investigating the viability of dendrochronological analysis of conifer timbers imported into England. Consequently as the roof timbers were considered a potentially valuable source of data this site was incorporated into the research programme.

Of particular interest to this programme of analysis are the timbers of the east – west orientated main range, and those of the short connecting range at the west end of the main range which link it to the Banqueting Hall. Within the roof of the main range are a series of what appear to be principal rafter with collar trusses (the apexes of the trusses and any common rafters are hidden from view behind or above a closed ceiling), there being at least one purlin, though sometimes two purlins, to each slope. An illustrative example of a truss is given in Figure 3a. These trusses are made of pine (*Pinus* spp.), and given the possibility that they may date to the post-Dissolution construction phase, would represent an unusual example of the early use of such timber in England.

The basement of the main range also contains a small number of oak (*Quercus* spp.) timbers. These too could date to the late-sixteenth century construction phase but there is a

possibility that they might represent the reuse of earlier material from one of the Abbey's construction phases.

Also of interest to this analysis are the roof timbers of the short north – south range connecting the main house and the Banqueting Hall. The roof here comprises four 'half'-trusses, each composed of a single principal rafter supported by a diagonal strut rising from a short 'tiebeam'. The half-trusses are set against a vertical wall at their 'inner' end. An illustration of a truss from this roof is shown in Figure 3b. These timbers are again of pine and are believed to date to some time in the eighteenth century.

From this material a total of 27 core samples were obtained. Each sample obtained was given the code WIT-B (for Whitby, site 'B') and numbered 01 – 27. Twelve samples, WIT-B01 – B12, were obtained from the pine roof of the main range, with a further ten samples, WIT-B13 – B22, being obtained from the pine timbers of the connecting range. Five samples, WIT-B23 – B27, were obtained from the oak timbers of the basement.

The positions of these samples are marked on plans provided by English Heritage or made at the time of sampling. These are reproduced here as Figures 4a – d. All the pine roof timbers appeared to form composite roof-trusses and as such all appeared to be integral to each other, all being jointed and pegged. The oak timbers of the basement, on the other hand, are probably separate timbers, there being no pegged joints visible between them. Details of the samples are given in Table 1. In this Table, all frames or trusses, and individual timbers, are identified and numbered from either north to south, or from east to west, as appropriate.

The Laboratory would like to take this opportunity to particularly thank Craig and Sarah Pattinson, managers of the adjacent Youth Hostel for their help, hospitality, and interest during sampling. We would also like to thank Dr Adam Menuge, Senior Investigator and Team Leader of English Heritage's Yorkshire region who helped interpret the possible phasing of the roofs. Various dendrochronologists from Scandinavia and countries around the Baltic Sea have kindly either carried out cross-dating procedures or made reference data available. Reference data has also been obtained from the International Tree-Ring Data Bank based in Boulder, Colorado, funded by the National Geophysical Data Center (part of the World Data Center). Tim Lawrence (Kew Gardens), Rowena Gale (wood anatomist), and Alex Wiedenhoeft (Center for Wood Anatomy Research, Wisconsin, USA) provided valuable advice concerning the identification of pine species.

Analysis

Each of the 27 samples obtained was prepared by sanding and polishing. It was seen at this time that six samples, WIT-B01, B02, B05, B09, B10, and B13, all pine samples, had less than the minimum of 54 rings required for reliable tree-ring dating and all such short samples were rejected from the programme of analysis. The annual growth-ring widths of the remaining 21 samples were, however, measured, the data of these measurements being given at the end of the report.

The growth-ring widths of all 16 measured pine samples were compared with each other by the Litton/Zainodin grouping procedure (see appendix) in one sub-set programme of analysis, the growth-ring widths of the five measured oak samples being compared with each other as a separate sub-set. The species were analysed separately as the oaks are likely to have been obtained from a local woodland source, where as the pines are likely to have been imported. At a minimum value of t=4.5, four groups of cross-matching pine samples, accounting for 13 measured pine samples, could be formed, (there being no satisfactory cross-matching between any of the oak samples).

The cross-matching samples of each group were then combined at their indicated positions to form site chronologies WITBSQ01 – SQ04. The relative positions of the constituent samples in these four site chronologies are shown in the bar diagrams, Figures 5 – 8. Each pine site chronology was compared with the other three, and with the remaining three measured but ungrouped pine samples. There was, however, no further satisfactory cross-matching.

Taking into account the expected date of the two roofs under investigation, it was anticipated that they were most likely to be imported from northern Europe. Documentary evidence relating to importation of conifers implies that the main range roof timber is likely to be Scandinavian origin where as the connecting range roof is most likely to be either Scandinavian or Baltic region origin (eg Groves 2000; Groves 2004). Each of the four pine site chronologies plus the remaining individual measured but ungrouped pine samples was therefore compared with an extensive range of European pine reference chronologies. There was however, no satisfactory cross-matching. Consequently the site master chronologies were also compared with reference chronologies from Canada and the north-eastern area of the United States of America, but again no consistent conclusive results were obtained. The data from the four site chronologies were sent to various colleagues for further comparisons to be made but, despite these exhaustive checks, no consistent results were obtained for any of the ring sequences, and thus the dendrochronological analysis has been unable to provide precise calendar dates for any of the timbers.

The oak samples were also compared individually with an extensive series of reference chronologies from both the British Isles and, taking into account the presence of imported pine, elsewhere in Europe but again there was no satisfactory cross-matching. These samples must also remain undated.

Conclusion

Analysis by dendrochronology has produced four pine site chronologies, one of seven samples and three of two samples each. Despite being compared to an extensive range of reference chronologies both the pine material from the roofs, and the oak material from the ground floor, remains undated.

Pine samples

The failure to produce reliable dendrochronological dates for any of the pine timbers from either of roofs is clearly disappointing, particularly in the light of the recent successes with various conifer assemblages (Groves 2002; Groves and Locatelli 2005; Arnold *et al* forthcoming). This could be the result of the use of timber from multiple diverse sources but intra-site cross-matching, at least for the connecting range roof, suggests this is unlikely to be the case (see below). Intra-site cross-matching, particularly for the main range roof, is likely to have been adversely affected by the relative shortness of the rings sequences. All samples from this roof have less than 90 rings. A significant percentage of timbers from successfully analysed sites have far more than 100 rings and indeed at 107 Jermyn Street it was noticeable that none of the samples analysed which had less than 100 rings were successfully dated (Groves and Locatelli 2005). The site chronologies produced are all relatively short and none are particularly well-replicated thus reducing the chances of successful dating. However as the conifer research project progresses and reference data becomes more extensive it may prove possible to provide dates for the Whitby Abbey material.

Despite the lack of dating it is noticeable that of the four site chronologies created from the Whitby material, the one with the most samples is made up of entirely of material from the roof of the connecting range. This would suggest that all the timbers used in this element of

Abbey House are from the same locality or woodland. Judging by the similarity of the relative positions of the heartwood/sapwood boundaries it is likely that these timbers were all felled at the same time, and that this roof is, as might be suspected from the structural evidence, of one phase of construction.

The material from the main range produces less satisfactory internal cross-matching, with three groups of two samples each being formed of this material. As noted above this could possibly be due to the samples from this roof having low numbers of rings (Table 1). This prevents the dendrochronological analysis confirming or refuting whether the timbers used represent a single phase of construction.

Whilst there are clear differences between the groups of pine timbers of the two roofs which could be taken as further evidence that they do indeed represent different phases of construction, the lack of conclusive dating evidence means that, from a dendrochronological perspective, this remains unproven.

Oak samples

The lack of cross-matching and dating amongst the oak timbers is again possibly due in some cases to low numbers of rings, and also, according to the actual date of the material, possibly due to insufficient relevant reference material. Given that there is little evidence for jointing between some of these timbers, and that they are possibly reused, it is possible that each timber has a different felling date and is from a different place. While single samples can on occasion be dated individually, it is often more difficult than with a group of cross-matching timbers where the data is well replicated.

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Table 1: Details of samples from Whitby Abbey, Whitby, North Yorkshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date	Last heartwood ring date	Last measured ring date
	Main range roof timbers (pine)					
WIT-B01	East principal rafter, truss 3	nm	---	------	------	------
WIT-B02	West principal rafter, truss 3	nm	---	------	------	------
WIT-B03	Collar, truss 3	71	h/s	------	------	------
WIT-B04	West purlin, truss 3 – 4	84	h/s	------	------	------
WIT-B05	East purlin, truss 3 – 4	nm	---	------	------	------
WIT-B06	East principal rafter, truss 2	63	h/s	------	------	------
WIT-B07	Collar, truss 2	62	h/s	------	------	------
WIT-B08	East purlin, truss 1 – 2	64	h/s	------	------	------
WIT-B09	West purlin, truss 2 – 3	nm	---	------	------	------
WIT-B10	West principal rafter, truss 5	nm	---	------	------	------
WIT-B11	West purlin, truss 4 – 5	63	h/s	------	------	------
WIT-B12	West purlin, truss 6 – 7	87	h/s	------	------	------
	Connecting range roof timbers (pine)					
WIT-B13	Strut, truss 1	nm	---	------	------	------
WIT-B14	Principal rafter, truss 1	100	h/s	------	------	------
WIT-B15	Purlin, truss 1 – 2	127	h/s	------	------	------
WIT-B16	Strut, truss 2	114	h/s	------	------	------
WIT-B17	Principal rafter, truss 2	116	h/s	------	------	------
WIT-B18	Purlin, truss 3 – 4	126	h/s	------	------	------

Table 1: continued

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date	Last heartwood ring date	Last measured ring date
	Connecting range roof continued					
WIT-B19	Principal rafter, truss 3	113	no h/s	------	------	------
WIT-B20	Strut, truss 3	100	h/s	------	------	------
WIT-B21	Principal rafter, truss 4	63	no h/s	------	------	------
WIT-B22	Strut, truss 4	79	no h/s	------	------	------
	Main range ground-floor timbers (oak)					
WIT-B23	East wall plate	87	22	------	------	------
WIT-B24	West wall plate	73	21	------	------	------
WIT-B25	North west corner post	105	h/s	------	------	------
WIT-B26	West support post	62	h/s	------	------	------
WIT-B27	Central bridging beam	139	11	------	------	------

* h/s = the heartwood sapwood boundary is the last ring on the sample
nm = sample not measured