Nottingham Tree-ring Dating Laboratory
Dendrochronology, timber analysis, and historic building consultants

TREE-RING ANALYSIS OF TIMBERS FROM 'PENY'S HEY', 43 HEY LANE, LOWERHOUSE, HUDDESRFIELD, WEST YORKSHIRE

A J ARNOLD
R E HOWARD
M HURFORD

With an historical introduction
by Patricia Dyson

Core sample HUD-B05

Nottingham Tree-ring Dating Laboratory
Dendrochronology, timber analysis, and historic building consultants

TREE-RING ANALYSIS OF TIMBERS FROM 'PENY'S HEY', 43 HEY LANE, LOWERHOUSE, HUDDESRFIELD, WEST YORKSHIRE

A J ARNOLD
R E HOWARD
M HURFORD

With an historical introduction
by Patricia Dyson

Summary

Analysis by dendrochronology of samples from 10 different oak beams in this house suggest that at least two, and possibly three, phases of felling are represented in the timbers found here.

The earliest timbers, comprising ground floor ceiling beams, a post, and a fireplace bressummer, were probably all felled in 1481. Later timbers, represented by roof beams and a ground-floor lintel, were possibly felled *c.* 1580.

A single site chronology, HUDBSQ01, comprising seven samples can be produced from the analysed samples, its 188 rings spanning the years 1386 – 1573. Three other samples remain undated.

Historical introduction

The House, Peny's Hey, stands on a shale outcrop overlooking the village of Longley, about one mile south-east of Huddersfield, in West Yorkshire (SE 158 153 Fig 1); it is so called because it appears on William Senior's map of 1634 as 'William Peny – his Hey' (Fig 2). In the past, Longley was part of the Manor of Almondbury, which in turn takes its name from the nearby Iron Age fort, and is the original hilltop village that pre-dates Huddersfield.

The Manor of Almondbury formed part of the Honour of Pontefract, which William the Conqueror gifted to Ilbert de Laci. The De Laci heiress eventually married Thomas, Earl of Lancaster, and after his rebellion in 1322 the Manor was sequestered to the Crown, eventually becoming part of the Duchy of Lancaster, part of the English Monarch's personal holdings. The Ramsden family purchased the Manor from the Crown in 1627.

The earliest recorded tenants at Hey were the Wood family. They first appeared in Longley in 1330 when Robert Wood witnessed a Deed. This family prospered in Longley for the next 200 years. In 1523 a taxation roll of Henry VIII assessed John Wood of Longley at £10, which made him the richest man in Almondbury. In 1530 John Wood disowned his son and sensing a business opportunity Robert Ramsden married his son William to one of John Wood's daughters. Eventually, William Ramsden acquired all of his father-in-law's estates within the Manor, including Hey. Thus, in 600 years, Hey was held by just 2 families.

'Hey' comes from the Old English word 'Aeg', meaning an enclosure, and at Peny's Hey this enclosure was historically 6 acres. The suffix 'ley', as in 'Longley', means a clearing, and both names pre-date the Norman Conquest.

Between 1340 and 1584 three Inquisitions (enquiries into land tenure and rents) were held into the Manor of Almondbury. Rent details from these surveys show a pattern which could be taken indicate the building of a house on the site sometime after 1340:

1340
Robert Wood - 15½ acres - 5s 2d
Thomas Wood - 6 acres - 2s 2d

1425
John Wood - 15½ acres - 5s 2d
John Wood, Hey - 6 acres - 5s 1d

1584
John Ramsden - 15½ acres - 5s 2d
John Ramsden, Hey, Messuage - 6 acres - 5s 1d

It will be seen that while, between 1340 and 1425, the rent of the 15½ acres remains the same, that for the 6 acres rises sharply, implying some change here. It will further be seen that between 1425 and 1584 the rent for both the 'Hey' and the 15½ acres remain static, ie, there has been no change during those years. As the 1584 Inquisition describes Hey as a 'messuage' (a house and outbuildings), it is probable that the messuage has been there since at least 1425 - hence the big increase in rent by that time.

After 1584, Peny's Hey is shown on two estate maps drawn in 1634 and 1716, and appears continuously in the Ramsden Estate Rentals up until 1920 when the estate, amounting to some 4,300 acres, was acquired by Huddersfield Corporation.

The House

From 1920 onwards the house, Figure 3, suffered indifferent neglect, and by 1985 it was officially unfit for habitation, and home to pigs. The present owners' subsequent restoration was therefore radical, and exposed the bare bones of the building. The presence of a number of large oak timbers showing signs of specific earlier use was sufficiently intriguing to prompt professional advice from an expert in timber framed buildings, in this instance, David Michelmore. He identified a 'wealth of medieval timbers' and suggested the following phasing:

1. A timber framed house – evidenced by purlins with cut-outs for wind braces, and the header from an oak-mullioned window.

2. A complete rebuild in stone in the sixteenth century – which he deduced from chamfered and stopped ceiling joists typical of that period, reused during the eighteenth century in what is now the dining room.

3. The Ramsden Estate Rental for 1780 states that the house has been divided and Mr Michelmore found evidence to indicate that the western end of the house had been completely reconstructed. Beams in the ground floor room are of imported pine, tying in well with the opening of the Huddersfield Canal in 1775. As previously mentioned, the pine beams are used in conjunction with the much older oak joists. The roof construction in this part of the house is typically eighteenth century, being of queen post with tusked tenon purlins, some showing signs of earlier use as they are grooved to take wattle and daub panels.

The timbers

The timbers presently within Peny's Hey comprise what are now single oak bridging beams (they may originally have been purlins and are reused here) to two of the ground-floor ceilings, that of the living room and the kitchen (at the east end and middle of the building respectively), as well as a series of door and window lintels, wall plates or posts. There is also a bressummer to the fireplace in the dining room at the west end of the house (Fig 4a-c). To the upper floors the timbers comprise a single principal rafter truss with tiebeam, vertical queen posts, and diagonal struts, at the west end of the building, there also being single purlins to each pitch of the roof at the west end (Fig5 a/b). A number of these timbers showed evidence, by way of redundant mortices and pegholes, of having been salvaged and reused in their present position. All the roof timbers to the middle and east end of the house are modern replacements.

Not all the oak timbers were suitable for tree-ring dating, being derived from fast-grown trees which were unlikely to provide samples with sufficient rings for reliable analysis, ie, with more than 54 rings. There were, in addition to the oak, a small number of pine timbers, most notably the two ceiling beams to the dining room, and timbers to the south window of the kitchen. Samples were not taken from such timbers.

Sampling

Sampling and analysis by tree-ring dating of the timbers within Peny's Hey were commissioned by the owners, Mr and Mrs Dyson. This was undertaken out of personal interest and concern for the building, and as part of a general programme of research in to its history and development.

It was realised, however, that some of the timbers showed little structural integrity, that is they were not all jointed and pegged together to form a coherent structural frame, and that many of them showed signs, by way of redundant mortices and pegholes, of previous use, and as such might not necessarily be related directly to the present building. Despite this it was hoped that tree-ring dating, in conjunction with the structural and stylistic interpretation undertaken by David Michelmore, and the documentary evidence unearthed by Mrs Pat Dyson, that some further information might be deduced from tree-ring analysis.

Thus, from the oak timbers available a total of 10 samples was obtained by coring. Each sample was given the code HUD-B (for Huddersfield, site 'B') and numbered 01–10. The positions of these samples are marked on a sketch plan made at the time of sampling, worked-up to that given in Figure 6a/b. Details of the samples are given in Table 1. In this Table the frames, beams and individual timbers have been located and numbered on a north-south or east-west basis as appropriate.

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 most frequently used building timber in England) 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 any number of consecutive years is unique, so too is the growth-ring pattern of the tree. The pattern of a short 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. 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 54 years or so. In essence, a short period of growth, anything less than 54 rings, is not reliable, and the longer the period of time under comparison the better.

The third principle of tree-ring dating is that, until the early- to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland, or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction

with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

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 relevant 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. In the Tables and bar diagrams of this report, the retention of complete sapwood on a sample is denoted by upper case 'C'.

Sometimes, complete sapwood is found on a timber, but, because of its soft condition, some, or all of it, crumbles as the sample is cored. It is possible to measure how much of the sapwood part of the core has been lost and from this it is sometimes possible to estimate the number of rings the lost portion might have represented, From this it is possible to make a reasonable estimate the felling date of the timber. Such a state is represented by lower case 'c' in the Tables and bar diagrams.

Where the sapwood is not complete it is necessary to calculate a likely felling date range for 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, it is 95% probable 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)).

Given that in a timber-framed building the trees required for each phase are almost certainly to have been cut in a single felling operation especially for that building, it is usual to calculate the average date of the heartwood/sapwood boundary from *all* the dated samples from each phase of a building and add 15 to 40 rings to this average to get the likely overall felling date of all the timbers used. In this calculation, wide variations in the position/date of the heartwood/sapwood boundary (possibly suggesting different felling dates) must be noted and taken into consideration.

Analysis

In the case of the 10 samples obtained from 43 Hey Lane, each was prepared by sanding and polishing, and their annual growth-ring widths were measured. The data of these measurements were then compared with each other. At a minimum value of *t=3.5* a single group comprising seven samples could be formed, cross-matching with each other at the positions indicated in the bar diagram, Figure 7. The seven cross-matching samples were combined at these indicated off-set positions to form a site chronology, HUDBSQ01, this having an overall length of 188 rings. Site chronology HUDBSQ01 was then satisfactorily dated by repeated and consistent comparison with a number of relevant reference chronologies for oak as spanning the years 1386 to 1573. The evidence for this dating is given in the *t*-values of Table 2.

Site chronology HUDBSQ01 was then compared with the three remaining measured samples but there was no further satisfactory cross-matching. Each of the three remaining samples was then compared individually with the full range of reference chronologies but there was, again, no further cross-matching and they must, therefore, remain undated.

Interpretation

Analysis by dendrochronology of 10 samples from this site has produced a single dated site chronology, HUDBSQ01, comprising seven samples, its 188 rings dated as spanning the years 1386 to 1573. However, although the seven samples overlap with each other to a certain extent, and cross-match with each other to produce a single site chronology, it would appear that at least two, and possibly three, phases of felling are represented.

As may be seen from the bar diagram, Figure 7, there is a considerable difference in the relative positions, and absolute dates, of the heartwood/sapwood boundary on some of the samples, and that, in effect, we appear to have two distinct sapwood periods. It will be seen from the bar diagram that one sub-group of samples, HUD-B02, B03, B05, and B07, have sapwood at a much earlier position and date than do samples HUD-B01, B08, and B09.

Indeed, one of the earlier samples, HUD-B03, retains complete sapwood, that is, it has the last ring produced by the tree it represents before it was felled. This last measured complete sapwood ring, and thus the felling of the tree, is dated to 1481. The relative position and date of the heartwood/sapwood boundary on the other three samples in this sub-group is such that they represent trees that were probably felled in 1481 as well.

The sapwood of the remaining three dated samples, HUD-B01, B08 and B09 is much later, though the actual felling date of the trees represented by these is a little less precise. One sample, HUD-B09, is from a timber, the south-west purlin of the roof, which retains complete sapwood. However, a small portion of the sapwood, about 5mm, was lost during coring. It is estimated that this loss represent no more than 5-7 rings, and thus, given that the last extant sapwood ring on

sample HUD-B09 is dated to 1573, it is estimated that the timber was felled, in round terms, approximately 1580.

It is possible that the timber represented by sample HUD-B01 (a wall plate), was also felled *c.* 1580. However, given that the heartwood/sapwood boundary on this sample is dated to 1525, in order for this to have been the case the tree would have had 55 sapwood rings. Whilst this number of sapwood rings is not unheard of, it is above the 95% probability limit. Whilst this does not preclude it having been felled *c.* 1580, the possibility that it was felled in the period 1540 to 1565 (ie, 1525+15 to 1525+40), must also be considered.

Given that the third sample of this later group, HUD-B08, does not have a heartwood/sapwood boundary, it is not possible to give a felling date range for the timber represented. It is unlikely, however, given that its last measured heartwood ring is dated to 1532, to have been felled before 1547 (1532+15 - assuming the next ring the timber might have had was at the heartwood/sapwood boundary). It is therefore *possible* that the timber represented was felled at the same time as the timbers represented by either HUD-B01 or B09, but also possible that it was felled at another time altogether.

Conclusion

Given the evidence of the tree-ring dating it is clear that a number of timbers were felled in 1481. This probably represents the remains of the phase 1 timber-framed house of unknown date identified by the structural interpretation. Tree-ring dating also indicates the probable felling of further trees c. 1580, these timbers probably representing the phase 2, late-sixteenth century, total rebuild also identified by the structural survey, and being the building seen on William Senior's map of 1634 as 'William Peny – his Hey'. It is in the final phase identified, phase 3, stylistically dated to *c.* 1780, that these older timbers are reused in conjunction with newly imported pine timbers.

The late-fifteenth and late-sixteenth century building phases represented by the dated timbers cannot be directly related to the documentary evidence. It would appear that the rent had increased from 2s 2d to 5s 1d by 1425, some 55 years before the 1481 house was built, and remained at this level in 1584, shortly after the house was supposedly re-worked. It is of course possible that the 1481 house detected here was not the first house on the site, but a replacement of one built after 1340, the building of which might account for the increase in rent. No evidence of such a house has been detected by this analysis. Why the rent did not increase by 1584 is unknown.

Three samples, HUD-B04, B06 and B10, remain ungrouped and undated. It will be seen from Table 1 that only sample HUD-B04, has sufficient rings, 70, for reliable analysis. There appears to be no particular problem with this sample such as complacent rings (showing little annual variation) or compressed or distorted rings, which might account for its remaining undated. This is a common feature of dendrochronology. The other two samples, HUD-B06 and B10, have marginal numbers of rings and while it is sometimes possible to date such cores, it is often more difficult where, as in this case, timbers of different dates are to be found, rather than in situations where large numbers of well-replicated, single-date, timbers are obtained.

Bibliography

Arnold, A J, Howard, R E, and Litton, C D, 2003 *Tree-ring analysis of timbers from the Bell Frame and Tower Roof of St Margaret's Church, Wetton, Staffordshire,* Centre for Archaeol Rep, **22/2003**

Arnold, A J and Howard R E, Tree-ring analysis of timbers from All Hallow's Church, Kirkburton, West Yorkshire, Res Dep Rep Ser, **49/2007**

Baillie, M G L, and Pilcher, J R, 1982 unpubl A master tree-ring chronology for England, unpubl computer file *MGB-EOI,* Queens Univ, Belfast

Fletcher, J, 1978 unpubl computer file *MC10–H*

Howard, R E, Laxton, R R, and Litton, C D, Nottingham University Tree-ring Dating Laboratory, and Roberts, H M, North East Vernacular Architecture Group, 1995 List 62 no 3a - Nottingham University Tree-Ring Dating Laboratory: buildings of the religious estates in medieval Durham; dendrochronological survey 1994 - 5, *Vernacular Architect*, **26**, 55 – 6

Laxton, R R, and Litton, C D, 1988 An East Midlands master tree-ring chronology and its use for dating vernacular buildings, University of Nottingham, Dept of Classical and Archaeol Studies, Monograph Series, **III**

Morgan, R A, 1977 Dendrochronological dating of a Yorkshire Timber-framed building, Vernacular Architect, **8**, 9 – 14

Tyers, I, 1997 *Tree-ring Analysis of Timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/1997**

Table 1: Details of samples from 'Peny's Hey', 43 Hey Lane, Lowerhouses, Huddersfield, West Yorkshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date	Last heartwood ring date	Last measured ring date
HUD-B01	Wall plate at rear window of living room	105	7	1428	1525	1532
HUD-B02	Ceiling beam in living room	57	13	1420	1463	1476
HUD-B03	Vertical post in living room	96	19C	1386	1462	1481
HUD-B04	Rear (south) wall plate to dining room	70	7	------	------	------
HUD-B05	Kitchen ceiling beam	62	9	1414	1466	1475
HUD-B06	Vertical post in dining room	53	13	------	------	------
HUD-B07	Bressummer to dining room fireplace	72	18	1408	1461	1479
HUD-B08	North-east purlin	82	no h/s	1425	------	1506
HUD-B09	South-west purlin	119	23c	1455	1550	1573
HUD-B10	North-west purlin	50	no h/s	------	------	------

*h/s = heartwood/sapwood boundary
c = complete sapwood is found on the timber, all or part has been lost from the sample during coring
C = complete sapwood retained on the sample, the last measured ring date is the felling date of the timber

Table 2: Results of the cross-matching of site chronology HUDBSQ01 and relevant reference chronologies when first ring date is 1386 and last ring date is 1573

Reference chronology	*t*-value	
England Master Chronology	8.4	(Baillie and Pilcher 1982 unpubl)
St Margaret's Church, Wetton, Staffs	7.7	(Arnold *et al* 2003)
Sinai Park, Burton on Trent, Staffs	7.6	(Tyers 1997)
SFF-B01M	7.5	(Morgan 1977)
All Hallow's Church, Kirkburton, W Yorks	7.4	(Arnold and Howard 2007)
Old Durham Farm, Durham	7.3	(Howard *et al* 1995)
MC10---H	7.0	(Fletcher 1978)
East Midlands Master Chronology	7.0	(Laxton and Litton 1988)

Figure 1: Map to show general location of Peny's Hey

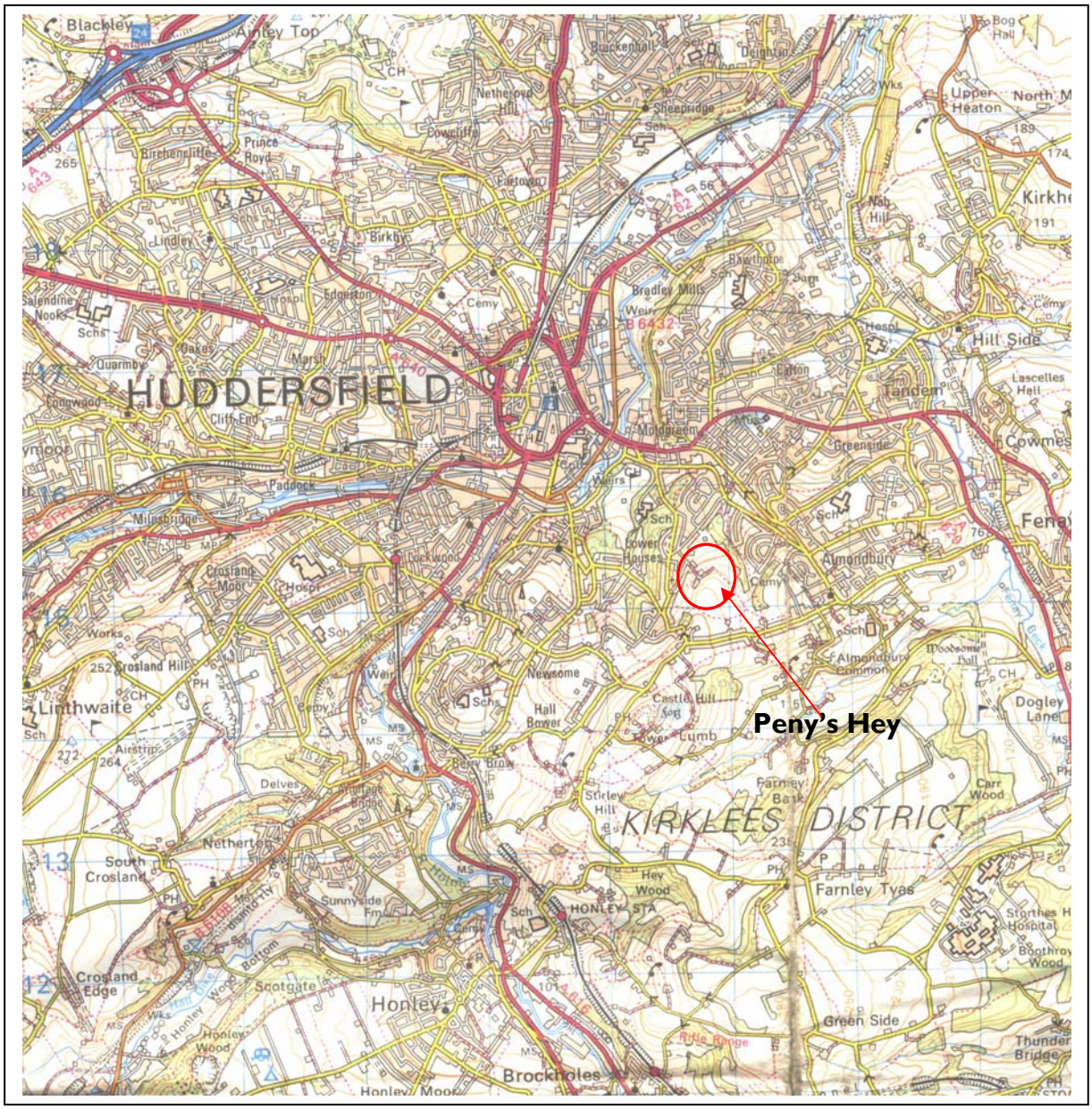


Figure 2: William Senior's Map of 1634 showing 'William Peny – his Hey'

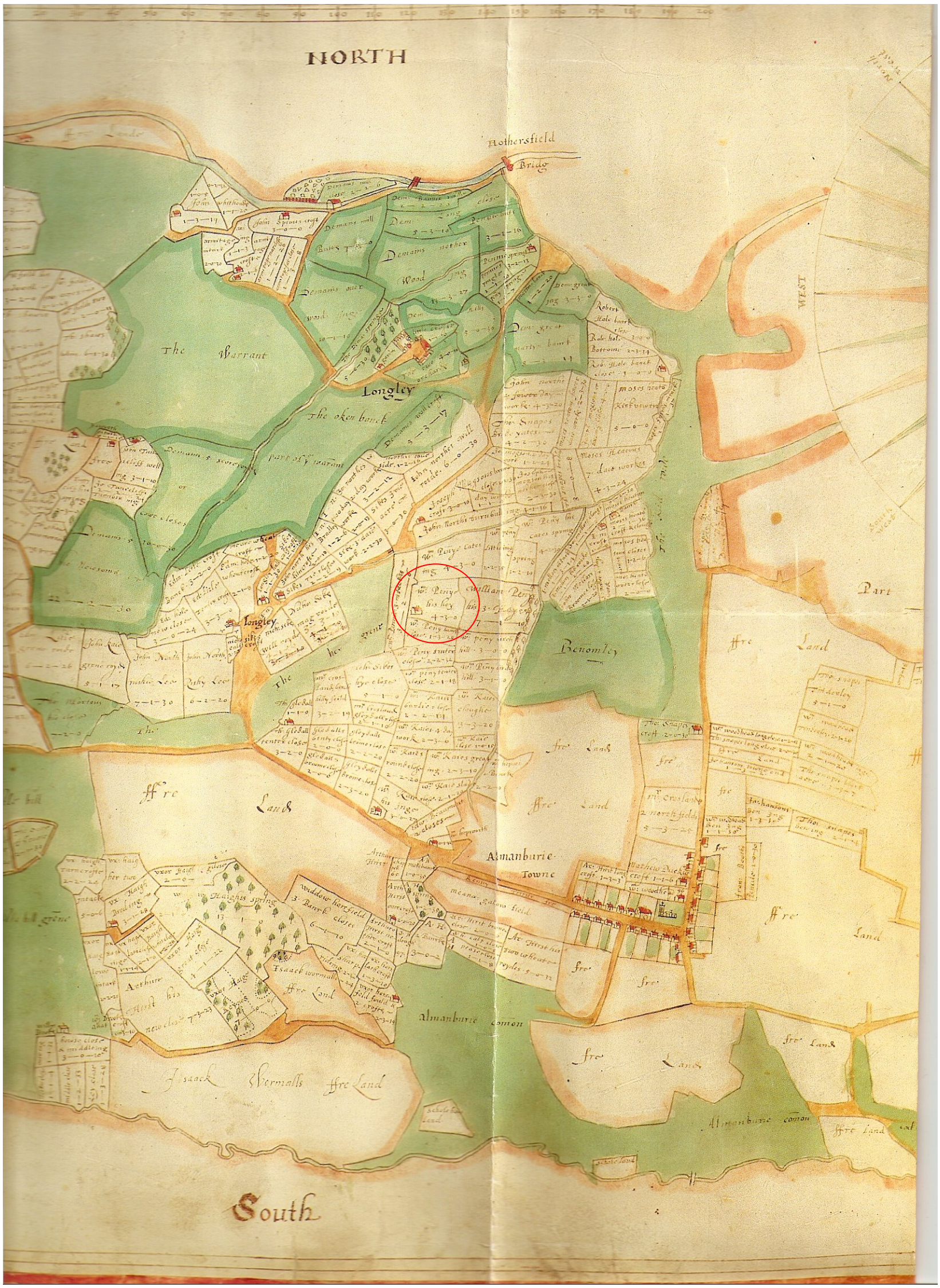


Figure 3: View of Peny's Hey prior to renovation
(photo Pat Dyson)

Figure 4a-c: View of ground-floor timbers

4a above: *view of the ceiling beam and vertical post in the living room*

4b above: *view of the ceiling beam in the kitchen*

4c left: *view of the vertical post in the dining room*

Figure 5a (top): Views of the principal rafter truss
Fig 5b (bottom): View of the south-west purlin

Figure 6a: Simple sketch plan at ground floor level to show sample locations
(not to scale)

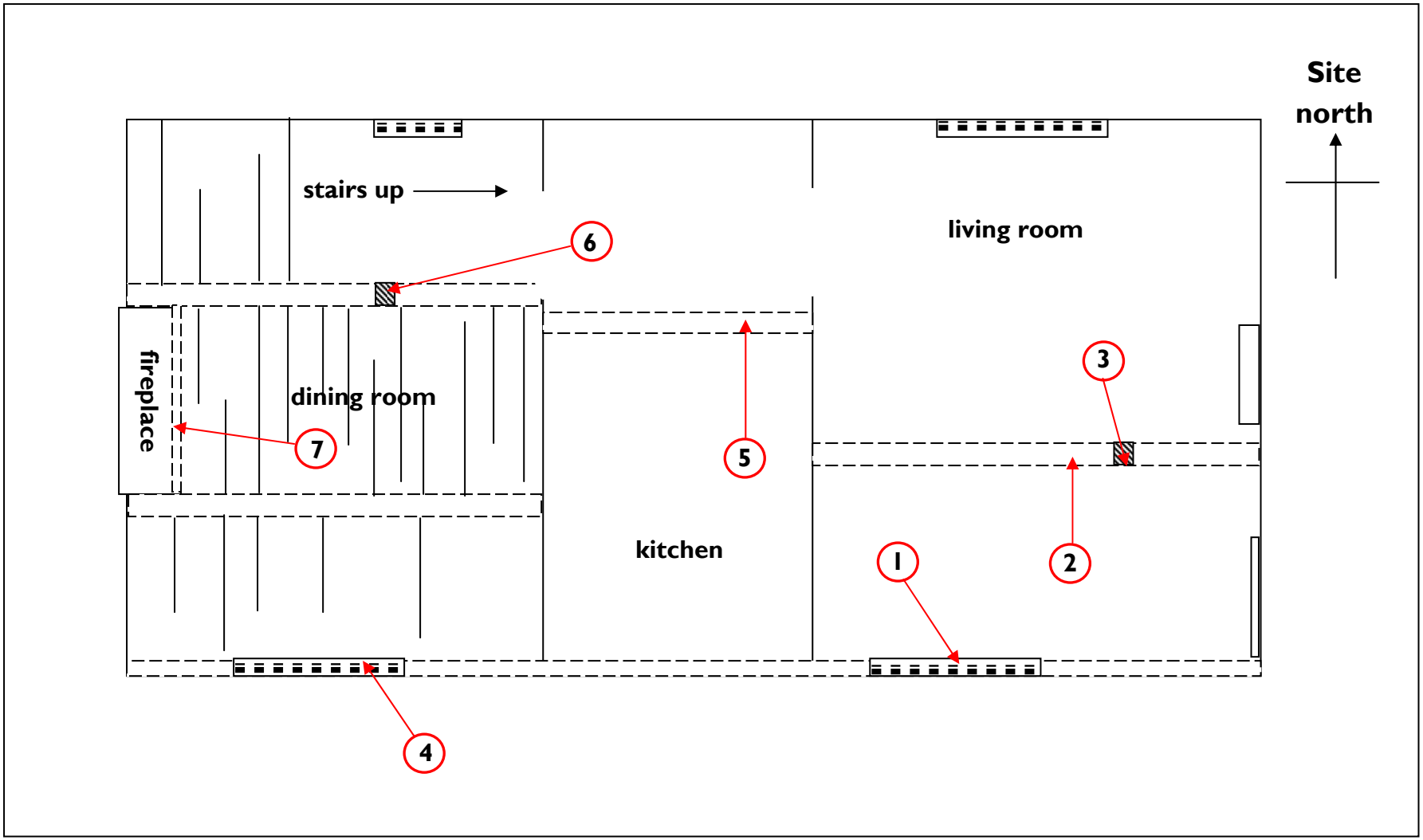


Figure 6b: Simple sketch plan at first floor level to show sampled timbers
(not to scale)

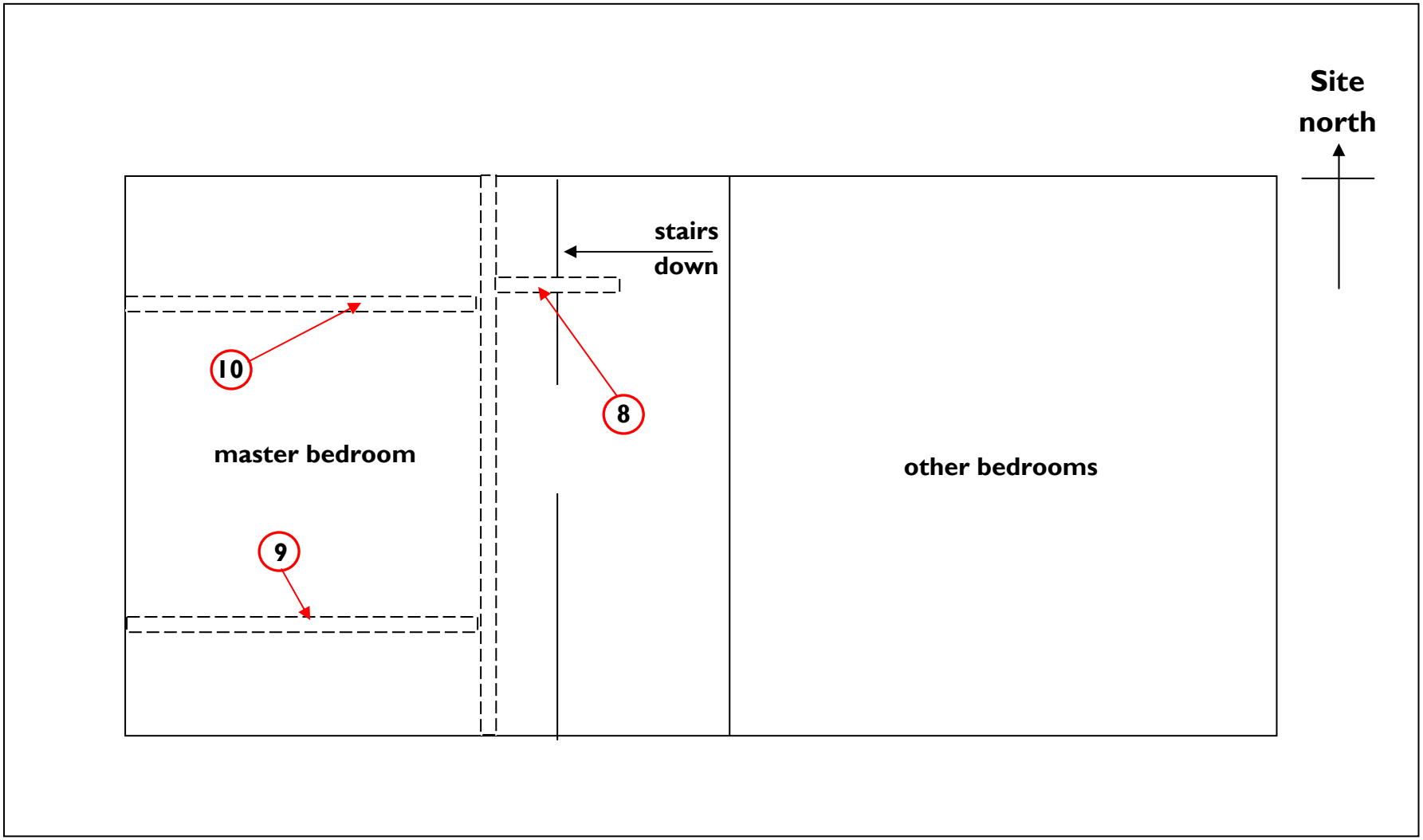
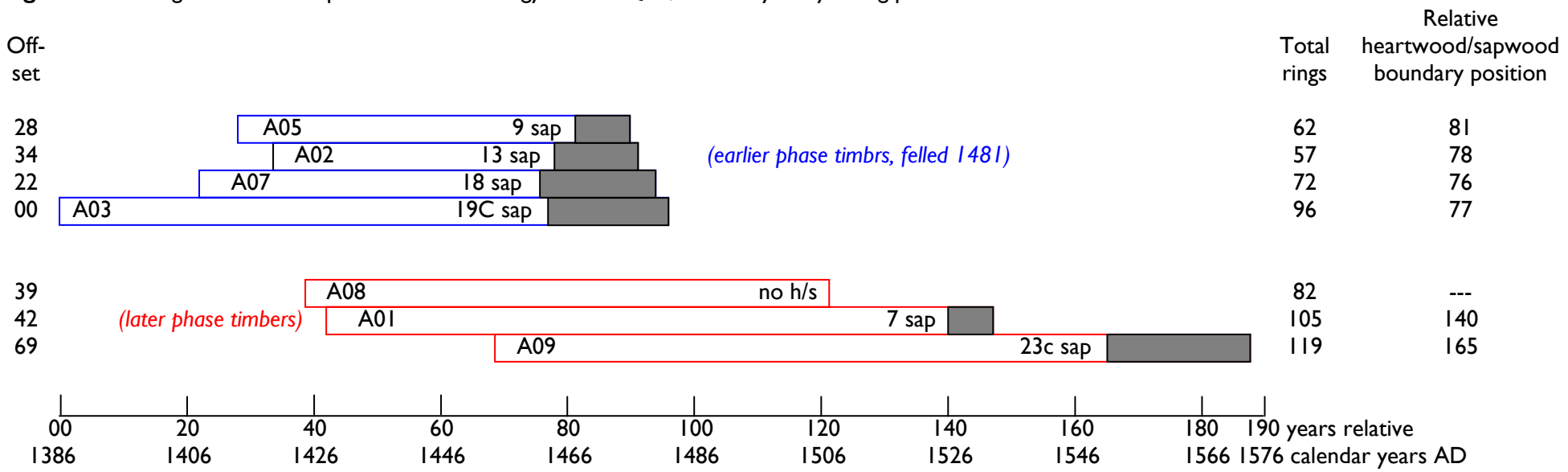


Figure 7: Bar diagram of the samples in site chronology HUDASQ01, sorted by likely felling phase



White bars = heartwood rings, shaded area = sapwood rings
h/s = the last ring on the sample is at the heartwood/sapwood boundary; only the sapwood rings are missing
c = complete sapwood is found on the timber, all or part has been lost from the sample during coring
C = complete sapwood is retained on the sample, the last measured ring date is the felling date of the timber