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TREE-RING ANALYSIS OF TIMBERS FROM
No. 2 THE HOLLOW,
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DERBY

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SUMMARY

Core samples were obtained from four different timbers within 2 The Hollow, Mickleover. Analysis of these four samples has resulted in the production of a single site chronology, MKVASQ01, comprising two samples, and has dated a third sample, MKV-A04 individually. Another sample, MKV-A03, remains undated.

Site chronology MKVASQ01 has an overall length of 171 rings, these rings dated as spanning the years 1164–1334. Interpretation of the sapwood on these two samples indicates that the trees represented, both used for the principal rafters of the single remaining truss, were felled together in 1334. It is not certain, however, that these timbers represent the remains of an original, or earlier, building here and are perhaps more likely to have been salvaged from some demolished structure and reused in the construction of a new house.

Sample MKV-A04, from the main ground-floor ceiling beam of the lounge, has 128 rings, these dated as spanning the years 1464–1591. Interpretation of the sapwood on this sample indicates that the tree represented was felled some time between 1597 and 1622. Although there is no absolute certainty that this timber belongs directly with the construction of a new house at this time, the ceiling timbers do seem to be all of a piece, and to be a single-phase unit, and there is no evidence of the frame having been inserted, reused, into an already existing building. It would appear to indicate, therefore, that a new house was built here in the early seventeenth century, incorporating early fourteenth century timbers into its roof frame, and it is probably this house which was given its present appearance in the late-eighteenth or early-nineteenth century.

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Introduction

The listing for No. 2 The Hollow, Mickleover (Figs 1a/b), describes the house as being part of a group of red-brick, two storey houses, with dog-tooth eaves below a tiled roof. It further describes No. 2 as being of late-eighteenth or early-nineteenth century date. Thus, from the outside, there is no intimation of the timber framing within which comprises the vestigial remains of a single principal-rafter-with-tiebeam truss at first floor level at approximately the middle of the house (Fig 2a). This truss incorporates other timbers such as struts and posts, and has a visible panel of wattle and daub infill (Fig 2b).

Judging by the size of the empty mortices, the truss would originally have had a substantial collar, although this now gone, being replaced by a reused timber morticed into the rafters and also held by iron straps. The truss would also have carried a single purlin to each pitch of the roof. It is likely that, in its original form, there were wind-braces, either straight or curved, between the principal rafters and the purlin (Fig 3a/b).

This principal rafter truss does not support the present roof (Fig 4). This would suggest that either the truss was incorporated into the present building purely for show when the house was given its present appearance in the late-eighteenth or early-nineteenth century, which seems unlikely, or that an older existing, at least partially timber-framed, house, probably of two bays, was redeveloped at this time, and the roof and upper floor were raised by a few feet.

In addition to the truss and timber framing at first floor level, there is a full-framed ceiling to the ground floor lounge (Fig 5). This frame comprises a large longitudinal bridging beam from which run a series of much smaller transverse common joists. This frame appears to be all of one piece and to be of a single phase of construction.

Sampling

Sampling and analysis by tree-ring dating of the timbers within 2 The Hollow were commissioned by the owners, Mr and Mrs Pym, out of personal interest in the building and its history, and as part of a general programme of research in to its origins and development, a certain amount of investigation having already been undertaken. It was hoped that tree-ring dating might not only establish the date of its original construction, but also show the dates of its subsequent changes and possibly establish how much, if any, re-used older, or later inserted, material it contained.

With the aim of fulfilling this brief, core samples were obtained from the four different timbers which appeared suitable for tree-ring dating by reason of having sufficient rings for reliable analysis, and by appearing to be pertinent to the construction and development of the house. Although there were other timbers potentially available for sampling most of these either appeared to have insufficient rings for dating, or appeared to be later pieces inserted into the frame. Such timbers were not sampled.

Each sample was given the code MKV-A (for Mickleover – site 'A'), and numbered 01–04. The sampled timbers are located on photographs taken at the time of coring, shown here as

Figures 2a/b and 5. 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 the front of the house is taken to be facing west, the rear to be facing east.

In one instance, the rear or east principal rafter, it was necessary to take two cores from the timber. The first core, MKV-A02a, contains the majority of rings of the tree, including the inner rings of the tree, while core MKV-A02b contains the outer part of the tree, this being important for determining when the tree was cut down. It was not possible to obtain all the rings on a single core due to the sapwood on the tree being close to a mortice. The data from the two cores could be combined into a single sample.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank Mr and Mrs Pym for organising this research project, for the application of tree-ring dating to its timbers, and for its generous private funding. The Laboratory would also like to pay note to their generous hospitality

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 buildings and archaeological excavations) grow by adding one, and only one, growth-ring to their circumference each year, 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 6).

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

All four samples obtained from this building were prepared by sanding and polishing and the widths of their annual growth rings were measured. The data of these measurements were then compared with each other as described in the notes above. By this process a single group of two samples (one sample made up of two cores from the same timber), both from the principal rafters, could be formed, the samples cross-matching with each other at the positions as shown in the bar diagram Figure 7. The two cross-matching samples were combined at these off-set positions to form MKVASQ01, a site chronology with an overall length of 171 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 1164 to 1334. The evidence for this dating is given in the *t*-values of Table 2.

The two remaining ungrouped samples, MKV-A03 and A04, were then compared individually with the full corpus of reference data. This process indicated a cross-match for only sample MKV-A04, its 128 rings dated as spanning the years 1464–1591. The evidence for this dating is given in the *t*-values of Table 3. There was no cross-matching or date for sample MKV-A03.

Interpretation

Analysis of four samples obtained from this site has produced a single dated site chronology, MKVASQ01, comprising two samples (one sample made up of two cores) and having a last measured ring date of 1334, and dated another sample, MKV-A04, from the main ground floor ceiling beam, individually. This single sample has a last measured ring date of 1591.

One of the samples, MKV-A02, in site chronology MKVASQ01, retains complete sapwood, on core 02b. This means that this core has the last growth ring produced by the tree it represents before it was cut down (this indicated by upper case 'C' in Table 1 and the bar diagram, Figure 7). This last growth ring, and thus the felling of the tree, is dated to 1334.

The other sample, MKV-A01, in site chronology MKVASQ01, retains some sapwood and the heartwood/sapwood boundary, the relative position and date of this boundary being at a very similar position and date to that on sample MKV-A02, from the timber whose felling date is known. Such similarity in this boundary would suggest that the timber this sample represents was almost certainly felled in 1334 as well.

Such an interpretation is supported by the relatively high degree of cross-matching (t=8.2), between samples MKV-A01 and A02a/b, which would suggest that the timbers are derived from two different trees which were originally growing close to each other in the same area of woodland. Had the two trees been felled at different times it is unlikely that they would be used for principal rafters in the same truss, in the same building. It is much more likely that the two trees were felled at the same time for the same building.

The individually dated sample, MKV-A04, from the ground floor ceiling beam, has a last ring date of 1591. This sample does not retain complete sapwood, and it is thus not possible to give a precise date for the felling of the tree. The sample does, however, retain some sapwood (nine rings) and the heartwood/sapwood boundary, the boundary ring being dated to 1582. Given that most oak trees have between a minimum of 15 sapwood rings, and a maximum of 40, this would suggest that the tree represented by sample MKV-A04 was felled at some point between 1597 (1582+15) and 1622 (1582+40).

Undated timbers

One sample, MKV-A03, from the tiebeam, remains ungrouped and undated. This sample has only 55 rings, which, although being statistically sufficient, is at the lower end of the acceptable range. While such short samples can very occasionally be dated, it is much more difficult, and less reliable, than with longer samples, or with groups of samples.

Conclusion

It is not possible to be certain that the timbers felled in 1334, the principal rafters, are integral to an original building on this site, and that they represent the primary phase of construction here. If they did, it would be an unusual, not to say spectacular, survival, and might necessitate a complete re-appraisal of this house, and others in its group. It is, therefore, perhaps more likely that the timbers have been salvaged from some other demolished building, possibly one close-by, or perhaps even an earlier building on this same site. Further survey, recording, and interpretation, of this and perhaps other buildings in the group, might help with its interpretation, though even with this, it may be difficult to reach a conclusion; there is perhaps a slight possibility that timbers of the same date are incorporated into other local houses. Perhaps further research of the documentary sources at the relevant dates might help.

The date at which the present house initially began life might be represented by the later timber, the main ground floor ceiling timber, which was felled at some point between the very end of the sixteenth century and the early seventeenth century, a more likely time, perhaps, that older timbers might be reused in a newer building. It is perhaps this house, with its lower height roof and upper floor, which was reconfigured in the late-eighteenth or early nineteenth century. As such, this too makes 2 The Hollow an unexpected survival and may have implications for the interpretation of others in its group.

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Table 1: Details of tree-ring samples from 2 The Hollow, Mickleover, Derby

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
MKV-A01	Front, or west, principal rafter	157	9	1164	1311	1320
MKV-A02a/b	Rear, or east, principal rafter	159	30C	1176	1304	1334
MKV-A03	Tiebeam	55	h/s	------	------	------
MKV-A04	Main ground floor ceiling beam	128	9	1464	1582	1591

*h/s = the last measured ring on the sample is at the heartwood/sapwood boundary, ie, only the sapwood rings are missing
C = complete sapwood is retained on the sample, the last measured ring date is the felling date of the tree represented

Table 2: Results of the cross-matching of site chronology MKVASQ01 and relevant reference chronologies when the first ring date is 1164 and the last ring date is 1334

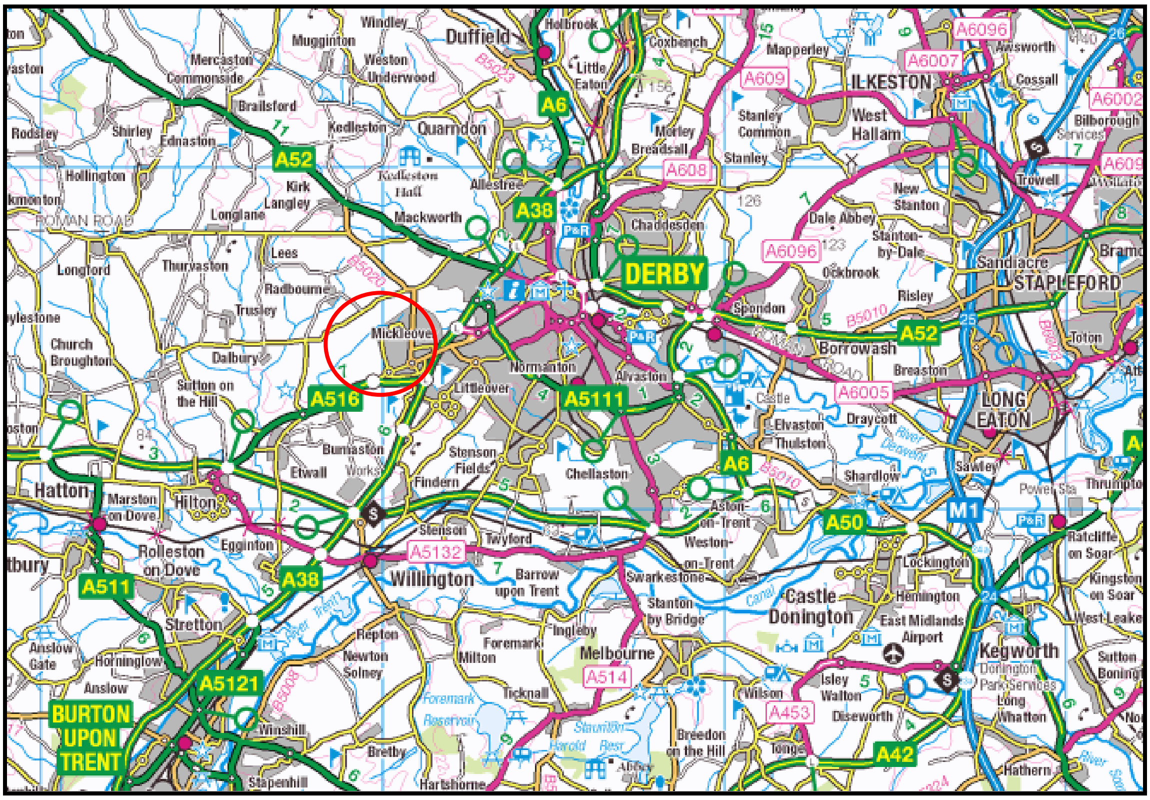
Reference chronology	*t*-value	
Manor House, Burton-upon-Trent, Staffs	15.4	(Howard *et al* 1998 unpubl)
Quaintree House, Braunston, Leics	9.1	(Alcock *et al* 1991)
East Midlands Master Chronology	8.7	(Laxton and Litton 1988)
51/52 High Street, Burton-upon-Trent, Staffs	8.6	(Howard *et al* 1997)
Sandiacre Tithe Barn, Derbys	8.6	(Howard *et al* 2004 unpubl)
Kenilworth Castle Gatehouse, Warwicks	8.6	(Arnold and Howard 2007b)
Abbey Gatehouse, Polesworth, Warwicks	8.4	(Arnold and Howard 2007a)
Severns, Castle Road, Nottm	8.0	(Howard *et al* 1996)

Site chronology MKVASQ01 is a composite of the data of the two cross-matching samples seen in the bar diagram, Figure 7. This composite data produces an 'average' tree-ring pattern, where the overall climatic signal of the combined ring growth is enhanced, and the possible erratic variations of either individual sample are reduced. This 'average' site chronology is then compared with several hundred reference patterns covering every part of Britain for all time periods. As can be seen here, MKVASQ01 matches only when its 171 rings span the years 1164–1334, the degree of similarity between it and the reference chronologies listed indicated by '*t*-values' (ie, degrees of similarity).

In respect of these *t*-values it may be seen that, while all of them are unusually high, there is an exceptional degree of similarity between the timbers found at 2 The Hollow and the reference pattern made up of samples from the timbers at the Manor House at Abbey Green, Burton upon Trent. The cross-match found here, with a value of *t*=15.4, would suggest that the trees used in both buildings not only came from the same woodland source (wherever that was), but must have been growing virtually side-by-side.

Table 3: Results of the cross-matching of sample MKV-A04 and relevant reference chronologies when the first ring date is 1464 and the last ring date is 1591

Reference chronology	*t*-value	
Old Hall Farmhouse, Mayfield, Staffs	5.3	(Arnold and Howard 2006 unpubl)
East Midlands Master Chronology	5.2	(Laxton and Litton 1988)
Old Hall Cottage, Twyford, Leics	5.2	(Arnold *et al* 2008)
Ordsall Hall, Stockport, Cheshire	5.1	(Arnold *et al* 2004)
Kingsbury Hall, Kingsbury, Warwicks	5.0	(Arnold and Howard 2006)
Hilltop Farm, Staunton Harold, Leics	4.9	(Arnold *et al* 2008)



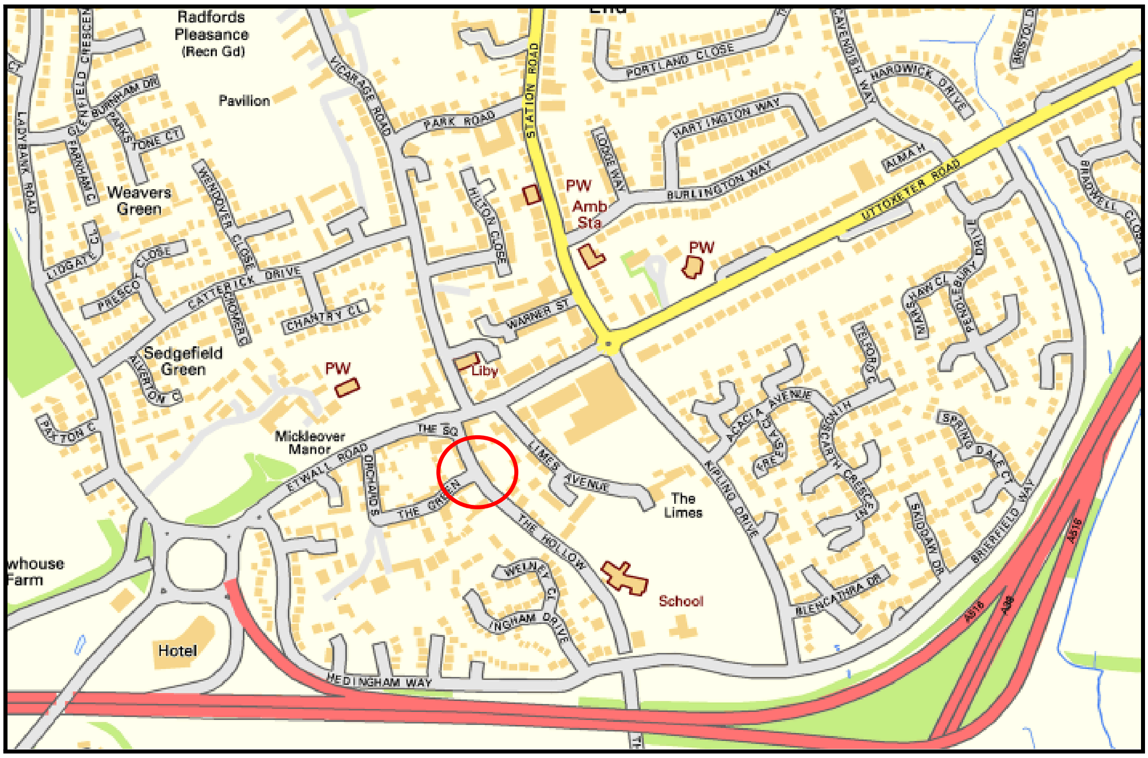


Figure 1a/b: Maps to show location of Mickleover (top) and the 2 The Hollow (bottom)

Figure 2a/b: Views of the single remaining truss (top) and the panel of wattle and daub in-fill (bottom). The sampled timbers are also shown

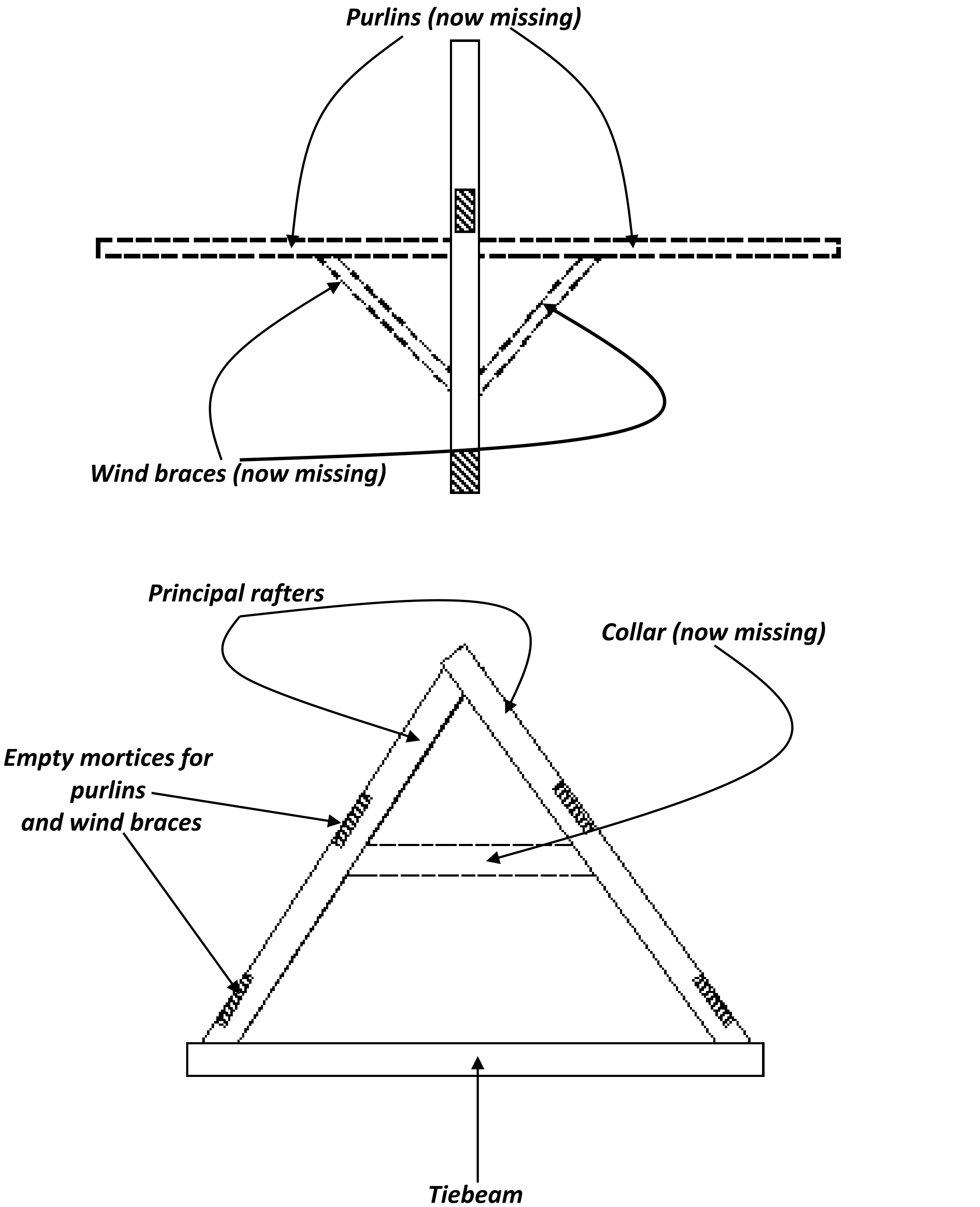


Figure 3a/b: Reconstructed possible long-section of the original roof (top), and cross-section through truss (bottom)

Figure 4: View of the apex of the remaining truss showing that it does not support the roof

Figure 5: The main bridging beam of the ground floor ceiling to the lounge, cored as sample MKV-A04

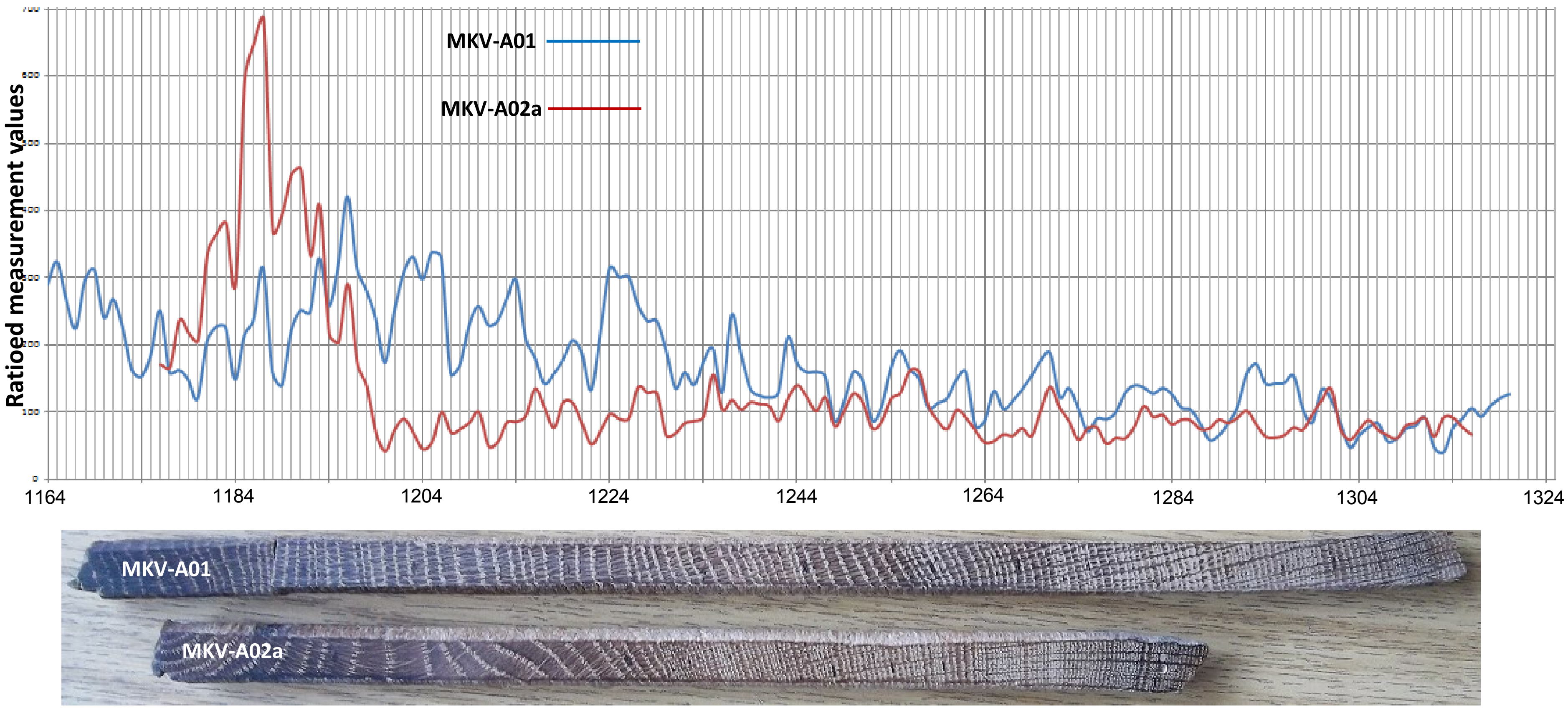
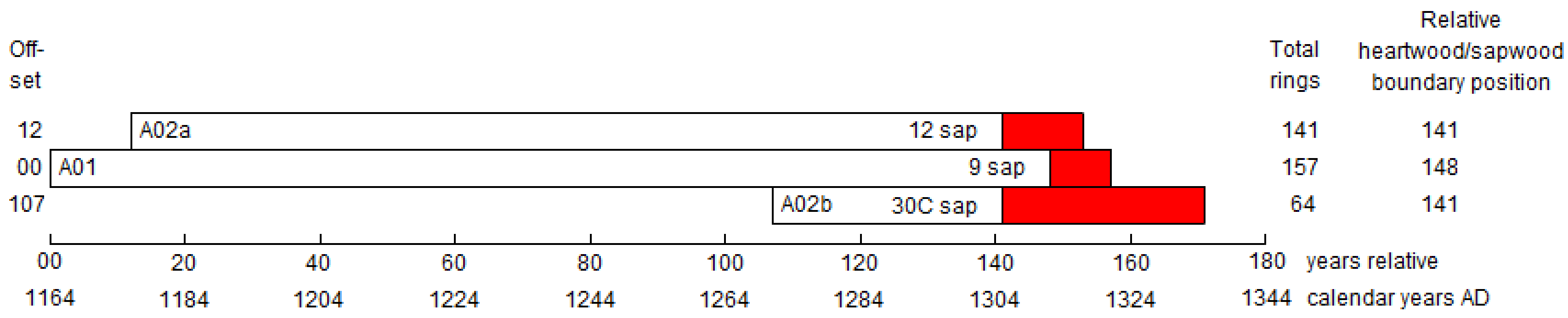


Figure 6: Graphic representation of the cross-matching of two samples, MKV-A01 (blue) and A02a (red). It can be seen that when cross-matched at the correct off-set positions, as here, the variations in width of the annual growth rings of these two samples correspond with a high degree of similarity. As the annual rings 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 should never cross-match at any position.



White bars [ ] = heartwood rings, shaded bars [ ] = sapwood rings

C = complete sapwood is retained on the sample; where dated the last measured ring date is the felling date of the tree represented

Figure 7: Bar diagram of the samples in site chronology MKVASQ01

This figure shows the samples 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 measured data of the annual growth rings of the samples are combined to form a 'site chronology', and it is this 'averaged' data which is dated by comparison with the 'reference' chronologies.