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56 POTTER STREET,
MELBOURNE,
DERBYSHIRE;

TREE-RING ANALYSIS OF TIMBERS

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SUMMARY

Analysis by dendrochronology of 15 core samples taken from a number of different timbers to this house has resulted in the production of two dated site chronologies.

The first site chronology comprises 12 samples and has an overall length of 232 rings, these rings dated as spanning the years 1375–1606. Allowing for missing sapwood rings to the outer edges of the trees on these samples, it is estimated that the majority of timbers represented, principal rafters, tiebeams, collar, purlins, and wall posts, were all cut as part of a single programme of felling in 1610.

The anomaly amongst this group is the spine beam to the ground floor ceiling. This has a heartwood/sapwood boundary 30 years earlier than the rest of the group and would suggest it was felled in, say, 1580, and is reused here.

The second site chronology comprises two samples (both from the jambs of the door between the two main first floor rooms) and has an overall length of 72 rings. These rings are dated as spanning the years 1402–1473. Neither of these samples has certain sapwood or the heartwood/sapwood boundary on them and it is a little difficult to be certain exactly when the timbers were cut. It is unlikely, however, that they were felled before the early sixteenth century.

One sample, from the bresummer to the fireplace of the main ground floor room, remains undated.

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Introduction

56 Potter Street, standing to the south side of the street (SK 387 251, Figs 1a/b), now presents a thatched, single-storey with attics, timber-framed, building of two bays, with a cross-passage at its east end which runs behind the fireplace and chimney stack, the first floor being 'jettied' over the cross-passage (plan Fig 2a). It is Grade II listed, the listing description suggesting it is of sixteenth century date.

Within, there are three main trusses, one to the middle (section Fig 2b) and one at either gable end, these each comprising principal rafters with collar and tiebeams, the trusses carrying single purlins to each pitch of the roof. There is some timber framing to the front and rear walls, though that to the rear has been extensively repaired, with further timber to the ground floor ceilings.

The configuration of the "jettied" floor over the entry, to give a slightly wider room above, is thought to suggest that the main room (the 'houseplace') at number 56 was originally open to the roof (the evidently inserted doorway between the two first floor rooms also hinting that the parlour originally had a chamber over it, but not the houseplace). This would suggest, therefore, that the present brick chimney is a later insertion (although there is some debate about this) and that the house is a late example of its type.

There were formerly (in the 1970s) two doorways between the houseplace and the parlour, one at each end of the dividing wall (one is now bricked up). It is likely that one of these, probably the southern one, would once have given access to the foot of a small staircase up to a chamber over the parlour, it being thought unlikely that one would pass through the parlour in order to get upstairs, bearing in mind that a parlour was usually a private room/bedroom. The building was not surveyed as part of this programme of tree ring analysis, but was investigated as part of an earlier programme of recording.

Description

Derby Buildings Record 42

This timber framed, thatched house stands on the south side of Potter Street between two taller brick houses, facing north. There is a long, secluded and very pretty garden behind. The north, or front, has a door at the eastern end, two ground-floor windows, and two windows in dormers in the thatch. The timber wall-frame is built on a continuous sill lying on a plinth built of well squared stone blocks. There are seven posts numbered from the western end: I, II, III, IIII, and V, with an un-numbered post to the west of the door and to the east of it a post marked IIII. The posts flanking the door are a little thinner than the rest. The marks are short chisel cuts, and their position is shown on the elevation drawing.

The wall panels are divided by horizontal rails, in three cases into equal squares, but between posts II and IIII the rails are set lower, probably to allow for windows above them, though the present windows cut into the rails. The easternmost rail is raised to go over the door head. There are straight upward braces from posts IIII and from the east end post. The wall-plate is scarfed in two places: near the top of the brace from post I is a modern side-

halved scarf, the plate west of it being a replacement, and the scarf just west of post IIII in the middle of the plate is an original splayed scarf whose detail is concealed by a modern patch. There is double pegging at every joint. The easternmost post is not quite at the end of the building, the sill and wallplate continuing to the east, but the post has no peg holes for joints into its east side.

The rear, south, wall is built exactly the same as the front wall with seven posts, on which we did not see numbers, but with single pegging throughout. There is a similar stone plinth, but the middle rail is at the same level all along except for where it is raised over the doorway. There are three ground-floor windows, two cutting the rail and one under it, and two dormers above the wallplate. There is one chimney on the south side of the ridge just west of the doorway.

Where it can be seen, the infill appears to consist of a single skin of bricks laid in stretcher bond; on the front wall this is whitened but on the back it is left its natural colour. The timber is painted black. The front door opens into a passage running across the house from front to back. On the east side there are four posts in the wall, standing on a sill set on a stone plinth, between which are hardboard panels that open to give shallow cupboards against the outer brick wall of the adjoining house. On the west side there is a doorway between the second and third uprights, leading into the living room. A modern stair has been built against the north wall, and on the other side of the door is a big inglenook fireplace. This is built of brick with a brick spere wall under the main ceiling beam of the room, and in the fireback a recess or keeping hole to the north of the main flue. The hood of the chimney is also brick and can be seen from the inside here, and from the outside in the room above. The fireplace is spanned by an arched timber bressumer, splayed inside and roughly chamfered outside. There is a small fire-window in the brick wall on the south of the hearth. The ceiling of this room is carried on a roughly chamfered east-west beam which has at each end an empty mortice and peghole in the soffit, but there is no indication as to how it is now fastened into the wall at each end. The common joists are square section, chamfered and run out, set into the beam with a tongue cut from the upper two-thirds of its depth, with what may be a half dovetail; the joists fit neatly and it is difficult to be sure about this, but there is certainly not a soffit tenon. The door is at the north end of the framed cross-wall, and leads into what must have been an unheated parlour, now the kitchen and dining room. There are east-west common joists similar to the joists in the living room.

At the top of the stairs you turn south to face the brick hood of the chimney. On the left behind this is a bathroom with no window occupying the space over the passage. Some of the roof timbers, purlins and windbraces, are fire-scorched. On the west side of the stack is the main bedroom, with dormer windows on each side. The roof structure is exposed in the cross wall (see section). There is a heavy square ridge piece set diagonally on crossed principals which stand on a tiebeam above floor level that is cut to make a door through the wall. The door jambs are tenoned and pegged in as part of the original frame. There is a collar at the level of the door head, and a pair of overlapping trenched purlins with windbraces. There is one central stud between collar and tie, and under the tiebeam there are straight braces. All the pegging is single except at the apex and where the principals are tenoned into the tiebeam. Beyond the cross wall is the rather smaller parlour chamber.

Historical Development

This house has a particularly interesting plan. It resembles closely the Thatched House in Willington Road, Repton (DBB 18) in having a passage behind the hearth; the houses are the same width but the Repton house is considerably longer. The significance of this is that, when this house was built, it extended at least one bay further east, and this is confirmed by the east end posts not standing at the end of the frame. Originally we should expect to find either a low end service room on the far side of the passage, or even a cowhouse. The same plan in a larger, cruck-built, house occurs at 11–19 High Street, Melbourne (DBR 22) and there, also, the low end has been rebuilt; in fact, this has happened in every case so far found in this region, the present example being the fifth. The date is difficult to determine, but provisionally I would place it in the early seventeenth century. This is chiefly because there is a proper doorway built into the upper floor of the cross-wall, showing that an upper storey was provided for, rather than just a storage loft in the roof space.

In wall framing, and in overall size, the closest comparison is with Trentside Cottage, Willington (DBB 29) but this has a different plan. The walling in both is superior on the street side, but whereas at Willington this takes the form of more panels on the street side, at Melbourne the pegging is doubled. We must look at the wall framing with a certain amount of caution because a fire took place in 1978, after which the house had to be rebuilt, though using the original timbers. The traces of charring are seen at the eastern end over the passage, and probably the fire must have destroyed the original stairs, but the rebuilding does not seem to have been extensive nor the damage to the structure severe. Probably the thatch, most of the rafters, and the infilling of the wall panels, were destroyed. The house remains essentially as it was built except that, probably at an early stage (seventeenth or eighteenth century?) the low end of the house was divided off with that part of the land that lay behind it, and rebuilt as a separate dwelling. This might show up on the tenancy or rent rolls but unfortunately Potter Street was so densely occupied from an early date that it is not possible to distinguish which tenement was which; this very fact, however, lends probability to the original site being divided. By 1790 the house and garden contained 73 perches, belonged to Lord Melbourne and was occupied by John Radford; by 1840 the house, joiner's shop and garden contained 15 perches and was occupied by Edward Lemmon. The joiners shop is a single-storey stone shed at the far end of the garden, probably built about 1800. After the 1978 fire Mr Ernest Upton rebuilt the house and Mr David Raffles thatched it.

Barbara Hutton and Howard Usher, 1 July, 1989

Sampling

Sampling and analysis by tree-ring dating of the timbers within 56 Potter Street were commissioned and funded in a joint programme of investigation by the owners, Mr & Mrs Dobby, and by Philip Heath, Conservation and Heritage Officer for South Derbyshire District Council. This analysis was undertaken following a recent visit by members of the Vernacular Architecture Group. The views of the group, on the basis of the structural form and plan of the house, differed as to whether it was possibly originally of fifteenth century date, being

given an inserted floor in the seventeenth century, or whether it was of seventeenth century date in its entirety. It was hoped that this programme of tree-ring analysis would establish the date for the main structure of the house and determine dates for a number of timbers which could possibly have been later insertions.

With this aim in mind core samples were obtained from several different timbers distributed throughout the house at both roof, first, and ground floor level, and from internal partitions, front and rear walls, and from ceilings. Each sample was given the code MLB-E (for Melbourne site 'E'), and numbered 01–15. The sampled timbers are located on photographs taken at the time of coring, these being given here as Figures 3a–e. 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. In this Table, and on the drawings, the trusses, bays, and individual timbers, have been located on a site north–south/east–west basis as appropriate, the front of the house on to Potter Street, taken to be facing north.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank the owners of 56 Potter Street, Mr & Mrs Dobby, for their enthusiasm, help, and cooperation with this programme of analysis, and for their keen interest in the conservation of the house. We would also like to thank Philip Heath of South Derbyshire District Council arranging this programme of analysis and for his help and advice on the interpretation of the building's possible phases.

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 found preserved in archaeological excavations) 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 (Fig 4)

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.

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 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.

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 15 samples obtained from the various timbers of 56 Potter Street were prepared by sanding and polishing, and the annual ring widths of each samples were measured. The

data of these measurements were then compared with each other as described in the notes above, this comparative process indicating that two groups of cross-matching samples could be formed.

The First group comprises 12 samples from a wide range of different timbers, these samples cross-matching with each other at the relative positions as shown in the bar diagram Figure 5a. These 12 samples were combined at their indicated off-set positions to form MLBESQ01, a site chronology with an overall length of 232 rings. This site chronology was then satisfactorily dated by repeated and consistent comparison with a large number of relevant reference chronologies for oak as spanning the years 1375 to 1606. The evidence for this dating is given in the *t*-values of Table 2.

The second group comprises only two samples, both of them from the jambs of the door between the two main first floor rooms. These samples cross-match with each other at the relative positions as shown in the bar diagram Figure 5b. The two samples were also combined at their indicated off-set positions to form MLBESQ02, a site chronology with an overall length of 72 rings. This site chronology was then also satisfactorily dated by repeated and consistent comparison with a large number of relevant reference chronologies as spanning the years 1402 to 1473. The evidence for this dating is given in the *t*-values of Table 3.

The final remaining ungrouped sample, from the bresummer of the ground floor fireplace, was compared individually with the full corpus of reference material but there was no satisfactory cross-matching and this timber must remain undated for the moment.

Interpretation

Site chronology MLBESQ01

None of the dated samples in site chronology MLBESQ01 retains complete sapwood on its core (the last growth ring produced by the tree represented before it was cut down), and it is thus not possible to say for certain exactly when any of the trees represented were felled. Five of the samples, MLB-E02, E08, E10, E13, and E15, do, though, come from timbers which appear to have complete sapwood on them but from which (due to the soft and fragile nature of this part of the timbers) part of the sapwood has been lost from the core in sampling (this is indicated by lower case ‘c’ in Table 1 and the bar diagram, Fig 5a). Under such circumstances it is possible, at the time of sampling, to note the approximate amount, in millimetres, lost from each of the five cores. Upon analysis at the laboratory, it is then possible to make some approximation of the number of sapwood rings the lost portion of core might have contained, and produce a more reliable estimate of the felling date.

In this instance, allowing for the amount of sapwood these five samples retain and how much they might have lost, it is estimated that the felling of the trees they represent took place in, or about, say, 1610. The amount of sapwood and the relative position of the heartwood/sapwood boundary on four other samples, MLB-E05, E06, E07, and E09, in this group, and the high degree of cross-matching with samples MLB-E01 and E14 which are without the heartwood/sapwood boundary, is such that it is very likely that they were felled in about 1610 as well.

There is, however, an anomaly amongst this first group of timbers as represented by sample MLB-E11, from the spine beam of the ground floor ceiling. As may be seen from Table 1 and the bar diagram Figure 5a, this sample has the earliest heartwood/sapwood boundary of any in site chronology MLBESQ01, this being dated to 1548. As such, this date is some 19 years before the next earliest (1567 on sample MLB-E06), and some 30 years earlier than the average date of the heartwood/sapwood boundary of this group. Were the timber represented by sample MLB-E11 to have been felled in 1610 along with all the others it would have had 62 sapwood rings, an amount virtually unheard of in tree-ring analysis. The inference is, therefore, that the timber used for the spine beam was felled earlier than all the other. Allowing for an 'average' number of sapwood rings, say 25–30, it is likely that this felling to place in, or about, 1573–78.

Site chronology MLBESQ01

In the case of the two dated samples in site chronology MLBESQ02, neither of them retains a certain heartwood/sapwood boundary, and they are thus missing not only their sapwood rings, but an unknown number of heartwood rings as well. However, if we were to allow that the latest dated ring, 1473, on either sample, MLB-E04, were starting to approach the heartwood/sapwood boundary, and if we were to allow for an average number of sapwood rings, again say 25–30, we could say that the timbers are unlikely to have been felled before, say, 1500–1505, and of course might actually have been felled a lot later.

Conclusion

It would appear therefore, that the majority of timbers used in the construction of 56 Potter Street were felled in the early seventeenth century, the timbers being cut, it is estimated, in or about 1610. The house does, though, contain a few timbers which were probably felled earlier, the spine beam of the ground floor ceiling being felled about 1580, and timber, presumably reused for door jambs, possibly being cut in the early sixteenth century.

The house therefore appears to be a textbook example of the property of a standard, small, early-seventeenth century yeoman farmer's inventory - houseplace, parlour, chamber over the parlour, and perhaps a few loose boards laid over part of the houseplace to form a makeshift first floor for some storage.

A feature of note amongst the samples from 56 Potter Street is the considerable age which some of the trees may have reached when they were felled. While the earliest extant ring on any sample, MLB-E10, is dated to 1375, this is not the centre, or first growth ring, of the tree (this not being on the sample), but is probably some 20–30 years earlier. If it were estimated that this tree began growing in, say, 1350, and allowing that it was felled in 1610, it would have been 280 years of age when cut. While trees of such age are not unknown in tree-ring studies, they are not particularly common, especially amongst trees felled in the early seventeenth century. Although its exact location cannot be determined, this tree, and almost certainly many of its companions in the house which also have high numbers of annual rings, appears to have been derived from a single, particularly long-lived, forest or woodland.

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Table 1: Details of tree-ring samples from 56 Potter Street, Melbourne, Derbyshire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
MLB-E01	North (front) principal rafter, truss 2 (middle)	147	no h/s	1415	------	1561
MLB-E02	North purlin, truss 1 – 2	195	13c	1399	1580	1593
MLB-E03	North first floor door jamb	67	no h/s	1402	------	1464
MLB-E04	South first floor door jamb	72	no h/s	1402	------	1473
MLB-E05	Collar, truss 2	145	5	1440	1579	1584
MLB-E06	Tiebeam, truss 2	149	22	1441	1567	1589
MLB-E07	North main wall post, truss 2	176	6	1409	1578	1584
MLB-E08	North main wall post, truss 3	156	20c	1448	1583	1603
MLB-E09	Tiebeam, truss 3	148	h/s	1422	1569	1569
MLB-E10	North purlin, truss 2 – 3	221	21c	1375	1574	1595
MLB-E11	Ground floor kitchen ceiling beam	65	h/s	1484	1548	1548
MLB-E12	Fireplace bresummer	56	h/s	------	------	------
MLB-E13	Kitchen door jamb	139	19c	1468	1587	1606
MLB-E14	South (rear) main wall post, truss 1	120	no h/s	1424	------	1543
MLB-E15	Common joist, ground floor ceiling	124	21c	1479	1581	1602

* c = complete sapwood is found on the sampled timber but all or part of this has been lost from the sample in coring

Table 2: Results of the cross-matching of site chronology MLBESQ01 and the reference chronologies when the first ring date is 1375 and the last ring date is 1606

Reference chronology	***t*-value**	
Stoneleigh Abbey, Stoneleigh, Warwicks	9.3	(Howard *et al* 2000)
St Peter's Church, Saltby, Leics	8.6	(Howard *et al* 1995)
Apethorpe Hall, Apethorpe, Northants	8.2	(Arnold and Howard forthcoming)
Thatched Cottage, Melbourne, Derbys	7.8	(Howard *et al* 1997)
East Midlands Master Chronology	7.5	(Laxton and Litton 1988)
Coates' Barn, Cosby, Leics	7.2	(Alcock *et al* 1991 unpubl)
Gotham Manor, Gotham, Notts	7.0	(Howard *et al* 1991)
Old Hall Farmhouse, Mayfield, Staffs	7.1	(Arnold and Howard 2006 unpubl)

Table 3: Results of the cross-matching of site chronology MLBESQ02 and the reference chronologies when the first ring date is 1402 and the last ring date is 1473

Reference chronology	*t*-value	
Holy Trinity, Hagworthingham, Lincs	6.6	(Laxton *et al* 1984)
Stoneleigh Abbey, Stoneleigh, Warwicks	5.7	(Howard *et al* 2000)
Moot Hall, Hexham, Northumberland	5.6	(Arnold *et al* 2004)
Dog and Duck, Shardlow, Derbys	5.5	(Howard *et al* 1993)
Southern England Master Chronology	5.3	(Bridge 1988)
East Midlands Master Chronology	5.2	(Laxton and Litton 1988)
Rectory Farm, Weston-on-Trent, Derbys	5.2	(Howard *et al* 1996 unpubl)
Ulverscroft Priory, Charnwood, Leics	4.6	(Arnold *et al* 2008)

Site chronologies MLBESQ01 and SQ02 are composites of the data of the relevant cross-matching samples, this producing 'average' tree-ring patterns, where the overall climatic signal of the ring growth is enhanced, and the possible erratic variations of any one individual sample is reduced. These 'average' site chronologies are then compared with several hundred reference patterns covering every part of Britain for all time periods. As can be seen here, site chronology MLBEQ01 matches only when its 232 rings span the years 1375–1606, and site chronology MLBESQ02 matches only when its 72 rings span the years 1402–1473, the degree of similarity between site and reference chronology being indicated by the '*t*-values'.

It is interesting to note that these two site chronologies do not cross-match with each other despite the fact that they share a common period of growth (1402–1473). This would suggest that the trees used for the respective timber have come from different woodland sources and have different growth-ring patterns because they were affected by different weather and growing conditions

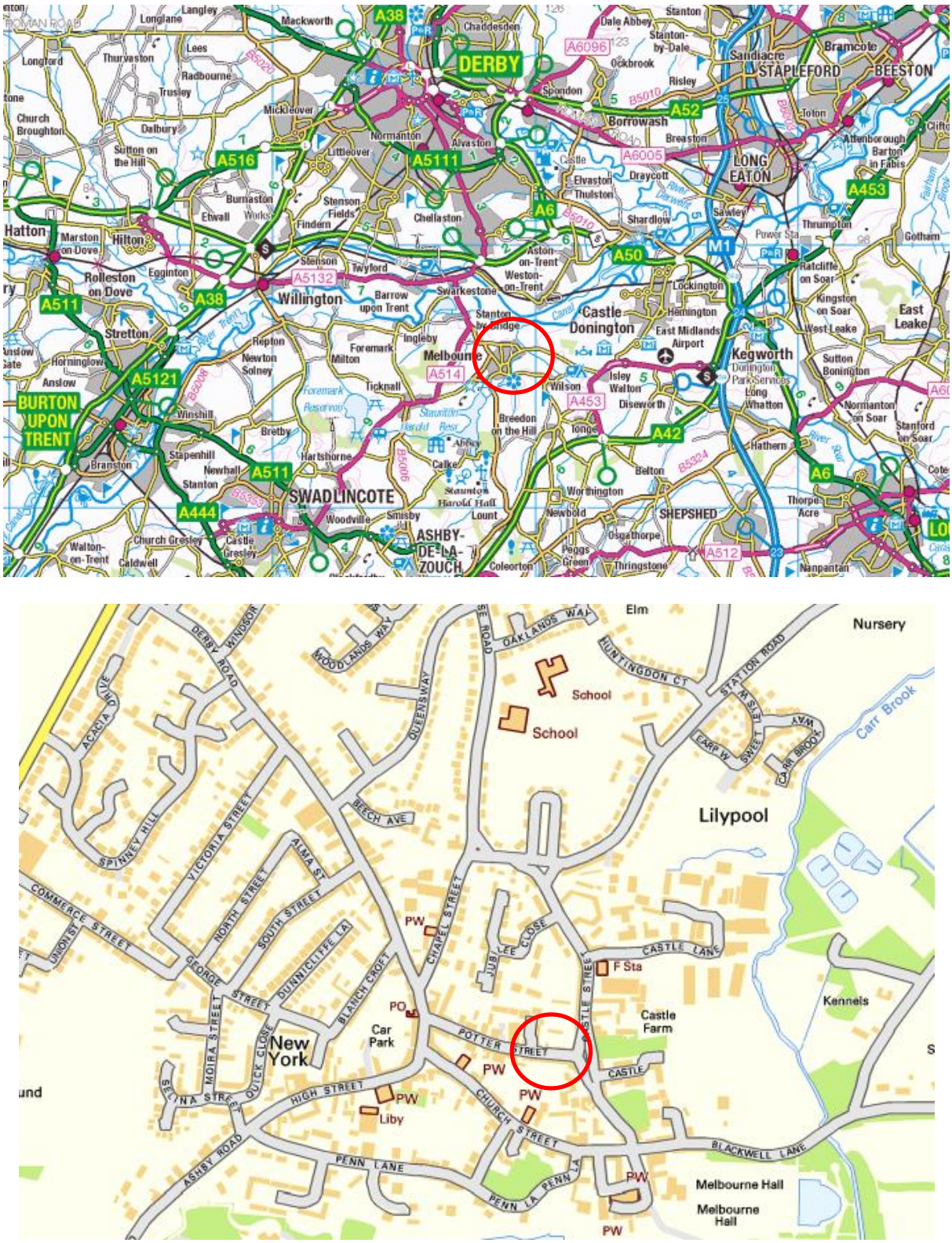


Figure 1a/b: Maps to show location of Melbourne (top) and 56 Potter Street (bottom)

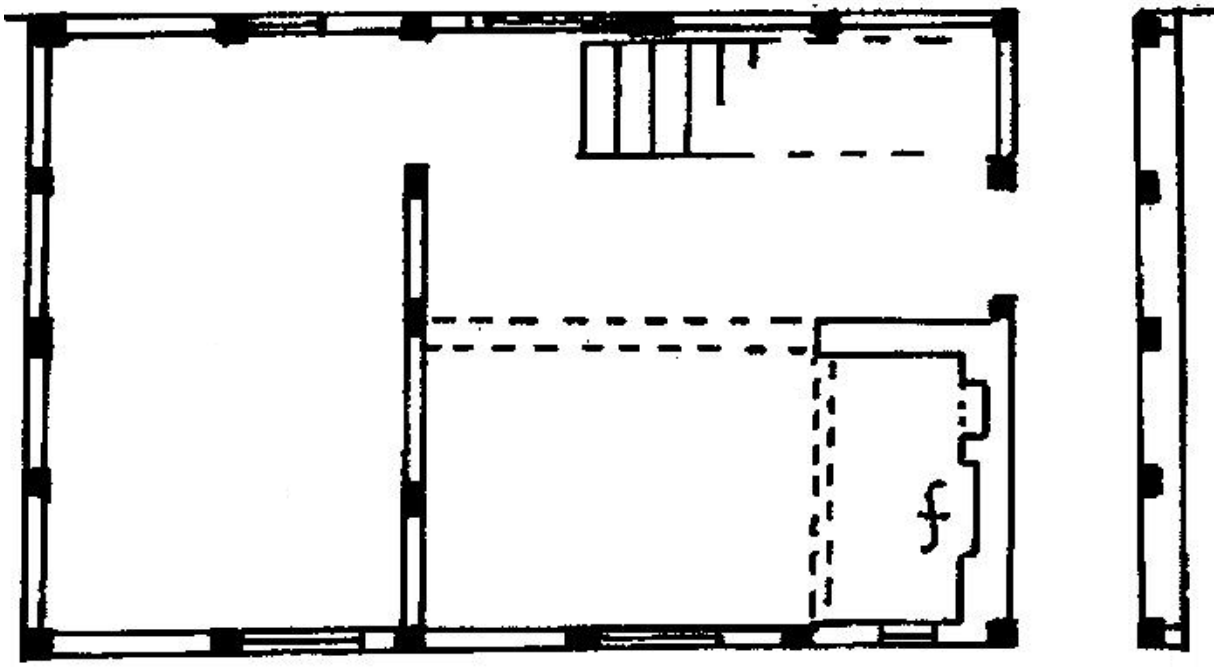


Figure 2a: Ground floor plan of 56 Potter Street (after Barbara Hutton and Howard Usher)

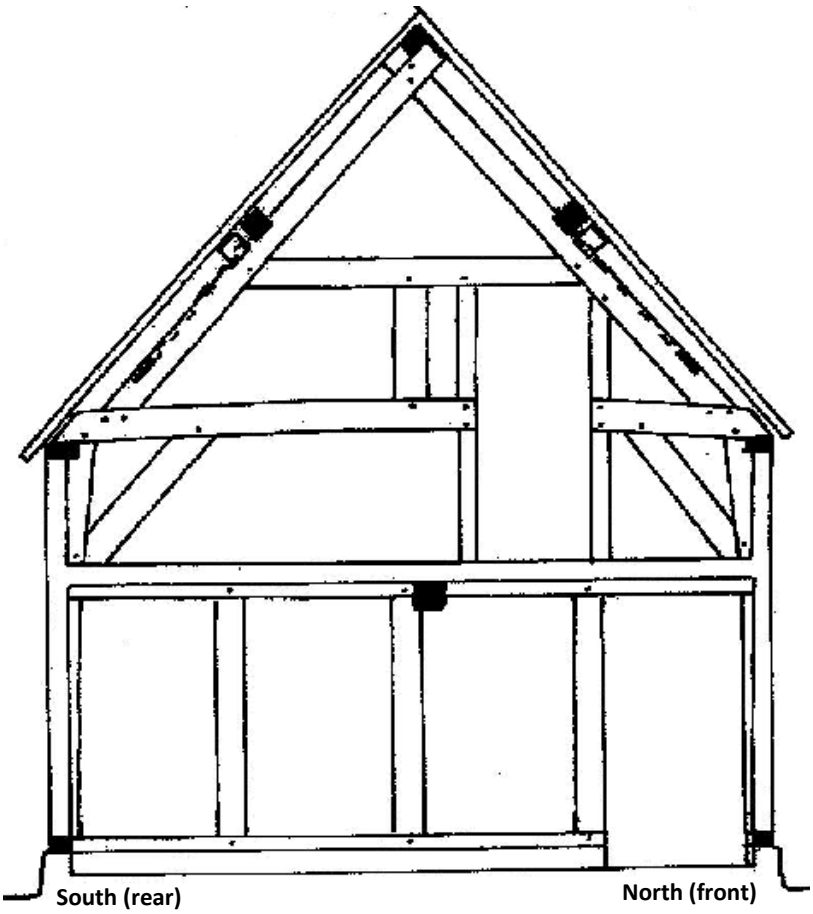
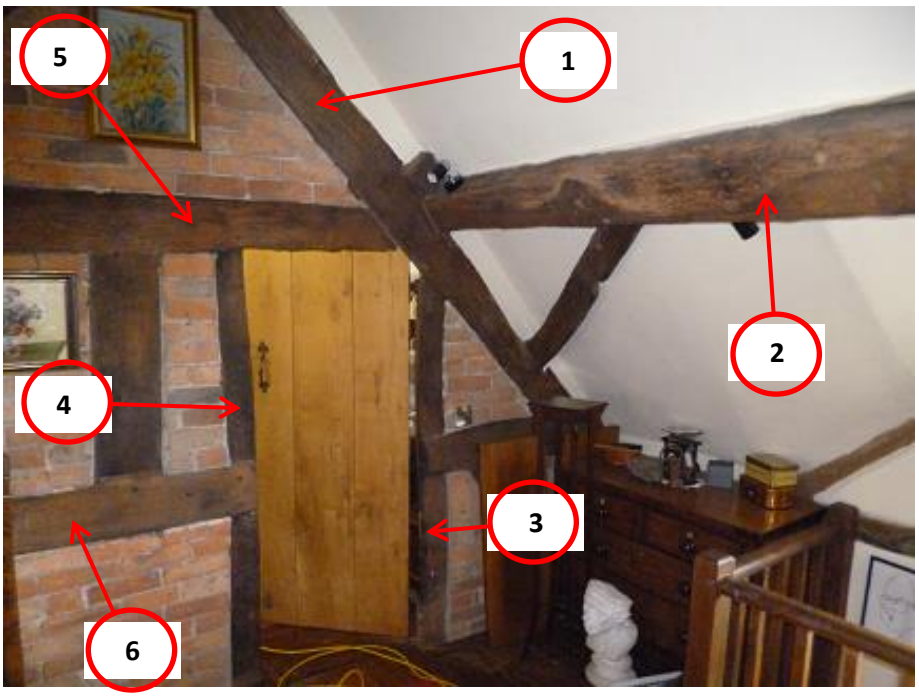


Figure 2b: Cross-section through middle truss (after Barbara Hutton and Howard Usher)



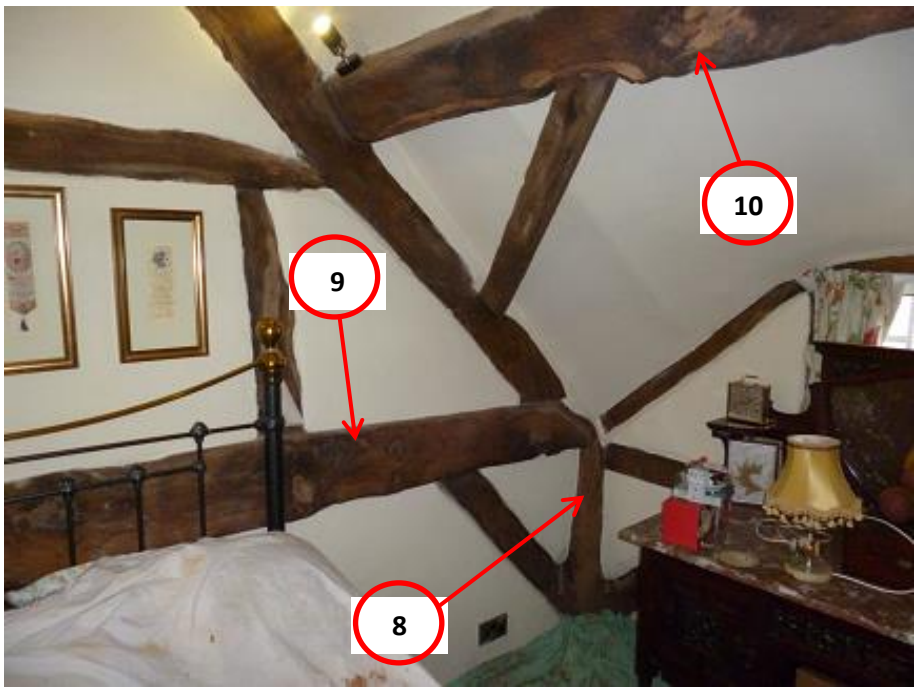


Figure 3a/b: Views to locate the sampled timbers

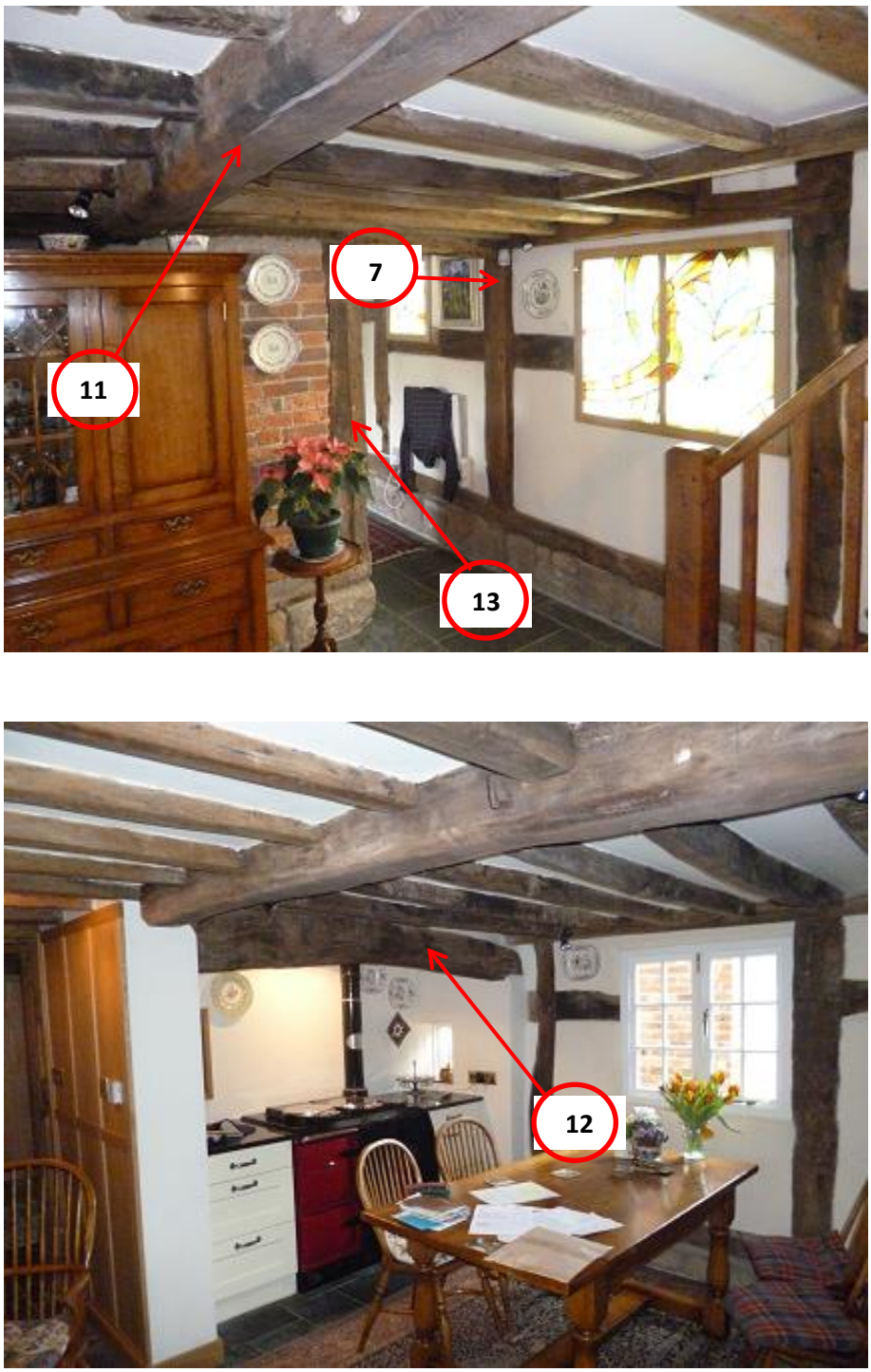


Figure 3c/d: Views to locate the sampled timbers

Figure 3e: View to locate the sampled timbers

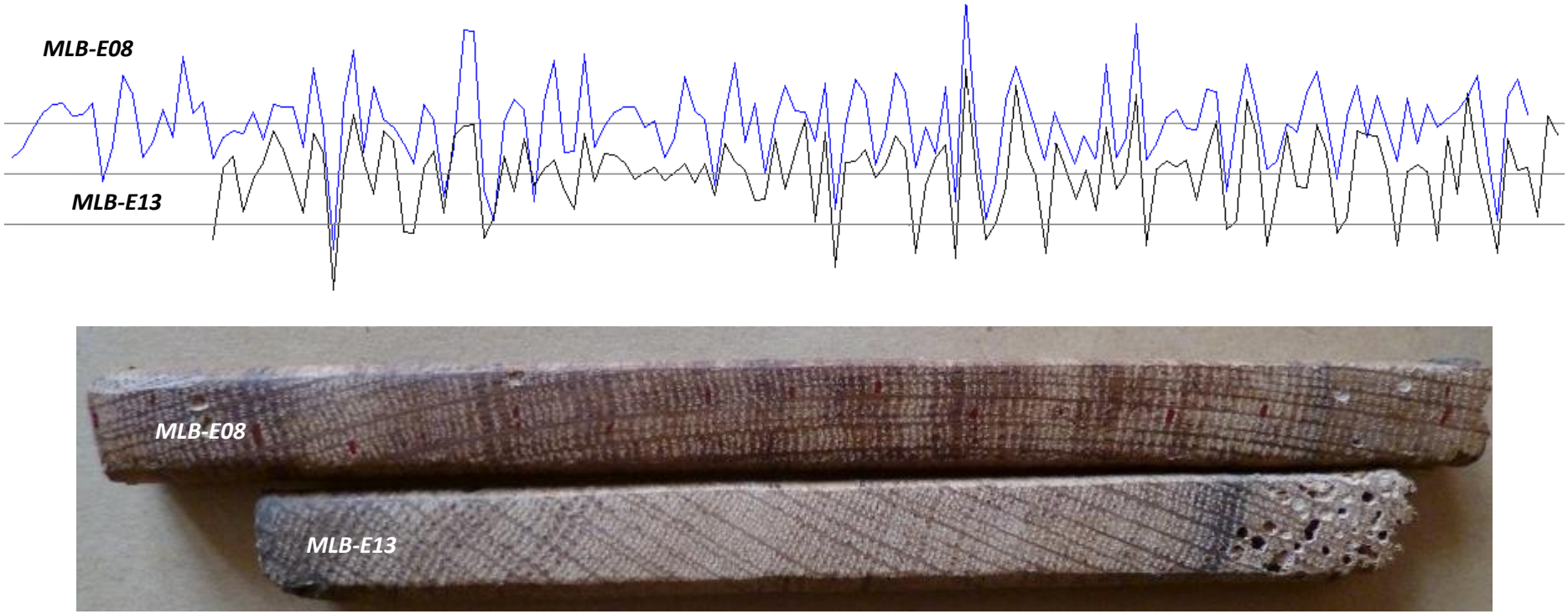
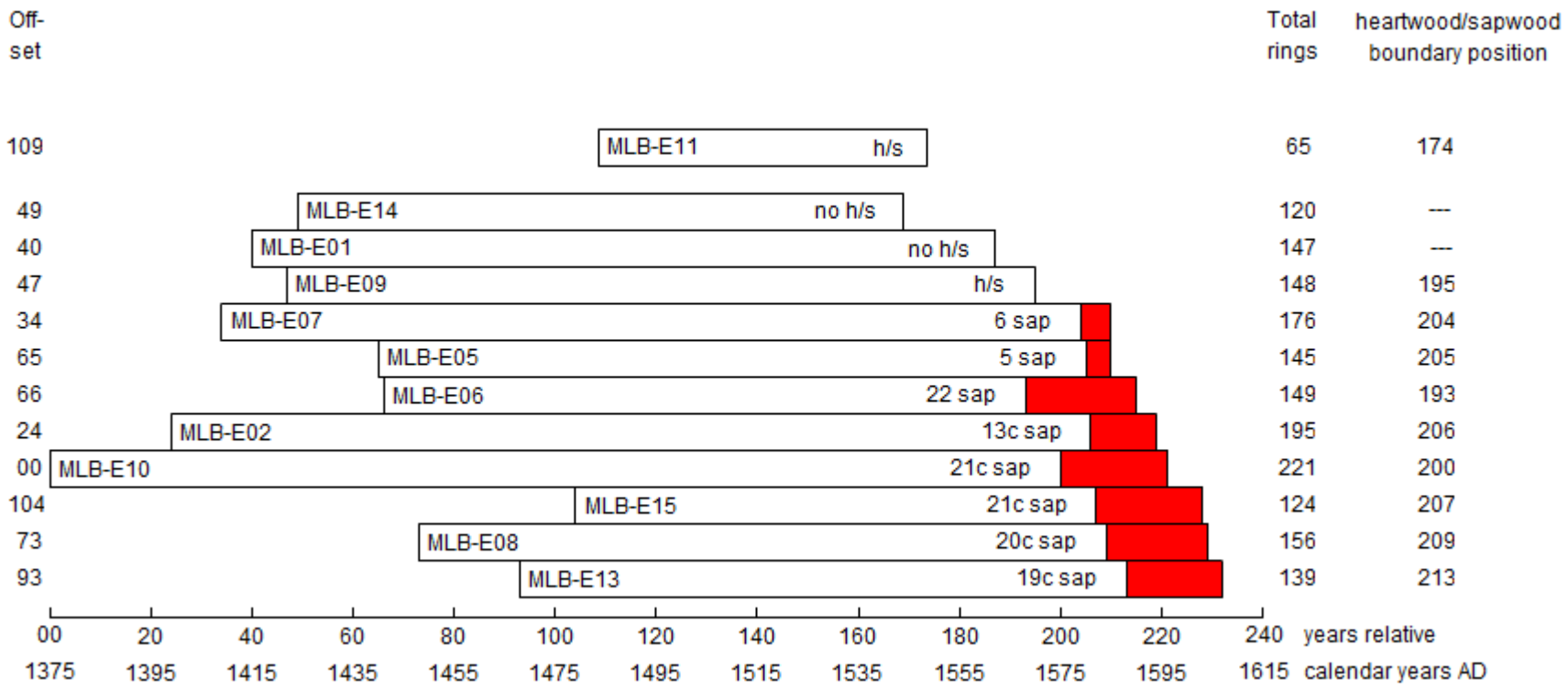


Figure 4: Graphic representation of the cross-matching of samples MLB-E08 and E13

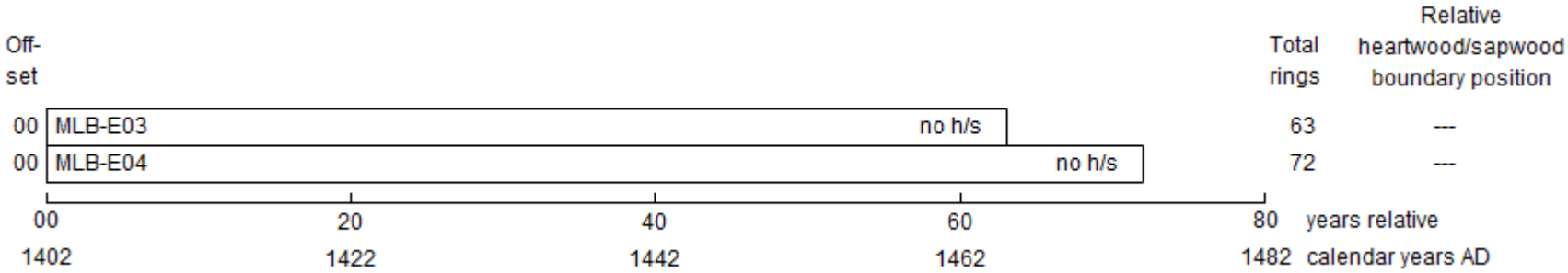
When cross-matched at the correct positions, as here, the variations in the rings of two samples correspond with a high degree of similarity. As the ring widths of one sample increase (represented by peaks in the graph), or decrease (represented by troughs), so too do the annual ring widths of the second sample. This similarity in growth pattern is a result of the two trees represented having grown in the same area *at the same time.* The growth ring pattern of two samples from trees grown at different times would never correspond so well.



White bars = heartwood rings, shaded bars = sapwood rings
c = complete sapwood is found on the sampled timber but all or part of this has been lost from the sample in coring

Figure 5a: Bar diagram of the samples in site chronologies MLBESQ01

The samples of site chronology MLBESQ01 are shown here in the form of 'bars' at the positions where the variations in the rings cross-match with each other, this similarity being produced by the trees from which the sampled beams were derived all growing in the same place, *at the same time*. The samples are combined to form a 'site chronology', and it is this 'averaged' data which is dated by comparison with the 'reference' chronologies (see Table 2).



White bars = heartwood rings, shaded bars = sapwood rings

Figure 5b: Bar diagram of the samples in site chronologies MLBESQ02

The samples of site chronology MLBESQ02 are again shown in the form of ‘bars’ at the positions where the variations in the rings cross-match with each other. The samples are again combined to form a ‘site chronology’ and dated by comparison with the ‘reference’ chronologies (see Table 3).