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THE CAVENDISH ARMS,
MARKET PLACE,
DALTON-IN-FURNESS,
CUMBRIA.
TREE-RING ANALYSIS OF TIMBERS

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SUMMARY

Twelve core samples were obtained from the cruck trusses and the roof of the northern range of the Cavendish Arms public house in the Market Place in Dalton-in-Furness, Cumbria. Analysis by dendrochronology of these cores resulted in the production of a single dated site chronology comprising nine samples. This site chronology is 131 rings long, these rings dated as spanning the years 1407–1537. Interpretation of the sapwood on the samples would indicate that all the dated timbers were cut as part of a single programme of felling in 1537.

Three samples remain ungrouped and undated.

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Introduction

The Cavendish Arms is situated in the heart of medieval Dalton (SD 226 739, Figs 1a-c), on the edge of an area of the town considered to consist mainly of medieval plots, and is in close proximity to two sites of considerable historical importance, the parish church and the castle, both of which are of medieval date. The origin of the Cavendish Arms itself is, however, obscure, a number of different dates being possible; a newspaper article of 1915 states that it had been suggested that it was as old as the castle, ie, fourteenth century, and was originally known as the Black Cock, although no source for this is given (Walton 1984). Directory entries and other sources certainly show that it was in existence from at least 1824 and known then by its current name. The building is Listed Grade II.

The site is orientated approximately north-west/southeast (although in this report it will be deemed as orientated north/south) and, in outline, is effectively of three sections. Primary amongst these is a basic three-bay north range set side-on to the Market Place (the front therefore facing north onto Market Place, while the rear elevation faces south onto the garden), possibly with a cross-passage on the ground floor.

The three bays of the north range are formed by two cruck trusses, an east truss (truss 1) and a west truss (truss 2), and the east and west gable walls (Fig 2). The cruck blades of both trusses (Fig 3a/b) are relatively straight, and have additional packing pieces, particularly on the north side. The trusses each have a short collar just below the apex and a longer one close to the floor/ceiling level, with the cruck blades extending through the floor level to be encased in the stud walls of the rooms below. There are also additional spurs. All of the joints between the timbers are pegged. There are only three purlins between the two trusses, two on the north side and one on the south, plus a diagonally set ridge plate. The faces of the blades to both trusses have empty lap-mortices which do not correspond to the current arrangement of the timbers and suggests that they may be reused, or perhaps re-set.

In 1772, to the east side of the plot, a large block extending to the south was built, this probably corresponding to the Sportsman's Hall. In the early nineteenth century these two sections were joined together. In the twentieth century many of the internal walls were knocked through to open up the ground floor, and a range of single-storey rooms were created along the west side of the plot. It is probable that the roof to the Sportsman's Hall was also replaced at this time.

Internally, all the original exposed ground floor timbers are typically hand-finished, some of these being evidently re-used, along with modern replacements artificially finished in the same manner, all timbers being painted black. Elsewhere internally the finish was generally heavily modernised and early fabric largely obscured.

Sampling

Prior the submission of a planning application for the conversion of the Cavendish Arms into domestic dwellings, Barrow Borough Council recommended an archaeological building recoding be carried out. This work was undertaken by Greenlane Archaeology Ltd, the survey and recording revealing the presence of potentially significant early historic fabric in the form of the two cruck trusses and other associated timbers (Greenlane Archaeology Ltd, 2011). It was hoped that tree-ring analysis of these timbers might more reliably and accurately determine their date and the potential antiquity of the building, and establish with greater certainly how much original material might still remain.

Thus, from the timbers available in the northern range of the building, a total of 12 core samples was obtained. Each sample was given the code DIF-A (for Dalton-in-Furness, site 'A'), and numbered 01–12. The positions of the sampled timbers are shown on drawings taken from the archaeological survey report by Greenlane Archaeology Ltd, given here as Figure 4a/b. In this report, the timbers and sample positions are located following the schema of these drawings.

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 theory, there may have been other timbers which could potentially have been sampled. These, however, to both the roof and the lower floors, were often small and/or derived from fast-grown trees, and as such were thought to have too few rings for reliable dating. Other timbers, particularly a number to the ground floor, were also believed to have been salvaged from other buildings and have no connections with the Cavendish Arms.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank Dan Elsworth of Greenlane Archaeology Ltd for commissioning this programme of analysis and for providing both the information used in the introduction above and the drawings elsewhere in the report. The Laboratory would also like to thank the owner and developer of the site, Phil Murry, for allowing access to the building, and Alan Greenwood and the other contractors working on the building at the time, for cooperating so enthusiastically with sampling. Finally, we would like to thank the Cumberland and Westmorland Antiquarian and Archaeological Society for generously providing funds for this programme of tree-ring dating.

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 (see Fig 5).

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 45 years or so. In essence, a short period of growth, anything less than 45 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 12 samples obtained from the various timbers of the north range of the Cavendish Arms 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. This comparative process indicated that nine of the 12 samples (all but sample DIF-A04, A06, and A11) cross-matched with each other and could be formed into one single group, the length, relative position, and overlap of the samples being shown in the bar diagram Figure 6. These nine samples were combined at their indicated off-set positions to form DIFASQ01, a site chronology with an overall length of 131 rings. This site chronology was then satisfactorily dated by repeated and consistent comparison with a number of relevant reference chronologies for oak as spanning the years 1407 to 1537. The evidence for this dating is given in the *t*-values of Table 2.

Site chronology DIFASQ01 was then compared with the three remaining ungrouped samples, but there was no further satisfactory cross-matching. Each of the three remaining samples were then compared individually with the full corpus of reference material, but again there was no further cross-matching and all three samples must, therefore, remain undated for the moment.

Interpretation

One of the dated samples, DIF-A01, in site chronology DIFASQ01, retains complete sapwood. This means that it has the last growth ring produced by the tree it represents before it was cut down (this is indicated by upper case ‘C’ in Table 1 and the bar diagram Fig 6). In this case this last growth ring, and thus the felling date of the tree, is dated to 1537. The heartwood/sapwood boundary (h/s in Table 1 and the bar diagram) on the seven other dated samples in site chronology DIFASQ01 which retain it (all but sample DIF-A09), is at such a relative position as to suggest that the trees they represent were felled in 1537 as well.

The final sample of this group (DIF-A09) is without the heartwood/sapwood transition, and it is thus not possible to be absolutely certain as to when the tree it represents was cut down (in theory it is possible that the tree went on growing long after its last extant ring date of 1488). However, the cross-matching between the nine dated samples is such as to suggest that the source trees were all growing close to each other in the same patch of woodland, and it might be considered unusual to find trees which were originally growing close to each other, but felled at different times, being used in the same building. In short, taken in conjunction with the structural evidence, the dating of the timbers would strongly suggest that they were all felled at the same time as each other, in 1537, specifically for the original construction of what is now the north range of the Cavendish Arms.

As such, this is perhaps not quite as early as the fourteenth century date once mooted for the building, but it is possibly slightly earlier than might have been realistically expected. In any case, the dates of the timbers are now reliably, and very accurately, established. Although the timbers show some apparent evidence of reuse, the fact that a good number of them are all of the same date might suggest that they have merely been reset at some time, perhaps in the eighteenth century, possibly due to alterations to the roofline. These alterations might also account for the number of backing pieces the trusses contain.

Undated sample

Three of the 12 samples obtained from the north range of the Cavendish Arms, DIF-A04, A06, and A11, remain ungrouped and undated. With, respectively, 160, 168, and 84 rings, the three would certainly appear to contain sufficient data for reliable analysis. Samples DIF-A04 and A06 do, though, show bands of compressed, or very narrow, rings, and some possible distortion, and it is possibly these features, which may represent interference with the climatic signal, which accounts for the lack of cross-matching and dating. Sample DIF-A11, shows no such problems. It is not uncommon, however, in most programmes of tree-ring analysis, to find that some samples are undated, many of them for no apparent reason.

Woodland source

In this instance it is not possible to be very exact as to the precise location of the woodland source for the timbers utilised for the construction of this part of the Cavendish Arms (this may in part be due to the lack of reference data for this part of Cumbria, a deficit which the material from the Cavendish Arms will help to alleviate). However, as may be seen from Table 2, although site chronology DIFASQ01 has been compared with reference chronologies from all parts of Britain, the highest *t*-values (or the greatest degrees of similarity), are found against those chronologies made up of material from other sites in northwest England. This would suggest that the timbers used here are at least from a similar general area.

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Table 1: Details of tree-ring samples from the Cavendish Arms, Market Place, Dalton-in-Furness, Cumbria

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
DIF-A01	North blade truss 1 (east cruck truss)	101	26C	1437	1510	1537
DIF-A02	South blade, truss 1	98	20	1426	1503	1523
DIF-A03	Tiebeam, truss 1	113	8	1410	1514	1522
DIF-A04	Collar, truss 1	160	58	------	------	------
DIF-A05	Yoke, truss 1	84	10	1426	1499	1509
DIF-A06	Ridge beam, truss 1 – 2	168	h/s	------	------	------
DIF-A07	North upper purlin, truss 1 – 2	79	9	1438	1505	1516
DIF-A08	South upper purlin, truss 1 – 2	90	h/s	1419	1508	1508
DIF-A09	North blade truss 2 (west cruck truss)	82	no h/s	1407	------	1488
DIF-A10	South blade, truss 2	92	h/s	1433	1524	1524
DIF-A11	Collar, truss 2	84	h/s	------	------	------
DIF-A12	Yoke, truss 2	80	h/s	1421	1500	1500

h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing

C = complete sapwood is retained on the sample, the last ring date is the felling date of the tree represented

Table 2: Results of the cross-matching of site chronology DIFASQ01 and the reference chronologies when the first ring date is 1407 and the last ring date is 1537

Reference chronology	*t*-value	
Speke Hall, Liverpool, Cheshire	7.4	(Howard *et al* 1992)
Combermere Abbey, Cheshire	7.2	(Howard *et al* 2003)
England Master Chronology	6.7	(Baillie and Pilcher 1982 unpubl)
Primrose Hill, Kings Norton, Birmingham	6.5	(Arnold and Howard 2008)
Bramall Hall, Stockport, Greater Manchester	6.2	(Arnold and Howard 2013 unpubl)
Ordsall Hall, Salford, Greater Manchester	6.1	(Arnold *et al* 2004)
Nether Levens Hall, Kendal, Cumbria	6.1	(Howard *et al* 1991)
West Barn, Parbold, Lancs	6.0	(Arnold and Howard 2011)

Site chronology DIFASQ01 is a composite of the data of the relevant cross-matching samples as seen in the bar diagram Figure 6 below. This composite data produces an ‘average’ tree-ring pattern, where the possible erratic variations of any one individual sample are reduced and the overall climatic signal of the group is enhanced. This ‘average’ site chronology is then compared with several hundred reference patterns covering every part of Britain for all time periods, cross-matching with a number of these only at the date span indicated, the table giving only a small selection of the very best matches as represented by ‘*t*-values’ (ie, degrees of similarity). It may be noticed from this Table that the resultant *t*-values are well in excess of the *t*=3.5 value usually taken as the minimum acceptable level for satisfactory dating. These values, along with the many other slightly lower, unlisted, cross-matches, indicate a very firm and reliable date for the timbers.

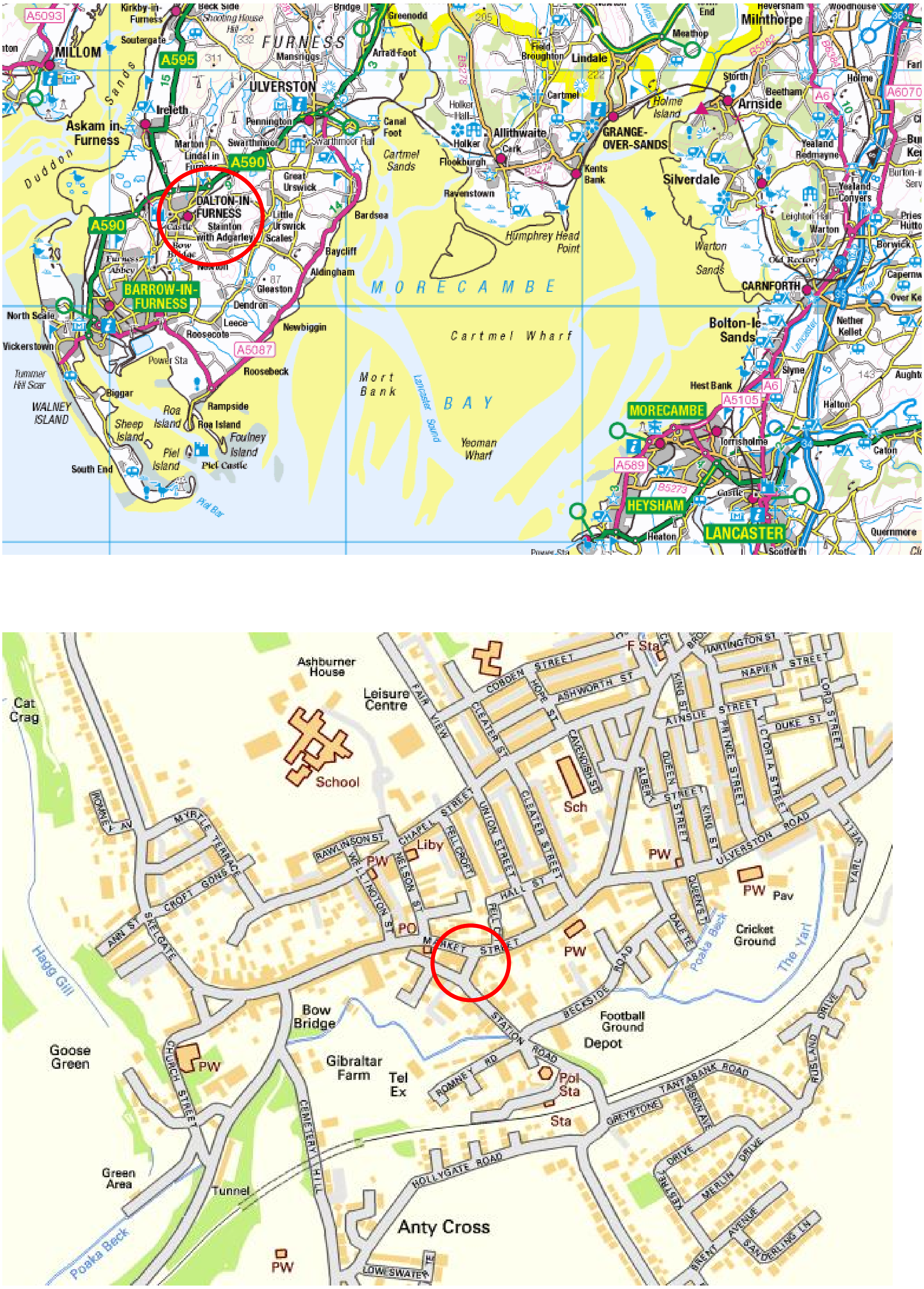


Figure 1a/b: Maps to show location of Dalton in Furness (top) and the Market Place (bottom)

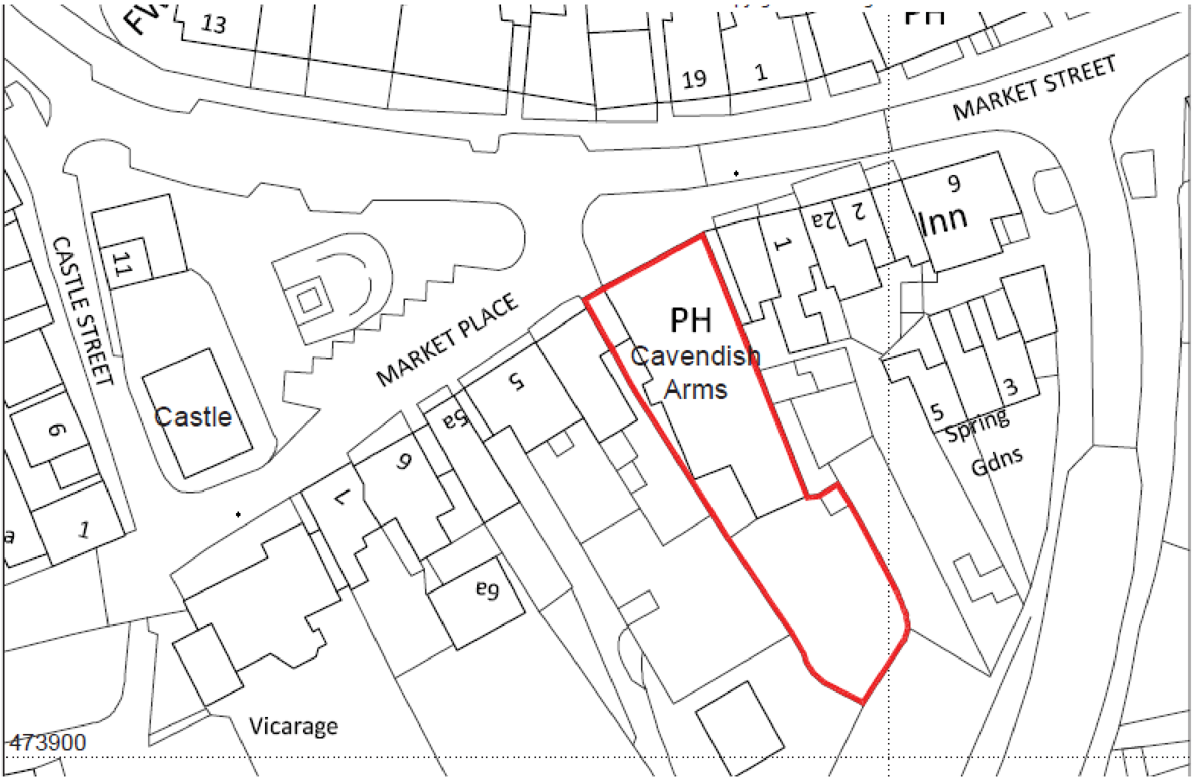


Figure 1c: Map to show location of the Cavendish Arms in the Market Place

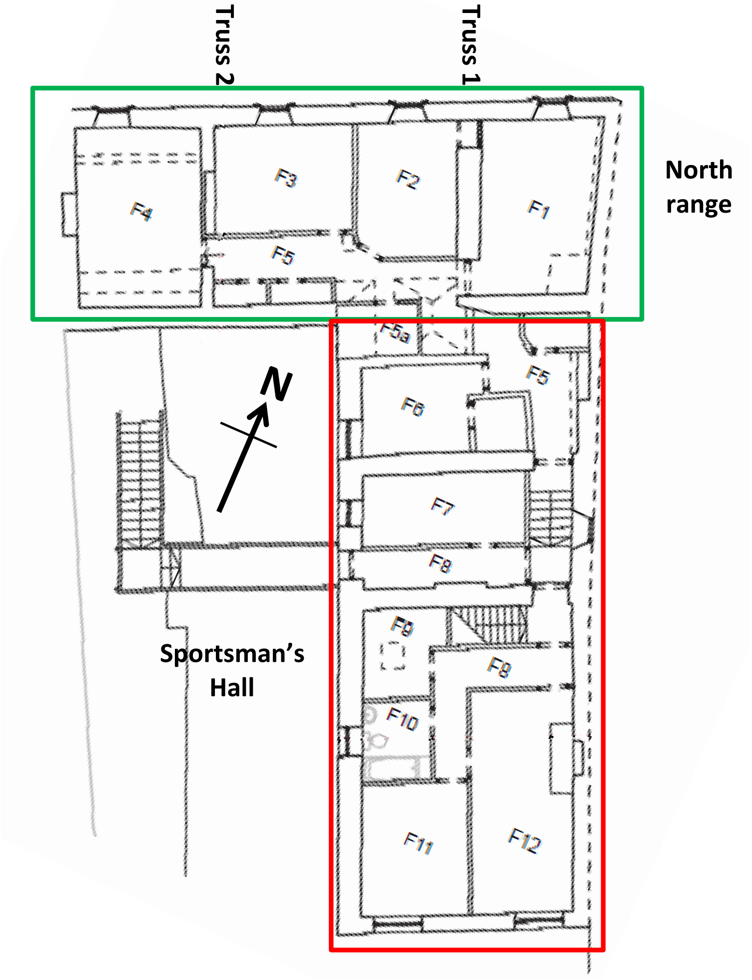


Figure 2: Plan at first floor level to show layout and arrangement of the Cavendish Arms, and the positions of the trusses to the north range (after Dan Elsworth, Greenlane Archaeology Ltd)

Figure 3a/b: View of truss 1 (east truss), showing east face (top) and truss 2 (west truss), also showing east face (bottom)

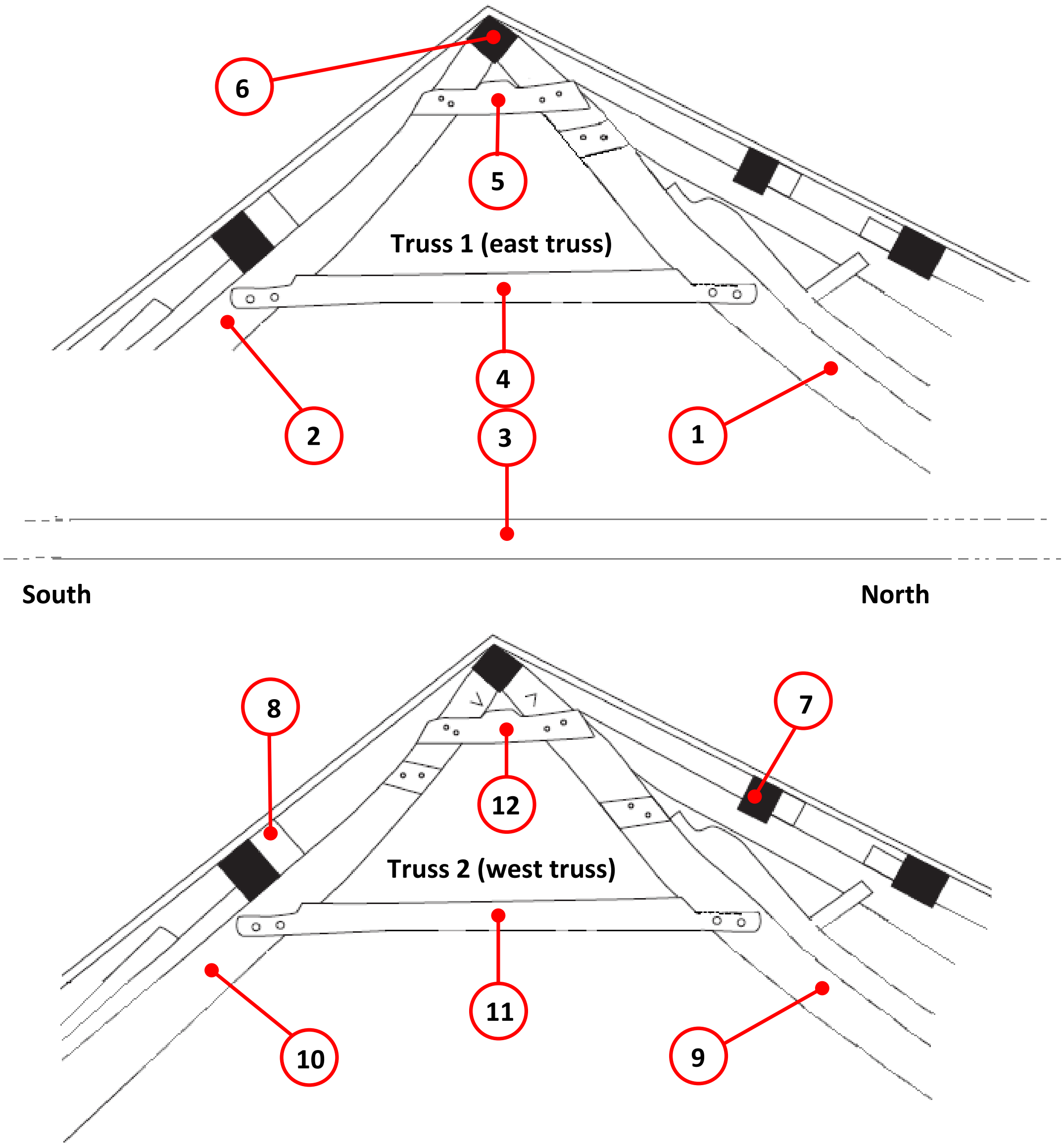


Figure 4a/b: Drawings of the trusses, showing their east faces, to locate sampled timbers (see Table 1) (after Dan Elsworth, Greenlane Archaeology Ltd)

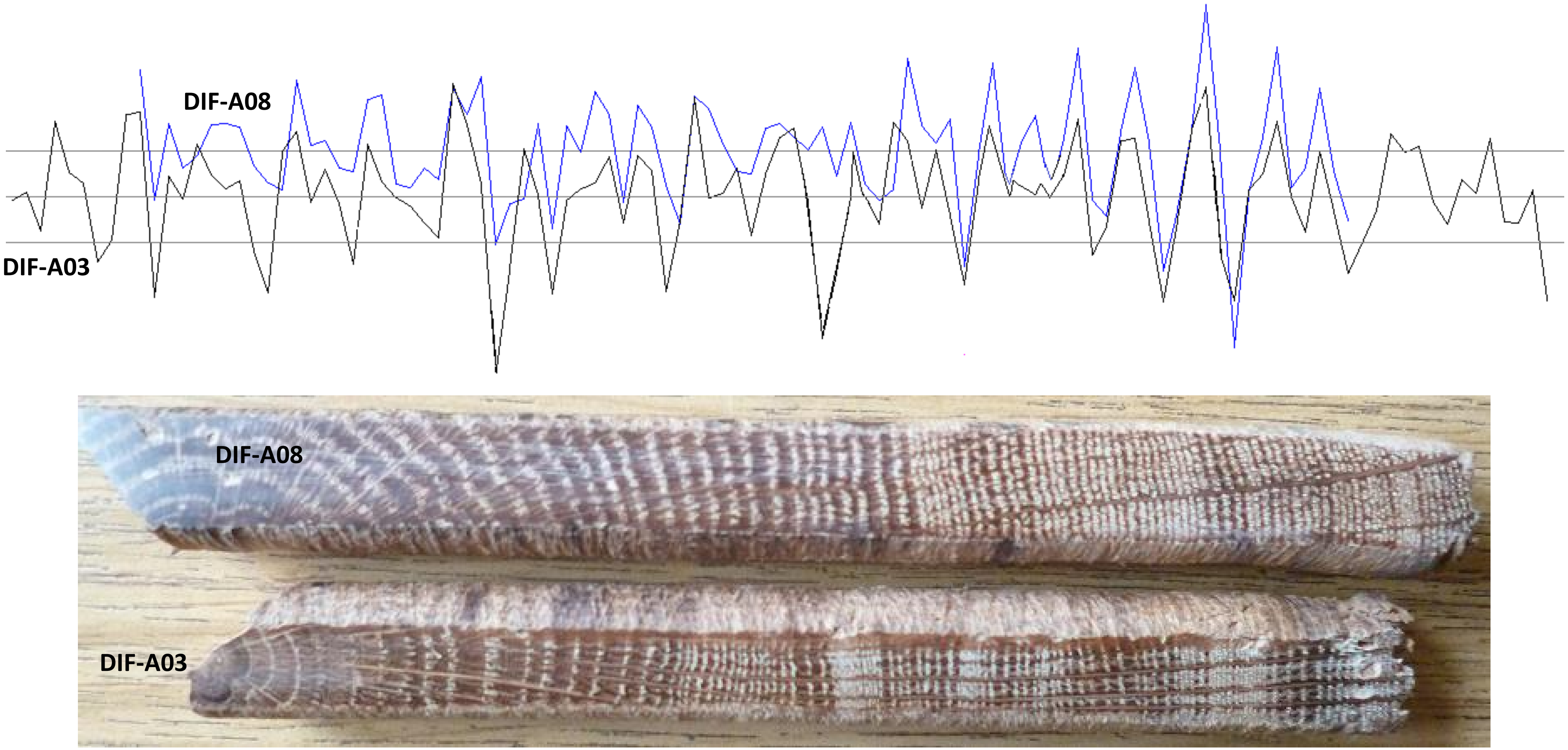
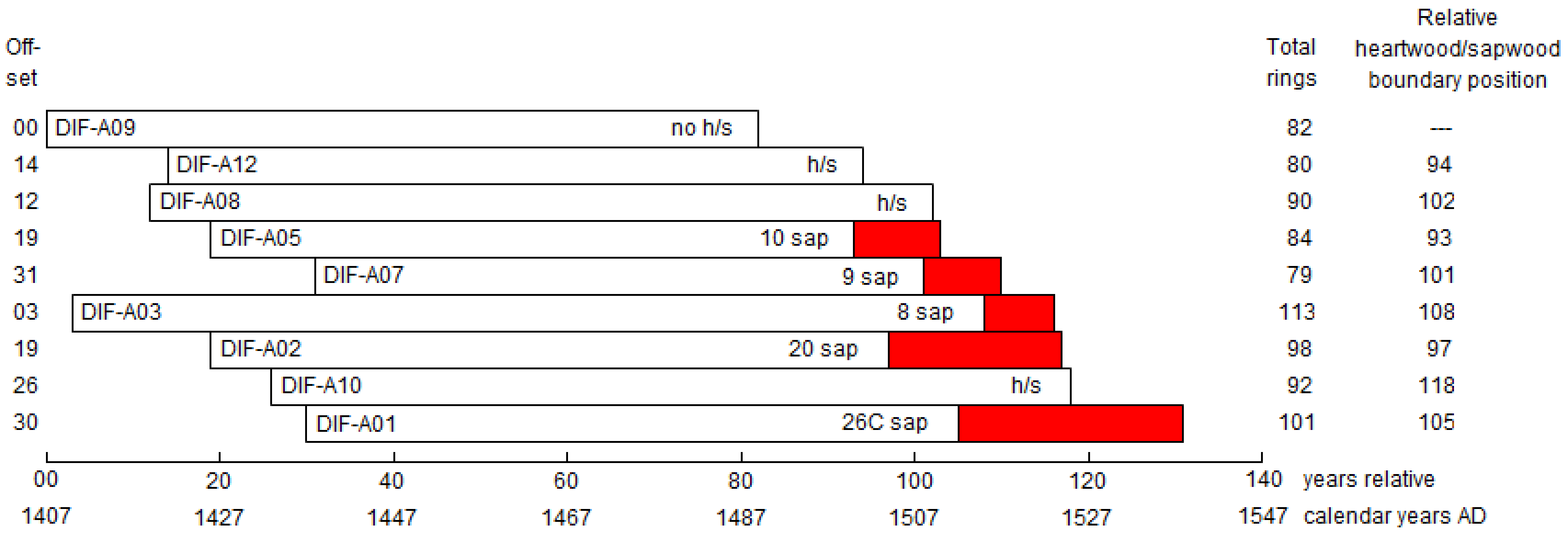


Figure 5: Graphic representation of the cross-matching of two samples, DIF-A03 and A08

When cross-matched at the correct positions, as here, the variations in the rings of these two samples (where they overlap) 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 at the *same time* in the *same place.* The growth ring pattern of two samples from trees grown at different times would never correspond so well.



blank bars ☐ = heartwood rings, shaded bars 🟥 = sapwood rings
C = complete sapwood is retained on the sample, the last ring date is the felling date of the tree represented
h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing

Figure 6: Bar diagram of the samples in site chronology DIFASQ01 at positions indicated by their grouping. The samples are shown in the form of bars at positions where the ring variations of the samples cross-match with each other, this similarity being produced by the trees represented growing at the *same time* as each other in the *same place.* The samples are combined to form a ‘site chronology’, which is dated by comparison with the ‘reference’ chronologies (see Table 2).