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Dendrochronology, timber analysis, and historic building consultants

DRONFIELD WOODHOUSE HALL,
CARR LANE,
DRONFIELD WOODHOUSE,
DERBYSHIRE;
TREE-RING ANALYSIS OF TIMBERS

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SUMMARY

Six core samples were obtained from the timbers to the roof and the single remaining cruck truss within the former two-bay hall range at Dronfield Woodhouse Hall. Analysis by dendrochronology of these cores has resulted in the production of a single dated site chronology comprising five samples. This site chronology is 192 rings long, these rings dated as spanning the years 1342–1533. Interpretation of the sapwood on the samples would indicate that all the dated timbers were cut as part of a single programme of felling in 1533.

One sample, from a brace between the northern cruck blade and the north purlin, remains ungrouped and undated. Although it cannot be proven by tree-ring analysis, it is possible that this timber is a later insertion, such a possibility also being inferred by the structural evidence of the joint between the timbers here. The fact that the timber has not dated to the 1533 phase, however, does not mean that it is certainly of a different date.

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Introduction

Dronfield Woodhouse Hall, a one-time farmhouse, stands to the south side of Carr Lane, the B6056 (SK 329 785, Figs 1a/b). It is listed as Grade II*, being described as 'Hall Farmhouse' with attached boundary walls (formerly listed Nos 181 and 183). The listing, used here directly, describes the house as being of late-sixteenth century date, with extensive remodeling in the early-eighteenth century, and having nineteenth and twentieth century alterations.

The listing also states that the house is constructed of coursed squared coal measures sandstone rising from a shallow plinth. It has ashlar gable and ridge chimney stacks, coped gables with moulded kneelers, and a stone slated roof. It is of Irregular plan (see Fig 2), with an entrance lobby to the centre onto the main central stack. There is a central range with gabled ranges at either end, that to the south west end being advanced or set forward. The ranges are of two stories with attics, the main range being five bays in length, with two doorways to the central range. The north-east doorway is the earlier, with quoined surround, and a massive lintel, the doorway to the south-west set within a seventeenth century offshut or bay of stone, now part-rendered. To the right of the doorway there are two single lights, one pointed, and above, a flat headed opening. There is a third doorway with a quoined surround and twentieth century half glazed door on the north-east wall of the south-west wing.

The gable of the north-east wing has two 2-light recessed chamfer mullioned windows below dripmoulds to the ground floor, a 3-light window to the first floor, and a small blocked light to the apex. The advanced gable has stacked 4-light chamfer mullioned windows to ground and first floors, and former 3-light window to attic, now with a single mullion repositioned to the centre. There is an inserted 2-light window to the left of the ground floor window, with flush surround and a chamfer mullion. The rear elevation has a gabled range to the south-west end with early-eighteenth century remodeling of two bays, with stacked 2-light flush mullioned windows with transoms, the heads being linked by continuous bands. There is also a 2-light mullioned window to the attic.

The two-bay central range has tall, nineteenth century, windows beneath plain lintels flanking a seventeenth century doorway with massive chamfered lintel and quoined surround. There is also a twentieth century planked door.

The gable range to north east end has stacked 4-light chamfer mullioned windows and a 2-light, seventeenth century, mullioned window to the left to light stair landing. There is a blocked and mutilated seventeenth century single-light window to the right, now obscured by a twentieth century 2-light inserted window.

Attached walls enclose the rear garden, this having an outer skin of coursed sandstone and an inner skin of brick. The doorway to centre of the south-east wall has ashlar quoining and projecting keyblock to flat head, the doorway itself now being blocked. A second doorway towards the north-west end has a quoined surround and a four-panel door.

Within the house, there is a single cruck truss to the central range (here designated truss 2, plus a few other, roof, timbers, Figs 3a/b). The house also has an eighteenth century plaster

ceiling to the ground floor room with a central inset panel, formerly with circular embellishment to middle, the inset panel delineated by modillions. The wall paneling to this room is also of plaster. A second ground floor room has eighteenth century plaster paneling and paneled doors. There is an eighteenth century splat baluster stair, with polygonal finials to the newel posts and moulded handrail. A close-studded wall incorporating two doorways is found to a ground floor room of the north-east range, this also having a massive hearth with segmental stone arch, there being smaller segmental headed doorways to either side.

Surveys undertaken by buildings archaeologist Stanley Jones (1990 & 2008) have revealed four principal building phases. The first phase shows the house to have originated as a linear-planned timber-framed cruck structure of at least 4 bays, and probably late-medieval in date. Two central bays had formed an open hall. Of the original cruck trusses that divided the long medieval range only one (truss 2, Fig 2), a partition truss at the west end of the former two bay hall, has survived. The apex of the truss, from the upper tie-beam to the saddle into which the blades are tenoned, was solidly in-filled as a stave and daub panel. The saddle carried a square-set ridge-piece.

The second phase, dated to about 1650, is marked by the replacement of the original side walls by coal measure sandstones with gritstone dressings and the insertion of a large chimney-stack or new fire hood; a baffle or lobby entrance was made on the north side of the hood or stack.

There were then major improvements to the main range in the third phase, dated about 1690-1700, with the rebuilding of the western bay as a high-ceiled parlour above a cellar, with parlour chamber, attic, and a new stair.

The fourth phase saw the rebuilding of the south side of the hall to a level well above the former eaves. A central doorway leading directly into the centre of the hall with identical flanking windows at ground and upper levels was created. This phase probably dates to the first half of the nineteenth century.

Sampling

Sampling and analysis by tree-ring dating of the remaining timbers to the central two-bay hall range of the main body of the house were commissioned by the owners Drs Hal Spencer and Ruth Dils. This was undertaken as an extension of an earlier survey and record of the site made by buildings archaeologist Stanley Jones, and was commissioned out of personal interest in the history of the site, and particularly for its conservation. It was hoped that this programme of tree-ring analysis would establish the date of the hall range and determine how much of the fabric might be original and how much, if any, may represent later repair and alteration. Although there are further timbers in other parts of the house, these were not sampled as part of this programme of analysis.

Thus, from the timbers available in this part of the house, a total of six core samples was obtained. Each sample was given the code DRN-B (for Dronfield, site ‘B’), and numbered 01–06. The layout and arrangement of the former trusses and the single remaining truss of the hall range are shown on a plan made and kindly provided by Stanley Jones (Fig 2), with the

sample positions being shown on the annotated photograph, Figure 4. In this report, the timbers and sample positions are located following the schema of these drawings.

Details of the samples are given in Table 1, including the timber sampled and its location, 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 Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank the owners of Dronfield Woodhouse Hall, Drs Hal Spencer and Ruth Dils, for their enthusiasm and support for this programme of analysis, as well as Local Historian Joan Dils for her generous funding of the project. The Laboratory would also like to thank Stanley Jones for providing drawings used in this report, and for his helpful discussions concerning the possible phasing of the house. Finally, we would like to thank David Hey, Emeritus Professor of Local and Family History at the University of Sheffield, for not only promoting and supporting this project, but also for his documentary research into the property, and the notes on the owner and builder of the original hall house.

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 5).

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 millimeter. 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 six samples obtained from the various timbers of the hall range at Dronfield Woodhouse Hall 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 that five of the six samples (all but sample DRN-B05) cross-matched with each other and could be formed into one single group, the length, relative position, and overlap of the samples being

shown in the bar diagram Figure 6. These five samples were combined at their indicated off-set positions to form DRNBSQ01, a site chronology with an overall length of 192 rings. This site chronology was then satisfactorily dated by repeated and consistent comparison with a number of relevant reference chronologies for oak as spanning the years 1342 to 1533. The evidence for this dating is given in the *t*-values of Table 2.

Site chronology DRNBSQ01 was then compared with the single remaining sample, DRN-B05, but there was no further satisfactory cross-matching. This single remaining sample was then compared individually with the full corpus of reference material, but again there was no further cross-matching and this sample must, therefore, remain undated for the moment.

Interpretation

One of the dated samples, DRN-B01, in site chronology DRNBSQ01, retains complete sapwood. This means that it has the last growth ring produced by the tree it represents before it was cut down (this is indicated by upper case 'C' in Table 1 and the bar diagram Fig 6). In this case the last growth ring, and thus the felling date of the tree, is dated to 1533. The heartwood/sapwood boundary on two of the other dated samples in site chronology DRNBSQ01 (samples DRN-B02 and B04), is at such a relative position as to suggest that they too were felled in 1533.

The two final samples of this group (DRN-B03 and B06) are without the heartwood/sapwood transition, and it is thus not possible to be certain as to when the trees these two represent were cut down (in theory it is possible that these trees went on growing after 1533). However, the cross-matching between all five samples is such as to suggest that the source trees were all growing close to each other, and it might be a little unusual to find trees which were originally growing close to each other, but felled at different times, being used in the same building. In short, taken in conjunction with the structural evidence, the dating of the timbers would strongly suggest that they were all felled at the same time as each other, in 1533, specifically for the construction of this part of Dronfield Woodhouse Hall.

As such, this date is perhaps just a little earlier than that expected on the basis of stylistic and structural evidence and earlier than that given in the listing description which suggests that it is of late-sixteenth century date.

Documentary research

Having obtained a date of 1533 by dendrochronology, local historian Professor David Hey has been able to identify the man who built the timber-framed hall at Dronfield Woodhouse. At that time, the property belonged to the Guild of St Mary and St John the Baptist, a parish guild that had been founded in 1349 and which was dissolved in 1548. All the farms that were owned by the guild were leased to tenants. The tenant at Dronfield Woodhouse was Mr Thomas Barley, a younger member of the Barleys of (the demolished) Barlow Hall. The 'Mr' implied gentry status.

Thomas Barley was described as 'of Dronfield Woodhouse' in 1520 and again in 1537. He was succeeded by his son, Robert, who was the tenant at the time of the 1561 survey of former guild lands and who died in 1588.

Undated sample

One of the six samples obtained from this site, DRN-B05, remains ungrouped and undated. With 89 rings, the sample certainly contains sufficient data for reliable analysis. It does, however, show two bands of slightly compressed rings, and possible distortion, and it is possibly this which accounts for its lack of cross-matching and dating. It is also believed that the source timber, a brace between cruck blade and purlin, might be a later insertion. If this is so, it would make the sample a 'singleton', and while such single samples can sometimes be dated, it is often more difficult than with groups of samples which supply well replicated data. The lack of dating does not, however, mean that it is certainly of a different date, but it does add further weight to the possibility that it is an inserted timber.

Woodland source

In this instance it is not possible to be very precise as to the exact location of the original woodland source for these timbers. However, as may be seen from Table 2, although site chronology DRNBSQ01 has been compared with reference chronologies from all over Britain, some of the highest t-values (or the greatest degrees of similarity), are found against those chronologies made up of material from other sites in Derbyshire, or at least 'Midland', and northern England. This would suggest that the timbers used here are from a similar general area.

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Table 1: Details of tree-ring samples from Dronfield Woodhouse Hall, Carr Lane, Dronfield Woodhouse, Derbyshire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
DRN-B01	North upper purlin, truss 2–3	192	41C	1342	1492	1533
DRN-B02	North cruck blade, truss 2	117	h/s	1398	1514	1514
DRN-B03	Collar, truss 2	85	no h/s	1359	------	1443
DRN-B04	First floor stud post to truss 2	84	6	1434	1511	1517
DRN-B05	East brace from north blade to north upper purlin	89	h/s	------	------	------
DRN-B06	South lower purlin, truss 3–4	83	no h/s	1364	------	1446

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

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

Table 2: Results of the cross-matching of site chronology DRNBSQ01 and the reference chronologies when the first ring date is 1342 and the last ring date is 1533		
Reference chronology	*t*-value	
England Master Chronology	8.5	(Baillie and Pilcher 1982 unpubl)
All Hallow's Church, Kirkburton, W Yorks	8.5	(Arnold and Howard 2007)
Offerton Hall, Offerton, Derbys	7.8	(Howard *et al* 1995)
Primrose Hill, Kings Norton, Birmingham	7.8	(Arnold and Howard 2008)
Unthank Hall, Holmesfield, Derbys	7.3	(Howard *et al* 1993)
Kingsbury Hall, Kingsbury, Warwicks	7.1	(Arnold and Howard 2006)
East Midlands Master Chronology	6.9	(Laxton and Litton 1988)
Hardwick Old Hall, Doe Lea, Derbys	6.7	(Howard *et al* 2002)

Site chronology DRNBSQ01 is a composite of the data of the relevant cross-matching samples as seen in the bar diagram Figure 6 below. This 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 span indicated; the table giving only a small selection of the very best matches as represented by '*t*-values' (ie, degrees of similarity). It may be noticed from this Table 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. These values, along with the many other slightly lower, unlisted, cross-matches, indicate a very firm and reliable date for the timbers.

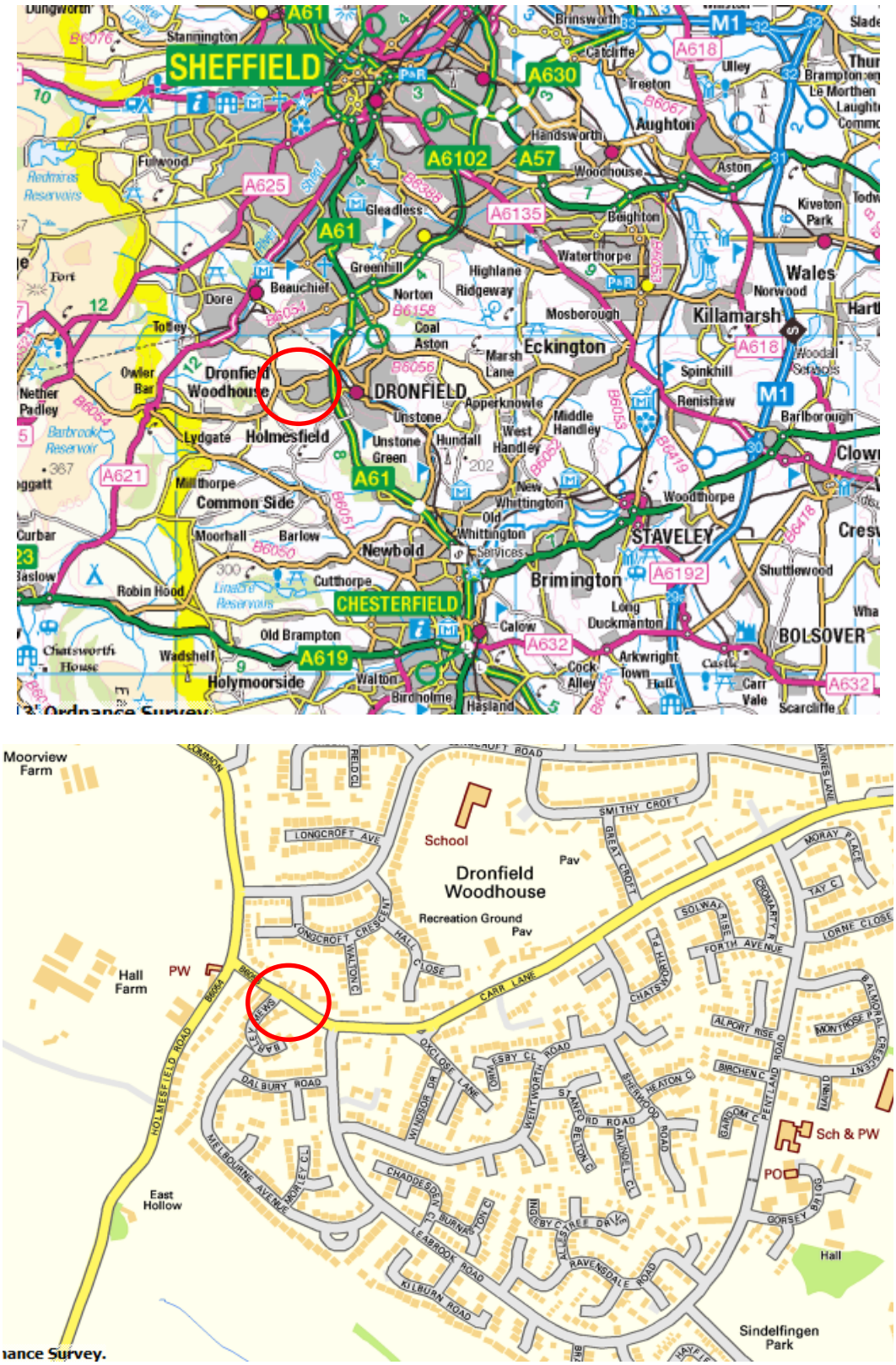


Figure 1a/b: Maps to show location of Dronfield Woodhouse (top) and Dronfield Woodhouse Hall (bottom)

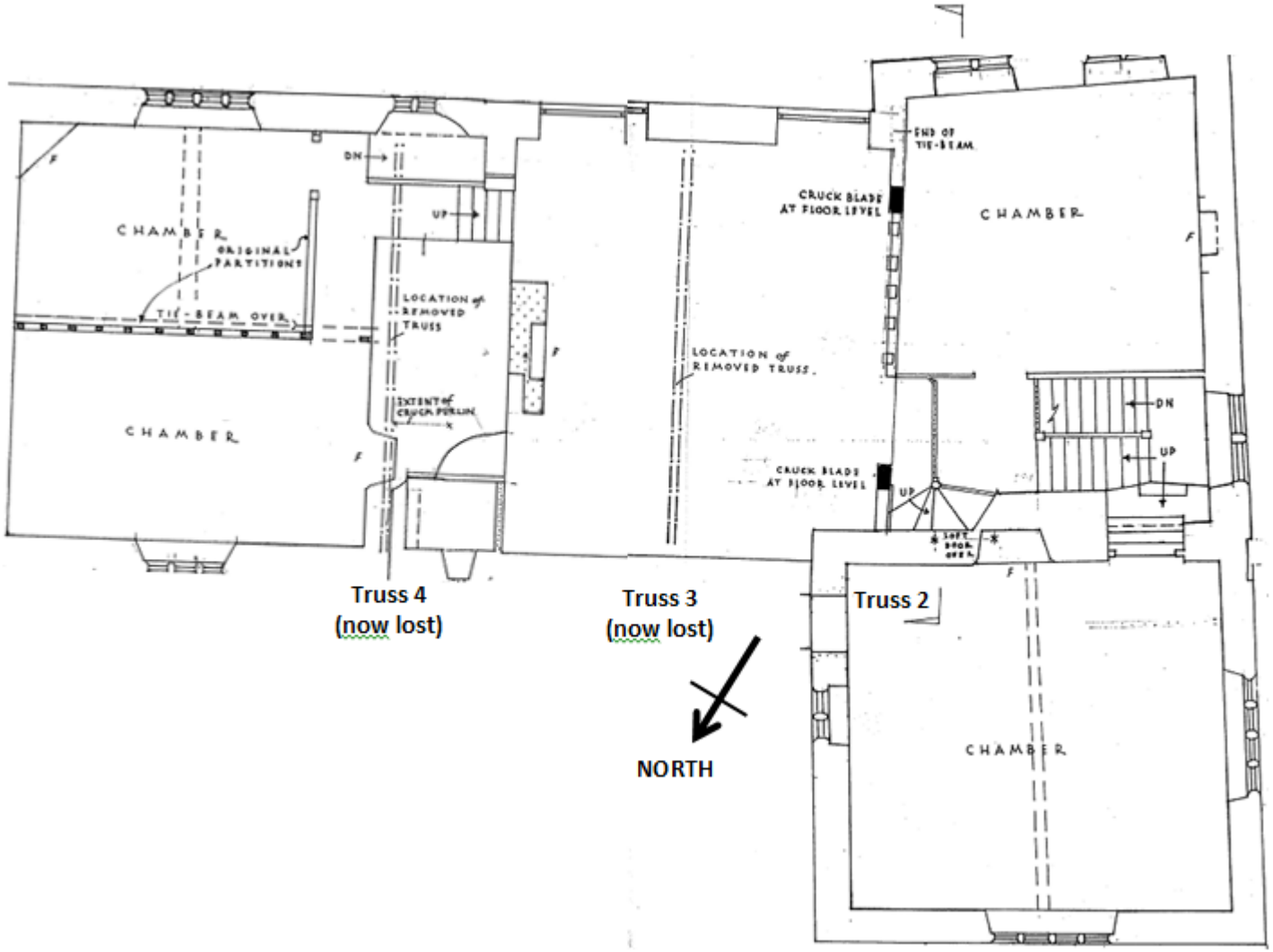


Figure 2: First floor survey plan of Dronfield Woodhouse Hall (after Stanley Jones 1990)

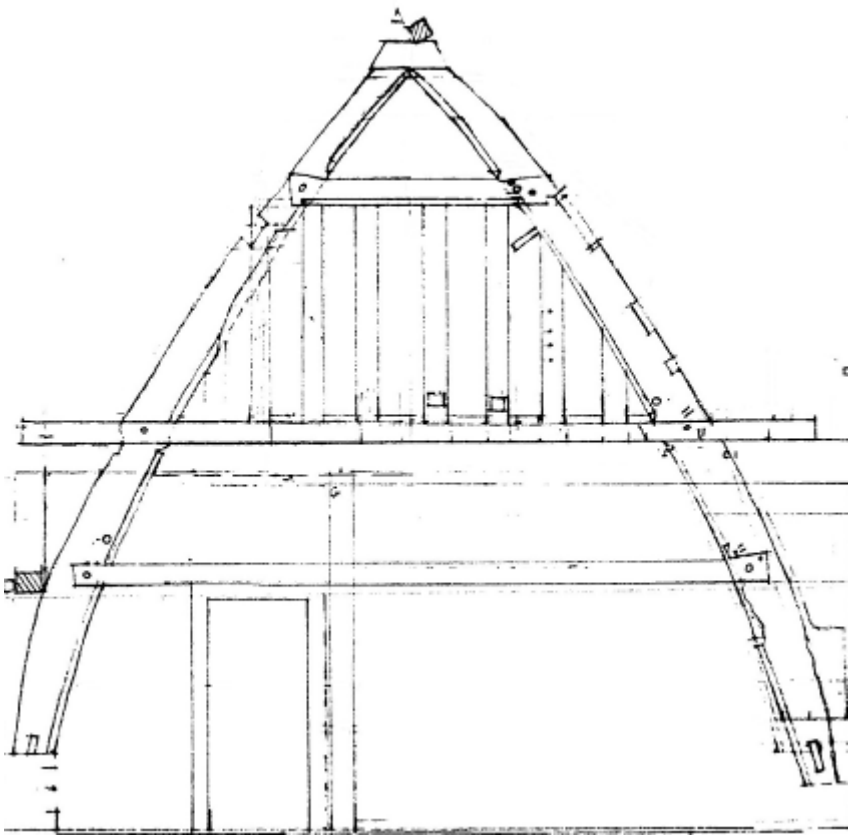


Figure 3a (top): View of the single remaining cruck truss to the hall range
Figure 3b (bottom): Survey drawing of same (after Stanley Jones 1990)

Figure 4: Photograph to locate sampled timbers

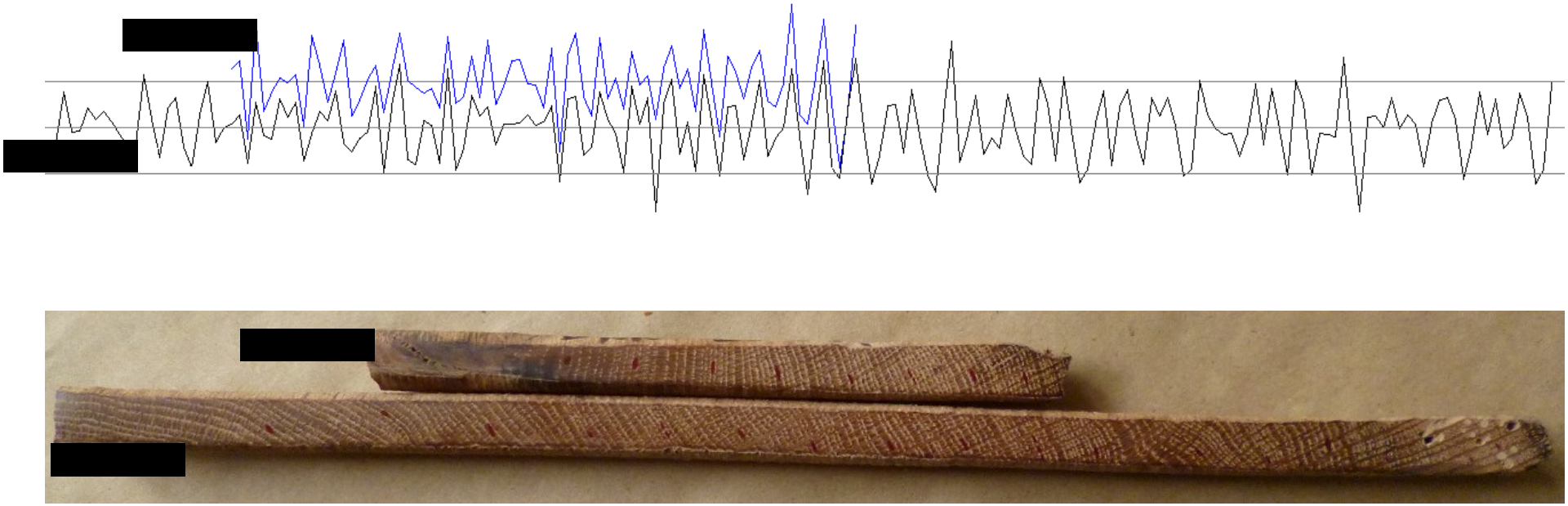
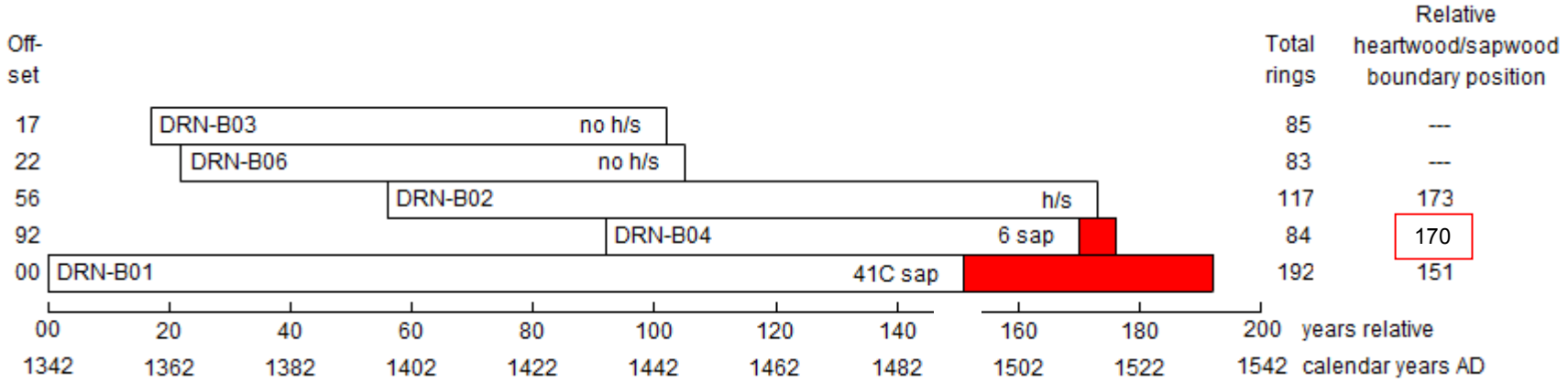


Figure 5: Graphic representation of the cross-matching of two samples, DRN-B01 and B06

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 a result of the two trees represented having grown at the *same time* in the *same place.* 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
C = complete sapwood is retained on the sample, the last ring date is the felling date of the tree represented
h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing

Figure 6: Bar diagram of the samples in site chronology DRNBSQ01 at positions indicated by their grouping. The samples are shown in the form of bars at positions where the ring variations of the samples cross-match with each other, this similarity being produced by the trees represented growing at the *same time* as each other in the *same place.* The samples are combined to form a 'site chronology', which is dated by comparison with the 'reference' chronologies (see Table 2).