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RENARD CLOSE LATHE
KILNSEY
NORTH YORKSHIRE

TREE-RING ANALYSIS OF TIMBERS

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SUMMARY

Analysis by dendrochronology of cores samples from seven timbers to this building demonstrates that timbers with different felling dates are to be found here.

The earliest timber is represented by the west principal rafter of truss 1. Having a last heartwood ring date of 1436 and no heartwood/sapwood boundary, it is unlikely to have been felled before 1451, but is probably not later than, say, the late-sixteenth century.

The next felling is represented by the tiebeam of truss 2. This sample has a heartwood/sapwood boundary ring date of 1573 giving the timber an estimated felling date of between 1588 at the earliest and 1613 at the latest.

A further felling is represented by the west principal rafter of truss 2. The sample has a heartwood/sapwood boundary date of 1620, giving this timber an estimated felling date of between 1635 at the earliest and 1660 at the latest.

An approximately similar felling is represented in the west lower purlin between truss 1 and the north gable. This sample has a complete sapwood ring, and thus a felling date, of 1664.

The latest phase of felling is represented by the west upper purlin between truss 1 and the north gable. This timber has an estimated felling date of between 1717 at the earliest and 1742 at the latest.

Two samples, KLN-D03 and D05 remain ungrouped and undated.

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Introduction

Renard Close Lathe stands isolated in fields up the valley slope westwards of Kilnsey, close to Sikes Beck (SD 9712 6746, Fig 1a/b). Its single main door facing site north, it comprises a three-bay structure of two tiebeam-with-principal rafter trusses, these supporting double purlins to each pitch of the roof. The building has been surveyed and recorded by the Upper Wharfedale Heritage Group (Fig 2a/b).

Sampling

Currently in private ownership, sampling and analysis by dendrochronology of the timbers within Renard Close 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, from the timbers available, a total of seven samples was obtained by coring. Each sample was given the tree-ring code KLN-D (for Kilnsey, site 'D'), and numbered 01–07. 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 3. In this report the barn is taken to be lying site east–west, with one long side containing the main door facing site north, the other long side facing site south.

The Nottingham Tree-ring Dating Laboratory would firstly like to thank the owner of Renard Close Lathe, Jamie Roberts, for his interest, cooperation, and help with this programme of dating. We would also like to thank the Upper Wharfedale Heritage Group for commissioning and generously 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.

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

Each of the seven samples obtained from the various timbers of Renard Close 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 indicated, however, that unusually there was no cross-matching between any of the samples (it usually being the case that a number of samples will match with each other to form a site chronology).

All seven samples were, therefore, compared individually with the full corpus of reference material for oak, this giving cross-matches and dates for five of these as listed in Tables 2-6.

Interpretation

Interpretation of the results for the five dated samples from Renard Close Lathe suggests that timbers were felled at different times.

The earliest timber appears to be represented by sample KLN-D04 from the west principal rafter of truss 1. This sample has a last ring date of 1436, but it does not retain the heartwood/sapwood boundary, and it is thus not possible to calculate a felling date range with reliability. This is because not only has it lost all its sapwood rings, but an unknown number of heartwood rings as well, and it is possible that the tree went on growing for many years after the sample's last extant heartwood ring date.

What might be speculated is that, allowing for a minimum of 15 sapwood rings (the lower limit of the 95% confidence figure), it is unlikely that the tree was felled before 1451, and if it did not go on growing to an exceptionally old age, ie, not more than 200 years, that it was not felled later than the late-sixteenth century. This is as suggested, however, speculation.

The next felling is represented by sample KLN-D07 from the tiebeam of truss 2. This sample has a last ring date of 1573, this ring being at the heartwood/sapwood boundary. Using a minimum/maximum figure of 15-40 sapwood rings (the 95% confidence interval) this would give the timber an estimated felling date of between 1588 at the earliest and 1613 at the latest.

A further felling is represented by sample KLN-D06 from the west principal rafter, truss 2. This sample has a last ring date of 1620, this ring also being at the heartwood/sapwood boundary. Using the same sapwood estimate as above, 15-40 rings, would give this timber an estimated felling date of between 1635 at the earliest and 1660 at the latest.

An approximately similar felling is represented by sample KLN-D01 from the west lower purlin from truss 1 to the north gable. Given that this sample retains complete sapwood, it has the last ring produced by the tree before it was felled. In this case this last ring, and thus the felling of the tree, is dated 1664. It is thus possible that the west principal rafter of truss 2, represented by sample KLN-D06, was felled at, or about, this time too, but it would have required a few more sapwood rings than usual.

The latest phase of felling is represented by sample KLN-D02 from the west upper purlin, truss 1 to north gable. This sample has a last ring date of 1705 and, with 3 sapwood rings, a heartwood/sapwood boundary date of 1702. Using the same sapwood estimate as above, 15-40 rings, would give this timber an estimated felling date of between 1717 at the earliest and 1742 at the latest.

This analysis and interpretation may be summarised thus:

Sample	**location**	**h/s or last ring**	**Felling date**
KLN-D04	W principal rafter truss 1	1436	Not before 1451
KLN-D07	Tiebeam truss 2	1573	1588-1613
KLN-D06	W principal rafter truss 2	1620	1635-60
KLN-D01	W lower purlin truss-N gable	1626/1664	1664
KLN-D02	W upper purlin truss-N gable	1702/1705	1717-42

The date-span and relationship of each individually dated sample, and the spread of felling dates, is illustrated in the bar diagram, Figure 4.

Conclusion

Analysis by dendrochronology of timbers to Renard Close Lathe has, therefore, shown that timbers of different phases of felling are to be found here. It is possible that one timber was felled at any time between the mid-fifteenth to later-sixteenth, while a second timber was felled in the later-sixteenth to early-seventeenth century. Two other timbers were felled in the mid- to later-seventeenth century (just possibly at the same time as each other), while the latest felling is dated to the earlier-eighteenth century.

Undated samples

Two samples, KLN-D03 and D05, remain ungrouped and undated. As may be seen from Table 1, both samples have sufficient numbers of rings for reliable dating, and neither sample shows any problems such as complacency, or compaction or distortion. The reason for the lack of dating is unknown, though it is a common feature of most programmes of tree-ring analysis to have some samples which remain undated often for no apparent reason.

Table 1: Details of tree-ring samples from Renard Close 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-D01	North lower purlin, truss 1 to east gable	122	38C	1543	1626	1664
KLN-D02	North upper purlin, truss 1 to east gable	45	3	1661	1702	1705
KLN-D03	Tiebeam, truss 1	82	h/s	------	------	------
KLN-D04	North principal, truss 1	62	no h/s	1375	------	1436
KLN-D05	South principal rafter, truss 2	58	no h/s	------	------	------
KLN-D06	North principal rafter, truss 2	70	h/s	1551	1620	1620
KLN-D07	Tiebeam, truss 2	85	h/s	1489	1573	1573

C = complete sapwood is retained on the sample; the last measured ring date is the felling date of the tree represented

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

Table 2: Results of the cross-matching of sample KLN-D04 and the reference chronologies when its first ring date is 1375 and its last ring date is 1436	
Reference chronology	*t*-value
Brockworth Court, Gloucestershire	6.3
Wenham Manor, Rogate, Sussex	5.8
Stuffenwood Farm, Shirebrook, Derbyshire	5.7
Hightown, Hereford	5.2
Pockerley Farm, Beamish, County Durham	5.1
Hambledon Church, Hampshire	5.1
Village Hall, Cradely, Worcestershire	4.9
Abbott's House, Ledbury, Herefordshire	4.8

Table 3: Results of the cross-matching of sample KLN-D07 and the reference chronologies when its first ring date is 1489 and its last ring date is 1573	
Reference chronology	*t*-value
Ling Bob, Horseforth, West Yorkshire	6.1
Old Hall, West Aukland, County Durham	5.6
Old Durham Farm, Durham	5.5
Tithe barn, Sandiacre, Derbyshire	5.4
Cannon's Garth, Helmsley, North Yorkshire	5.4
40 - 44 Castlegate, Newark, Nottinghamshire	5.3
Ulnaby Hall, Darlington, County Durham	5.2
Bramall Hall, Stockport, Cheshire	4.9

Table 4: Results of the cross-matching of sample KLN-D06 and the reference chronologies when its first ring date is 1551 and its last ring date is 1620	
Reference chronology	*t*-value
Bolsover Castle, Bolsover, Derbyshire	6.1
Brewhouse Yard Museum, Nottingham	5.2
Market Hall, Ledbury, Herefordshire	5.2
Staircase House, Stockport, Cheshire	5.1
Home Farm, Newdigate, Surrey	5.1
17 St Mary's Chare, Hexham, Northumberland	5.0
Raw End Barn, Calderdale, West Yorkshire	5.0
Hungry Bentley Hall, Derbyshire	5.0

Table 5: Results of the cross-matching of sample KLN-D01 and the reference chronologies when its first ring date is 1543 and its last ring date is 1664	
Reference chronology	*t*-value
Manor House Farm, Langcliffe, North Yorkshire	6.8
Manor House, Nether Poppleton, West Yorkshire	5.3
Staircase House, Stockport, Cheshire	5.2
Fell Close, Healeyfield, County Durham	5.1
Tithe barn, Sandiacre, Derbyshire	5.0
Old Hall, West Aukland, County Durham	4.8
Clumpcliff, Oulton, West Yorkshire	4.8
Sutton Scarsdale Hall, Derbyshire	4.6

Table 6: Results of the cross-matching of sample KLN-D02 and the reference chronologies when its first ring date is 1661 and its last ring date is 1705	
Reference chronology	*t*-value
Barn, Ragnall, Nottinghamshire	5.2
6-12 Chain Lane, Newark, Nottinghamshire	4.9
Worcester Cathedral composite chronology	4.9
Croom Park, Upton on Severn, Worcestershire	4.8
Bradgate Trees, Bradgate, Leicestershire	4.8
Hartlebury Castle, Stourport on Severn, Worcestershire	4.5
Old Barn, Stratford on Avon, Warwickshire	4.5

Each sample has been compared individually with the full corpus of reference material for oak, each sample cross-matching with a number of these only at the dates spans shown. Tables 2–6 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.

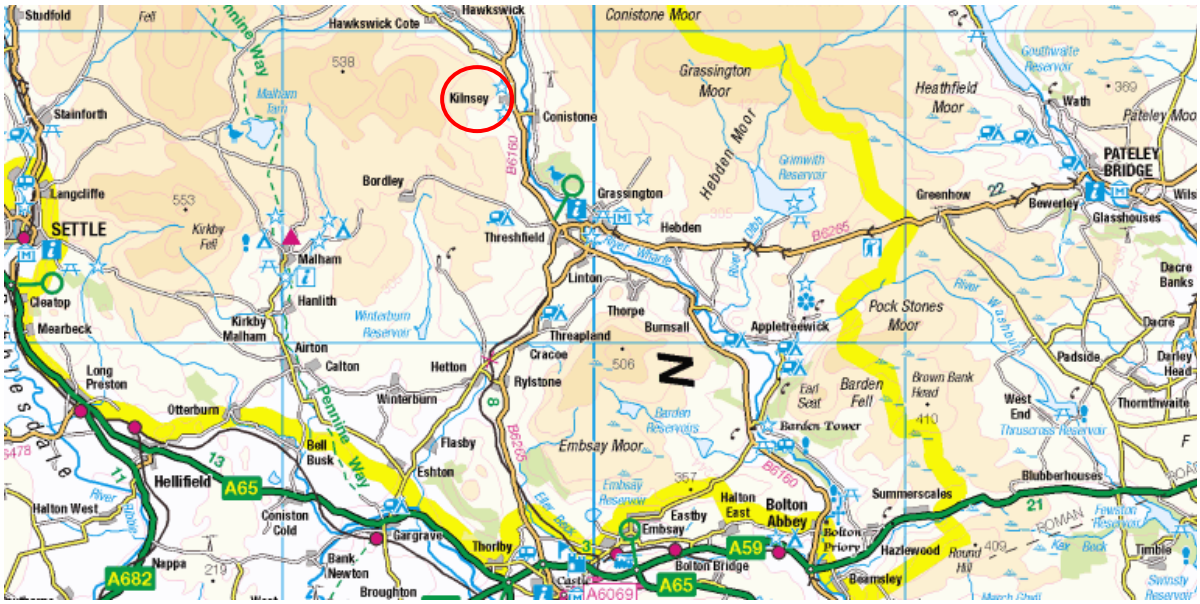


Figure 1a/b: Maps to show the location of Kilnsey (top) and Renard Close Lathe (bottom)

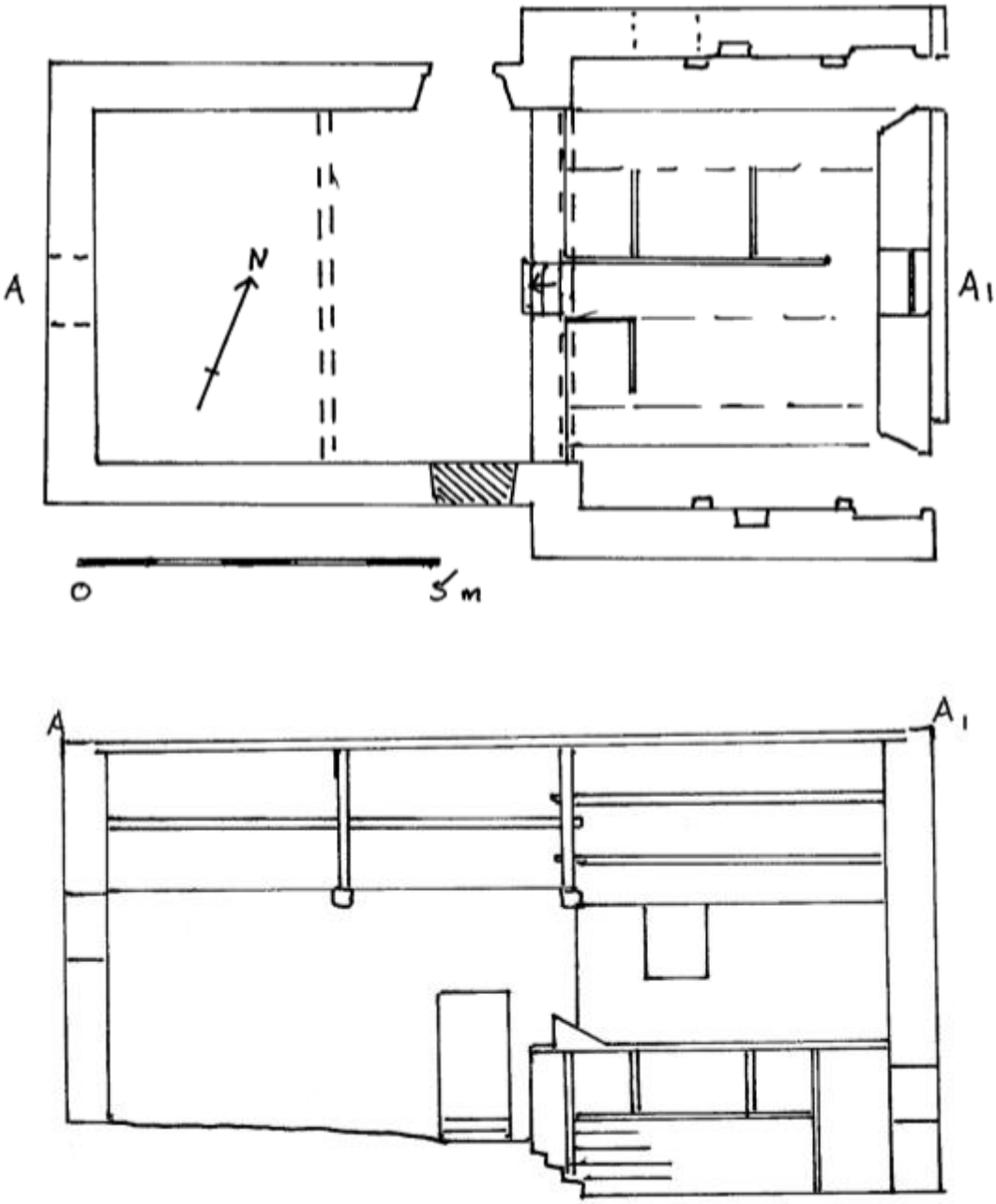


Figure 2a/b: Plan and long section through Renard Close Lathe (after Upper Wharfedale Heritage Group survey)

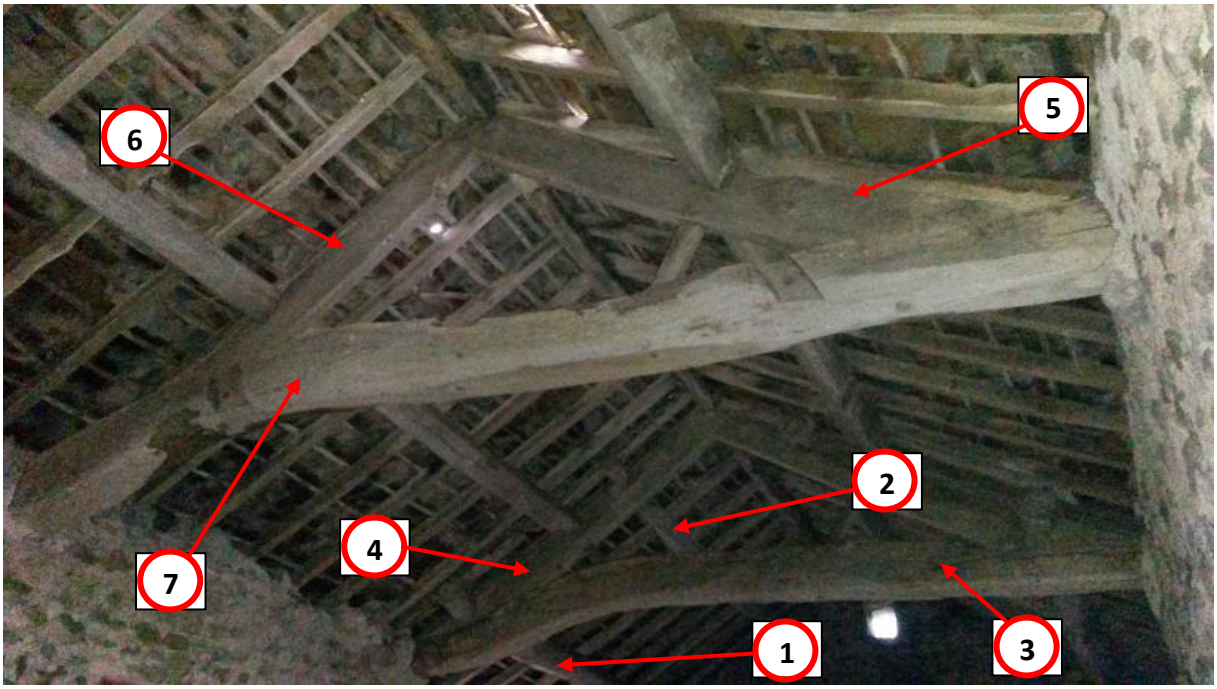
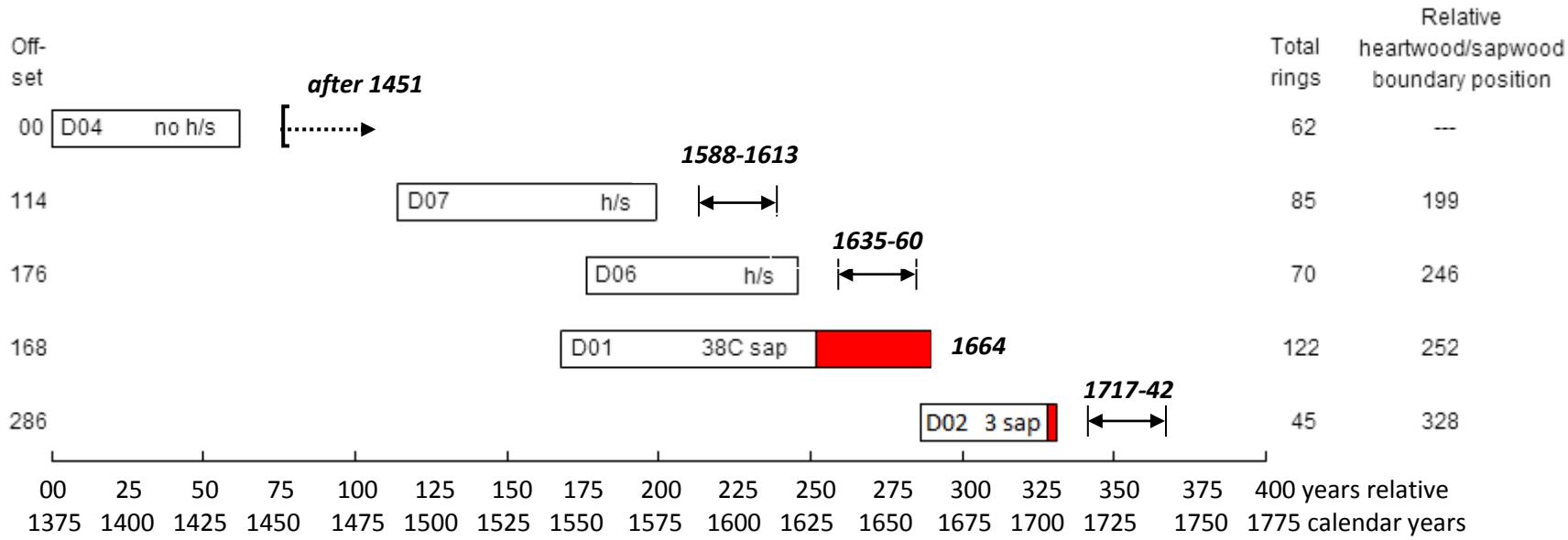


Figure 3: Views of the trusses to help locate sampled timbers (see Table 1)



blank bars = heartwood rings, shaded bars = sapwood rings
h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing
C = complete sapwood is retained on the sample; the last measured ring date is the felling date of the tree represented

Figure 4: Bar diagram of the individually dated samples in last measured ring date order

The five individually dated samples are shown in the form of bars to illustrate the date-span of each individual sample and the spread of felling dates represented. It clearly illustrates that the barn at Renard Close uses, or re-uses, timbers which were felled at different times. It is unlikely that the timber represented by sample KLN-D04 was felled before 1451, while the timber represented by D07 could have been felled as late as 1742. The timber represented by KLN-D01 was certainly felled in 1664, with D06 being a timber felled slightly earlier. The timber represented by sample KLN-D07 was felled at some point between the late-sixteenth and early-seventeenth century.