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HIGH LATHE
KILNSEY
NORTH YORKSHIRE

TREE-RING ANALYSIS OF TIMBERS

Alison Arnold and Robert Howard

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NTRDL, 20 Hillcrest Grove, Sherwood, Nottinghamshire NG5 1FT
Telephone 0115 960 3833 (office); 07913 427987 (mobile)

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ROBERT HOWARD

SUMMARY

Analysis by dendrochronology of samples from the two remaining historic timbers to the outshot of this barn resulted in both cross-matching with each other to produce a single site chronology. This site chronology, KLNCSQ01, is 165 rings long, these rings dated as spanning the years 1255–1419.

Interpretation of the sapwood on the samples suggest that the source tree (both timbers probably being derived from a single tree) was felled at some point between 1430 at the earliest and 1455 at the latest.

NTRDL, 20 Hillcrest Grove, Sherwood, Nottingham, NG5 1FT
Telephone 0115 960 3833 (laboratory);
07980 305583 / 07913 427987 (Mobiles)
roberthoward@tree-ringdating.co.uk
alisonarnold@tree-ringdating.co.uk

Introduction

This large barn is found to the south of Kilnsey by about one mile, at the far end of the farm yard off to the west side of the B6160 (SD 9762 6642, Fig 1a/b). It stands with a set of large central doors facing southeast. The roof to the main body of the barn is of typical nineteenth century form with softwood trusses of tiebeams and principal rafters to which rise diagonal braces from shouldered kingposts. Both pitches of the roof contain some double oak purlins between the trusses, these almost certainly be reused timbers.

To the front of the barn there are two cat-slide roofed out-shots of different dimensions, one either side of the central doors, and each probably of different date; there is a further near full-height extension attached to the east gable of the barn. Of these portions of the barn, only the east outshot (to the right-hand side of the central doors as viewed from the front) contains any historic timbers with potential for tree-ring analysis, with two large timbers being reused here as purlins to the cat-slide roof.

Sampling

Currently in private ownership, sampling and analysis by dendrochronology of the timbers within High Lathe were commissioned and generously funded by the Upper Wharfedale Heritage Group. It was hoped that tree-ring analysis might more accurately and reliably determine the date of the timbers, demonstrate their potential antiquity, and place their original felling more firmly in the development of the historical landscape, a number of other buildings in the area having also being surveyed and dated by dendrochronology.

Thus, core samples were obtained from the two timbers available to this outshot. Each sample was given the tree-ring code KLN-C (for Kilnsey, site 'C'), and numbered 01 and 02. Details of the samples are given in Table 1, including the timber sampled, the total number of rings each sample has, and how many of these, if any, are sapwood rings. The individual date span of each dated sample is also given. The sampled timbers are located on an annotated photograph shown here as figure 2. In this report the front of the barn is taken to be facing 'site south', its gables being to site 'east' and site 'west'.

The Nottingham Tree-ring Dating Laboratory would firstly like to thank the owner of High Lathe, Nick Carlisle, for his interest in and cooperation with this programme of dating. We would also like to thank the Upper Wharfedale Heritage Group for commissioning and entirely funding this programme of tree-ring analysis, for arranging access to the barn, and for their considerable help during sampling, appreciation particularly due to Alison Armstrong and Philip and Patricia Carroll. We would also like to thank the UWHG for providing their survey report from which the introductory information above is taken, and for the use of their plans and cross-sections elsewhere in this report.

Tree-ring dating

Tree-ring dating relies on a few simple, but quite fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees, the timber most commonly used in building construction until the introduction of pine from the late eighteenth century onwards) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March–September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically influenced pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way (see Fig 3).

Secondly, because the weather over a certain number of consecutive years (the statistically reliable minimum calculated as being 54 years) is unique, so too is the growth-ring pattern of the tree. The pattern of a shorter period of growth, 20, 30, or even 40 consecutive years, might conceivably be repeated two or even three times in the last one thousand years, and is considered less reliable. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 45 years or so. In essence, a short period of growth, anything less than 45 rings, is not reliable, and the longer the period of time under comparison the better.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimetre. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which is known. When the growth-ring sequence of a sample 'cross-matches' repeatedly at the same date span against a series of different reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference, is denoted by a '*t*-value'; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of samples and references have been produced by growing under the same conditions *at the same time*. The statistically accepted fully reliable minimum *t*-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phase of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a 'site chronology'. As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for reliable dating.

Having obtained a date for the site chronology as a whole, the date spans of the constituent individual samples can then be found, and from this the felling date of the trees represented may be calculated. Where a sample retains complete sapwood, that is, it has the last or outermost ring produced by the tree before it was cut, the last measured ring date is the felling date of the tree.

Where the sapwood is not complete it is necessary to estimate the likely felling date of the tree. Such an estimate can be made with a high degree of reliability because oak trees generally have between 15 to 40 sapwood rings. For example, if a sample with, say, 12 sapwood rings has a last sapwood ring date of 1400 (and therefore a heartwood/sapwood boundary ring date of 1388), it is 95% certain that the tree represented was felled sometime between 1403 (1400+3 sapwood rings (12+3=15)) and 1428 (1400+28 sapwood rings (12+28=40)).

Analysis

The samples obtained from the two timbers of High Lathe were prepared by sanding and polishing, and the widths of their annual growth rings were measured. The data of these measurements were then compared with each other as described in the notes above, this comparative process indicating that the two samples cross-matched with each other at positions as shown in the bar diagram, Figure 4.

The two cross-matching samples were combined at their indicated off-set positions to form site chronology KLNCSQ01, this having an overall length of 165 rings. Site chronology KLNCSQ01 was then compared with the full corpus of reference chronologies for oak, this indicating a repeated and consistent series of cross-matches with a large number of reference chronologies when the date of its first ring is 1255 and the date of its last ring is 1419 (see Table 2).

Interpretation

Neither of the two dated samples retains sapwood complete to the bark, and it is thus not possible to reliably say precisely when the timber was cut. Both samples do, though, retain the heartwood/sapwood boundary, this meaning that although each sample has lost all its sapwood rings, it is *only* the sapwood that has been lost.

The average heartwood/sapwood boundary ring on these two samples is dated 1415. Allowing for the usual 95% probability range for the number of sapwood rings on oak trees (15–40 rings), this would give the timbers an estimated felling date between 1430 at the earliest and 1455 at the latest. Indeed, given the cross-match between the samples, with a value of t=11.6, it is very likely that both beams have been derived from a single tree.

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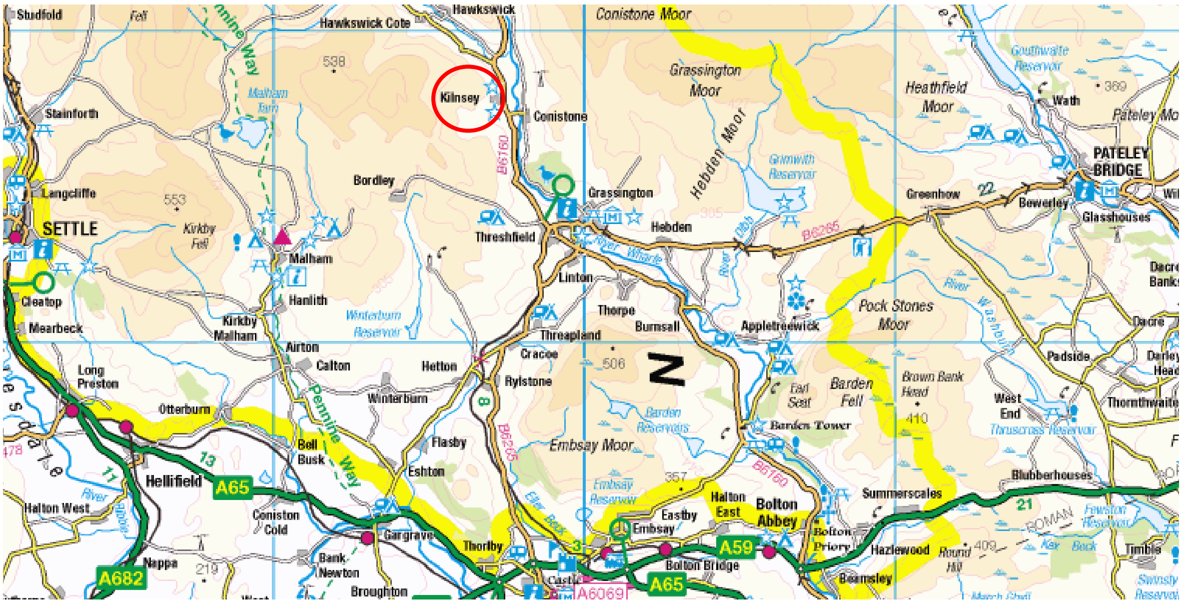
Table 1: Details of tree-ring samples from High Lathe, Kilnsey, North Yorkshire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
KLN-C01	Lower purlin	154	3	1266	1416	1419
KLN-C02	Upper purlin	160	h/s	1255	1414	1414

h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing

Table 2: Results of the cross-matching of site chronology KLNCSQ01 and the reference chronologies when the first ring date is 1255 and the last ring date is 1419		
Reference chronology	*t*-value	
Green Farm, Anstey, Leicestershire	5.7	(Alcock *et al* 1990)
Rose & Green Cottage, Hognaston, Derbyshire	5.6	(Arnold and Howard 2009 unpubl)
Church of St James, Bristol	5.3	(Arnold and Howard 2011)
Cobham Hall, Cobham, Kent	4.9	(Arnold *et al* 2003)
College House, Oakham School, Rutland	4.7	(Howard *et al* 1999)
Bilby Bridge, Bilby, Nottinghamshire	4.6	(Howard *et al* 1985)
The Granary, Bradford on Avon, Wiltshire	4.5	(Howard *et al* 1994)
Tithe Barn, Ashleworth, Gloucestershire	4.5	(Bridge 2002)

Site chronology KLNCSQ01 is a composite of the data of the two cross-matching samples as seen in the bar diagram below. The composite data produces an 'average' tree-ring pattern, where the possible erratic variations of any one individual sample are reduced and the overall climatic signal of the group is enhanced. This 'average' site chronology is then compared with several hundred reference patterns covering every part of Britain for all time periods, cross-matching with a number of these only at the date spans indicated. Table 2 give only a small selection of the very best matches as represented by '*t*-values' (ie, degrees of similarity). It may be noticed from this that the resultant *t*-values are well in excess of the *t*=3.5 value usually taken as the minimum acceptable level for satisfactory dating.



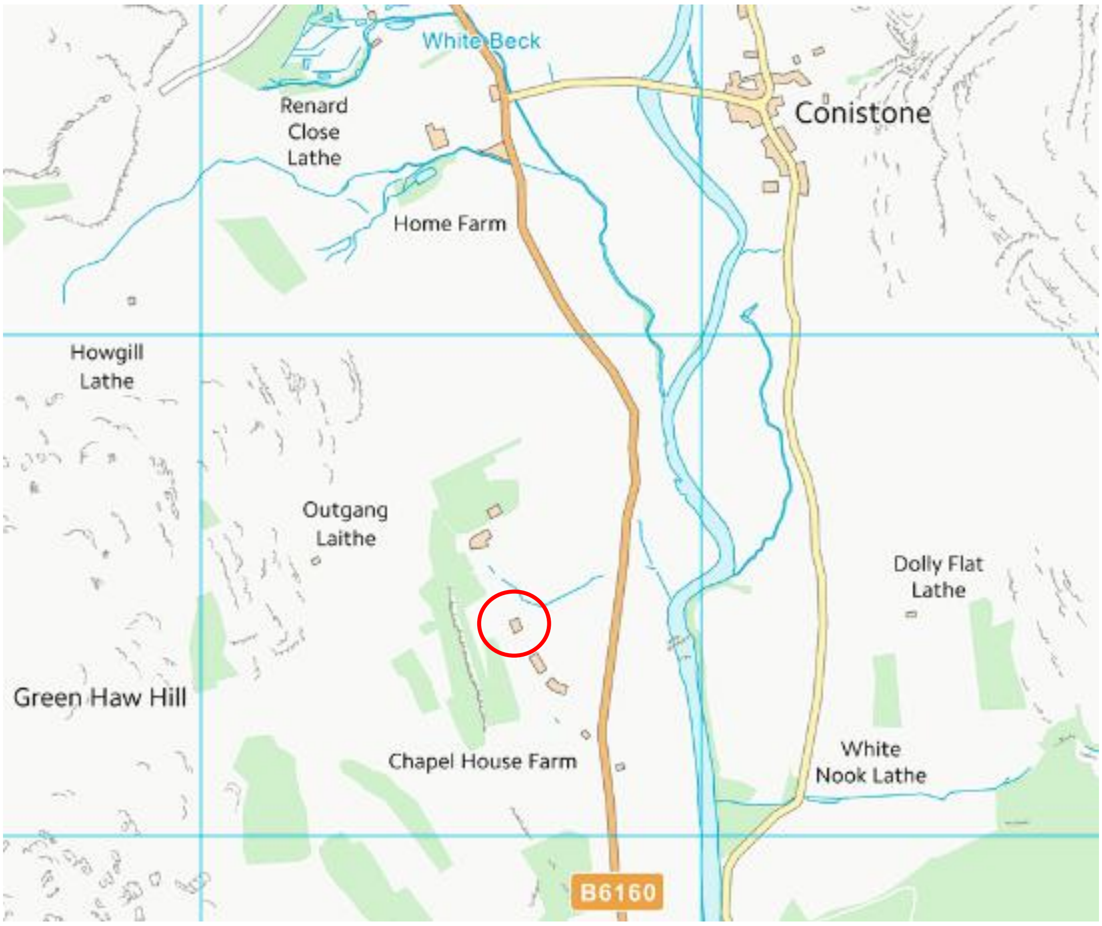
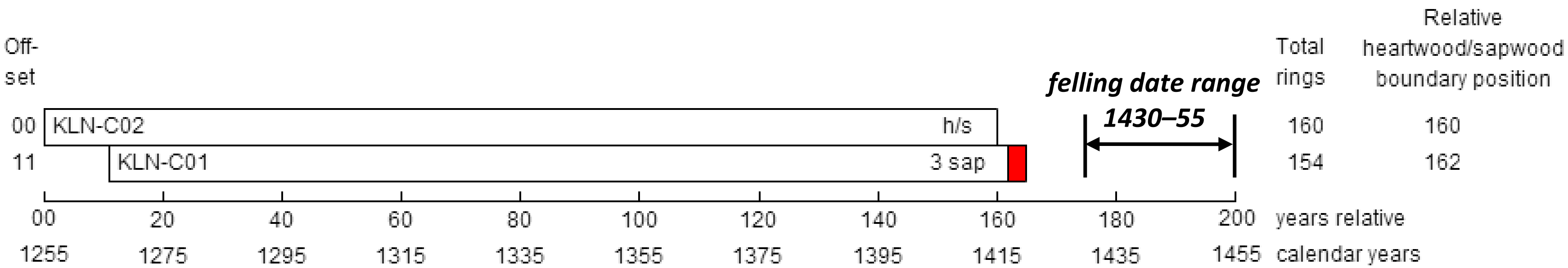


Figure 1a/b: Maps to show the location of Kilnsey (top) and High Lathe (bottom)

Figure 2: Annotated photograph to help identify sampled timbers

Figure 3: Graphic representation of the cross-matching of samples KLN-C01 and C02

When cross-matched at the correct positions, as here, the variations in the rings of these two samples (where they overlap) correspond with a high degree of similarity. As the ring widths of one sample increase (represented by peaks in the graph), or decrease (represented by troughs), so too do the annual ring widths of the second sample. This similarity in growth pattern is usually a result of trees having grown at the *same time* in the *same place.* In this case, however, it is likely that the two sampled beams have in fact been derived from a single tree. In any case, the growth-ring pattern of two samples from trees grown at different times would never correspond so well.



blank bars = heartwood rings, shaded bars = sapwood rings
h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing

Figure 4: Bar diagram of the samples in site chronology KLNCSQ01

The two samples of site chronology KLNCSQ01 are shown above in the form of bars at positions where their ring variations cross-match with each other. In this case the similarity is because the two sampled beams have come from the same tree. The samples are combined to form a 'site chronology', which is dated by comparison with the 'reference' chronologies (see Table 2).