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TREE-RING ANALYSIS OF TIMBERS FROM THE BARN AND HOUSE AT WHITWOOD FARM BAILIFF BRIDGE YORKSHIRE

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TREE-RING ANALYSIS OF SAMPLES FROM THE BARN AND HOUSE AT WHITWOOD FARM

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SUMMARY

Dendrochronological analysis was undertaken on samples taken from the timbers of the barn and house at this farm.

Site sequence WTWDSQ01, contains seven samples from the barn and spans the period 1316-1444. Two of the timbers were felled in the late spring/early summer of 1445, with it thought likely that the rest of the dated barn timbers were also felled at that time.

Two of the house samples were dated individually, a purlin to a *terminus post quem* (date after) of 1521 and a ridge to a felling of *c*. 1548.

These results suggest the barn was erected shortly after the felling of the timbers utilised in its construction in late spring/early summer of 1445. The house contains at least one timber (and possibly two) from the mid-sixteenth century.

TREE-RING ANALYSIS OF TIMBERS FROM THE BARN AND HOUSE AT WHITWOOD FARM

INTRODUCTION

Whitwood Farm is located in the northern township of Clifton, about 6km to the east of Halifax. Documentary sources reference a hamlet called Whitwood in a deed as far back as 1329 and the existence of lands at 'Whytwood' in 1592. The present farmhouse is located to the west of Whitwood Lane, the remnant of a medieval trackway, whilst the barn lies to the east. Surviving earthwork remains point towards the site of the farm once being part of a larger settlement than it is now. The earliest documentary evidence to Whitwood Farm itself is a conveyance of 1765 when the farm was sold to John Walker, a merchant from Halifax. This introduction is based on the historical research undertaken by Archaeological Services WYAS.

The farmhouse

This building is aligned approximately north-west – south-east (hereafter north-south) and is of six bays. Inspection of the roof ascertained the existence of only two timber trusses, at truss 2 and 6, containing principal rafters and what is thought to be a king-post (Fig 1), although access and visibility was limited. The roof also has a ridge and a one set of visible purlins to each slope (Fig 2). The common rafters are of mixed appearance with some of them showing signs of reuse in the form of empty mortices and others being smoke blackened.

The barn

The barn, as it stands presently, is of seven bays, aligned north-west –south-east (hereafter north-south), and aisled on the east side (Figs 3 and 4). Bays 1 and 7 are floored with 'modern', softwood joists. The upper portion of the trusses display some variation with trusses 1 and 6 having king-posts (Fig 5), truss 2 having queen posts, and trusses 3, 4, and 5 having crown-posts.

Principles of Tree-ring Dating

Tree-ring dating relies on a few simple, but fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees) 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 to 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 determined pattern. Furthermore, and importantly, all trees growing in the same area at a 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 pattern of the tree. The pattern of a short period of growth, 20 or 30 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 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal 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 a sample "cross-matches" repeatedly at the same date 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 the 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 phases 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 satisfactory analysis.

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 (1388+15 sapwood rings) and 1428 (1388+40 sapwood rings).

SAMPLING

A total of 15 timbers was sampled with each sample being given the code WTW-D and numbered 01-15; samples WTW-D01-09 being taken from the barn and WTW-D10-15 from house timbers. The location of samples was noted at the time of sampling and has been marked on Figures 6-10. Further details can be found in Table 1.

ANALYSIS, RESULTS, AND INTERPRETATION

At this stage, two of the samples taken from the timbers of the house roof (WTW-D14 and WTW-D15) were found to have too few rings for secure dating and so were discarded. The remaining 13 samples were prepared by sanding and polishing and their growth-ring widths measured. These growth-ring widths were then compared with each other.

Seven of the samples taken from the barn matched each other and were combined at the relevant offset positions to form WTWDSQ01, a site sequence of 129 rings (Fig 11). This site sequence was then compared against a series of relevant reference chronologies for oak where it was found to match consistently and securely at a first-measured ring date of 1316 and a last-measured ring date of 1444. The evidence for this dating is given by the *t*-values in Table 2. Two of these samples have complete sapwood and the last-measured ring date of 1444. When these two samples are looked at under the microscope it is possible to see the Spring growth cells of the following year, demonstrating that the timbers represented were felled in the late Spring or early Summer of 1445. The heartwood/sapwood boundary ring dates of all seven dated barn samples are broadly contemporary making it likely that the other five dated barn samples were also felled at this time.

Attempts were then made to date the remaining ungrouped samples by individually comparing them against the reference chronologies. This resulted in the successful dating of two of the house samples. Firstly, sample WTW-D10, taken from a ridge, was found to span the period 1453-1543. The evidence for this dating is given by the *t*-values in Table 3. This sample was taken from a timber with complete sapwood but unfortunately, *c.* 5mm of these outer rings were lost during the sampling procedure. It is estimated that these 5mm represent about 5 lost sapwood rings, giving this sample a felling date of *c.*1548. Sample WTD-W12, from a purlin, spans the period 1405-1506 (Table 4). Without the heartwood/sapwood boundary ring on this sample it is not possible to calculate a felling date but this would be estimated to be after 1521 at the earliest.

Felling date ranges have been calculated using the estimate that mature oak trees from this region have between 15 and 40 sapwood rings.

DISCUSSION

As noted above, documentary evidence for a settlement at Whitwood goes back as far as the first half of the fourteenth century although mention of Whitwood Farm itself is not found until the eighteenth century. The medieval history of this settlement has now been further confirmed by the tree-ring dating. The well preserved barn at Whitwood Farm is now known to be constructed from timber felled in the late Spring/early Summer of 1445. As mentioned earlier, during this period it is known that oak timber was used 'green' rather than being seasoned and so it is likely that construction occurred soon after the felling of the timber utilised.

Two timbers from the house have also been successfully dated; a ridge from bay 2 with a felling of *c.* 1548 and a purlin from bay 4 with a *terminus post quem* of 1521. It is possible that this latter timber was also felled in *c.* 1548 but without the heartwood/sapwood boundary ring it is not possible to say

this conclusively. With only two of the house timbers being successfully dated we are not able to make any definite conclusions about the construction date of the house except to say that it contains timber of the mid-sixteenth century.

It is unfortunate that the timbers of the house were not universally suitable for tree-ring dating, with many of them being from fast grown trees that had insufficient number of rings for secure dating. Sampling of other timbers was avoided as they appeared to have empty mortices suggesting they had been used in a different structure previously, and any date gained, therefore, would not have provided a date for their present use.

Acknowledgements

This work was commissioned and funded by Mr and Mrs Richard Baldwin, owners of the buildings, as part of recording work required for planning consent. Andy Swann, of Archaeological Services WYAS kindly allowed us to see their documentary and historical research, upon which the introduction above has been based, and to use some of their drawings to locate timbers sampled.

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Table 1: Details of samples from the barn and house at Whitwood Farm

Sample number	Sample location	*Total rings	**Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
Barn						
WTW-D01	East post, truss 6	85	h/s	1331	1425	1415
WTW-D02	West principal rafter, truss 6	74	--	----	----	----
WTW-D03	East post, truss 4	94	h/s	1332	1425	1425
WTW-D04	West brace, east post, truss 4	91	13	1344	1421	1434
WTW-D05	East post, truss 3	95	30C	1350	1414	1444
WTW-D06	Tiebeam, truss 3	129	25C	1316	1419	1444
WTW-D07	South brace, east post, truss 3	101	26	1343	1417	1443
WTW-D08	North brace, east post, truss 4	61	03	1374	1431	1434
WTW-D09	West wallplate, truss 5-6	54	10	----	----	----
House						
WTW-D10	Ridge, truss 2-3	91	21c (+*c*5lost)	1453	1522	1543
WTW-D11	East purlin, truss 4-5	130	24C	----	----	----
WTW-D12	West purlin, truss 4-5	102	--	1405	----	1506
WTW-D13	Ridge, truss 6-7	54	13	----	----	----
WTW-D14	East principal rafter, truss 6	NM	--	----	----	----
WTW-D15	West principal rafter, truss 6	NM	--	----	----	----

*NM = not measured

**h/s = the heartwood/sapwood boundary is the last ring on the sample; C = complete sapwood retained on sample; c = complete sapwood on timber, all or part lost during sampling

Table 2: Results of the cross-matching of site sequence WTWDSQ01 and relevant reference chronologies when the first-ring date is 1316 and the last-measured ring date is 1444

Reference chronology	*t*-value	Span of chronology	Reference
Horbury Hall, Wakefield, West Yorkshire	9.3	1368-1473	Howard *et al* 1992
Tithe Barn, Bolton Abbey, West Yorkshire	8.8	1371-1518	Arnold and Howard 2006 unpubl
Peny's Hey, Lowerhouses, Huddersfield, West Yorkshire	7.4	1386-1573	Arnold *et al* 2008a
Mercer's Hall, Gloucestershire	7.2	1289-1541	Howard *et al* 1996a
Witton Hall Farm, Witton Gilbert, County Durham	6.6	1342-1441	Howard *et al* 1996b
Tunstall Hall Farm, Hartlepool	6.4	1316-1484	Howard *et al* 2002a
Hopwood Hall, Rochdale, Manchester	6.1	1287-1427	Arnold *et al* 2003

Table 3: Results of the cross-matching of sample WTW-D10 and relevant reference chronologies when the first ring date is 1453 and the last-measured ring date is 1543

Reference chronology	*t*-value	Span of chronology	Reference
Manor House, Sutton in Ashfield, Nottinghamshire	5.3	1441-1656	Howard *et al* 1996c
Cromford Bridge Hall, Derbyshire	5.2	1416-1613	Arnold and Howard 2007 unpubl
Hardwick Hall (west lodge staircase), Derbyshire	5.0	1397-1625	Howard *et al* 2002b
Little Morton Hall, Cheshire	5.0	1377-1562	Howard 2003 unpubl
Green Farm, Offcote, Derbyshire	4.7	1460-1578	Arnold *et al* 2008a
Low Farmhouse, Maplebeck, Nottinghamshire	4.6	1385-1587	Arnold *et al* 2008a
Moor Farm Cottage, Shardlow, Derbyshire	4.5	1434-1614	Howard *et al* 1994

Table 4: Results of the cross-matching of sample WTW-D12 and relevant reference chronologies when the first ring date is 1405 and the last-measured ring date is 1506

Reference chronology	*t*-value	Span of chronology	Reference
Hardwick Old Hall, nr Chesterfield, Derbyshire	7.6	1375-1590	Howard *et al* 2002b
Hall Broom Farm, Dungworth, Derbyshire	6.1	1382-1495	Howard *et al* 1993
Seaton Holme, Easington, County Durham	6.0	1375-1489	Arnold *et al* 2008b
Ordsall Hall, Stockport, Greater Manchester	6.0	1368-1534	Arnold *et al* 2004
Unthank Hall, Stanhope, County Durham	5.9	1415-1527	Howard *et al* 2001
Hempshill Hall, Nottinghamshire	5.6	1315-1500	Arnold and Howard 2007
Scargill Castle, County Durham	5.5	1432-1540	Howard *et al* 2002c

Figure 1: The House; truss 2, photograph taken from the south

Figure 2: The House; bay 4, photograph taken from the south

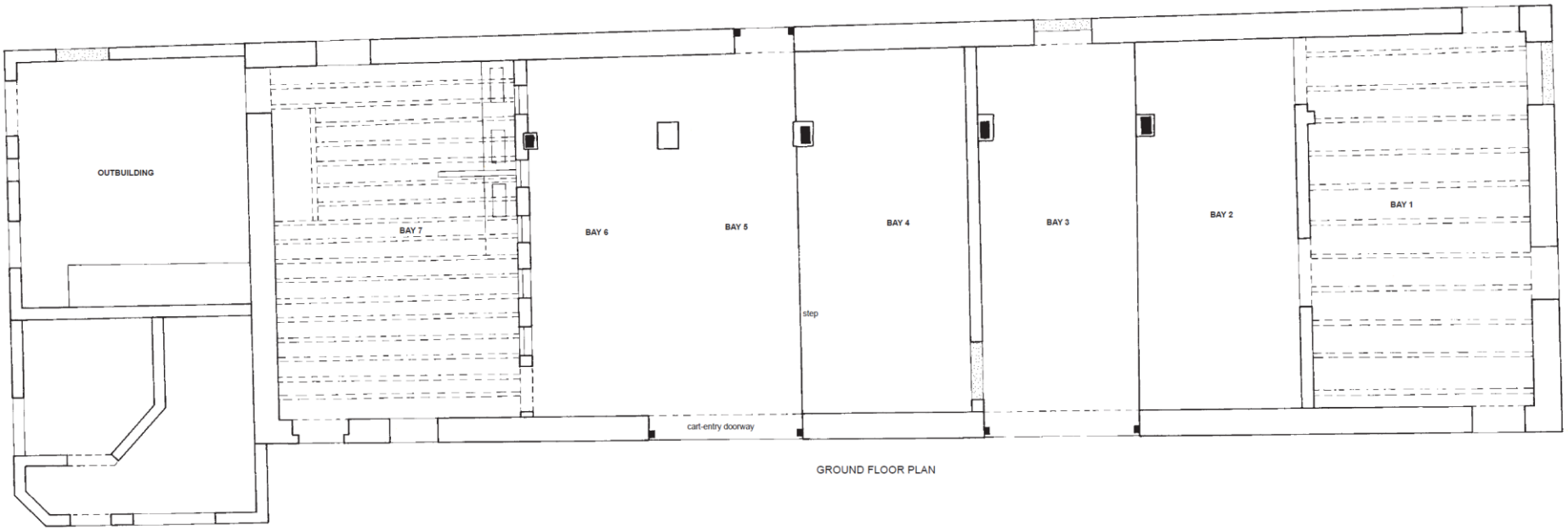

Figure 3: The Barn; ground-floor plan (Archaeological Services WYAS)

Figure 4: The Barn; east aisle post of truss 3

Figure 5: The Barn; truss 6, photograph taken from the north

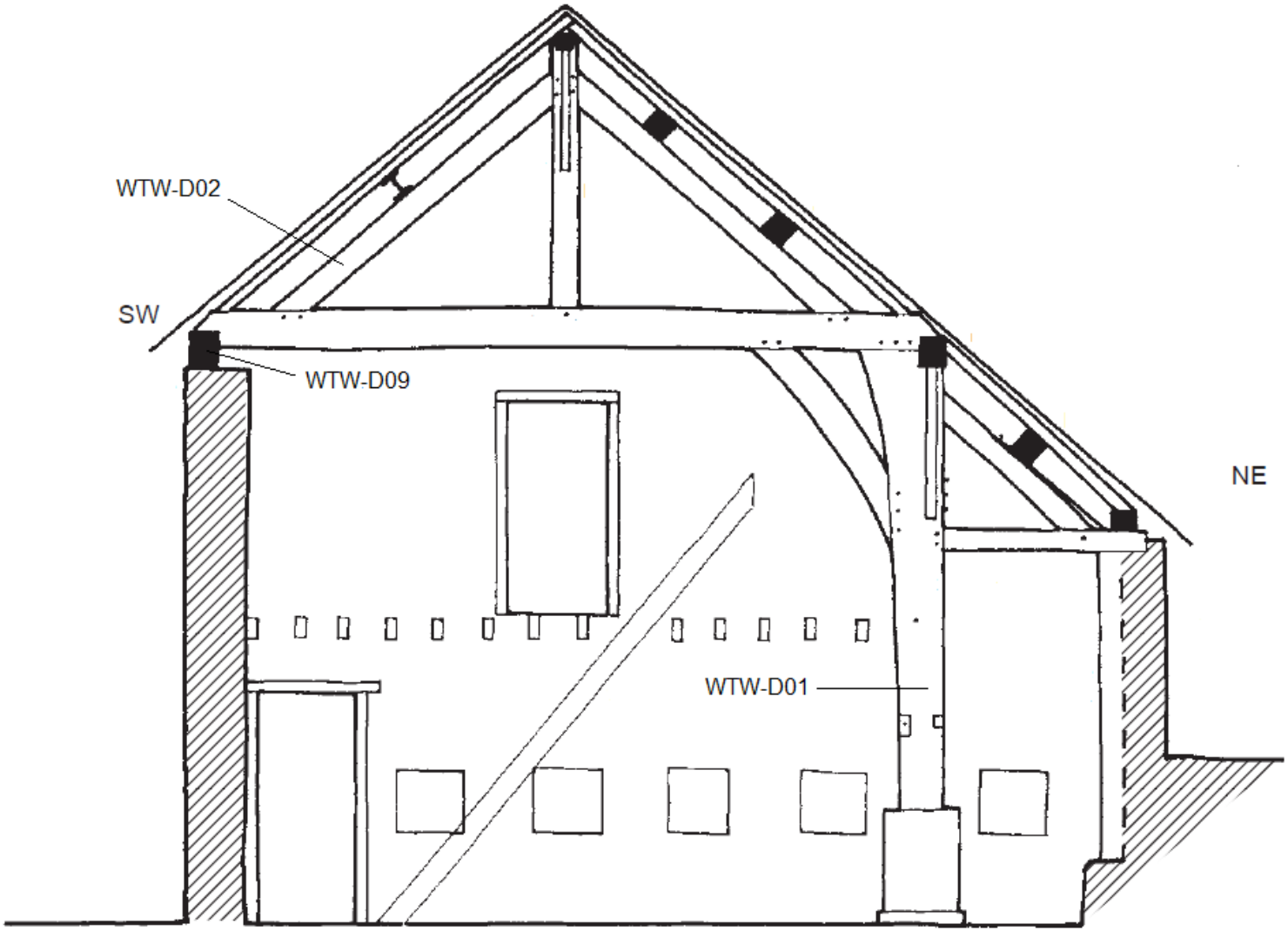

Figure 6: The Barn; truss 6, showing the location of samples WTW-D01, WTW-D02, and WTW-D09 (Archaeological Services WYAS)

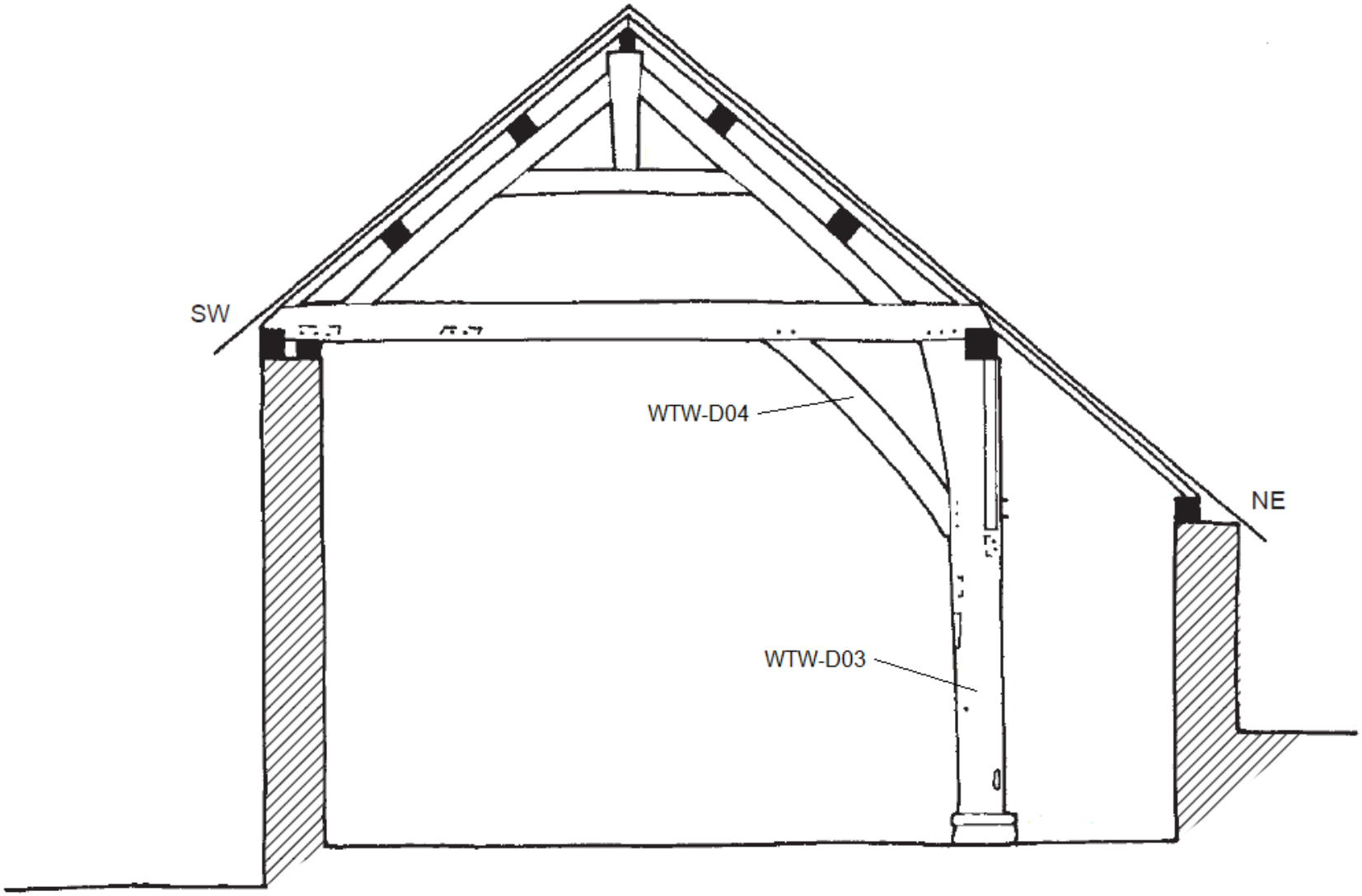

Figure 7: The Barn; truss 4, showing the location of samples WTW-D03 and WTW-D04 (Archaeological Services WYAS)

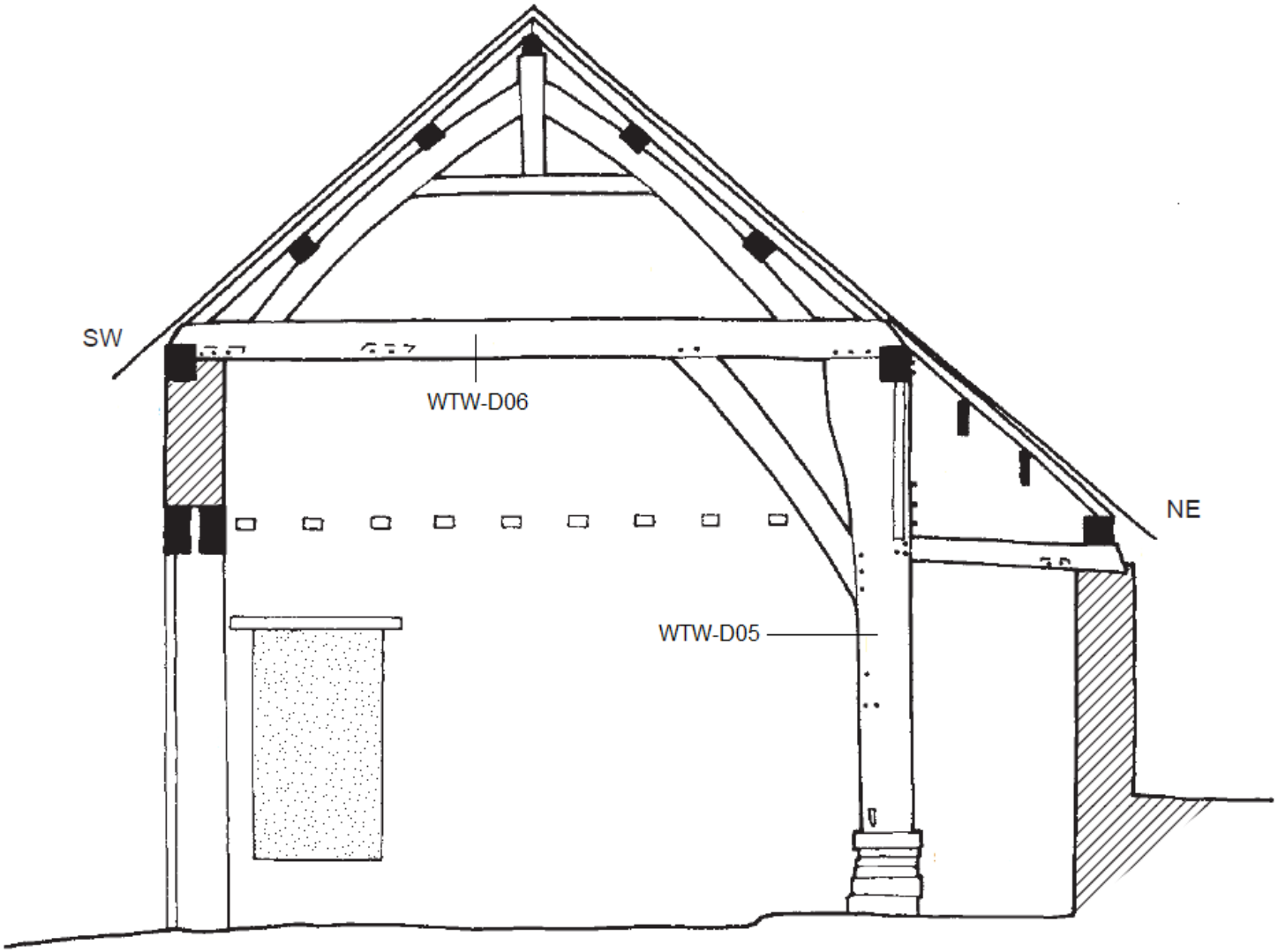

Figure 8: The Barn; truss 3, showing the location of samples WTW-D05 and WTW-D06 (Archaeological Services WYAS)

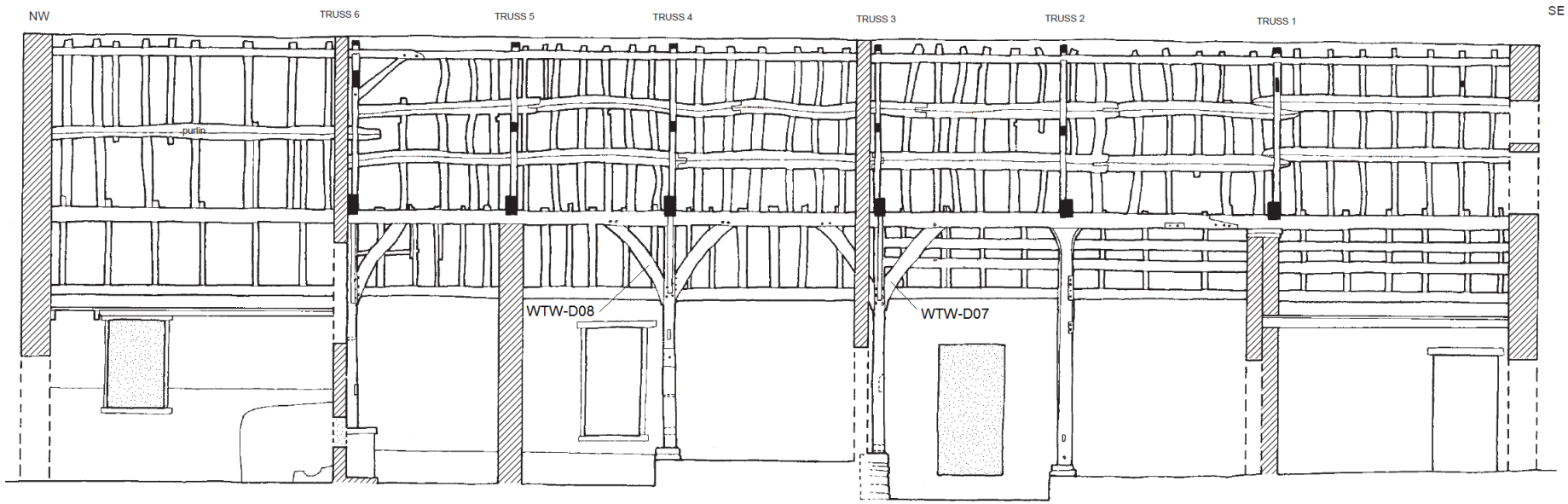

Figure 9: The Barn; section, showing the location of samples WTW-D07 and WTD-D08 (Archaeological Services WYAS)

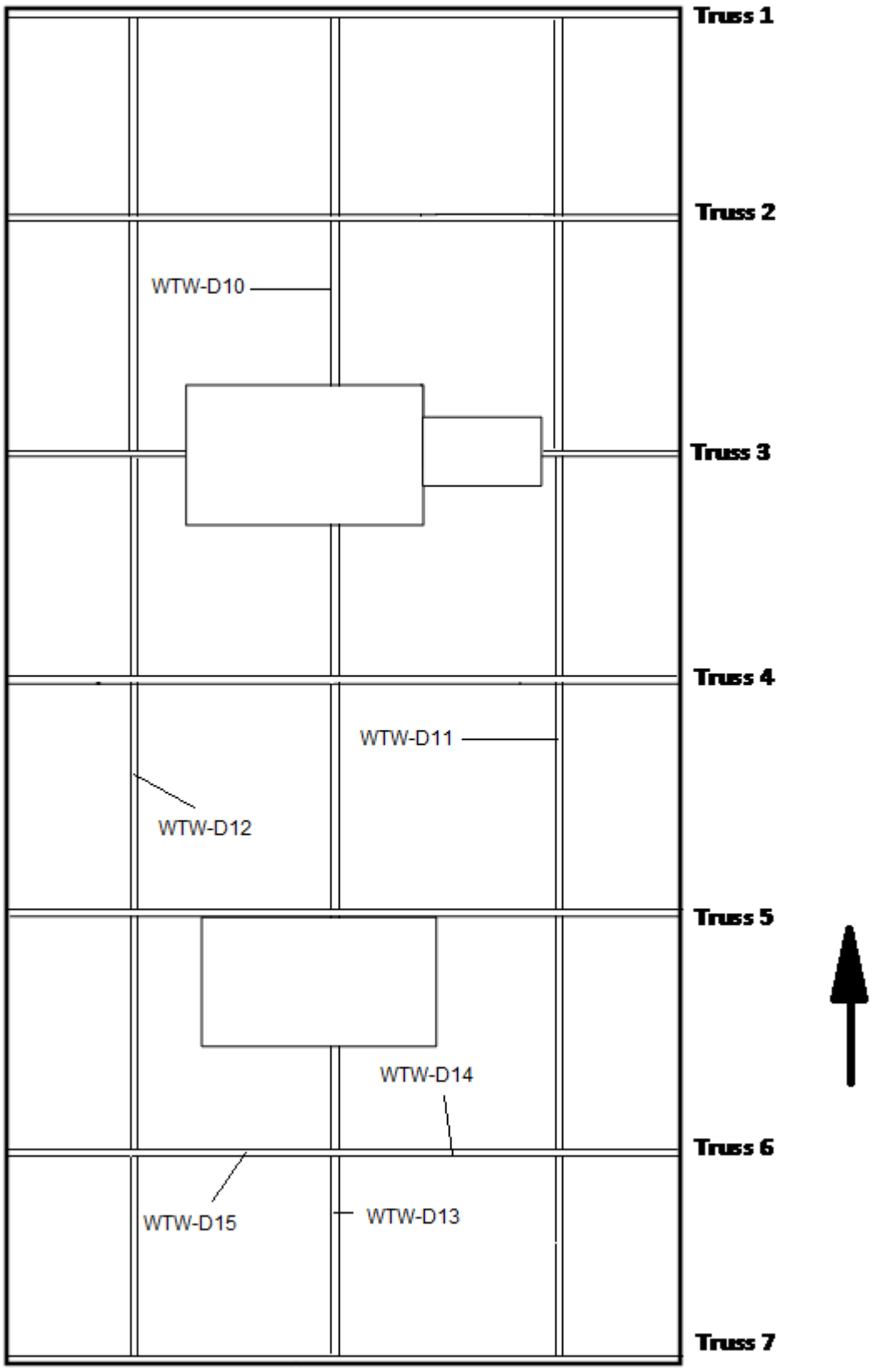

Figure 10: The House; sketch plan of farmhouse roof, showing the location of samples WTW-D10-15

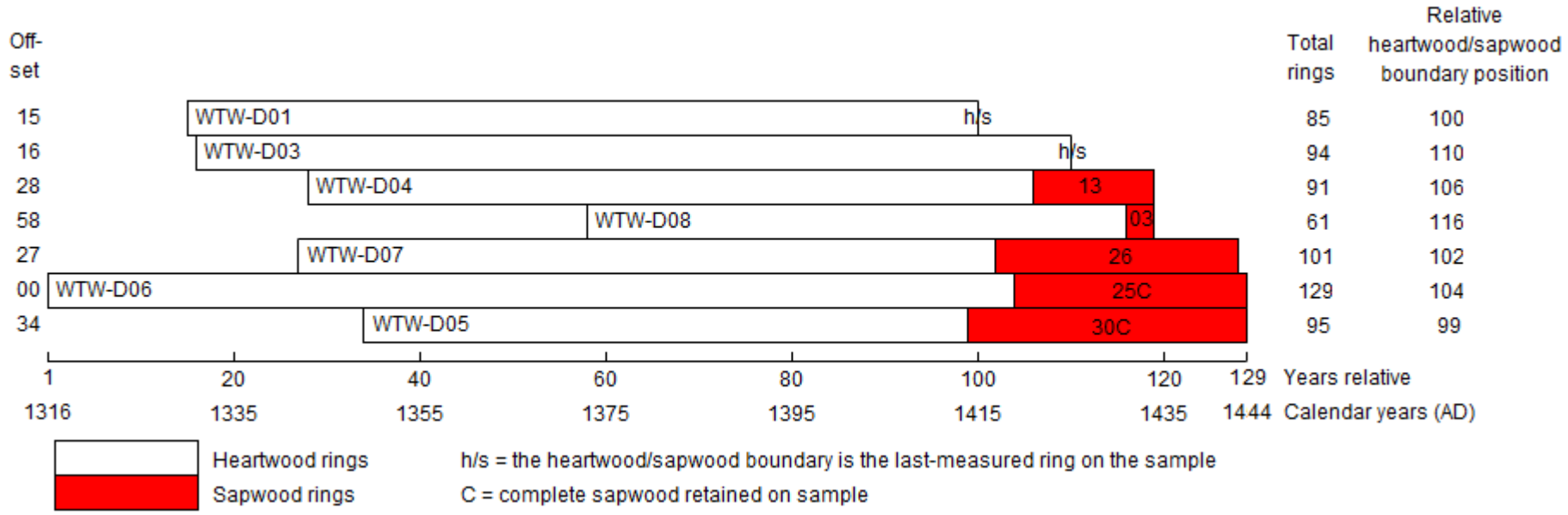

Figure 11: Bar diagram of samples in site sequence WTWDSQ01