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**TREE-RING ANALYSIS OF TIMBERS FROM
OLD HOUSE FARM,
PENTRE LANE,
BREDWARDINE,
HEREFORDSHIRE**

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SUMMARY

Dendrochronological analysis was undertaken on timbers from the roof, lintels, a cill, and ceiling beams at this house, resulting in the construction of a single site sequence.
This site sequence contains 12 samples and spans the period 1408–1595.
Interpretation of the sapwood suggests felling of all elements occurred in 1593/5 with construction likely to have occurred shortly after.
The cill is undated.

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INTRODUCTION

This Grade II house is located on the west side of Pentre Lane, in Bredwardine, some 20 km to the north-west of Hereford (SO 3294543555; Figs 1–3). The oldest, surviving part of the building is the two and a half bay range, aligned north-south. It is of two storeys plus attic with chimney stacks at the north and south ends and has a spiral staircase to the west. At ground-floor level the two rooms are separated by a plank and muntin screen (Fig 4) and there are exposed chamfered and stopped ceiling beams to both rooms (Fig 5). The roof consists of three trusses of principal rafters, tiebeams, and collars. Truss 2 also has struts and a post between collar and tiebeam (Fig 6). There are two rows of purlins to each side. This primary range is thought to date to the late-sixteenth century. At the south-west corner is a twentieth century extension (www.britishlistedbuildings.co.uk).

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 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 17 timbers was sampled with each sample being given the code BRE-D and numbered 01–17; samples BRE-D01–08 being taken from ground floor timbers (lintels, a cill, top beam of the screen, and ceiling beams) and BRE-D13–17 from roof timbers. The location of samples was noted at the time of sampling and has been marked on Figures 7–10. Further details can be found in Table 1.

ANALYSIS & RESULTS

Due to the high probability of all elements sampled being of the same date, the best 13 samples only were measured, with the rest set aside in the event that initial analysis suggested more than one phase being represented amongst the timbers. These 13 samples were prepared by sanding and polishing and their growth-ring widths measured. These growth-ring widths were then compared with each other.

Twelve of the samples matched each other and were combined at the relevant offset positions to form BREDSQ01, a site sequence of 188 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 1408 and a last-measured ring date of 1595. The evidence for this dating is given by the *t*-values in Table 2.

Attempts made to date the remaining ungrouped sample (BRE-D01) by comparing it individually against the reference chronologies were unsuccessful and it remains undated.

INTERPRETATION

Tree-ring analysis has resulted in the successful dating of 12 of the samples taken from this building, six from the roof, three ceiling beams, two lintels, and the partition beam. Two of the roof samples have complete sapwood and the last-measured ring dates of 1593 (BRE-D17) and 1595 (BRE-D10), the felling dates of the timbers represented. A third sample (BRE-D16) was taken from a roof timber with complete sapwood but unfortunately the end portion of this sample became detached during the sampling process and could not be re-attached with complete confidence. It is possible to count 35 sapwood rings on this detached portion which, when added to the last-measured ring date of 1560 gives a felling date for the timber represented of *c* 1595. Six other samples have the heartwood/sapwood boundary ring, which in all cases is broadly contemporary and suggestive of a single felling. The average heartwood/sapwood boundary ring date is 1563, allowing an estimated felling date to be calculated for the six timbers represented of 1578–1603, consistent with these samples also having been felled in 1593/5.

The other three dated samples do not have the heartwood/sapwood boundary ring but with last-measured ring dates in the first half of the sixteenth century it is possible that these timbers were also felled in 1593/5.

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 this part of the house was thought to date to the late-sixteenth century and it had been suggested that it was likely to be of one phase (*pers comm*. Duncan James). It is now known that the roof, beams of the first floor and partition and at least two window lintels all date to 1593/95, putting construction at the very end of the sixteenth century and indeed confirming a single building phase.

Unfortunately, the sample taken from the cill did not match any of the other samples and could not be dated individually. This does not necessarily signify it is of a different date to the rest of the timber but may simply mean that the tree represented experienced other, non-climatic influences which have unduly affected the growth pattern, masking the climatic signal. However, a cill is relatively easy to replace/remove signs of reuse and it is interesting to note that the average growth ring width of this sample is much smaller (ie., demonstrating slower growth) than the majority of the other samples (Table 1) which may lend support to the suggestion that it is from a different period in time.

The reference chronologies producing the very highest *t*-value matches against site sequence BREDSQ01 can be seen to be from sites in Gloucestershire and Worcestershire, suggesting the source of timber for Old House Farm to be reasonably local. The next best matches are more diverse, ranging from Kirkburton in West Yorkshire to Lansallos in Cornwall, however, these can all be seen to be located to the west of the country (Fig 12), thus possibly sharing certain climatic and site environmental (such as soil type or geomorphology) characteristics which might not be found to the east of the country.

Acknowledgements

This work was commissioned and funded by Dr & Mrs Staley, the owners of the house, in order to assist understanding of their home. The Laboratory would like to thank Duncan James of Insight – Historic Buildings Research, for his invaluable *on-site* advice and for providing the drawings used to locate samples.

Table 1: Details of samples taken from Old House Farm, Pentre Lane, Bredwardine, Herefordshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)	Average ring width (mm)
Ground-floor timbers							
BRE-D01	Cill 3	118	08	----	----	----	1.3
BRE-D02	Lintel 1	NM	--	----	----	----	--
BRE-D03	Lintel 2	83	h/s	1481	1563	1563	2.1
BRE-D04	Lintel 3	105	--	1440	----	1544	2.3
BRE-D05	North-east ceiling beam	110	h/s	1452	1561	1561	1.9
BRE-D06	North-west ceiling beam	99	--	1408	----	1506	2.5
BRE-D07	South-east ceiling beam	93	h/s	1479	1571	1571	2.0
BRE-D08	Partition beam	125	h/s	1431	1555	1555	1.7
Roof timbers							
BRE-D09	Tiebeam, truss 1	NM	--	----	----	----	--
BRE-D10	West principal rafter, truss 1	155	17C	1441	1578	1595	1.4
BRE-D11	Tiebeam, truss 2	73	--	1470	----	1542	2.1
BRE-D12	Post, collar to tiebeam, truss 2	65	h/s	1505	1569	1569	2.2
BRE-D13	West strut, truss 2	NM	--	----	----	----	--
BRE-D14	Tiebeam, truss 3	95	h/s	1463	1557	1557	1.7
BRE-D15	West lower purlin, north end – truss 1	NM	--	----	----	----	--
BRE-D16	East upper purlin, truss 2-3	108	04c(+*c*35NM)	1453	1556	1560(*c*1595)	1.4
BRE-D17	West upper purlin, truss 2-3	80	25C	1514	1568	1593	2.1

*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

c(+*c*xNM) = complete sapwood on timber, portion lost during sampling procedure with number of rings on detached portion in brackets.

Table 2: Results of the cross-matching of site sequence BREDSQ01 and relevant reference chronologies when the first-ring date is 1408 and the last-measured ring date is 1595

Reference chronology	*t*-value	Span of chronology
Court House, Shelsley Walsh, Worcestershire	8.8	AD 1387–1575
St Braivels Castle, Lyndney, Gloucestershire	7.5	AD 1362–1636
Little Moreton Hall, Cheshire	7.4	AD 1377–1562
All Hallows Church, Kirkburton, West Yorkshire	7.2	AD 1306–1633
Bramall Hall, Stockport, Manchester	7.1	AD 1359–1590
Wakelyn Old Hall, Hilton, Derbyshire	7.0	AD 1415–1573
St Ildierna, Lansallos, Cornwall	6.8	AD 1355–1514

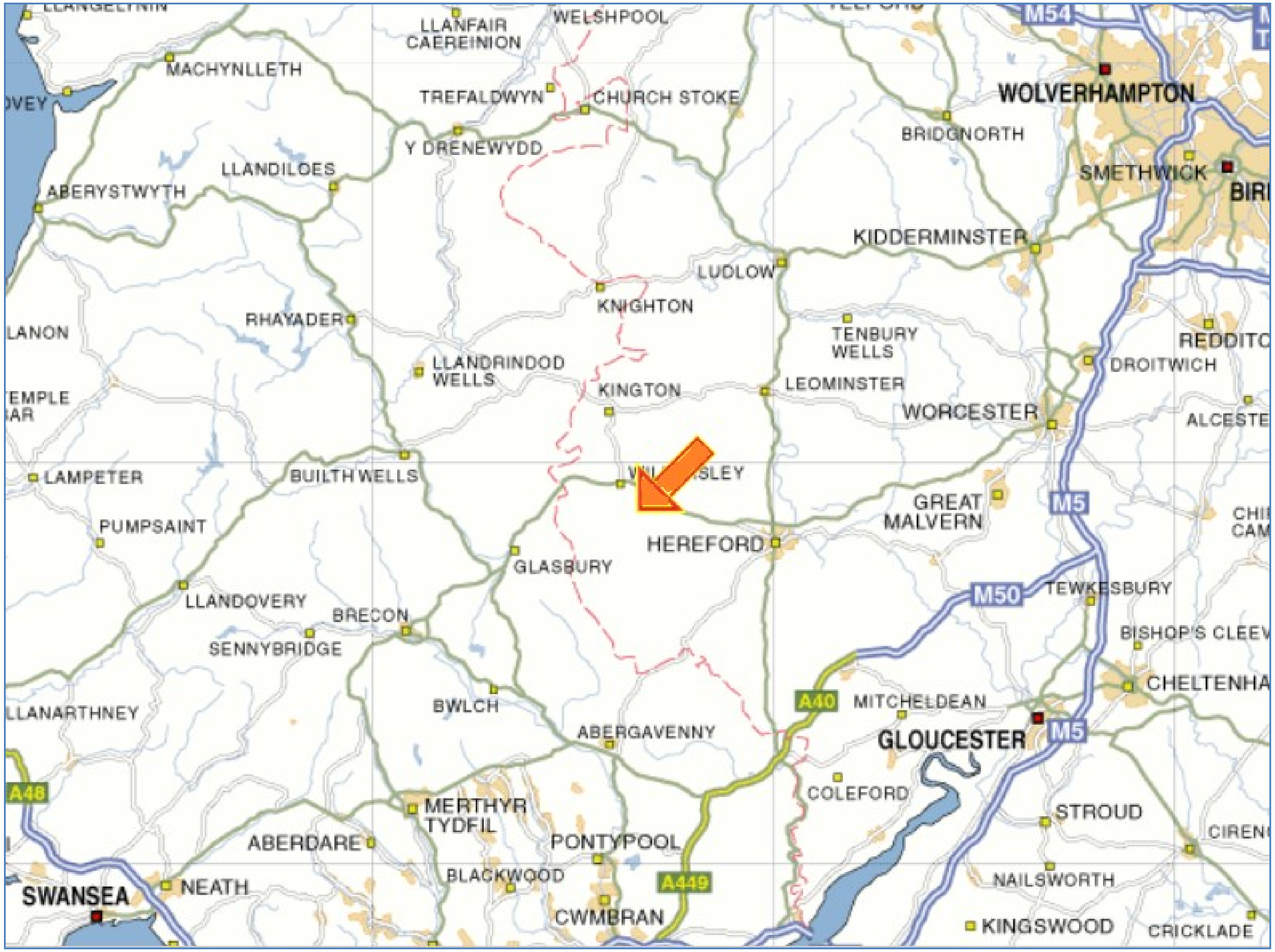

Figure 1: Map to show the general location of Bredwardine in Herefordshire, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

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

Figure 4: Plank and muntin screen

Figure 5: Ceiling beams

Figure 6: Truss 2 (photograph taken from the north)

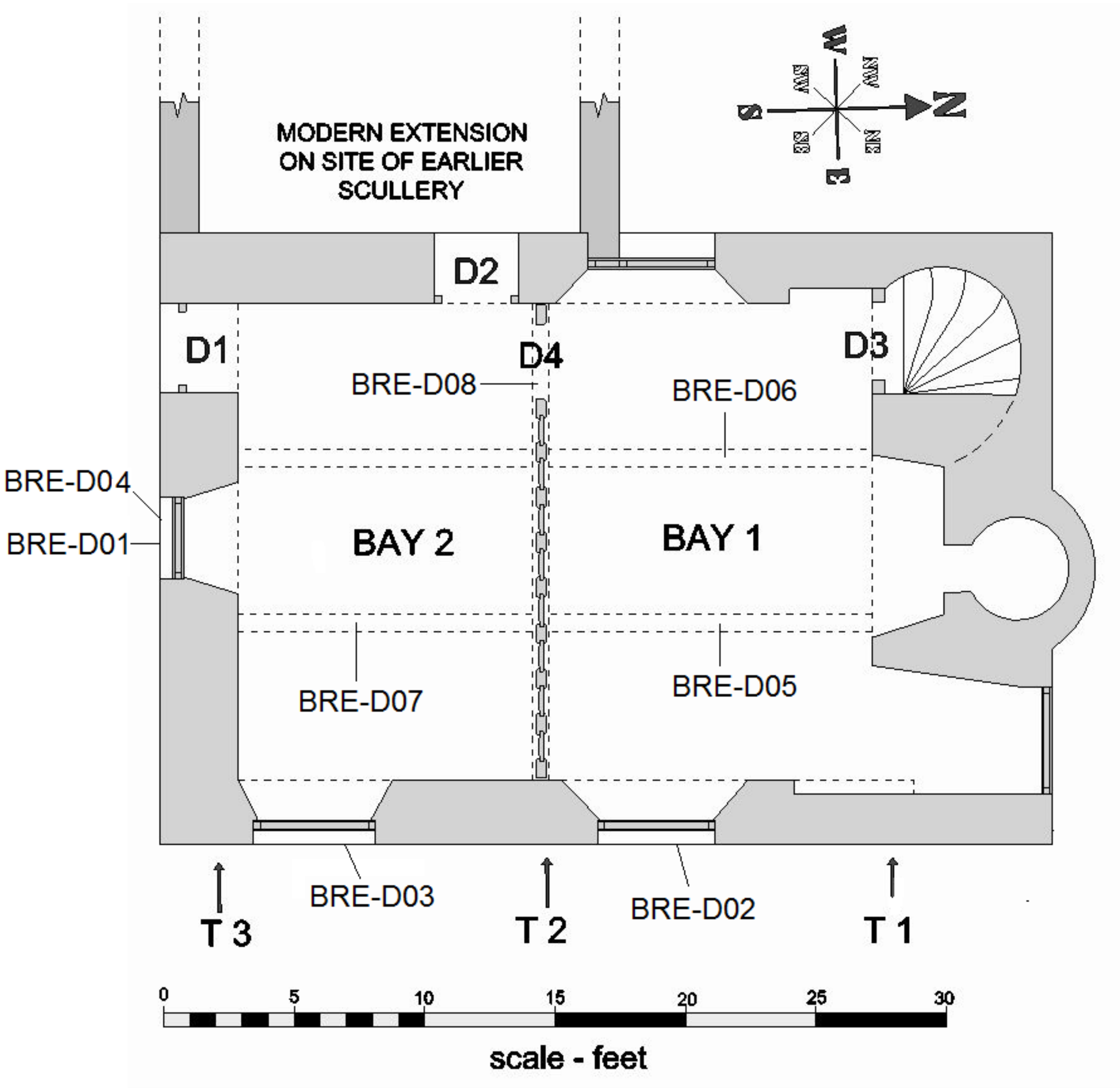

Figure 7: Ground-floor plan, showing the location of samples BRE-D01–08 and truss positions (Duncan James)

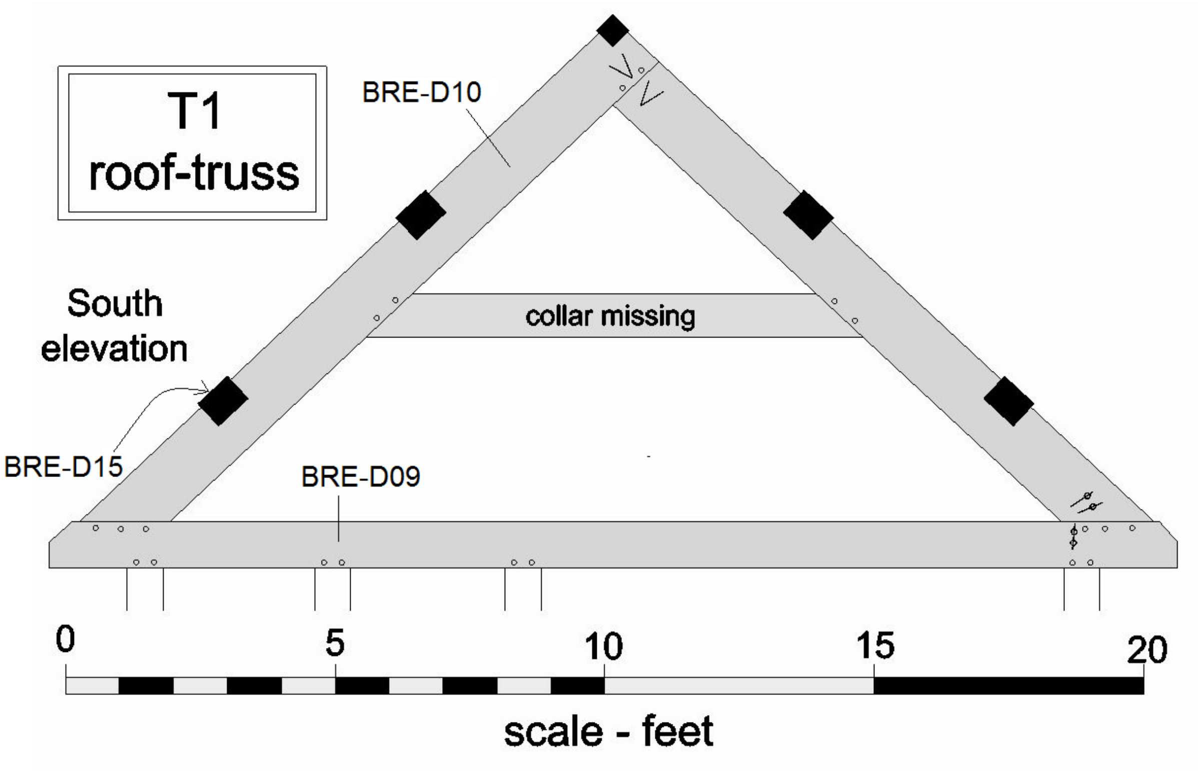

Figure 8: Truss 1, showing the location of samples BRE-D09, BRE-D10, and BRE-D15 (Duncan James)

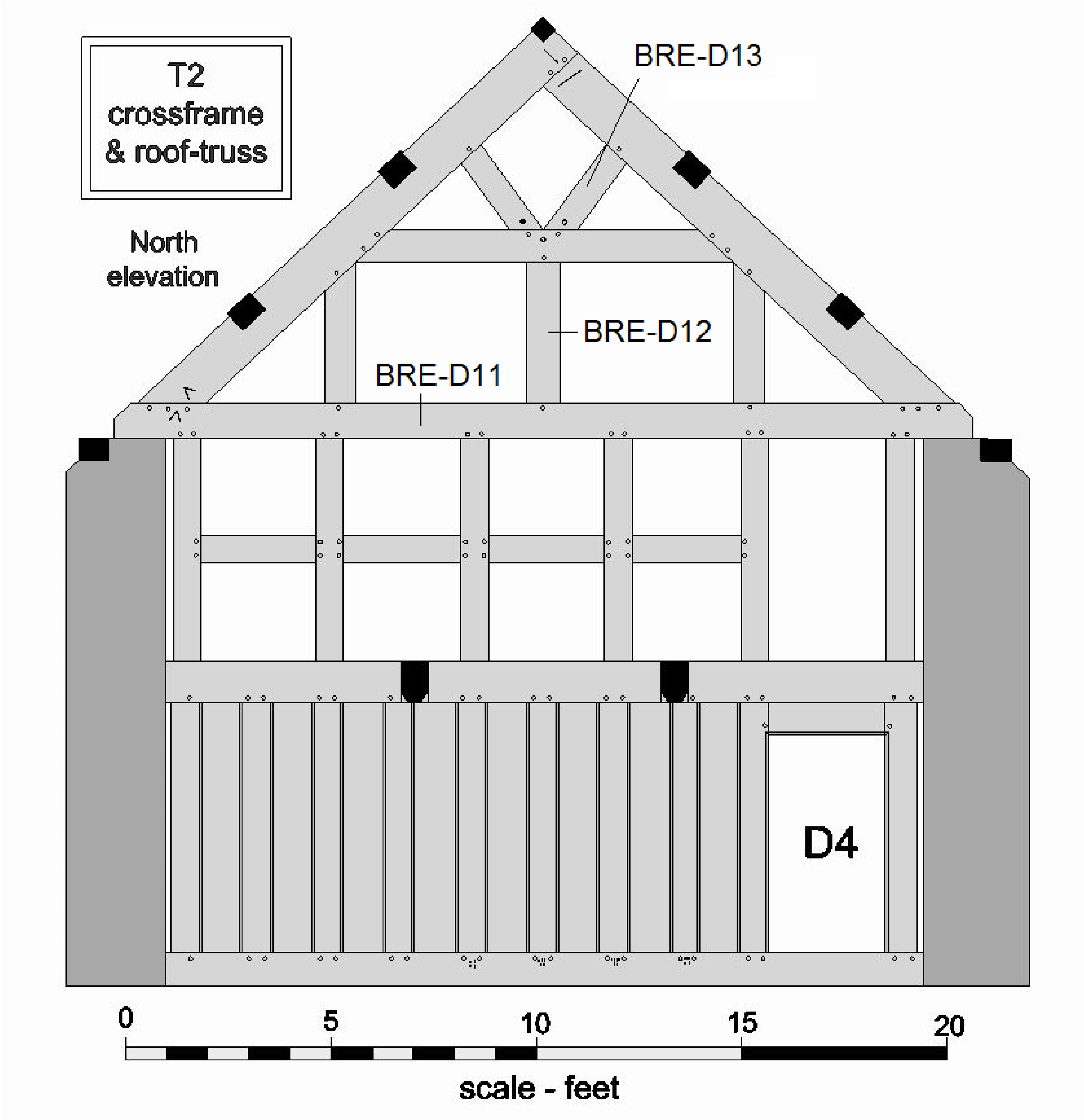

Figure 9: Truss 2, showing the location of samples BRE-D11–13 (Duncan James)

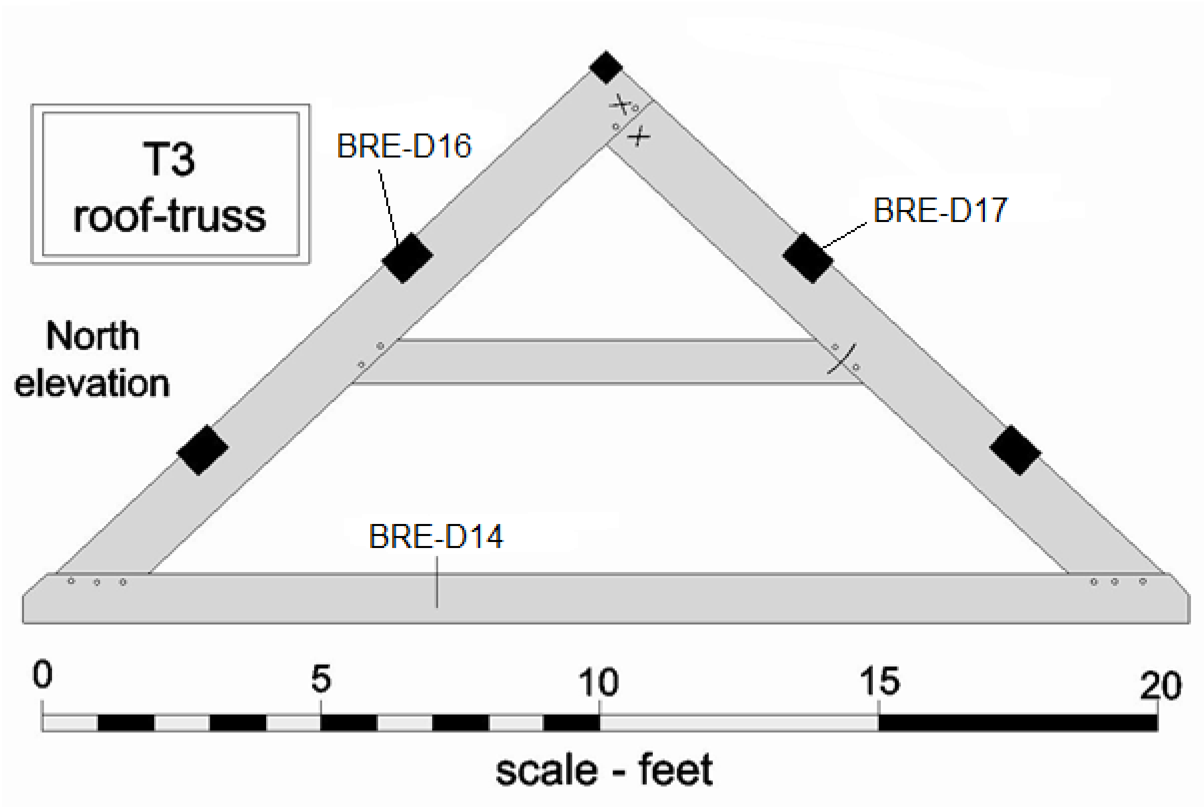

Figure 10: Truss 3, showing the location of sample BRE-D14, BRE-D16, and BRE-D17 (Duncan James)

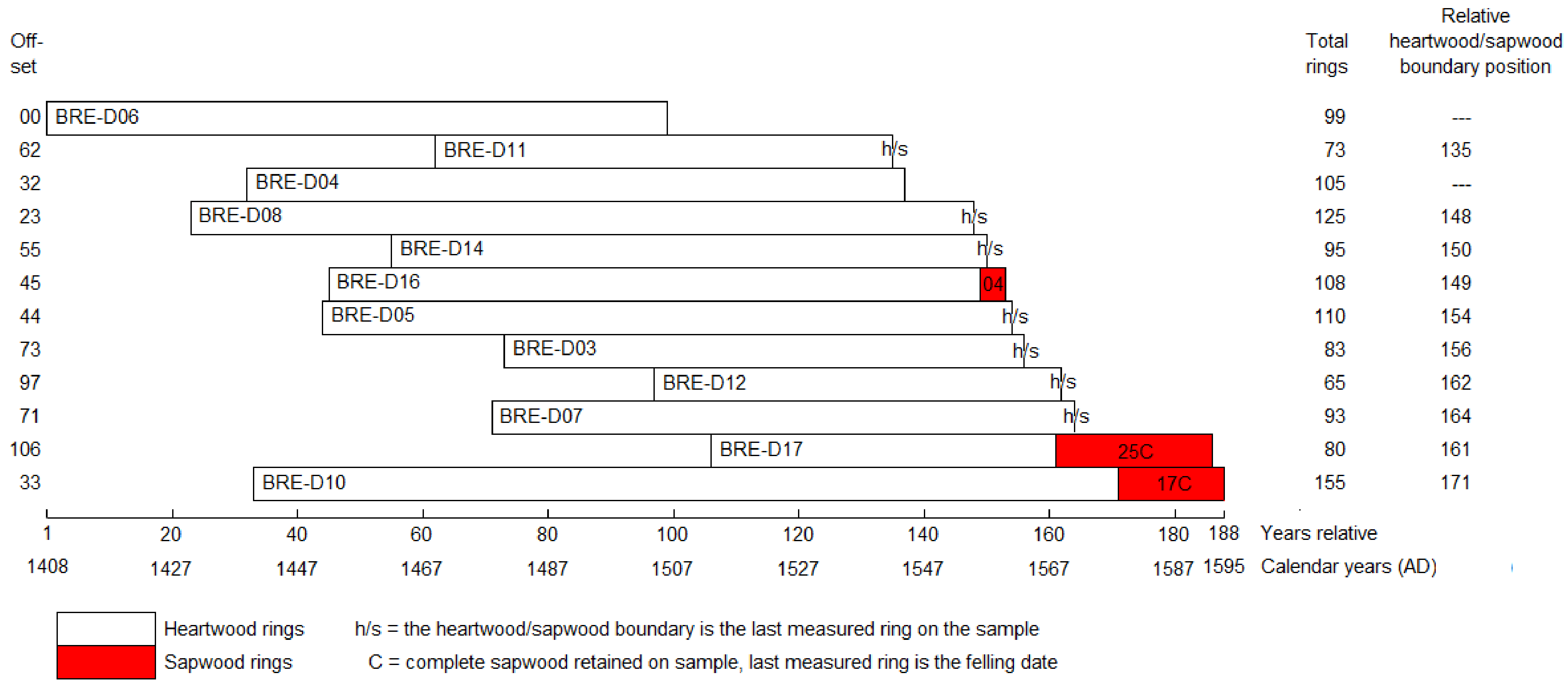

Figure 11: Bar diagram of samples in site sequence BREDSQ01

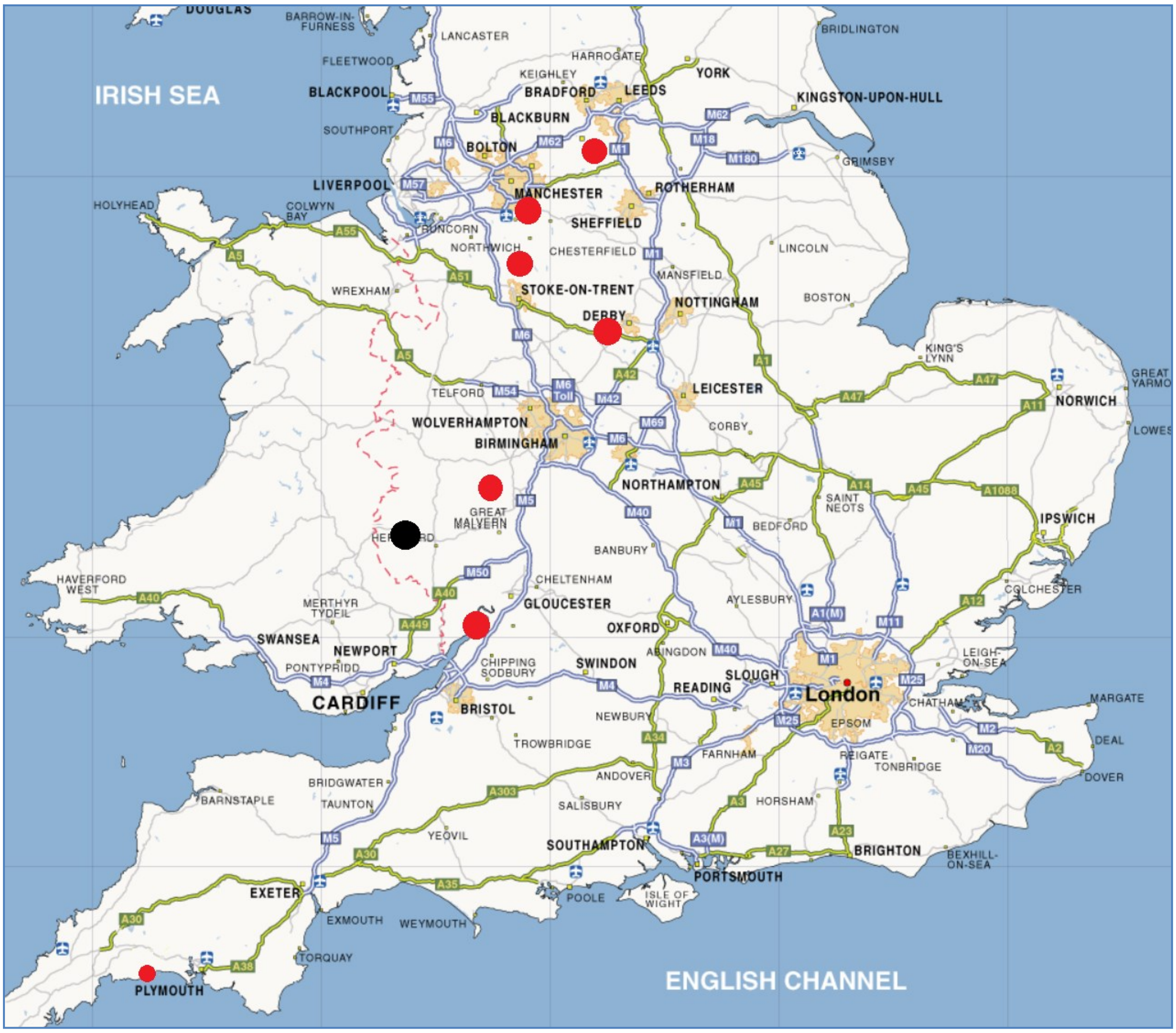

Figure 12: Map to show the location of sites with the highest t-value matches (red circles) when compared against the site sequence from Old House Farm (black circle)