TREE-RING ANALYSIS OF TIMBERS FROM 2–4 CHURCH STREET, LEEK, STAFFORDSHIRE

A J ARNOLD
R E HOWARD

With a building description and history by Faith Cleverdon

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SUMMARY

Tree-ring analysis of 11 samples from the three surviving trusses and floor-frame within 2–4 Church Street, Leek, shows that all the dated timbers were cut as part of a single programme of felling which took place between 1513 at the earliest and 1515 at the latest.

From the material analysed a single site chronology was created, LEKCSQ01, this comprising nine of the 11 samples obtained, and having an overall length of 107 rings. These rings were dated as spanning the years 1406–1512.

Nottingham Tree-ring Dating Laboratory
Dendrochronology, timber analysis, and historic building consultants

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

Leek's thirteenth century town charter gave each burgher the right to have timber for building, and a court roll dating to 1548 indicates that this remained the practise until at least the sixteenth century. For the town itself, and those parts of Leek parish that lay on the Sherwood Sandstone, timber remained the most important building material until the seventeenth century.

The humbler houses of Leek were cruck framed. Urban examples include 2–4 Clerk Bank, the Black Swan public house (Howard *et al* 1998), and 'Old Timbers' on Stockwell Street. Wealthier people built box-framed buildings. These allowed more spacious surroundings and better headroom on the upper floors. Outside the town centre the earliest examples of box-framed buildings are to be found at Mosslee Hall, and the Hall House, both in Cheddleton (Howard *et al* 1998).

2–4 Church Street, Leek, (Figs 1 and 2) is a multiphase building with a long history of remodelling to suit circumstances. The principal phases can be summarized as follows although the precise order is a matter for speculation, and there are many smaller changes.

1. The building of a timber-framed structure of at least four bays, with a large upper room spanned by a pair of open trusses and at least three bays long.
2. The re-building of the eastern end in stone with a further bay on the site of Foxlowe.
3. The building of a single bay detached kitchen/cottage to the rear.
4. Re-modelling to form a house, and the construction of a stable block.
5. Extensions linking the main house to the detached kitchen/cottage.
6. The alteration of the ground floor façade to create shop fronts.

Phase one: the timber-framed structure

The earliest elements of the building are the three roof trusses. Two of these, trusses C and D, are open, and one, truss E, is closed, implying that the building had at least one additional truss to the west, beyond truss C. In addition the majority of the first floor is carried on heavy joists that are wider then they are deep, and very closely spaced (approximately 19cms wide and 26cms apart) including those either side of the closed truss, truss E indicating the building had at least four bays. These form a marked contrast to the seventeenth century floor joists in the western bay, which are slighter.

The closed truss, E, formed a solid wall to the east, while the open trusses spanned a single open space in the centre and western part of the present building. The absence of smoke blackening, the use of steeply cambered tie beams to give extra headroom,

and the presence of the heavy floor joists discussed above, all suggest that they belonged to a first floor hall with a further bay to the west an argument borne out by the tree-ring dating.

All three trusses are principal rafter and tie-beam trusses with collars and raking or vertical struts above the collar. Each truss carried a single pair of tenoned purlins evidenced by the empty mortices to be found on the principal rafters. Long slender mortices near the base of the principal rafters held windbraces. In addition the cambered tie beams of the open trusses have a set of four closely spaces peg holes at either end indicating the use of arch braces.

Little of the lower structure survives, but where the ends of the tie beams are visible there is evidence for normal assembly (peg holes and mortices, shaping for the wall plates). Elsewhere plaster covered features suggest that portions of the main posts survive. The closed truss has lost most of its lower members, but what survives suggest the large square or oblong panels usually associated with the sixteenth century or earlier.

The eleven samples taken were all from this phase, and cut as part of a single programme of felling undertaken between 1513 at the earliest, and 1515 at the latest (see below).

Phase two: The re-building of the east end in stone

The absence of a timber-framed truss to the west, and the presence of the same style of wooden floor joists either side of the eastern truss, suggest the timber-framed building had at least four bays, with further closed trusses at either end. If so, they were replaced piecemeal. To the east the party wall with Foxlowe (the adjacent property) is built of Sherwood Sandstone, as is the rear wall of the room. In the eastern wall fireplaces serving rooms to either side indicate there was a further room beyond the present property boundary.

Sherwood Sandstone is the local bedrock, a poorly cemented sandstone rarely used for building as it weathers too badly. Here the evidence suggests a source of ready-cut stone, reused piecemeal indicating the walls were to be either plastered or panelled. At some point the lower part of the closed truss has also been rebuilt as its panels are smaller than the fragments discernable in the attic above. Here panels of wattle and daub survive in their original condition, without plaster, and without lime-wash. This, added to a slight ledge in the sill beam and a series of horizontal holes that are not part of the structure, suggests the room was panelled.

Phase three: the building of a single bay detached kitchen/cottage to the rear

When Thomas Jolliffe sold houses to William Mills in 1734 the sale included 'the kitchen and other outbuildings in the backside of the tenement'. The properties were still standing in 1770 but were then pulled down by Thomas Mills to make way for a new building adjacent to 2–4 Church Street, now known as 'Foxlowe'.

The plan of 2–4 Church Street shows a structure at the rear of the east end that was also likely to have been a detached kitchen. This element has a single room on each of its two floors, with a massive (and much remodelled) hearth on the ground floor. The lower part of the building is of Sherwood Sandstone, badly eroded and largely rendered. The upper part, also rendered, conceals a timber frame. Like the main house it has an attic, lit from the west by a leaded window.

The date of this building is uncertain, but the evidence suggests the upper walling was timber-framed, using close-studding with a mid-rail. Leek's best example is the Roebuck, dating to 1626. Similar internal walling date at Whitehough, Ipstones, relates to roof trusses whose timbers have estimated felling dates of between 1603 and 1627 (Howard *et al* 1988). Close- studding uses more wood than the large square or oblong panels found inside the main house, and without a mid-rail tends to be earlier. However, wealthy men like the builder of Sharpcliffe (Arnold *et al* 2008), continued to use massive timbers un-strengthened by a mid-rail well into the middle of the seventeenth century.

Phase four: the seventeenth century re-modelling to form a house and the construction of a stable block

In the seventeenth century the building was substantially remodelled. The extent of the alterations suggests the timber-framed building had reached a parlous state: nothing survives of its western gable, the heavy first floor joists are absent from the western bay, the roof structure required revision, and most the exterior walling was replaced in stone.

Dating the alterations on the basis of style is problematic. While the irregular spacing of the windows on the south front may result from the retention of internal features it could also be a demonstration of conservatism. The use of 3-, 4-, and 5-light windows, graduating from west to east and from the lower to the upper end of the house is more characteristic of the late sixteenth or early seventeenth century, rather than the mid/late seventeenth century when houses tended to have the lights arranged regularly in two and threes, concealing hierarchy of the rooms.

The evidence of the hearth tax is no help. In 1662 Mr Parker paid tax on only one hearth. Was he occupying another property, camping in the detached kitchen while

waiting for the main house to be refurbished, or occupying the house during the construction work? In 1666, the year of his son Thomas's birth, he paid for five hearths and a contemporary writer states his son was born here. By 1673 a further hearth had been added, reflecting its owner's prosperity, and making it one of the best-heated houses in Leek.

The revised plan reflects both conservatism and practicality. Where the major rural houses belonged to long-standing families they tended to rebuild to a ground plan familiar in the medieval period, with a cross-passage (known as the 'entry') dividing the service end from the hall (the main living area) and upper end (the parlour). Here a newly created cross-passage served as a cart entrance giving access to the rooms either side, and to rear yard, a new stable block, and the detached kitchen. To the west of the cross-passage timber-framed walls were formed at both first floor and ground floor level on the line of the existing open truss. To the east a single storey partition divided the passage from the central hall/houseplace.

The houseplace, served by a lateral stack on the rear wall, filled the area between the new partition and the closed truss, with the front door giving direct access from the street. Prior to its under-ceiling this room must have had an impressive array of floor joists supported on a cross-shaped arrangement of main beams. The creation of an entrance hall was probably a nineteenth-century alteration, as by then it was usual for the main room in a well-to-do household to be a private space rather than instantly accessible from the outside world.

The parlour, besides being the best-lit room, seems to have been panelled. In the major rural houses this would have been an unusual feature on the ground floor, although panelling was regularly found one of the major rooms upstairs. Elsewhere in Leek too little survives at ground floor level to know whether it was common practise in the town.

At attic level the house retains the divisions dictated by the original roof trusses, giving four separate rooms. To be a useable space the tie beams have had to be cut, and robust doorframes added that would link the collar to the beams inserted to support the attic floors. These beams are relatively slight when compared with those carrying the earlier style of first- floor joists. In addition the single tenoned purlins and their windbraces were replaced by pairs of trenched purlins. Access to the attics was by a projecting stair turret at the rear of the house which still serves two of the four sections. This is timber-framed and has diamond shaped wooden mullions to a series of lights. Both their style and the use of timber-framing suggest the stair turret pre-dates the main remodelling, for the diamond shaped mullions are associated with a lack of glazing, an unlikely feature in a house being remodelled by a man of substance in the mid-seventeenth century.

The later phases: extensions linking the main house to the detached kitchen/cottage and the alteration of the ground floor façade to create shop fronts

The style of the later staircase suggests the main house and its detached kitchen were linked together during the eighteenth century, when the lower part of the early staircase is likely to have been removed.

The partition creating an entrance passage from the front door was probably built in the nineteenth century when entrance halls became the norm. This is reflected both in alterations to early houses, and in the design of newly built town house from the eighteenth century onwards where an entrance hall with a staircase to the rear became the norm.

The last major alteration took place in the twentieth century when three shops were created on the ground floor, with the loss of the original fenestration. This probably occurred when the building ceased to be the office for the Macclesfield estate.

Faith Cleverdon, September 2009

Sampling

Sampling of timbers in 2–4 Church Street was commissioned by the Moorlands Partnership and funded by Staffordshire County Council and Staffordshire Moorlands District Council. This was undertaken during the repair and conservation of the building as part of a programme of development. It was hoped that tree-ring analysis would determine the date of the primary, timber-framed, phase of the building, and establish the development of this area of Leek with greater reliability.

Thus, from the timbers available at total of 11 core samples was obtained. Each sample was given the code LEK-C (for Leek, site "C") and numbered 01–11. An attempt was made to distribute the samples evenly between the three remaining trusses, C, D, and E, and the frame of the first floor. It was seen, however, that all the available timbers of the middle frame, truss D, were derived from fast-grown timbers. As such, these timbers were unlikely to provide samples with the minimum of 54 rings necessary for reliable analysis, and no cores were obtained.

The positions of these samples were marked at the time of sampling on sections and plans made and provided by Faith Cleverdon, buildings archaeologist. These are reproduced here as Figure 3a/b. Details of the samples are given in Table 1. In this Table, all trusses and the individual timbers have been identified following the schema of the drawings provided.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank the owner of 2–4 Church Street, Mr. Roger Warrillow, for permitting sampling and for his enthusiasm and interest in this programme of tree–ring analysis. We would also like to thank Chris Drage and Staffordshire Moorlands District Council for commissioning and funding this programme of work. Finally, we would like to thank Faith Cleverdon for the building history and description used in the introduction above and for the use of her plans and drawing elsewhere in this report.

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 most frequently used building timber in England) 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 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.

The third principle 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 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.

Analysis

Each of the 11 samples obtained from this building was prepared by sanding and polishing. It was seen at this time that one sample, LEK-C08, had less than 54 rings, the minimum required for reliable dating and it was rejected from this programme of analysis. The annual growth-ring widths of the remaining 10 samples were measured, and then compared with each other as described in the notes above.

At a minimum value of t=4.5 a single group comprising nine samples could be formed, the samples cross-matching with each other at the positions indicated in the bar diagram Figure 4. The nine cross-matching samples were combined at these indicated off-set positions to form LEKCSQ01, a site chronology of 107 rings. Site

chronology LEKCSQ01 was then satisfactorily dated by comparison with a large number of relevant reference chronologies for oak as spanning the years 1406 to 1512. The evidence for this dating is given in the *t*-values of Table 2.

Site chronology LEKCSQ01 was then compared with the single remaining, ungrouped, sample, LEK-C03, but there was no further satisfactory cross-matching. Sample LEK-C03 was then compared individually with the full range of reference chronologies but there was, again, no further cross-matching. This sample must, therefore, remain undated.

Interpretation

Analysis by dendrochronology of 10 measured samples from this building has resulted in nine of them being combined to form a single site chronology, LEKCSQ01. This site chronology is 107 rings long, these rings being satisfactorily dated as spanning the years 1406–1512.

None of the nine dated samples in site chronology LEKCSQ01 retains complete sapwood, that is, none of them has the last growth ring produced by the trees represented before it was cut. It is thus not possible to give a precise felling date for any of the timbers. A number of dated samples, however, come from timbers which *do* have complete sapwood on them, but from which, due to the soft and fragile nature of this part of the wood, portions of the sapwood was lost in coring. In the case of samples LEK-C02, C05, C06, and C07, this loss ranges from only 2–4 mm. Notes and observations made at the time of sampling, and during analysis, would suggest that this loss represents between 2–6 sapwood rings. Given the dates of the last extant, sapwood, rings on these samples, such a loss would suggest that the timbers represented were cut as part of a single programme of felling which could have been undertaken as early as 1513 but probably no later than 1515.

It is very likely that the three other dated samples which retain at least the heartwood/sapwood boundary (h/s in Table 1 and the bar diagram), LEK-C04, C09, and C11, also represent timbers felled 1513–15. Such an interpretation is based on the fact the position of the heartwood/sapwood boundary on these three samples is very similar to that on those from timbers with complete sapwood; a small variation in this boundary, 11 years overall, from 1489 on sample LEK-C05 to 1500 on sample LEK-C06, is indicative of a group of timbers cut as part of a single felling.

Two further samples, LEK-C01 and C10, do not have a heartwood/sapwood boundary and it is thus not possible to reliably indicate when the trees from which they were derived were felled. However, using the usual 95% confidence limit of a minimum of 15 sapwood rings the trees might have had, and given that the samples have last measured, heartwood, ring dates of 1486 and 1487 respectively, would make them unlikely to have been felled before 1501 and 1502, respectively. Given that the beams

represented, collars in both cases, are integral to the structure of their respective trusses, and that they show no evidence of reuse, there is no reason to suspect that they were not felled in 1513–15 as well.

Conclusion

Tree-ring analysis, therefore, indicates that all the dated timbers were cut as part of a single episode of felling dated 1513–15. As such, this date is highly consistent with that suggested in the building description above, based on the stylistic interpretation of the forms of the trusses, particularly the closed east truss. Although, as stated, this has lost most of its lower members, what survives suggests large square or oblong panels of a type usually associated with the sixteenth century or earlier.

It may be of interest to note at this point that although the exact location of the woodland source for the timbers used here cannot be determined precisely by tree-ring analysis, it is possibly to the north or north-west of Leek. As indicated in Table 2, which shows the reference chronologies against which site chronology LEKCSQ01 has been dated, particularly high *t*-values are found against material from a building at New Mills in Derbyshire (Mousley Bottom), and Congleton in Cheshire (Little Morton Hall). While the source woodland for these sites is not known either, it might indicate that the trees used at all three sites are from woodlands in the same general area, and probably relatively local to each.

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Table 1: Details of tree-ring samples from 2–4 Church Street, Leek, Staffordshire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary date (AD)	Last measured ring date (AD)
LEK-C01	Truss E–E1, collar	71	h/s	1416	1486	1486
LEK-C02	Principal rafter E1	80	13 c	1427	1493	1506
LEK-C03	Truss E–E1, tiebeam	61	15c	------	------	------
LEK-C04	Principal rafter E	66	h/s	1427	1492	1492
LEK-C05	First-floor frame, main beams truss D–E	102	18c	1406	1489	1507
LEK-C06	First floor frame, common joist 3, bay C–D	87	12c	1426	1500	1512
LEK-C07	First floor frame, common joist 2 Bay C–D	88	20c	1424	1491	1511
LEK-C08	Truss C–C1, tiebeam	nm	---	------	------	------
LEK-C09	Principal rafter C	55	h/s	1438	1492	1492
LEK-C10	Truss C–C1, collar	54	h/s	1434	1487	1487
LEK-C11	Principal rafter C1	68	h/s	1424	1491	1491

*h/s = The last ring on the sample is at the heartwood/sapwood boundary

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

nm = sample not measured

Table 2: Results of the cross-matching of site chronology LEKCSQ01 and relevant reference chronologies when the first-ring date is 1406 and the last-ring date is 1512

Reference chronology	*t*-value	Reference
Mousley Bottom, New Mills, Derbys	11.2	(Esling *et al* 1990)
Little Morton Hall, Congleton, Cheshire	9.6	(Howard 2003 unpubl)
Ordsall Hall, Salford, Greater Manchester	9.3	(Howard *et al* 1994a)
Raynor House, Bradfield, South Yorks	9.2	(Howard *et al* 1994b)
Cheddleton Grange, Cheddleton, Staffs	7.7	(Arnold *et al* 2008)
Tithe Barn, Bolton Abbey, West Yorks	7.6	(Arnold *et al* 2006 unpubl)
East Midlands Master Chronology	7.4	(Laxton and Litton 1988)
England Master Chronology	7.2	(Baillie and Pilcher 1982 unpubl)

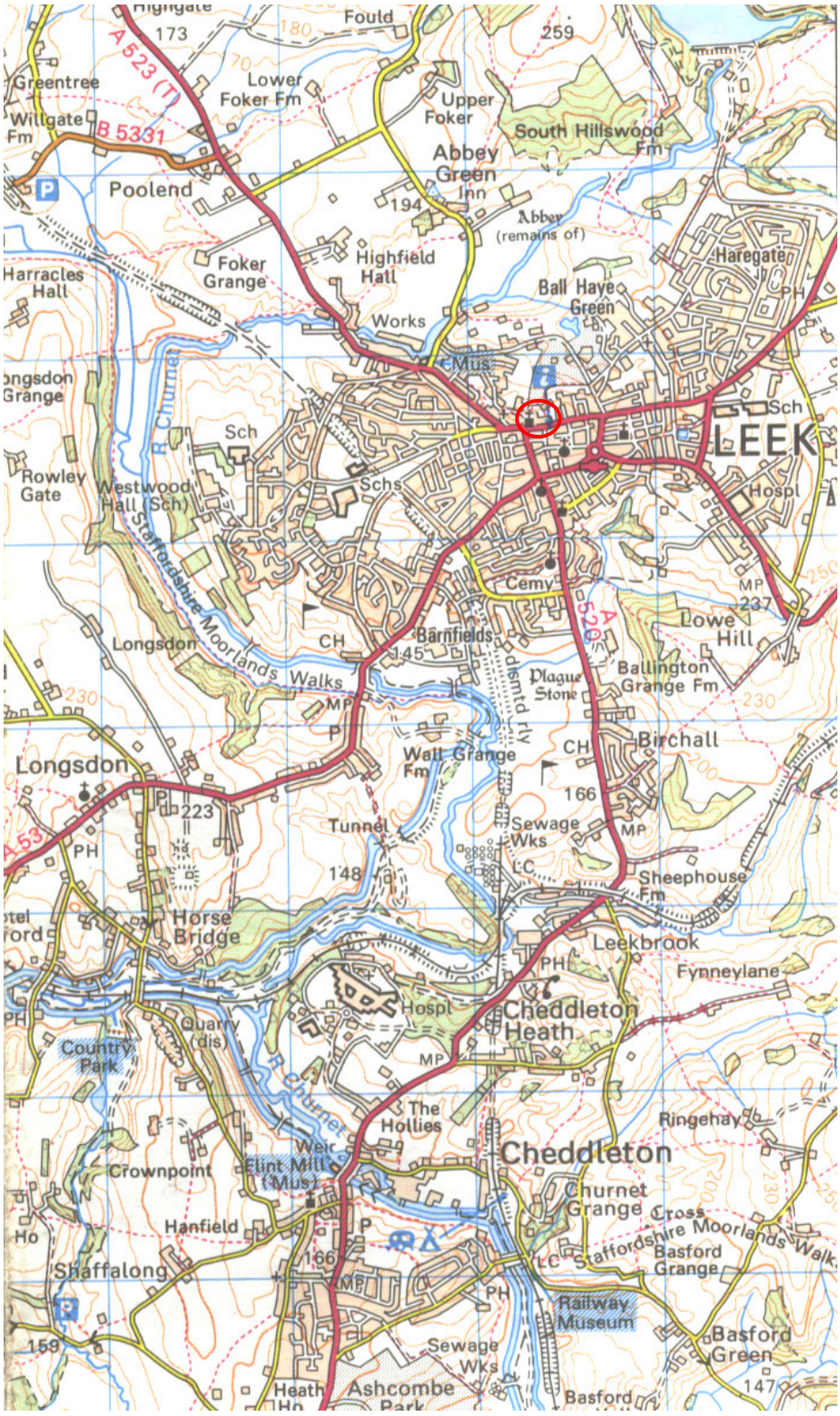

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Figure 1: Map to show approximate location of 2–4 Church Street, Leek

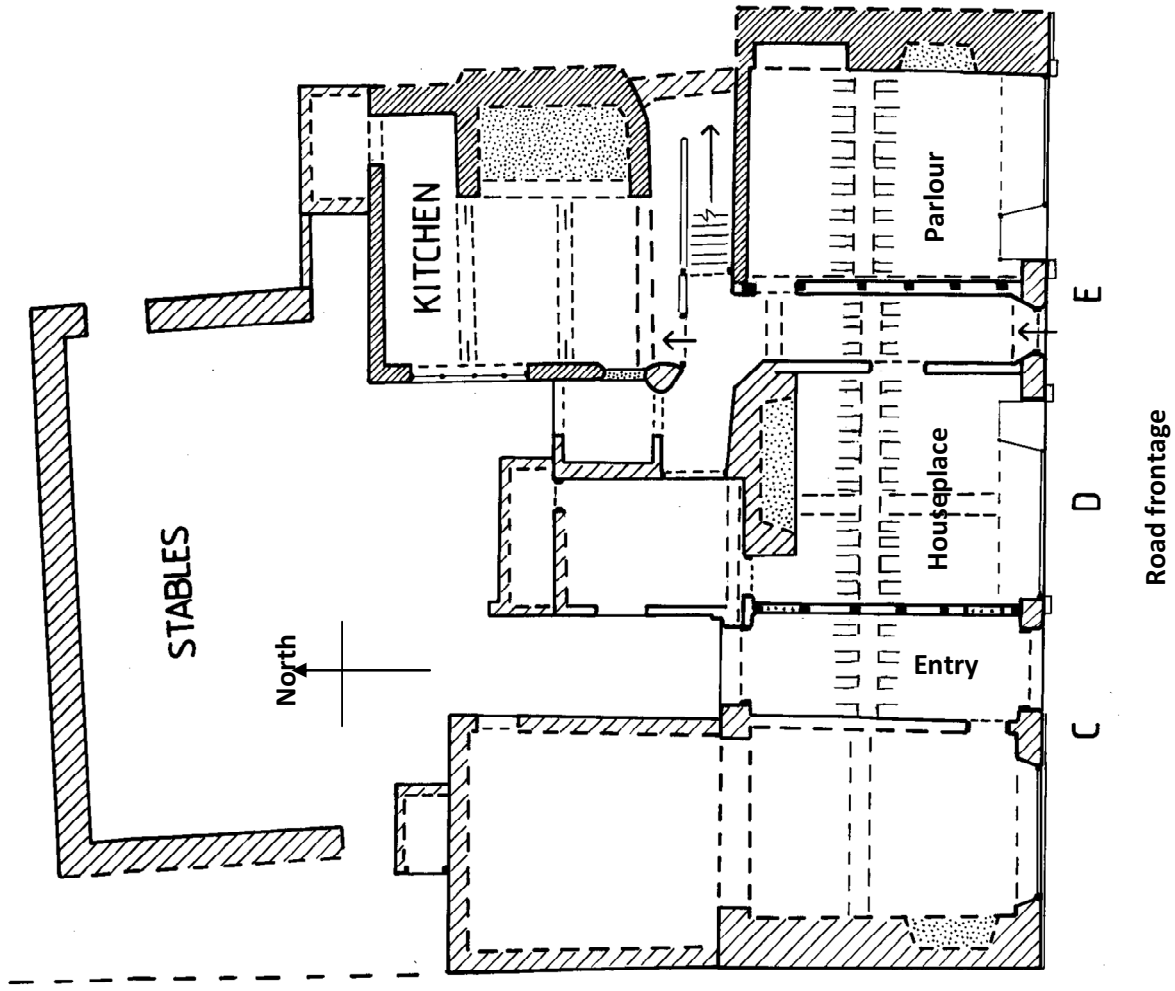


Figure 2: Basic plan at ground-floor level to show layout and truss positions (after Faith Cleverdon)

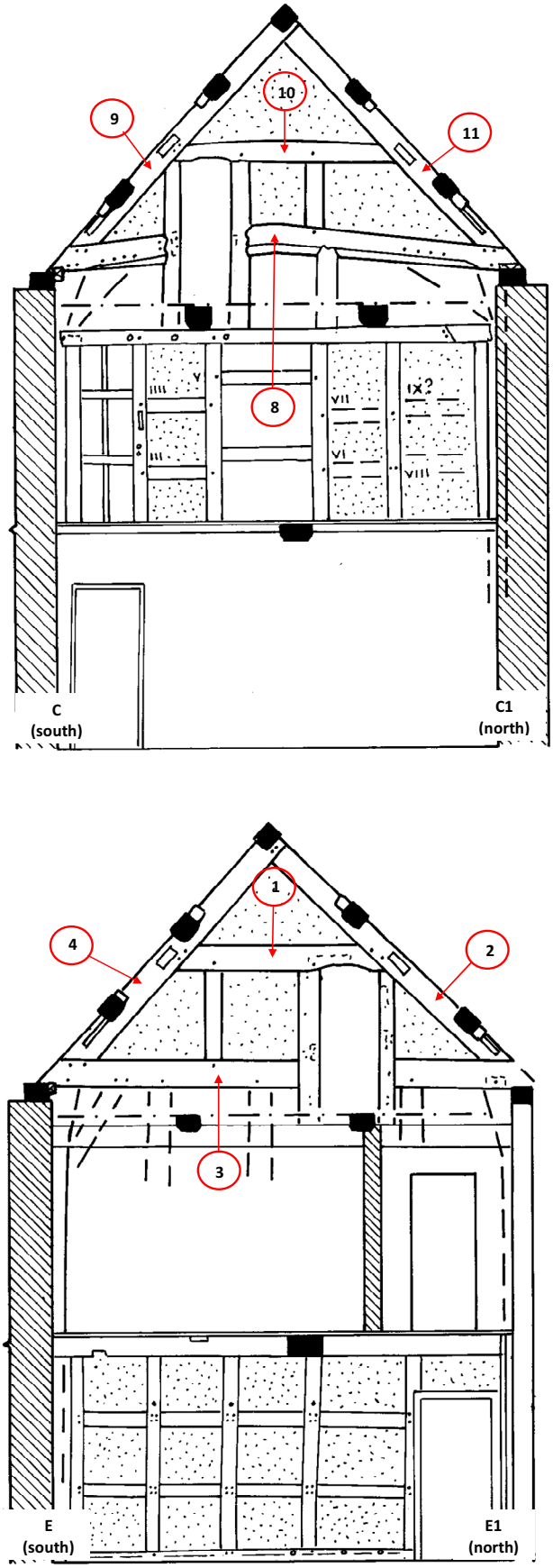


Figure 3a: Truss sections showing sample positions
(after Faith Cleverdon)

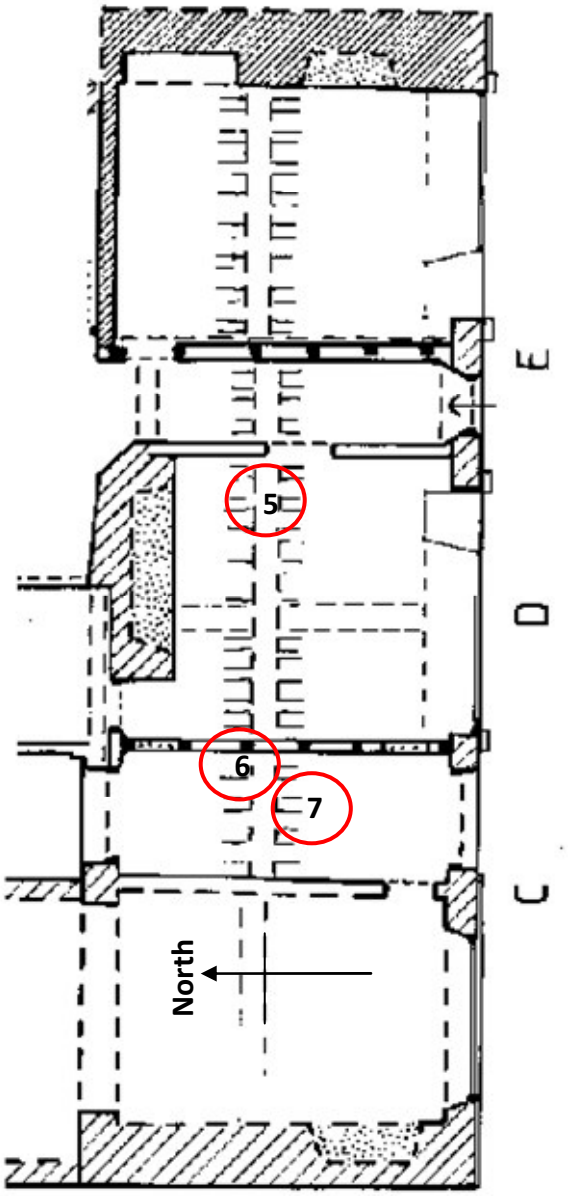
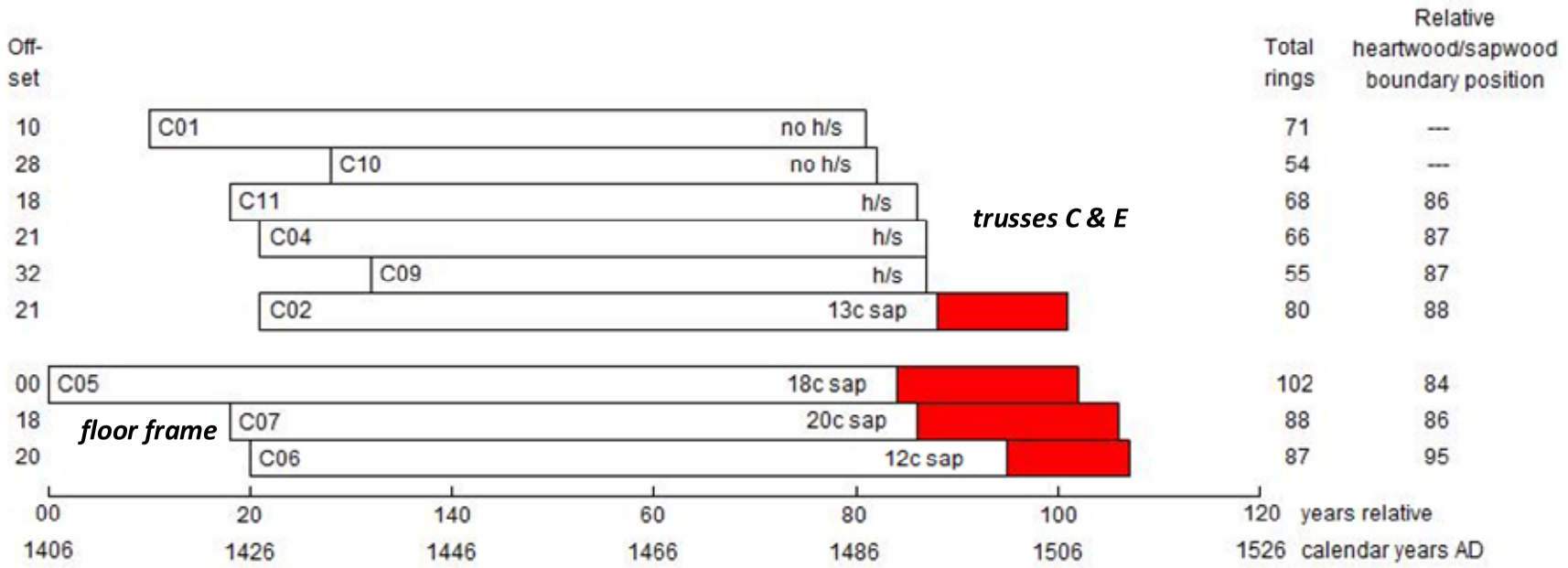


Figure 3b: Plan showing sample positions from first-floor frame (after Faith Cleverdon)



White bars = heartwood rings, shaded bars = sapwood rings
h/s = heartwood/sapwood boundary (only the sapwood rings are missing)
c = complete sapwood is found on the timber, but all or part has been lost from the sample in coring

Figure 4: Bar diagram of the samples in site chronology LEKCSQ01