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Dendrochronology, timber analysis, and historic building consultants

TREE-RING ANALYSIS OF TIMBERS FROM LING BOB FARM SCOTLAND LANE HORSFORTH, LEEDS YORKSHIRE

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SUMMARY

Dendrochronological analysis was undertaken on samples taken from timbers of the barn and former farmhouse at Ling Bob Farm, resulting in the construction and dating of two site sequences and the individual dating of two samples.
Site sequence LBOBSQ01 contains two samples and spans the period 950–1246 whilst site sequence LBOBSQ02 contains nine samples and spans the period 1496–1664. Sample LBO-B02 was dated to a first-ring date of 1420 and a last-measured ring date of 1532 and LBO-B16 to a first-ring date of 1513 and a last-measured ring date of 1573.
The barn contains reused timber dating to 1261–86 and at least one primary timber dating to 1666–91. Two other barn samples have *terminus post quem* felling dates of 1547 and 1653.
The roof of the former farmhouse contains timber of 1602 with construction likely to have occurred shortly after. A single purlin was found to be later, dating to 1661–86, and is thought to represent a repair.
A third site sequence is undated.

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INTRODUCTION

The complex of buildings making up Ling Bob Farm is located just off Scotland Lane, to the north of Horsforth and *c* 1.5km from Leeds Bradford Airport (Figs 1–3). Three of these buildings are Grade II listed and currently on the Buildings at Risk register; Ling Bob Farmhouse, thought to date to the seventeenth century but altered and remodelled in the eighteenth and twentieth centuries, the former farmhouse, and the barn. Due to the timbers of the present farmhouse being unsuitable for tree-ring dating investigations were restricted to the former farmhouse and the barn.

Former farmhouse

The former farmhouse (Farmhouse 1 in listing description and site plan) is located approximately 10m to the north-east of the present farmhouse (Fig 4). It is constructed of coursed, squared sandstone with a stone slate roof and is of end-lobby plan with a continuous rear outshut (Fig 5). The roof over this building consists of two king post trusses with principal rafters and struts. There are empty mortices in the king posts and ridge signifying there was once braces running between these two elements (Fig 6). There are a single tier of purlins to the main roof with a further two to the catslide to the north. The exception is in the westernmost bay where there can be seen to be two slender purlins rather than the heavier single purlin seen in other bays (Fig 6). On the ground floor is an exposed large, chamfered ceiling beam, with a scarf joint *c* 2m from the chimney breast, thought to indicate the presence of a former firehood. This building is believed to date to the later-seventeenth century but underwent alterations in the nineteenth and twentieth centuries.

Barn

To the north-west of the present farmhouse is the former stables and barn. This is a long building on a north-south alignment, aisled on the west side. At right angles to the north end of the barn is the arch barn (existing stable range). The stables and barn are again constructed of coursed squared sandstone with quoins, slate roof and has a large, segmental-headed wagon doorway with chamfered surround, near the north end (Fig 7). To the south of this there is a Tudor-arched doorway with chamfered surround, the lintel above it has the date 1680 carved into it. The roof over the northern part of this building consists of a king post truss, with tiebeam, principal rafters, and struts. A post survives on the west side but can be seen to have been cut down and now sits on a brick pillar. From this braces rise up to the tiebeam and a purlin of the aisle (Fig 8). The rest of the roof is in a very fragmentary state (Fig 9).

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 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 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.

SAMPLING

A total of 20 timbers was sampled, with each sample being given the code LBO-B and numbered 01–20; samples LBO-B01–08 being taken from the roof timbers of the barn and LBO-B09–20 from the roof and ceiling beams in the former farmhouse. The location of samples was noted at the time of sampling and has been marked on Figures 10–14. Further details can be found in Table 1. Interest had also been expressed in the roof of the present farmhouse and an assessment was made. From a

surface inspection of the timbers utilised within this roof it could be seen that they generally had a very wide growth pattern, signifying the use of fast-grown timber. It was thought likely that any samples taken would have less than 40 growth rings and would, therefore, be unsuitable for tree-ring dating. The style of roof over this building is not as archaic as those over the barn and former farmhouse and is one commonly seen in structures of the eighteenth century. Due to the unsuitability of the timbers of the roof, the decision was taken not to sample but instead to concentrate on the former farmhouse and barn.

ANALYSIS & RESULTS

At this stage, two samples taken from the former farmhouse, one from the roof (LBO-B13) and one from a ceiling beam (LBO-B19) were found to have too few rings for secure dating to be a possibility and so were discarded prior to measurement. The remaining 18 samples were prepared by sanding and polishing and their growth-ring widths measured. These growth-ring widths were then compared with each other resulting in 13 samples matching to form three groups.

Firstly, two samples matched each other and were combined at the relevant offset positions to form LBOBSQ01, a site sequence of 297 rings (Fig 15). 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 950 and a last-measured ring date of 1246. The evidence for this dating is given by the *t*-values in Table 2.

Secondly, nine samples grouped to form a site sequence of 169 rings (Fig 16). When compared against the reference material this site sequence matched at a first-ring date of 1496 and a last-measured ring date of 1664. The evidence for this dating is given by the *t*-values in Table 3.

Finally, two samples matched each other and were combined to form LBOBSQ03, a site sequence of 109 rings (Fig 17). Attempts to match this site sequence against the reference chronologies were unsuccessful and it remains undated.

Attempts were then made to date the remaining ungrouped samples by comparing them individually against the reference chronologies resulting in sample LBO-B02 being found to span the period 1420–1532 and sample LBO-B16 to the period 1513–73. The evidence for this dating is given by the *t*-values in Tables 4 and 5.

INTERPRETATION

Former farmhouse

Eight of the samples taken from the roof of this building have been successfully dated (Fig 18). Sample LBO-B10, taken from the king post of truss 1, has complete sapwood and the last-measured ring date of 1602, the felling date of the timber represented. Six other samples have similar heartwood/sapwood boundary ring dates to each other, suggestive of a single felling. The average heartwood/sapwood boundary ring date of these six samples is 1581, allowing an estimated felling date to be calculated for the timbers represented to within the range 1601–21, consistent with these samples also having been felled in 1602. This felling date range allows for sample LBO-B11 to have the last-measured ring date of 1600 with incomplete sapwood. The final dated sample, taken from a purlin, has the later heartwood/sapwood boundary ring date of 1646, giving an estimated felling date range for the timber represented of 1661–86.

Barn

Five of the samples taken from the barn have been successfully dated (Fig 18). Only two of these have the heartwood/sapwood boundary, interpretation of which suggests two separate fellings. Sample LBO-B07, taken from an aisle tie, has the heartwood/sapwood boundary ring date of 1246, allowing an estimated felling date to be calculated for the timber represented of 1261–86. With a last-measured heartwood ring date of 1218 it is possible that sample LBO-B08, again from an aisle tie, was also felled in 1261–86. Additionally, these two samples match each other at *t*=12.9, a value high enough to suggest both timbers were cut from the same tree. At the time of sampling the two beams represented by these samples could be seen to be reused (Fig 19).
The other sample with the heartwood/sapwood boundary ring date is LBO-B01, taken from the tiebeam. The heartwood/sapwood boundary ring date of this sample is 1651, allowing an estimated felling date to be calculated for the timber represented to within the range 1666–91.
Neither of the final two dated barn samples have the heartwood/sapwood boundary ring date and so a felling date range cannot be calculated for them. However, with last measured ring dates of 1532 (LBO-B02) and 1638 (LBO-B04), it is estimated that these two samples would have *terminus post quem* felling dates of 1548 and 1654, respectively.

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

DISCUSSION

Prior to tree-ring analysis being undertaken both the former farmhouse and the barn were thought to date to the late-seventeenth century; the latter building has a carved date of 1680 on a lintel.

It is now known that the majority of the timber utilised within the roof over the former farmhouse was felled in 1602, with construction likely to have occurred shortly afterwards, dating the building to the very beginning of the seventeenth century, somewhat earlier than previously thought. A single purlin in the westernmost bay was felled in 1661–86. This beam looks different to the rest of the purlins, being of smaller scantling and is likely to represent repair undertaken in the second half of the seventeenth century.

Two of the aisle ties of the barn have been dated to 1261–86; both of these timbers can clearly be seen to be reused. The tiebeam of truss 1, a timber thought to be primary, is now known to have been felled in 1666–91. Two further barn timbers, a king post and a purlin, have *terminus post quem* fellings of 1547 and 1653, respectively. During the sampling of these latter two timbers, the heartwood/sapwood boundary was seen on both beams and it was felt that this point was only just missed off the samples. This would mean that the actual felling dates are probably quite close to the *terminus post quem* dates, suggesting two separate fellings, one in the mid-later sixteenth century and the other in the second half of the seventeenth century, perhaps at the same time as the tiebeam. With at least one, and probably two timbers being dated to the second half of the seventeenth century, the dendrochronology has provided support for the 1680 date carved on the door lintel. However, it has also shown that reused timber from the thirteenth and possibly the sixteenth century was also utilised in its construction.

It is unfortunate that the third site sequence (LBOBSQ03), containing two samples from the barn could not be dated. With similar heartwood/sapwood boundary ring positions (Fig 17) it is possible to say that the two timbers represented are likely to have been felled at the same time, even though it is not possible to say when that might have been.

An interesting feature of the timber from Ling Bob Farm is the age of the trees at felling. By far the oldest tree is that represented by samples LBO-B07 and LBO-B08. With these two timbers thought to have been cut from the same tree (above), and without the centre ring or any sapwood being present on either sample (Table 1) the tree from which they were cut would have been older than 300 years at felling. The use of such ancient trees is generally a feature of the thirteenth and early-fourteenth centuries; after this period the age of trees at felling decreases, something again seen at Ling Bob Farm. The seventeenth-century timber identified within the former farmhouse and barn is likely to have been 100–150 years old at felling whilst the (probably) eighteenth-century timber used within the present farmhouse roof had too few growth rings to be suitable for tree-ring dating and was most probably even younger at felling.

The reason for this decrease of tree age at felling is probably to do with an increase in timber exploitation resulting in changes in the character of woodlands used. In the thirteenth and fourteenth centuries timber is likely to have come from densely packed, unmanaged forests where a lack of space meant trees would grow slowly and could be many hundreds of years old before achieving a usable size. As demand for timber increased and with the introduction of woodland management, the ancient forests became less packed with trees, and as space increased trees could reach a useable size much more quickly. The increase in demand also meant trees began to be felled at a much faster rate.

Acknowledgements

This work was commissioned by Paul Gwilliam of Archaeological Services WYAS on behalf of the owners of the buildings. The Laboratory would like to thank Paul Gwilliam for his invaluable *on-site* advice and for his comments on early drafts of this report. Details used in the introduction (above) were taken from the listed buildings description; drawings on which sample locations have been marked were based on those produced by Peter Harrison Architects.

Table 1: Details of samples from Ling Bob Farm, Scotland Lane, Horsforth, Leeds, Yorkshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)	Centre on sample
Barn roof							
LBO-B01	Tiebeam, truss 1	119	h/s	1533	1651	1651	Near
LBO-B02	King post, truss 1	113	--	1420	----	1532	No
LBO-B03	West post, truss 1	81	h/s	----	----	----	Yes
LBO-B04	Aisle, lower purlin, T1–2	48	--	1591	----	1638	Yes
LBO-B05	West post, T2	102	h/s	----	----	----	Near
LBO-B06	Aisle, lower purlin, T2–3	47	--	----	----	----	Near
LBO-B07	Aisle tie, truss 2	231	h/s	1016	1246	1246	No
LBO-B08	Aisle tie, truss 3	269	--	950	----	1218	No
Former farmhouse							
LBO-B09	Tiebeam, truss 1	70	h/s	1517	1586	1586	Yes
LBO-B10	King post, truss 1	73	17C	1530	1585	1602	Near
LBO-B11	North principal rafter, truss 1	59	16	1542	1584	1600	No
LBO-B12	South principal rafter, truss 1	81	03	----	----	----	Yes
LBO-B13	South strut, truss 1	NM	--	----	----	----	No
LBO-B14	King post, truss 2	79	18	1521	1581	1599	Yes
LBO-B15	North purlin, east end to truss 1	54	11	1542	1584	1595	No
LBO-B16	South purlin, east end to truss 1	61	h/s	1513	1573	1573	Near
LBO-B17	South upper purlin, truss 2 to west end	86	18	1579	1646	1664	Near
LBO-B18	Catslide – north lower purlin, east end to truss 1	99	14	1496	1580	1594	Yes
LBO-B19	East-west ceiling beam (east end)	NM	--	----	----	----	Near
LBO-B20	East-west ceiling beam (west end)	69	h/s	----	----	----	Yes

*NM = not measured

**h/s = the heartwood/sapwood boundary ring is the last-measured ring on the sample

C = complete sapwood retained on sample, last measured ring is the felling date

Table 2: Results of the cross-matching of site sequence LBOBSQ01 and relevant reference chronologies when the first-ring date is 950 and the last-measured ring date is 1246

Reference chronology	*t*-value	Span of chronology
Chapter House Roof, York Minster, Yorkshire	9.5	954–1150
32 Goodramgate, York, Yorkshire	7.6	992–1298
All Hallow's Church, Kirkburton, Yorkshire	7.7	999–1218
Medbourne Manor, Leicestershire	5.7	1068–1287
St Lawrence, Rush Spencer, Staffordshire	5.5	1034–1279
St Mary's Church, Stockport, Greater Manchester	5.3	1099–1293
Oakham Castle, Rutland	5.3	923–1153

Table 3: Results of the cross-matching of site sequence LBOBSQ02 and relevant reference chronologies when the first-ring date is 1496 and the last-measured ring date is 1664

Reference chronology	*t*-value	Span of chronology
Sandiacre Tithe Barn, Derbyshire	7.5	1427–1611
Staircase Café, Stockport, Manchester	9.1	1489–1656
Crowtrees, Ripley, Derbyshire	6.6	1504–1616
Howley Hall Farm, Morley, West Yorkshire	6.5	1415–1635
Sutton Scarsdale Manor Barn,	6.5	1520–1632
Sinai House, Burton-on-Trent, Staffordshire	6.3	1529–1616
Ulnaby Hall, High Coniscliffe, Darlington, County Durham	6.2	1493–1608

Table 4: Results of the cross-matching of sample LBO-B02 and relevant reference chronologies when the first-ring date is 1420 and the last-measured ring date is 1532

Reference chronology	*t*-value	Span of chronology
Norton Conyers Hall, West Yorkshire	10.6	1365–1486
Horbury Hall, Wakefield, Yorkshire	8.2	1368–1473
Low Harperley Farmhouse, Wolsingham, County Durham	7.3	1356–1604
Hunwick Hall Farm, Hunwick, County Durham	6.6	1402–97
Barbican/Gatehouse, Warwick Castle, Warwickshire	6.3	1310–1503
Hallgarth Pittington, County Durham	7.0	1336–1624
Dilston Castle, Corbridge, Northumberland	6.1	1402–1611

Table 5: Results of the cross-matching of sample LBO-B16 and relevant reference chronologies when the first-ring date is 1513 and the last-measured ring date is 1573

Reference chronology	*t*-value	Span of chronology
Pontefract Castle, Wakefield, West Yorkshire	6.1	1507–1656
Hallfield House, Bradfield, South Yorkshire	6.0	1482–1592
North Lees Hall, Outseats, Derbyshire	5.8	1468–1578
Grange Farm, Norton, Sheffield, South Yorkshire	5.6	1436–1599
Offerton Hall, Offerton, Derbyshire	5.4	1401–1592
Fair Flats Farm, Bradfield, South Yorkshire	5.3	1492–1633
Howley Hall Farm, Morley, West Yorkshire	4.9	1415–1635

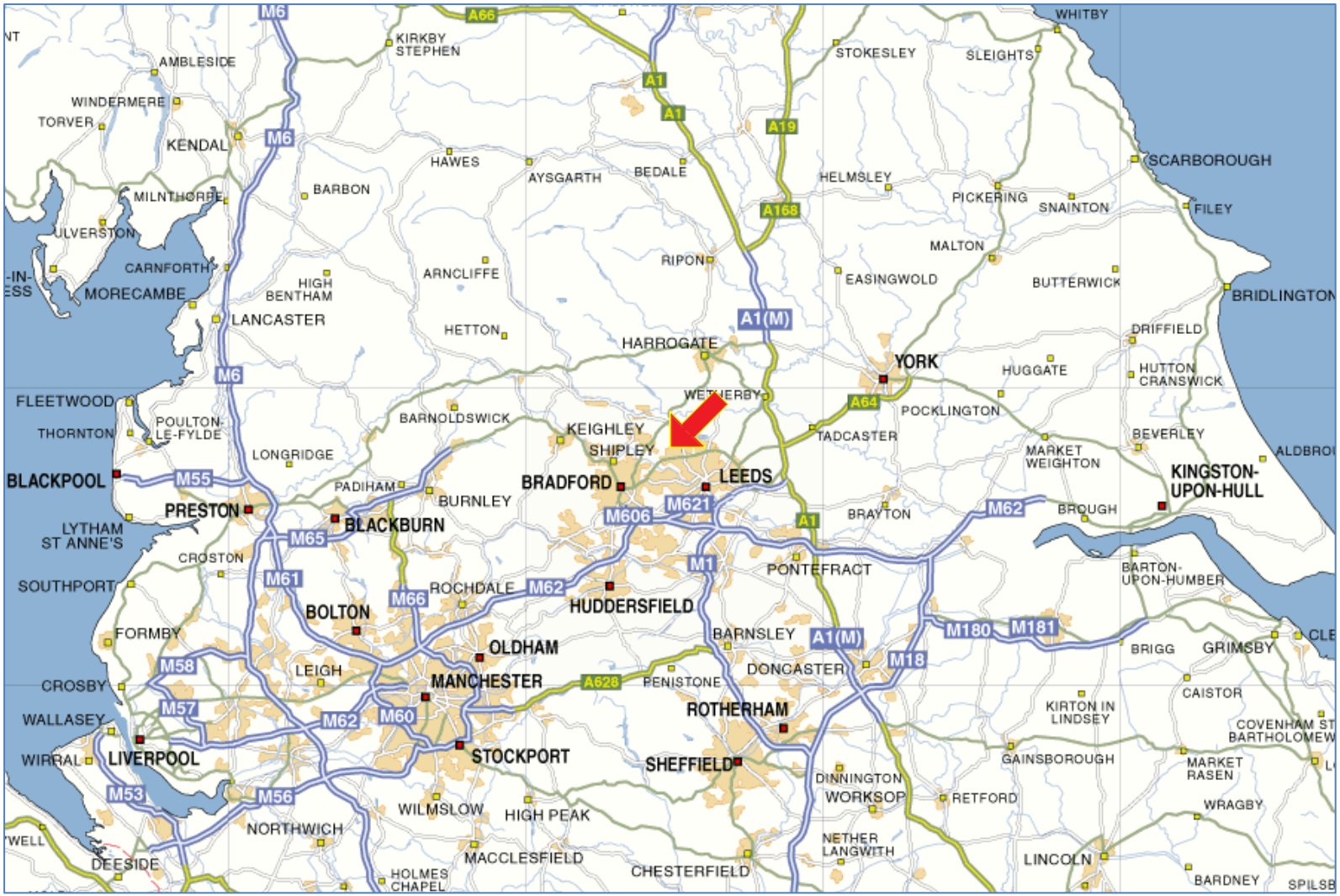

Figure 1: Map to show the general location of Horsforth, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

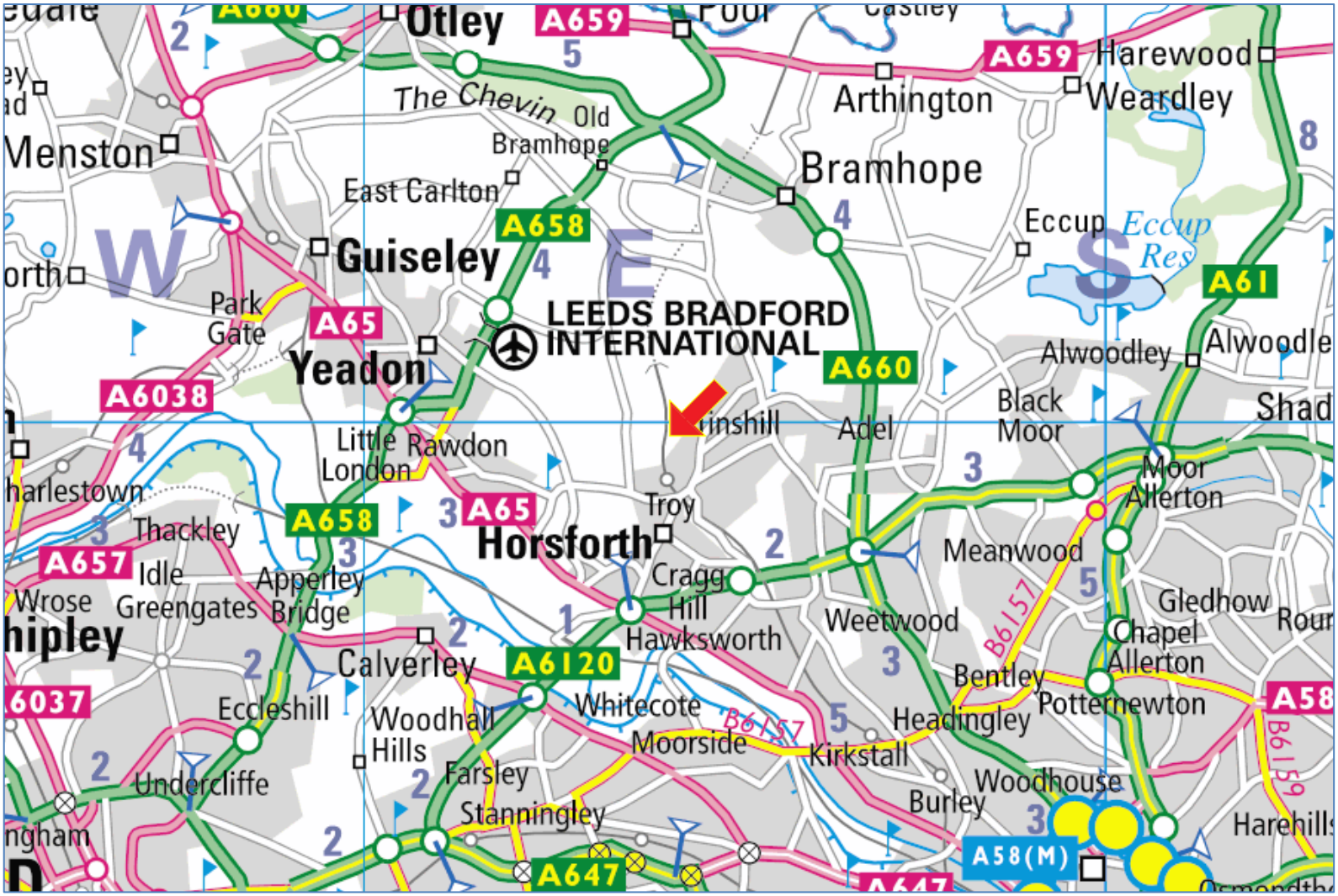

Figure 2: Map to show the general location of Ling Bob Farm, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

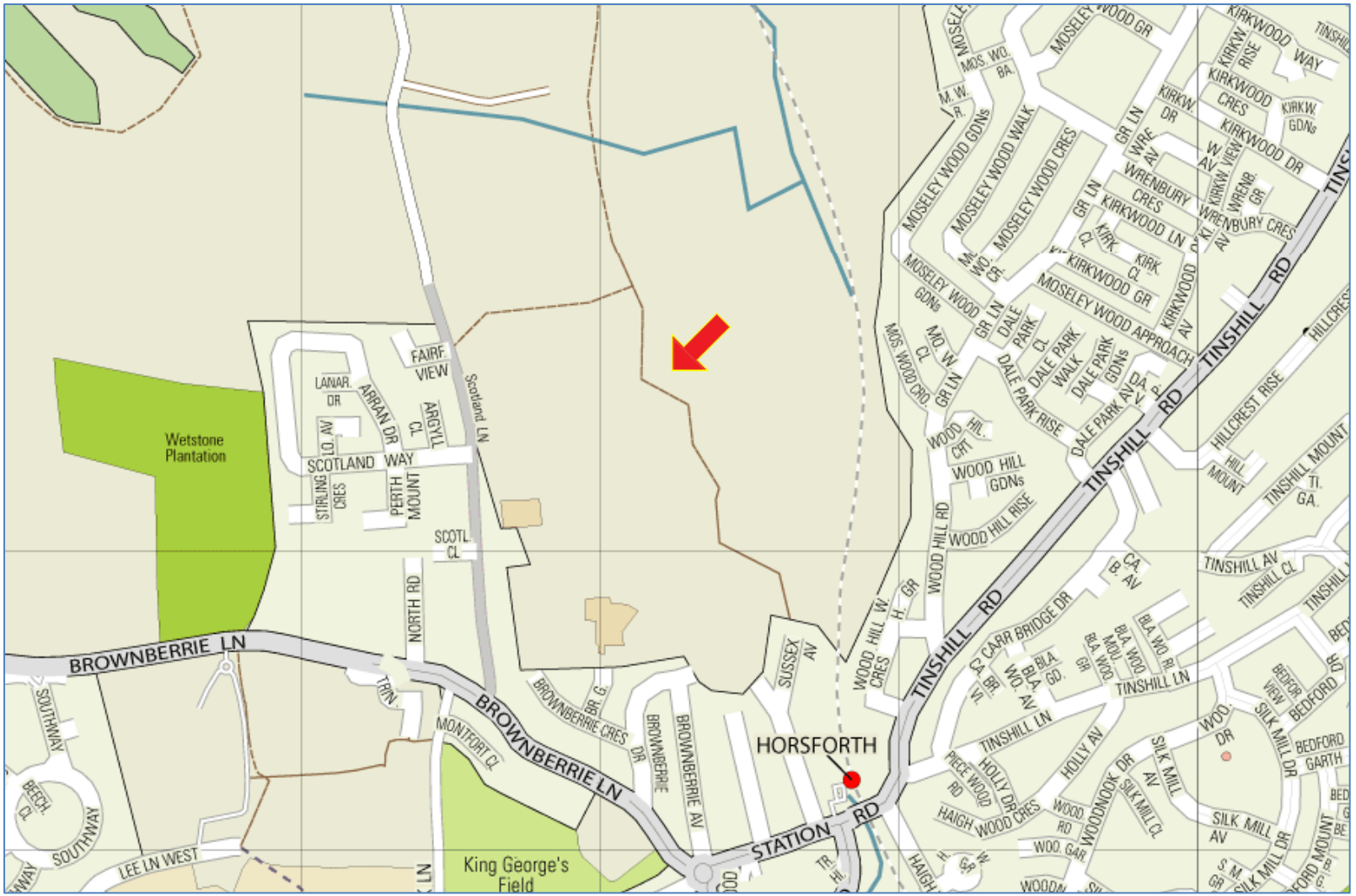

Figure 3: Map to show the location of Ling Bob Farm (arrowed; based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

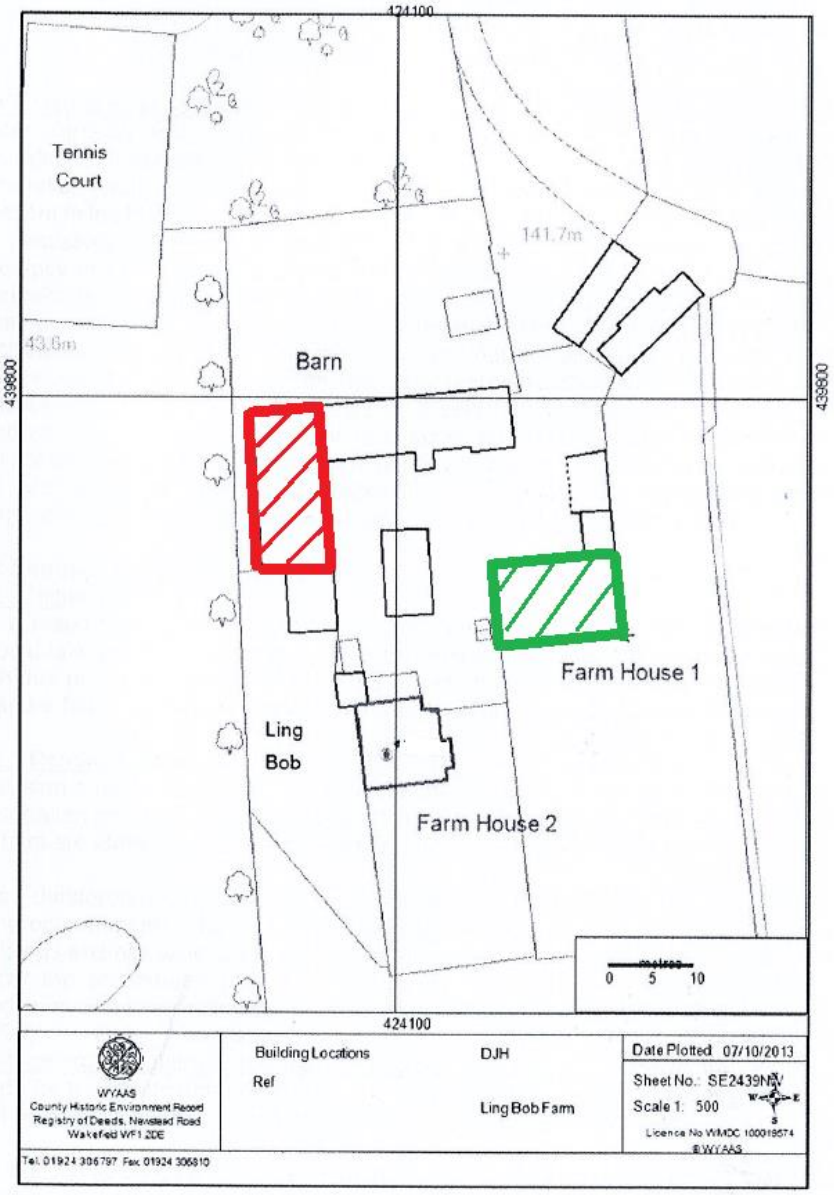

Figure 4: Site plan, with former farmhouse (green) and barn (red) hashed.

Figure 5: The rear of the former farmhouse, photograph taken from the north-west

Figure 6: Former farmhouse, truss 2 (photograph taken from the west)

Figure 7: The barn, photograph taken from the east

Figure 8: The barn, truss 1, photograph taken from the south

Figure 9: The barn roof, the post of truss 2 in the background, photograph taken from the south-east

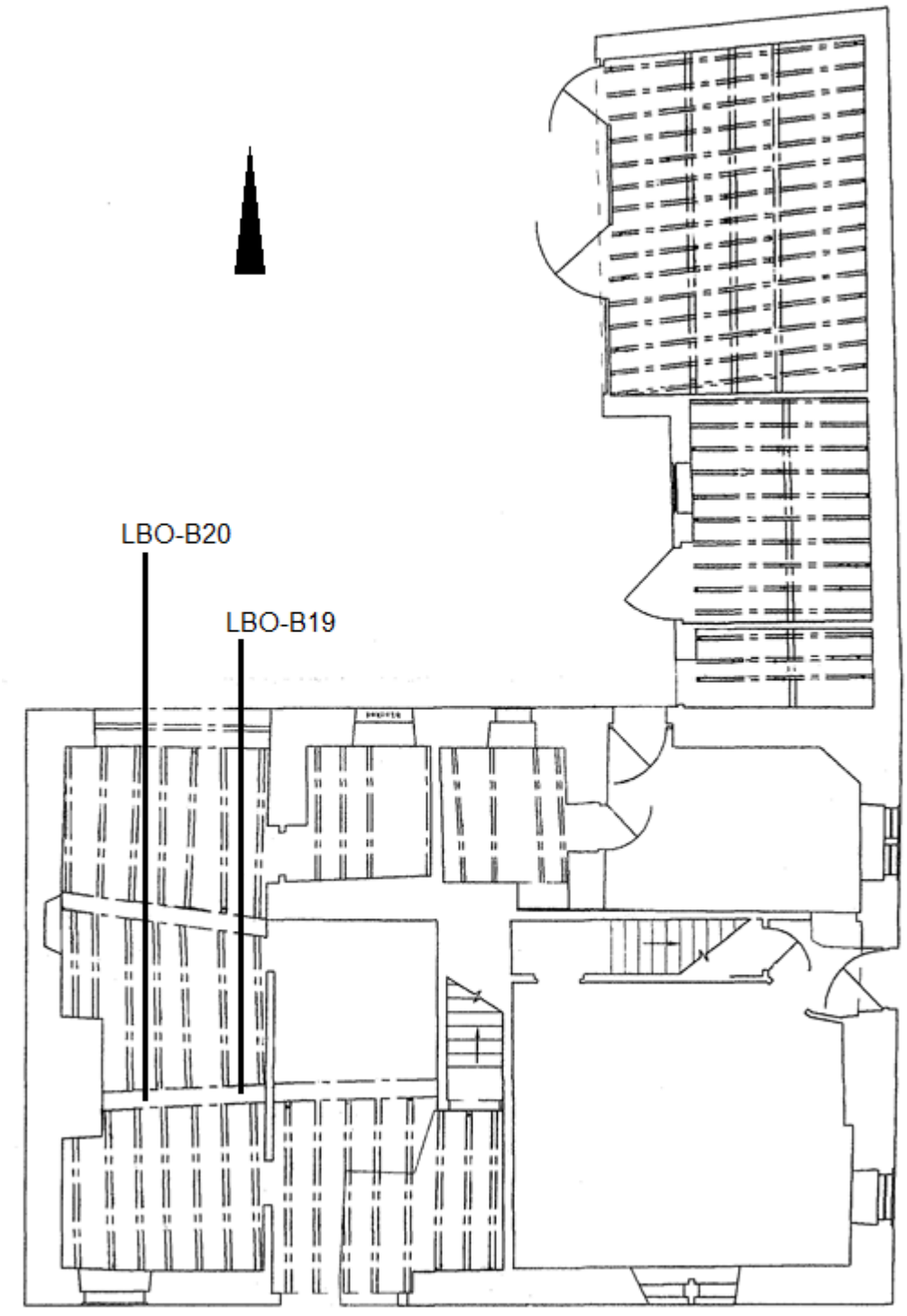

Figure 10: Former farmhouse, ground floor plan, showing the location of samples LBO-B19 and LBO-B20 (Peter Harrison Architects)

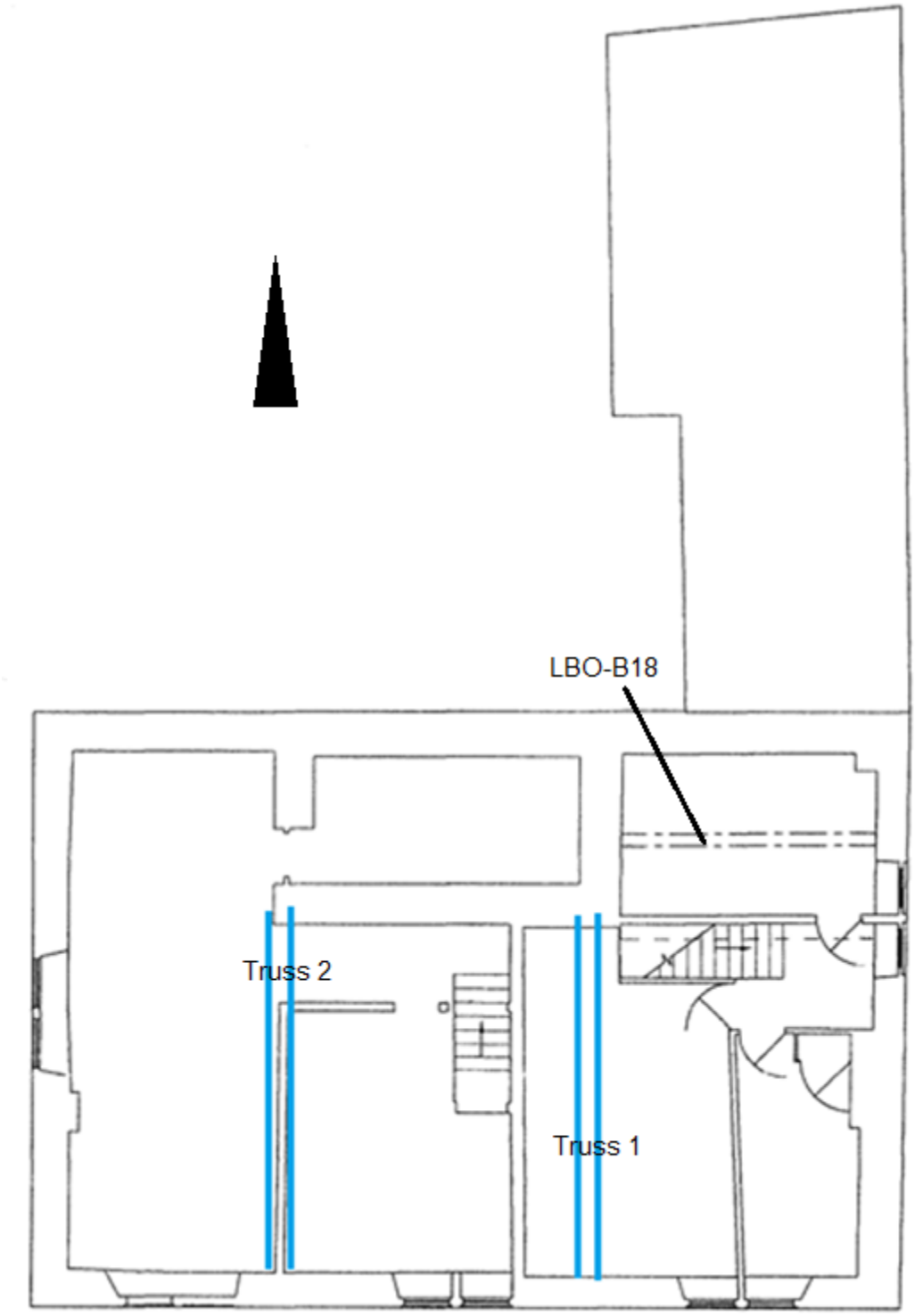

Figure 11: Former farmhouse, first-floor plan, showing truss positions and sample LBO-B18 (Peter Harrison Architects)

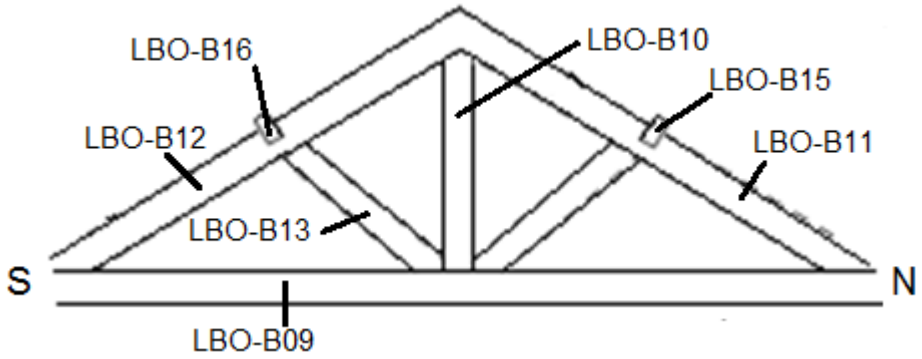

Figure 12: Former farmhouse, truss 1, showing the position of samples LBO-B09–13 and LBO-B15–16

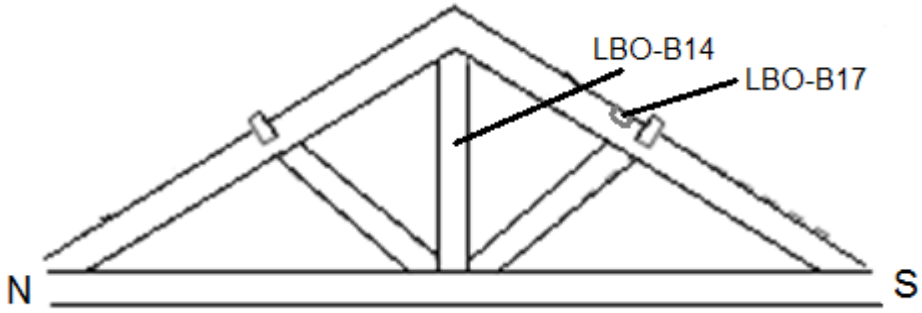

Figure 13: Former farmhouse, truss 2, showing the position of samples LBO-B14 and LBO-B17

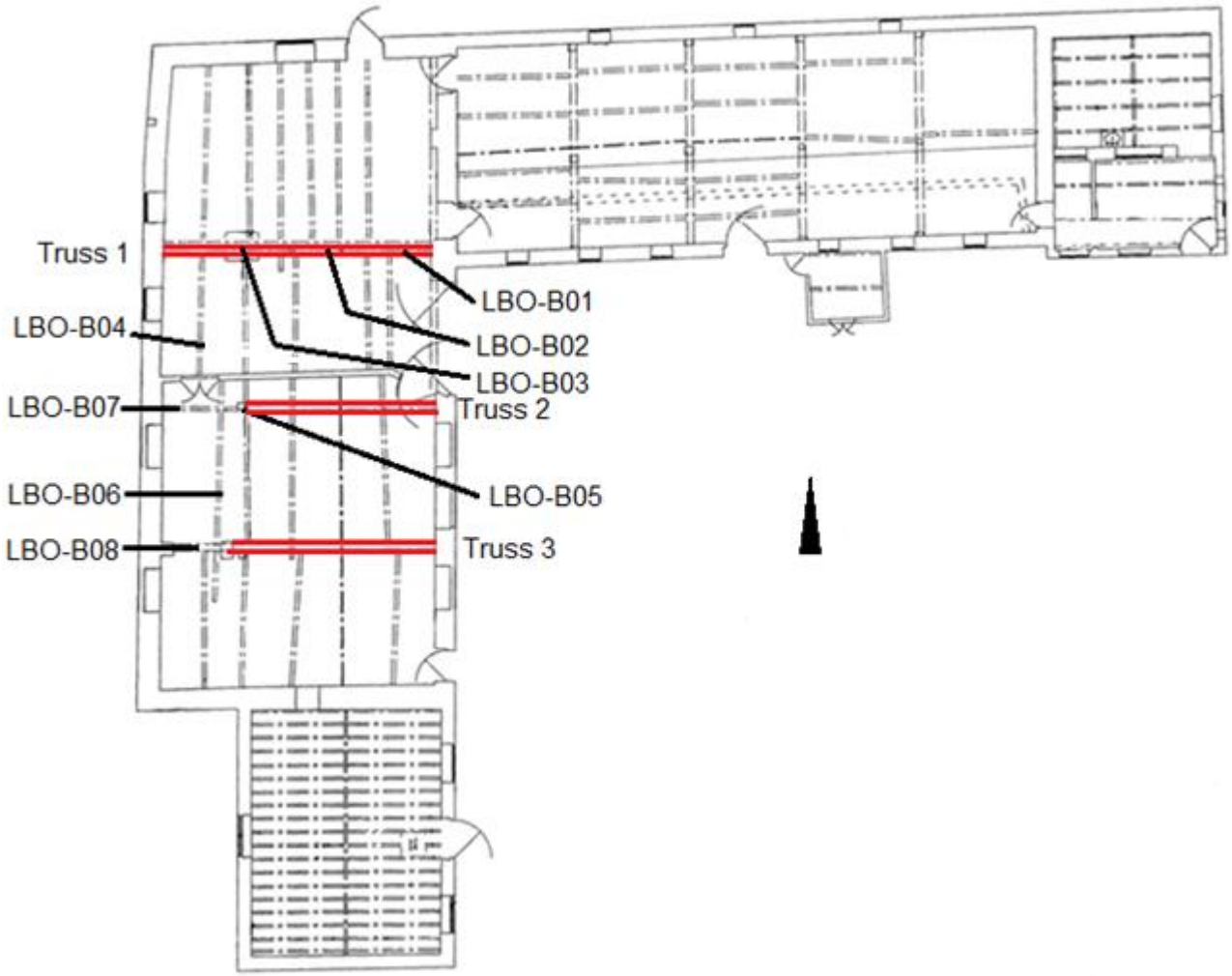

Figure 14: The barn, ground-floor plan, showing truss positions and the location of samples LBO-B01-08 (Peter Harrison Architects)

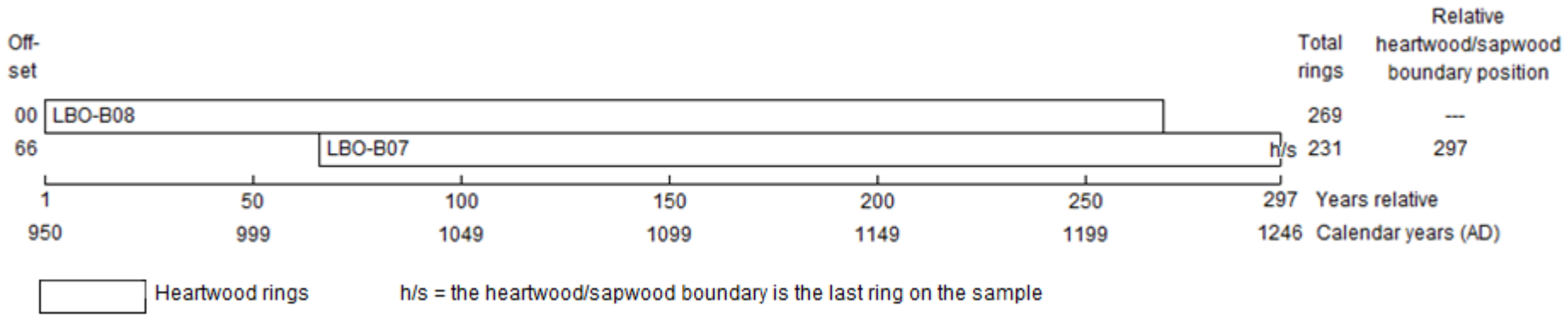

Figure 15: Bar diagram of samples in site sequence LBOBSQ01

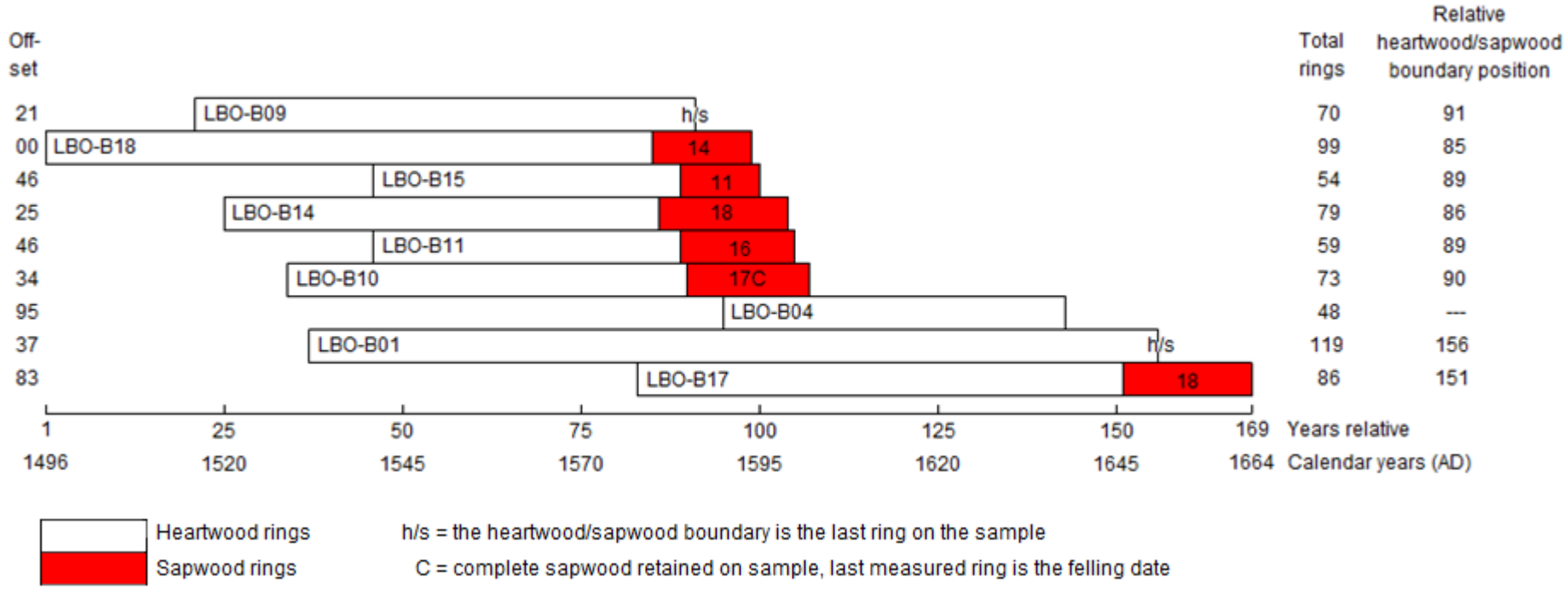

Figure 16: Bar diagram of samples in site sequence LBOBSQ02

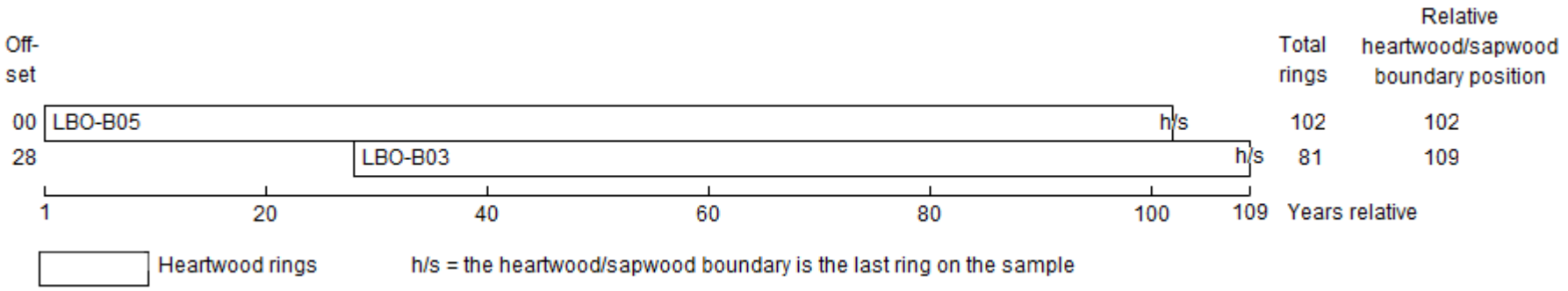

Figure 17: Bar diagram of samples in undated site sequence LBOBSQ03

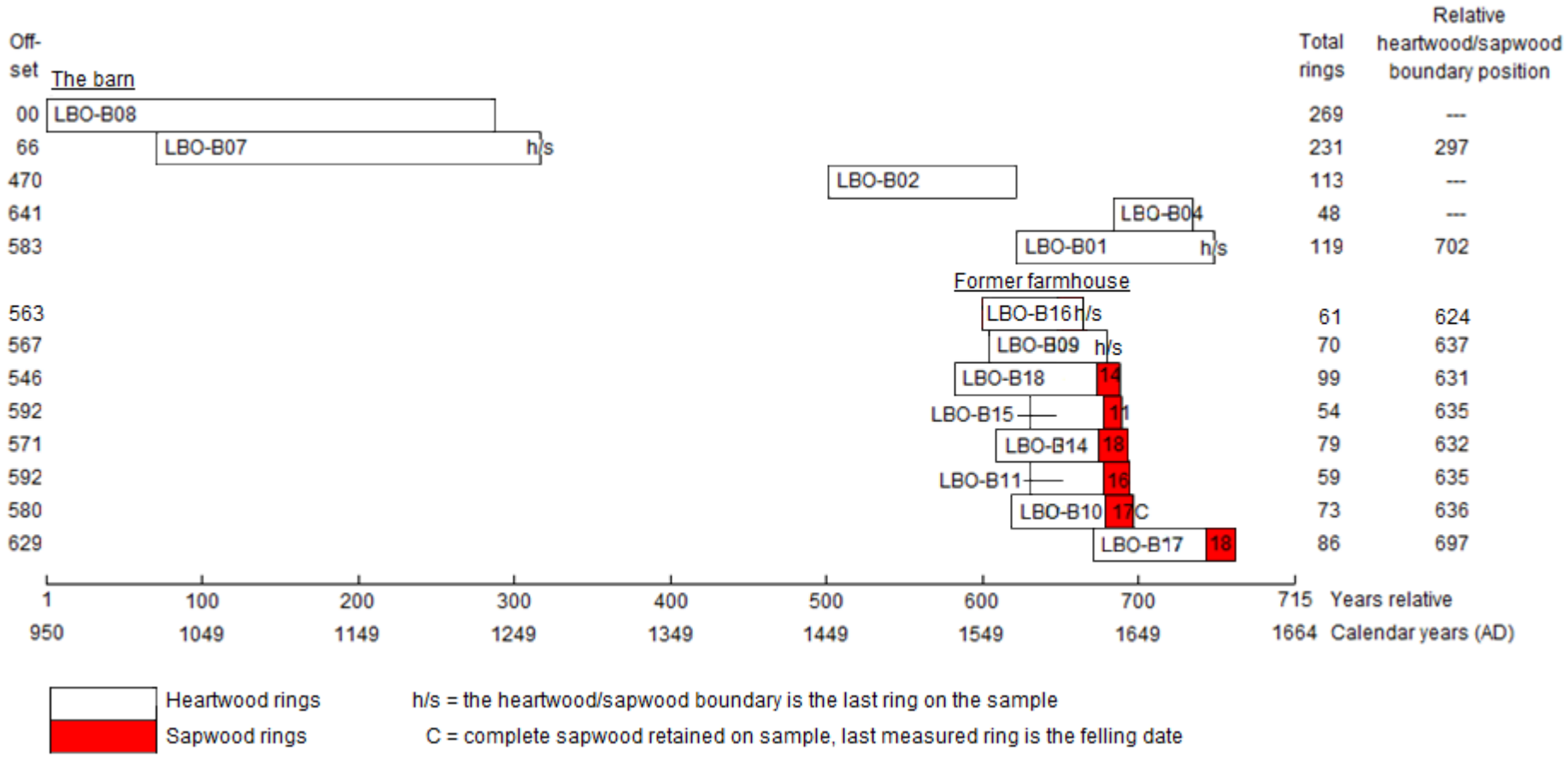

Figure 18: Bar diagram of all dated samples, sorted by area

Figure 19: Aisle ties of the barn, the redundant mortices and lap joints clearly demonstrate a previous use for this timber (aisle tie 3) and the one in the background (aisle tie 2), photograph taken from the south