ntrdl the nottingham tree-ring dating laboratory

Dendrochronology, timber analysis, and historic building consultants

BROOKSIDE HOUSE, BROOK LANE, GREAT EASTON, MARKET HARBOROUGH, LEICESTERSHIRE; TREE-RING ANALYSIS OF TIMBERS

A J ARNOLD
R E HOWARD

MARCH 2012

BROOKSIDE HOUSE, BROOK LANE, GREAT EASTON, MARKET HARBOROUGH, LEICESTERSHIRE; TREE-RING ANALYSIS OF TIMBERS

A J ARNOLD
R E HOWARD

SUMMARY

Analysis by dendrochronology of seven samples obtained from the roof timbers of this house has resulted in the production of two dated site chronologies.

The first site chronology, comprising two samples from what is believed to be an original truss, is 73 rings long, these rings dated as spanning the years 1547–1619. Interpretation of the sapwood on these two samples would indicate that the timbers, both principal rafters, were cut as part of a single episode of felling at some time between 1630 and 1635.

The second site chronology comprises three samples, all of them from what are thought to be later alteration phase timbers. This site chronology is 106 rings long, these rings dated as spanning the years 1682–1787. Interpretation of the sapwood on these samples would indicate that the timbers were cut in a single episode of felling in 1787.

Two further samples remain ungrouped and undated.

NTRDL, 20 Hillcrest Grove, Sherwood, Nottingham, NG5 1FT
Telephone 0115 960 3833 (laboratory);
07980 305583 / 07913 427987 (Mobiles)
roberthoward@tree-ringdating.co.uk
alisonarnold@tree-ringdating.co.uk

Introduction

Brookside House, in Brook Lane, Great Easton (Figs 1a/b), is a good quality stone building of three units and is two-and-a-half storeys tall. The house, having benefited from an historical survey by Nick Hill (Hill 1988 unpubl), from which this introductory information is taken, is seen as unusual for Great Easton in being of lobby-entrance plan. In this arrangement the main front door opens against the side of a massive central chimney stack, a form which grew in popularity in the south east of England from 1600 onwards and spread into the Midlands. Internally, on the ground floor, the house was divided into a kitchen at one end with a large fireplace, followed by a central hall, also with a fireplace, and then a parlour at the other end, this having a smaller fireplace (see plan Fig 2). The hall would have probably contained the stairs to the upper floor.

On the basis of the early-style hood-moulding to the front windows, a date prior to 1650 has been suggested for this house, while the advanced plan-form would more likely place it after this date. It has been suggested, therefore, that Brookside House dates to between 1630–70.

The roof of Brookside House has clearly been rebuilt, though some original timbers have been reused. Truss I has had its top half renewed, the replacement part being spliced into the original lower portion, while truss II is completely new. Truss III, however, is largely untouched and appears to be in its original form (Fig 3). This truss shows that the original roof was of principal rafter trusses with two collars supporting through purlins, but having no ridge. It is likely that all the other original trusses were of this form. To maximise the upper floor all three trusses have had their collars removed and replaced by a new one higher up. It is believed that this work was undertaken in the late-eighteenth or early-nineteenth century. Views of the roof are given in Figures 4a/b.

Sampling

Sampling and analysis by tree-ring dating of the timbers within Brookside House were commissioned by the owner, Dr Eric Craven 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 a number of 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 relatively modern (probably twentieth century) pieces inserted into the frame. Such timbers were not sampled.

Each sample was given the code GRE-A (for Great Easton – site 'A'), and numbered 01–07. The sampled timbers are located on a plan made by Nick Hill as part of his historic survey of the house, this being given as Figure 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, following the schema of the survey drawings, the front of the house is taken to be facing north, the rear to be facing south.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank Dr Craven 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 thank Nick Hill for his help in the interpretation and understanding of this building and for the use in this report of his plans and drawings

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 used in building construction until the introduction of pine from the late eighteenth century onwards) 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.

Secondly, because the weather over a certain number of consecutive years (the statistically reliable minimum calculated as being 54 years) is unique, so too is the growth-ring pattern of the tree. The pattern of a shorter 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, and is considered less reliable. 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 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 seven samples obtained from the roof timbers of the cottage was prepared by sanding and polishing, and the widths of their annual growth rings were measured. The data of these measurements then compared with each other as described in the notes above. By this process two separate groups of cross-matching samples could be formed.

The first group comprises two samples, GRE-A06 and A07, respectively from the north and south principal rafters of truss III; this truss is believed to be an original roof truss and to represent the primary phase of construction of the cottage. The two cross-matching samples were combined at their indicated off-set positions (see bar diagram Fig 6a) to form GREASQ01, a site chronology with an overall length of 73 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 1547 to 1619. The evidence for this dating is given in the *t*-values of Table 2.

Both samples GRE-A06 and A07 are from timbers which have complete sapwood on them, i.e. the timbers have the last growth ring produced by the trees they represent before they were cut down. Unfortunately, due to the soft and fragile nature of this part of the wood, small portions of the sapwood were lost from the samples in coring. Under such circumstances, however, having noted at the time of sampling the amount of sapwood lost from the core, it is possible to estimate the likely number of sapwood rings the lost portions might have contained. In this instance the lost sapwood portions are about 20 millimetres on sample GRE-A06, and only about 10 millimetres on GRE-A07. Taking the date of the last existing ring on each of these samples it is estimated that the trees represented were almost certainly felled about, say, 1630 at the earliest, and certainly no later than 1635 at the very latest.

The second group comprises three samples, GRE-A01, A02, and A03, all of them from what are believed to be timbers of a later re-roofing of the cottage. These two samples were combined at their indicated off-set positions (see bar diagram Fig 6b) to form GREASQ02, a site chronology with an overall length of 106 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 1682 to 1787. The evidence for this dating is given in the *t*-values of Table 3.

All three of these samples have some sapwood on them, with sample GRE-A01 retaining its sapwood complete, ie, it has the last growth ring produced by the tree it represents. The last growth ring on this sample, and thus the felling of the tree, is dated to 1787. Given the amount of sapwood on the other two samples in this group, GRE-A02 and A03, and the relative position of the heartwood/sapwood on them, it is almost certain that the trees they represent were felled at this time as well.

The two remaining ungrouped samples were compared individually with the full body of reference material, but there was no further satisfactory cross-matching or dating.

This analysis may be summarised as below:

Site chronology / samples	Number of samples	Number of rings	Date span	Felling date
GREASQ01	2	73	1547–1619	1630–35
GREASQ02	3	106	1682–1787	1787
Undated	2	---	---	---

Conclusion

Site chronology GREASQ01

Site chronology GREASQ01 comprises two samples, both of them from truss III which is believed to be original and primary to the cottage. Interpretation of the sapwood would indicate that both timbers were felled in 1630–35, which, given the supporting survey and stylistic evidence, is almost certainly the date of the original building.

Site chronology GREASQ02

Site chronology GREASQ02 comprises two samples from truss II and a lower purlin. It is believed that these timbers represent a later alteration phase. These timbers were felled in 1787.

It will be seen that the dates obtained through tree-ring analysis for the original building are very much in keeping with those intimated by the plan-form and stylistic evidence, with the plan-form suggesting that it ought to be after 1600, and the hood-moulding suggesting it is probably before 1650. Tree-ring dating has indicated that it is, in fact, 1630–35. As such, the tree-ring date is very much towards the earlier end of the proposed range for the house, 1630–70, suggesting perhaps that Great Easton was not as far behind the national trend as might otherwise be supposed.

The suggested date for the rebuilding of the roof, in the late-eighteenth to early-nineteenth century has also proved to be very accurate, the tree-ring dating indicating that this was undertaken in 1787.

Two samples, GRE-A04 and A05, remain ungrouped an undated. It will be seen from Table 1 that sample GRE-A04 contains only 44 rings, a little below the usual statistically reliable minimum of 54 rings, and it is probably this which accounts for the lack of dating. Sample GRE-A05 on the other hand has 56 rings, and shows no sign of distress or disturbance, but still does not date. The reason for its lack of dating us unknown, but a few samples remaining undated from any given building is a very common feature of tree-ring analysis.

Bibliography

Arnold, A J, Howard, R E, Laxton, R R, and Litton, C D, 2003 unpubl Composite Working Mean of tree-ring analysis of timbers from Salisbury Cathedral, Wiltshire – Nottingham Tree-ring Dating Laboratory, unpubl computer file *SALCSQ02*

Arnold, A J, Howard, R E, Litton, C D, and Dawson, G, 2005 *The Tree-ring Dating of a Number of Bellframes in Leicestershire*, Centre for Archaeol **Rep, 5/2005**

Arnold, A J, Howard, R E, and Litton, C D, 2005 *Tree-ring analysis of timbers from Poltimore House, Poltimore, Devon*, Centre for Archaeol Rep, **37/2005**

Arnold, A J, Howard, R E, and Litton, C D, 2006 *Tree-ring analysis of timbers from Lord Leicester's Stables, Kenilworth Castle, Warwickshire*, Res Dep Rep Ser, **21/2006**

Arnold, A J and Howard, R E, 2008 *Church of St Nicholas, Dereham, Norfolk, Tree-ring Analysis of Timbers from the North Transept/North Chapel and Nave Roofs*, Res Dep Rep Ser, **42/2008**

Arnold, A, Howard, R, and Hurford, M, 2008 *The Market House, Ledbury, Herefordshire, tree-ring analysis of timbers*, Res Dep Rep, Ser, **53/2008**

Arnold, A J, Howard, R E, and Litton, C D, 2008 List 197 no.15 – Nottingham Tree-ring Dating Laboratory, Vernacular Architect, **39**, 119–28

Arnold, A J, Howard, R E, and Litton, C D, 2008 – Nottingham Tree-ring Dating Laboratory: additional dendrochronology dates, no.16, Vernacular Architect, **39**, 107–11

Arnold, A J, and Howard, R E, 2009 unpubl Tree-ring analysis of timbers from Castle House, Castle Street, Melbourne, Derbyshire – Nottingham Tree-ring Dating Laboratory, unpubl computer file *MLBCSQ02*

Hill, N A, 1988 unpubl Brookside House, Great Easton, an historical survey.

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1992 unpubl Tree-ring analysis of timbers from Catholme, Staffordshire – Nottingham Univ Tree-Ring Dating Laboratory, unpubl computer file *CATHSQ03*

Howard, R E, Laxton, R R, and Litton, C D, 1996 List 68 no.5a – Nottingham University Tree-Ring Dating Laboratory: Sherwood Forest Oak; a dendrochronological Survey, *Vernacular Architect*, **27**, 87–90

Howard, R E, Laxton, R R, and Litton, C D, 1998 *Tree-ring analysis of timbers from 26 Westgate Street, Gloucester,* Anc Mon Lab Rep, **43/1998**

Howard, R E, Laxton, R R, and Litton, C D, 2000, *Tree-ring analysis of timbers from Stoneleigh Abbey, Stoneleigh, Warwickshire*, Anc Mon Lab Rep, **80/2000**

Tyers, I, 1997 *Tree-ring Analysis of Timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/1997**

Laxton, R R, and Litton, C D, 1988 An East Midlands master tree-ring chronology and its use for dating vernacular buildings, University of Nottingham, Dept of Classical and Archaeol Studies, Monograph Series, **III**

Table 1: Details of tree-ring samples from Brookside House, Brook Lane, Great Easton, Leicestershire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
GRE-A01	North lower purlin, truss I – II	56	13C	1732	1774	1787
GRE-A02	North principal rafter, truss II	89	h/sc	1682	1770	1770
GRE-A03	South principal rafter, truss II	70	10c	1714	1773	1783
GRE-A04	North lower purlin, truss II – stack principal	44	no h/s	------	------	------
GRE-A05	North lower purlin, stack principal – truss III	56	no h/s	------	------	------
GRE-A06	North principal rafter, truss III	54	h/sc	1557	1610	1610
GRE-A07	South principal rafter, truss III	73	7c	1547	1612	1619

*h/s = the sample has the heartwood/sapwood boundary, i.e., 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
c = complete sapwood is found on the sampled timber but all or part of it has been lost from the core in sampling

Table 2: Results of the cross-matching of site chronology GREASQ01 and the reference chronologies when the first ring date is 1547 and the last ring date is 1619

Reference chronology	*t*-value	
Poltimore House, Poltimore, Devon	7.5	(Arnold *et al* 2005)
26 Westgate Street, Gloucester	6.1	(Howard *et al* 1998)
Church of St Nicholas, Dereham, Norfolk	5.9	(Arnold and Howard 2008)
Leicester's Stables, Kenilworth Castle	5.8	(Arnold *et al* 2006)
The Market House, Ledbury, Herefs	5.5	(Arnold *et al* 2008)
Wren Wing, Easton Neston, Northants	5.5	(Arnold *et al* 2008)
Salisbury Cathedral, Wilts	5.5	(Arnold *et al* 2003 unpubl)
Southwell Minster, Southwell, Notts	5.3	(Howard *et al* 1996)

Table 3: Results of the cross-matching of site chronology GREASQ02 and the reference chronologies when the first ring date is 1682 and the last ring date is 1787

Reference chronology	*t*-value	
Castle House, Melbourne, Derbys	6.5	(Arnold and Howard 2009 unpubl)
Quenby Hall, Quenby, Leics	6.2	(Arnold *et al* 2008)
Catholme, Staffs	5.5	(Howard *et al* 1992 unpubl)
St John The Baptist, Grimstone, Leics	5.5	(Arnold *et al* 2005)
Sinai Park, Burton on Trent, Staffs	5.4	(Tyers 1997)
East Midlands Master Chronology	5.3	(Laxton and Litton 1988)
Bradgate Trees, Bradgate, Leics	5.1	(Laxton and Litton 1988)
Stoneleigh Abbey, Stoneleigh, Warwicks	4.8	(Howard *et al* 2000)

Site chronologies GREASQ01 and GREASQ02 are composites of the data of the relevant cross-matching samples as seen in the bar diagram Figures 6a/b. This composite data produces 'average' tree-ring patterns, where the overall climatic signal of the growth is enhanced, and the possible erratic variations of any one individual sample are reduced. These 'average' site chronologies are then compared with several hundred reference patterns covering every part of Britain for all time periods. Each site chronology dates only at the time span indicated, each table giving only a small selection of the very best matches as represented by '*t*-values' (ie, degrees of similarity).

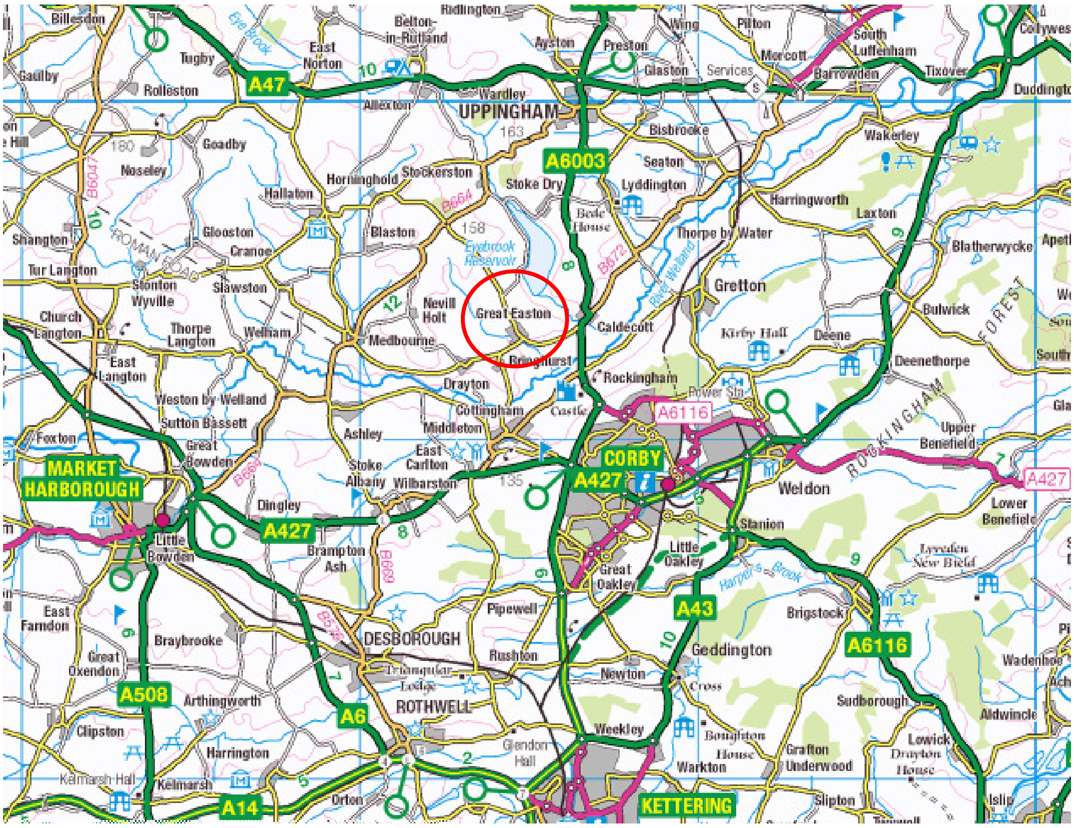


Figure 1a/b: Maps to show location of Great Easton (top) and Brookside House (bottom)

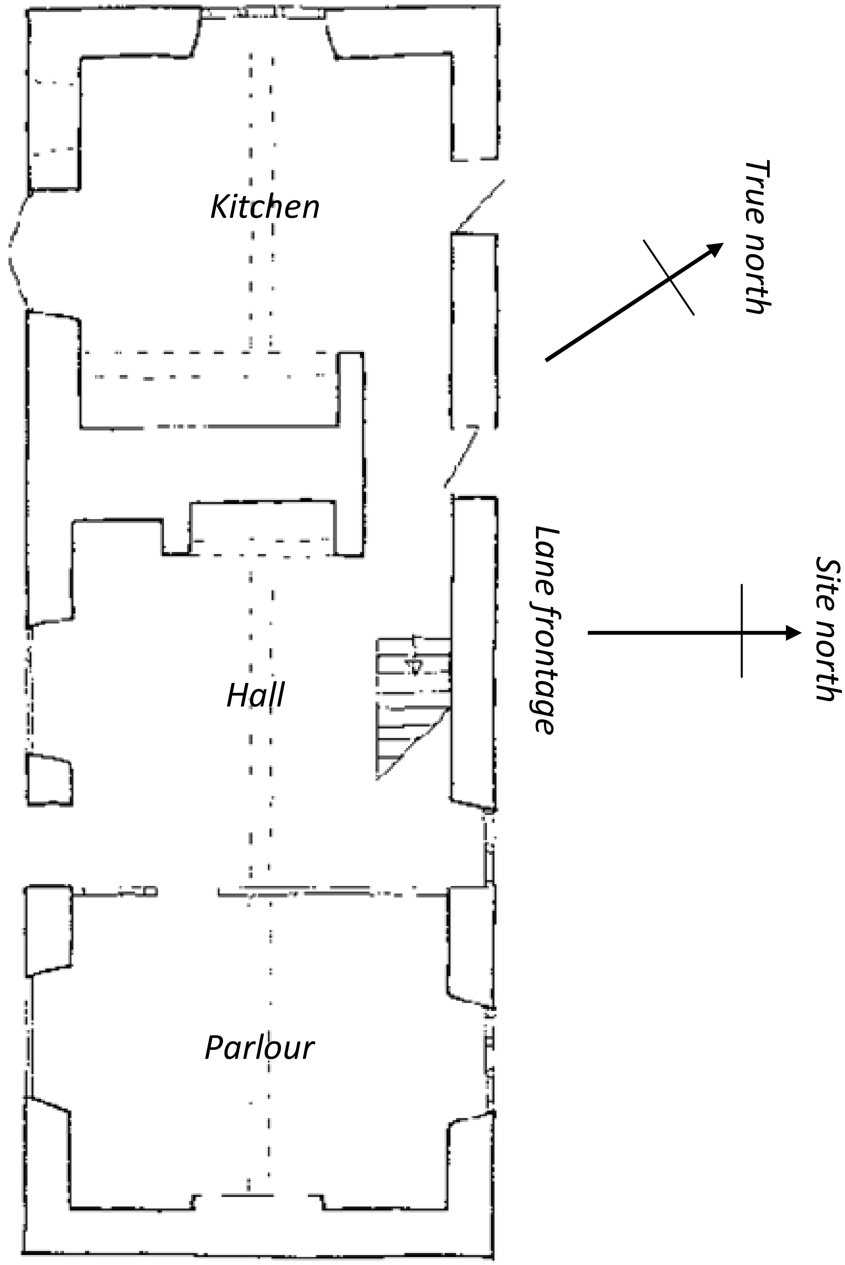


Figure 2: Plan of Brookside House to show arrangement of rooms at ground floor level (after Nick Hill)

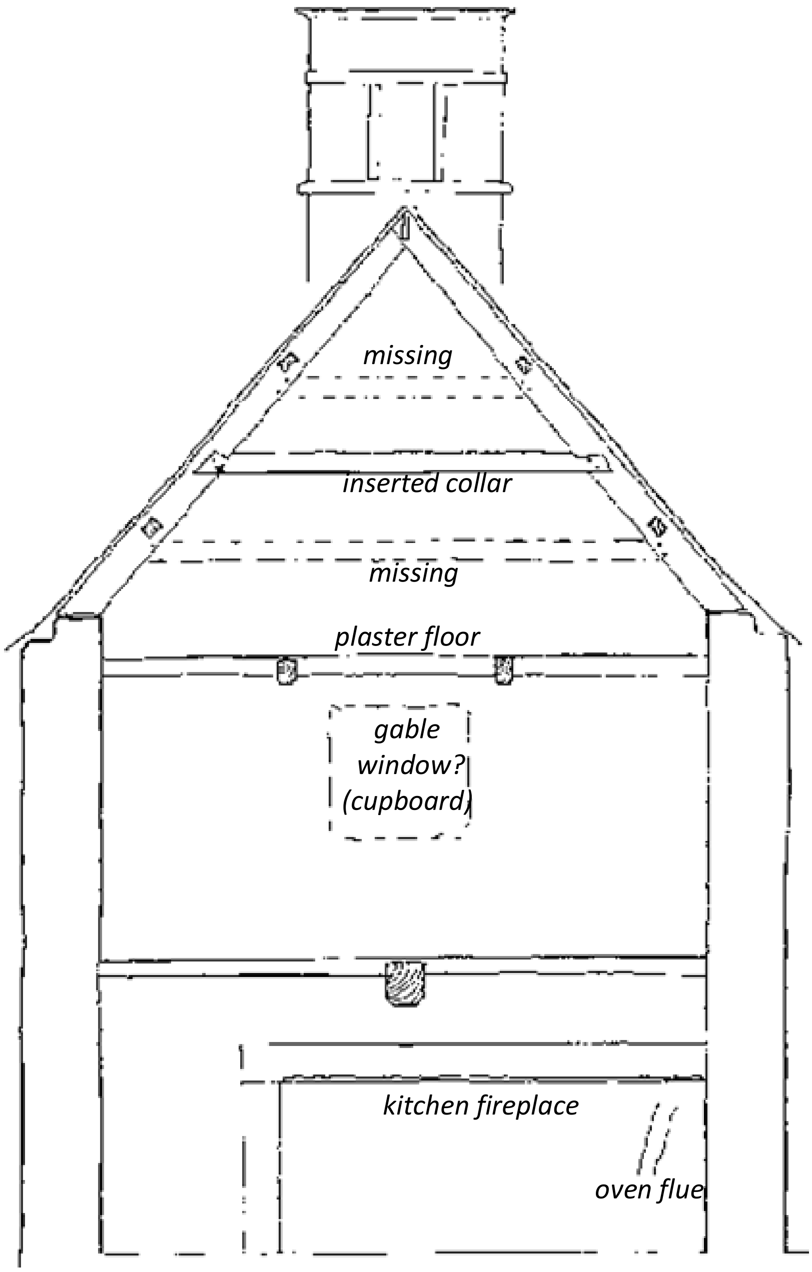


Figure 3: Cross-section of Brookside House at truss III
(after Nick Hill)

Figure 4a/b: View of the north principal of truss II (top) and the north principal of truss III (bottom)

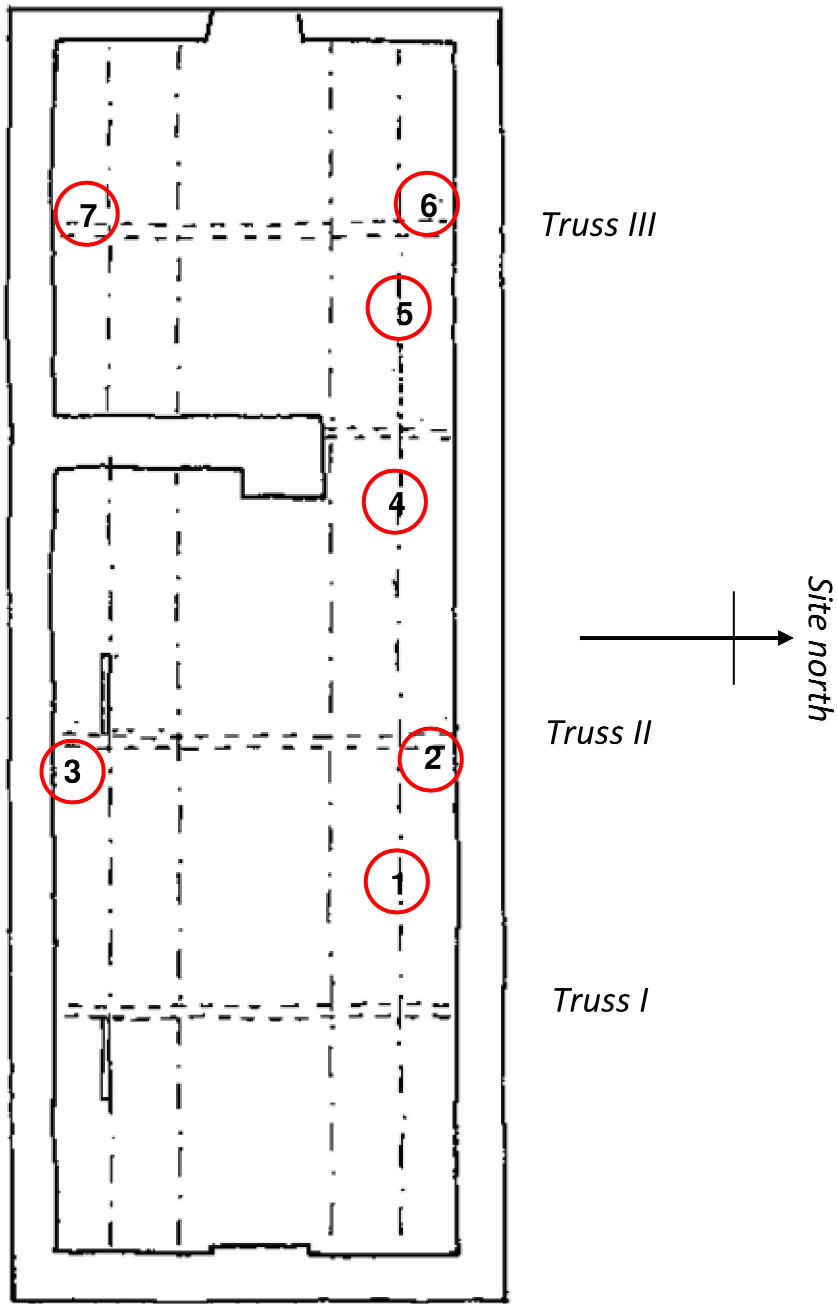
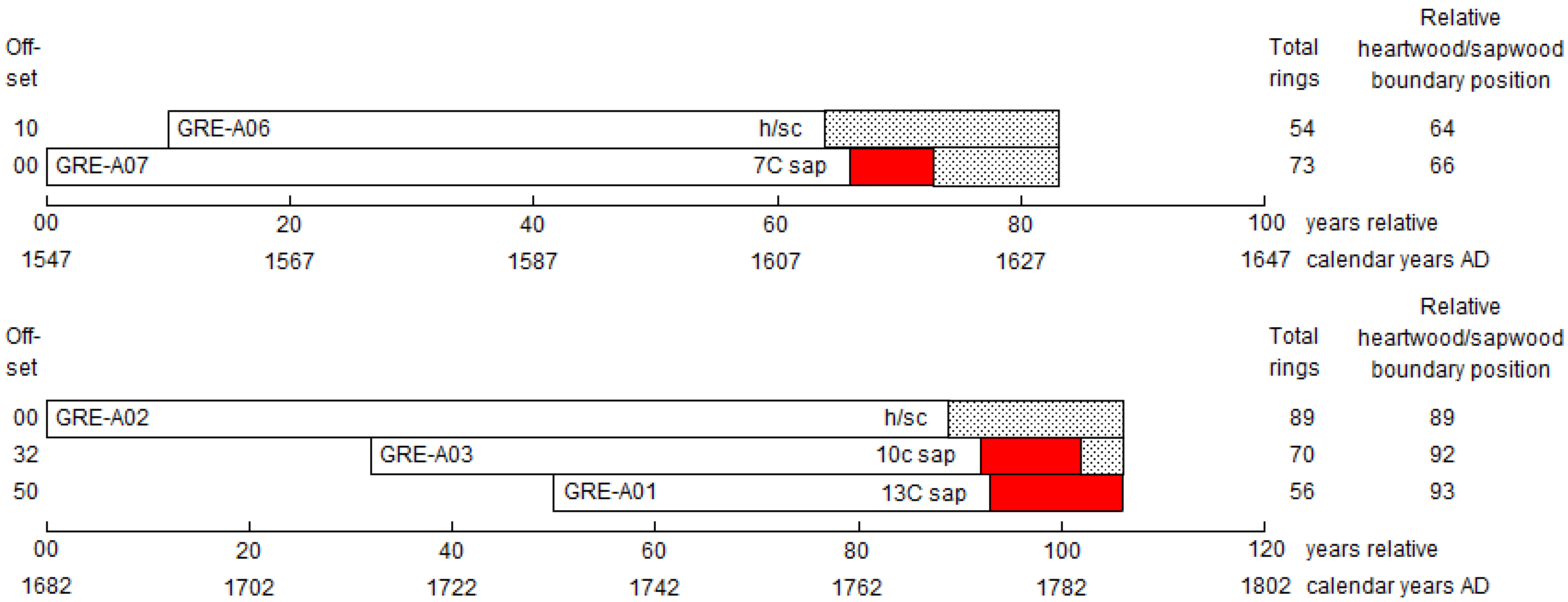


Figure 5: Plan to show the approximate positions of the sampled timbers (after Nick Hill)



Blank bars = heartwood rings, shaded bars = sapwood rings, hatched bars = estimated lost sapwood rings
h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing
c = complete sapwood is found on the timber but a portion of this has been lost from the sample in coring
C = complete sapwood is retained on the sample, the last measured ring date is the felling date of the tree represented

Figure 6a/b: Bar diagram of the samples in site chronologies GREASQ01 (top) and GREASQ02 bottom) at positions indicated by their separate grouping. The samples in the two separate site chronologies are shown in the form of bars at positions where the ring variations of the samples within each group cross-match with each other. This similarity is produced by the trees represented by each site chronology growing, *at the same time.* The samples are combined to form two 'site chronologies', each of which is dated by comparison with the 'reference' chronologies (Tables 2 and 3). The amount of sapwood lost from those timbers on which it is complete (that is, they have the last growth ring the tree produced before it was felled), has been estimated indicating that the earlier or original timbers, as represented by site chronology GREASQ01, were cut as part of a single episode of felling some time between, say, 1630–35, while the later repair timbers were all cut in 1787.