Dendrochronology, timber analysis, and historic building consultants

TREE-RING ANALYSIS OF TIMBERS FROM CRAG HOUSE FARM BARN, OTLEY OLD ROAD, COOKRIDGE LEEDS

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SUMMARY

Dendrochronological analysis was undertaken on samples taken from timbers of this aisled barn, resulting in the construction and dating of two site sequences.

Site sequence CRGHSQ01 contains six samples and spans the period 1416–1602 whilst site sequence CRGHSQ02 contains two samples and spans the period 1419–1488.

Interpretation of the sapwood has identified two separate fellings amongst the timbers used in the construction of this building. The earlier timbers, as represented by two tiebeams and a brace, were felled in *c* 1522 whilst two aisle plates, two principal rafters, and a brace were felled in 1602.

These results suggest original construction of the barn occurred towards the end of the first quarter of the sixteenth century with modifications being undertaken in or shortly after 1602.

A further site sequence is undated.

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INTRODUCTION

Crag House Farm, headquarters of 'Caring for Life', a Christian support charity working with disadvantaged and vulnerable people, is located in Cookridge on the outskirts of Leeds (Figs 1 & 2; SE 245 412). To the west of Crag House is a grade II listed aisled barn, which was thought to date to the sixteenth century with modifications of the seventeenth and twentieth centuries.

The barn is of five bays and is fully aisled on the north side and for three bays on the south side (Fig 3). The roof has four trusses consisting of posts, tiebeams, principal rafters, and braces which run from the post to the tiebeam and to the aisle plate. Additionally, truss 3 has V-struts from tiebeam to principal rafters and truss 4 has a king post. Between these main trusses are intermediate sets of principal rafters. There are two sets of purlins to each slope; these are trenched to the main principal rafters and through purlins to the intermediate ones. The ridge is similarly arranged (Fig 4).

Principles of Tree-ring Dating

Tree-ring dating relies on a few simple, but fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees) 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 to 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 determined pattern. Furthermore, and importantly, all trees growing in the same area at a 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 pattern of the tree. The pattern of a short period of growth, 20 or 30 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 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal 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 millimetre. 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 a sample "cross-matches" repeatedly at the same date 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 the 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 phases 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 satisfactory analysis.

SAMPLING

A total of 13 timbers was sampled with each sample being given the code CRG-H and numbered 01–13. The location of samples was noted at the time of sampling and has been marked on Figures 5–10. Further details can be found in Table 1. Trusses have been numbered from east to west.

ANALYSIS & RESULTS

All 13 samples were prepared by sanding and polishing and their growth-ring widths measured. These growth-ring widths were then compared with each other, resulting in the formation of three groups.

Firstly, six samples matched each other and were combined at the relevant offset positions to form CRGHSQ01, a site sequence of 187 rings (Fig 11). This site sequence was compared against a series of relevant reference chronologies for oak where it was found to match consistently and securely at a first-measured ring date of 1416 and a last-measured ring date of 1602. The evidence for this dating is given by the *t*-values in Table 2.

Two further samples matched each other and were again combined at the relevant offset position to for CRGHSQ02, a site sequence of 70 rings (Fig 12). This site sequence was found to span the period 1419–88. The evidence for this dating is given by the *t*-values in Table 3.

Finally, two samples were combined to form CRGHSQ03, a site sequence of 146 rings (Fig 13). Attempts to date this site sequence and the remaining ungrouped samples by comparing them against the reference chronologies were unsuccessful and they remain undated.

INTERPRETATION

Tree-ring analysis of timbers at this building has resulted in the successful dating of eight samples, the dates of which suggest two separate fellings.

The earlier of these fellings is represented by three samples, one dated with CRGHSQ01 and two within CRGHSQ02. One of these dated samples (CRG-H02) came from a timber with complete sapwood. However, the sapwood portion of the sample became detached during the sampling process and could not be confidently joined although the number of rings on it could be counted. This sample has the last-measured ring date of 1488; with the addition of 34 rings (the number on the detached portion) this would give the timber represented a felling date of *c* 1522. Sample CRG-H12 also came from a timber with complete sapwood but *c* 5mm of the sapwood was lost during the sampling process. By seeing how many rings are contained within the last 5mm on the sample it is possible to estimate that *c* 5 rings have been lost. With this sample having the last-measured ring date of 1517, the addition of these 5 rings would also give this sample the felling date of *c* 1522. The final sample (CRG-H01) has the last-measured heartwood ring date of AD 1476 which makes it possible that this timber was also felled in *c* 1522.

The second felling is represented by the other five dated samples. Two of these samples (CRG-H04 and CRG-H13) have complete sapwood and the last-measured ring dates of 1602, the felling date of the timbers represented. The other three samples have broadly contemporary heartwood/sapwood boundary ring dates to those of CRG-H04 and CRG-H13 making it likely that they were also felled in 1602.

DISCUSSION

Prior to tree-ring analysis being undertaken this barn was thought to date to the sixteenth century and that it underwent modifications in the seventeenth and twentieth centuries.

The earliest timbers identified within the barn are two tiebeams and a brace which are now known to have been felled in *c* 1522. These beams are thought to represent primary timbers. It had been suggested that the principal rafters belonged to a later phase of construction within the building (*pers comm* Paul Gwilliam). This idea has now been supported by the dendrochronological results, with two of these now known to have been felled in 1602. However, perhaps more surprising, is the fact that two of the aisle plates and one of the braces have also been dated to 1602.

These results have supported the dating previously suggested for the building with it thought likely that construction occurred in or shortly after felling of primary timbers in *c* 1522 and that further modifications were undertaken in 1602

It is unfortunate that a number of the sampled timbers, including two aisle posts, could not be dated. This is most likely due to the occurrence of bands of compacted rings on several of the samples. It is unclear as to whether the restricted growth experienced by the trees would have been due to a localised woodland management regime or some other factor, such as disease, but it appears that something has unduly influenced the growth pattern thereby masking the climatic signal necessary for successful dating.

Acknowledgements

This work was commissioned by Paul Gwilliam of Archaeological Services WYAS on behalf of the owners of the barn as part of a programme of recording being undertaken. Paul also provided the photographs and drawings incorporated within this report. Thanks are given to Nick Silcock of Townscape Architects for arranging access and to site staff for their assistance and co-operation whilst sampling was undertaken.

Table 1: Details of samples from Crag House Farm Barn, Otley Old Road, Cookridge, Leeds

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
CRG-H01	Tiebeam, truss 1	57	--	1420	----	1476
CRG-H02	Brace, aisle post to tiebeam, truss 1 (north side)	70	h/s+34NM	1419	1488	1488
CRG-H03	South principal rafter, truss 2A	99	19	1489	1568	1587
CRG-H04	North aisle plate, bay 1	186	45C	1417	1557	1602
CRG-H05	South aisle plate, bay 2	115	14	----	----	----
CRG-H06	Tiebeam, truss 2	105	19(*c*2mmlost)	----	----	----
CRG-H07	Tiebeam, truss 3	83	h/s	----	----	----
CRG-H08	South principal rafter, truss 3A	112	31	1486	1566	1597
CRG-H09	South aisle post, truss 3	146	h/s	----	----	----
CRG-H10	North aisle post, truss 3	118	--	----	----	----
CRG-H11	North aisle plate, bay 4	134	03	1437	1567	1570
CRG-H12	Tiebeam, truss 4	102	26(*c*5mmlost)	1416	1491	1517
CRG-H13	Brace, aisle post to aisle plate, bay 4 (north side)	77	27C	1526	1575	1602

*NM = not measured

**h/s = the heartwood/sapwood boundary ring is the last-measured ring on the sample

C = complete sapwood retained on sample, last ring is the felling date.

Table 2: Results of the cross-matching of site sequence CRGHSQ01 and relevant reference chronologies when the first-ring date is 1416 and the last-measured ring date is 1602

Reference chronology	*t*-value	Span of chronology
England	7.2	401–1981
Hallgarth Pittington, County Durham	7.8	1336–1624
Little Moreton Hall, Cheshire	6.8	1377–1562
Manor Farm, Bradfield, South Yorkshire	6.5	1380–1550
Manor House, Sutton in Ashfield, Nottinghamshire	6.5	1441–1656
Low Harperley Farmhouse, Wolsingham, County Durham	6.5	1356–1604
Dilston Castle, Corbridge, Northumberland	6.1	1402–1611

Table 3: Results of the cross-matching of site sequence CRGHSQ02 and relevant reference chronologies when the first-ring date is 1419 and the last-measured ring date is 1488

Reference chronology	*t*-value	Span of chronology
Manor Farm, Ickenham, Middlesex	5.3	1374–1483
Chalgrove Manor, Chalgrove, Oxfordshire	5.2	1355–1503
Newnham Hall Farm, near Wallingford, Oxfordshire	5.2	1414–1551
Headstone Manor Barn, Harrow, Middlesex	4.7	1374–1505
Cromwell Cottage, Coventry, West Midlands	4.7	1345–1575
49/50 Quarry Street, Guildford, Surrey	4.5	1341–1583
Low Harperley Farmhouse, Wolsingham, County Durham	4.5	1356–1604

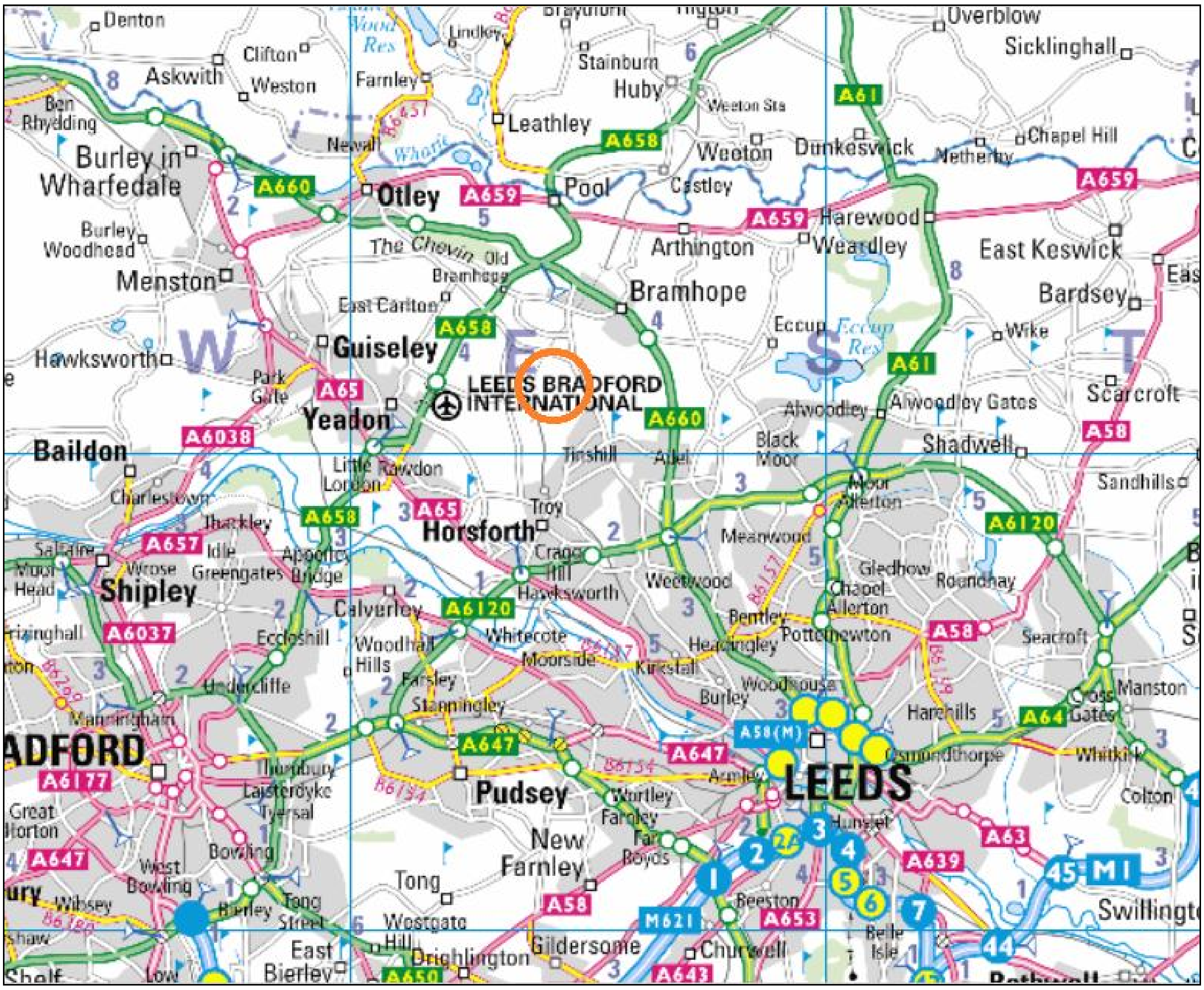

Figure 1: Map to show the general location of Cookridge, circled (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Figure 2: Location of Crag House Farm barn, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

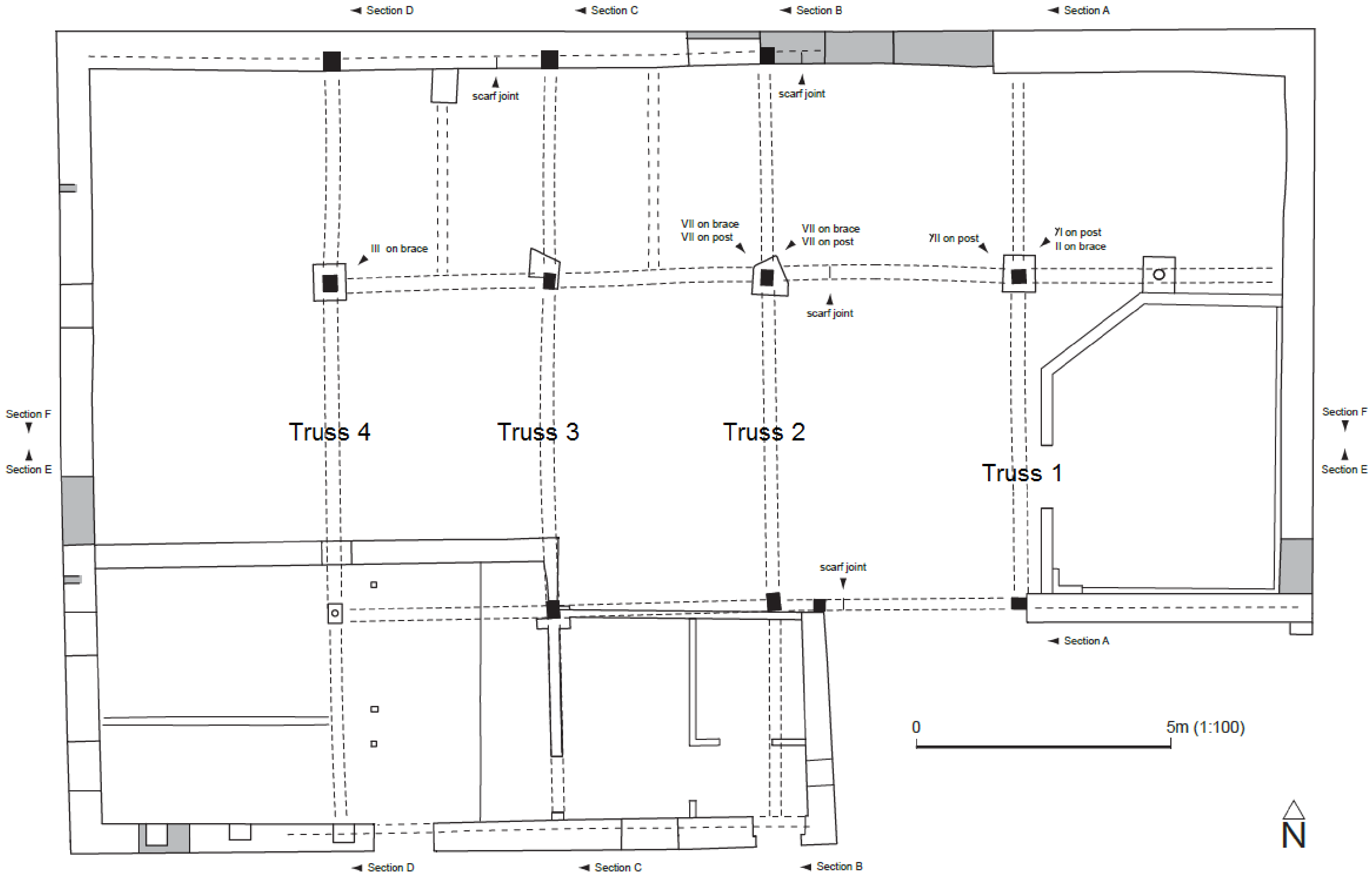

Figure 3: Plan, showing truss positions and location of sections (Archaeological Services WYAS)

Figure 4: Crag House Farm barn, photograph taken from the south-west (Archaeological Services WYAS)

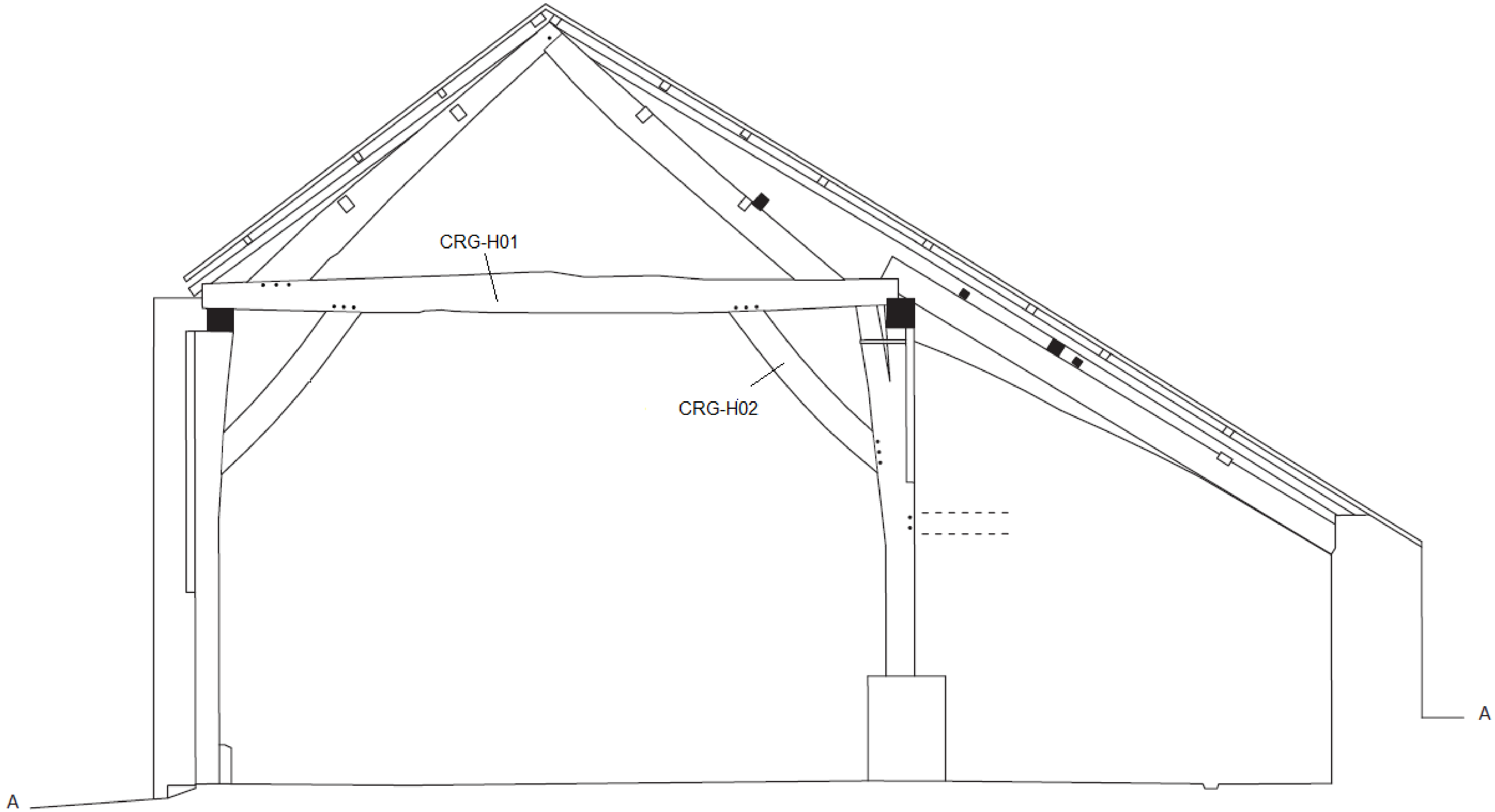

Figure 5: Section A–A, showing the location of samples CRG-H01 and CRG-H02 (Archaeological Services WYAS)

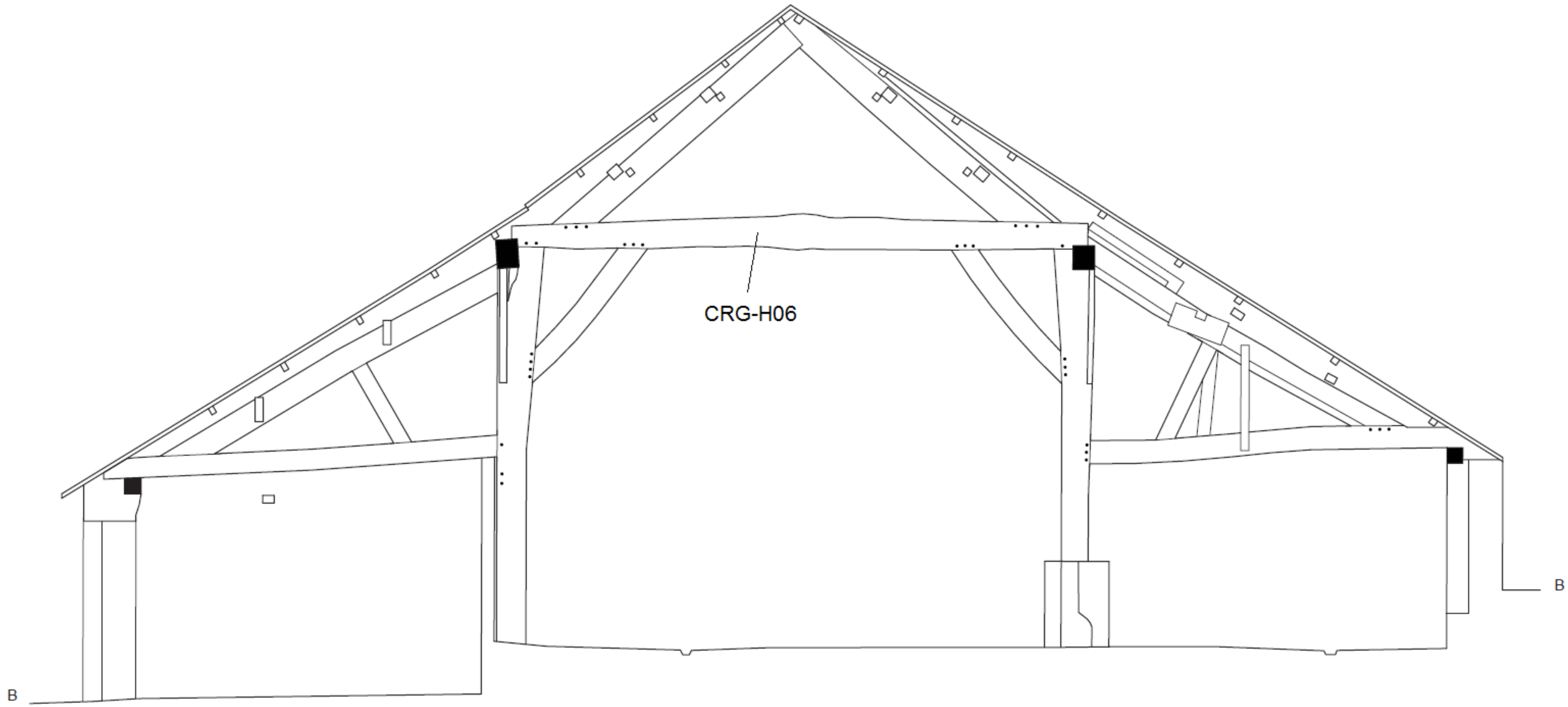

Figure 6: Section B–B, showing the location of sample CRG-H06 (Archaeological Services, WYAS)

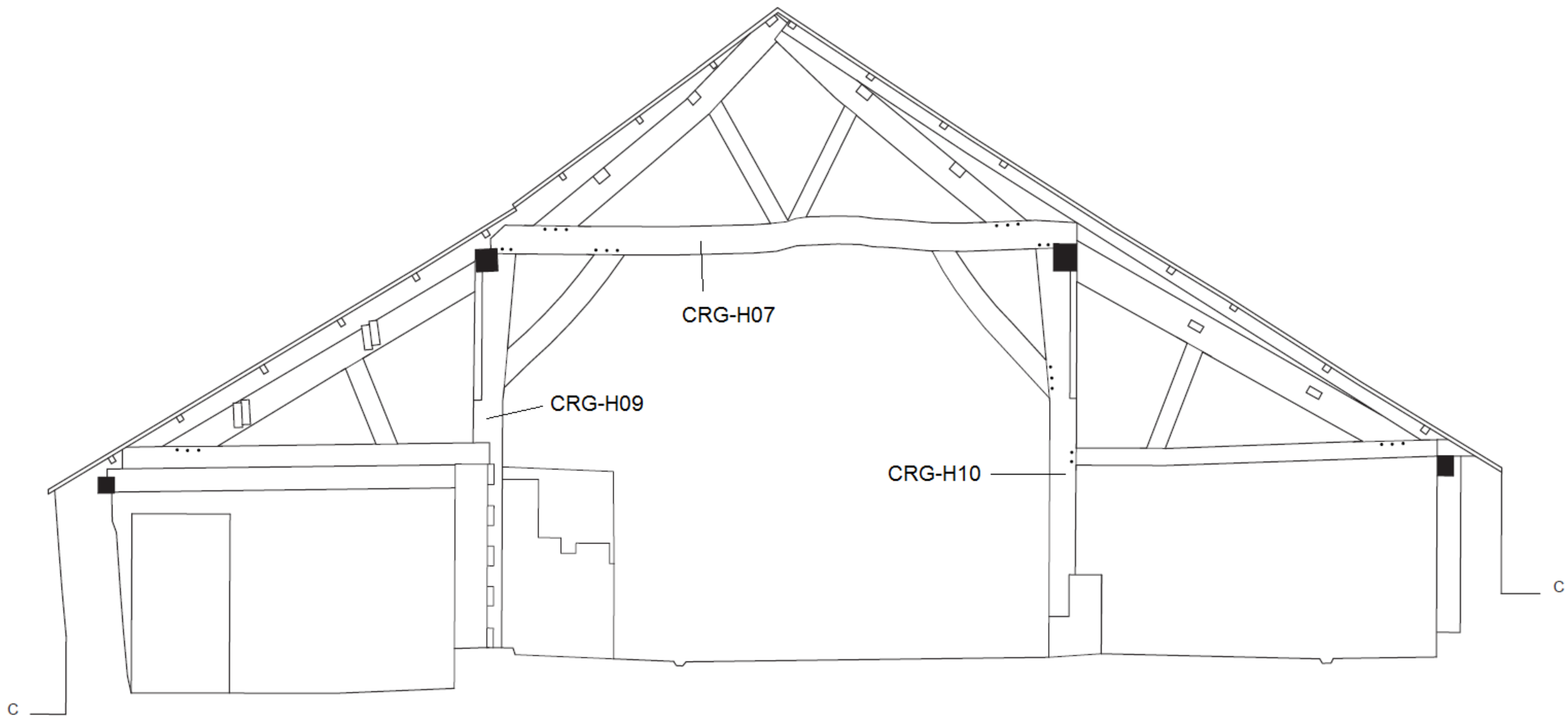

Figure 7: Section C–C, showing the location of samples CRG-H07, CRG-H09, and CRG-H10 (Archaeological Services WYAS)

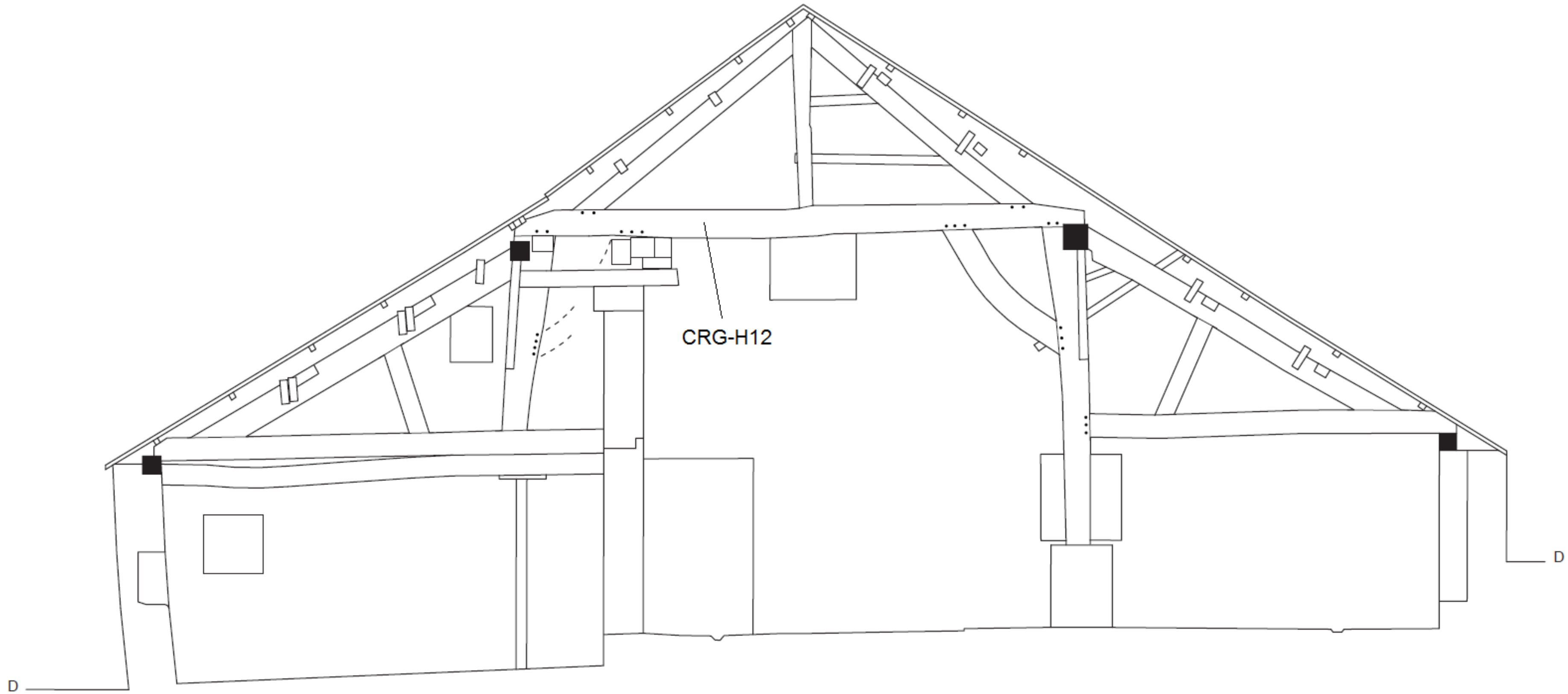

Figure 8: Section D–D, showing the location of sample CRG-H12

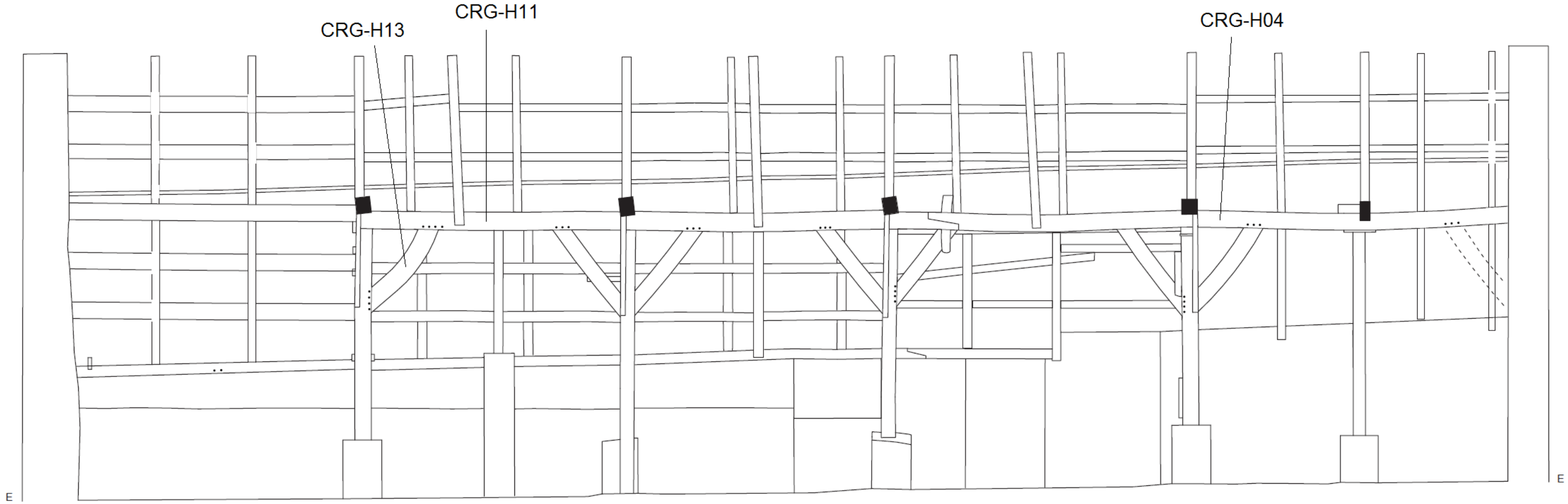

Figure 9: Section E–E, showing the location of samples CRG-H04, CRG-H11, and CRG-H13 (Archaeological Services WYAS)

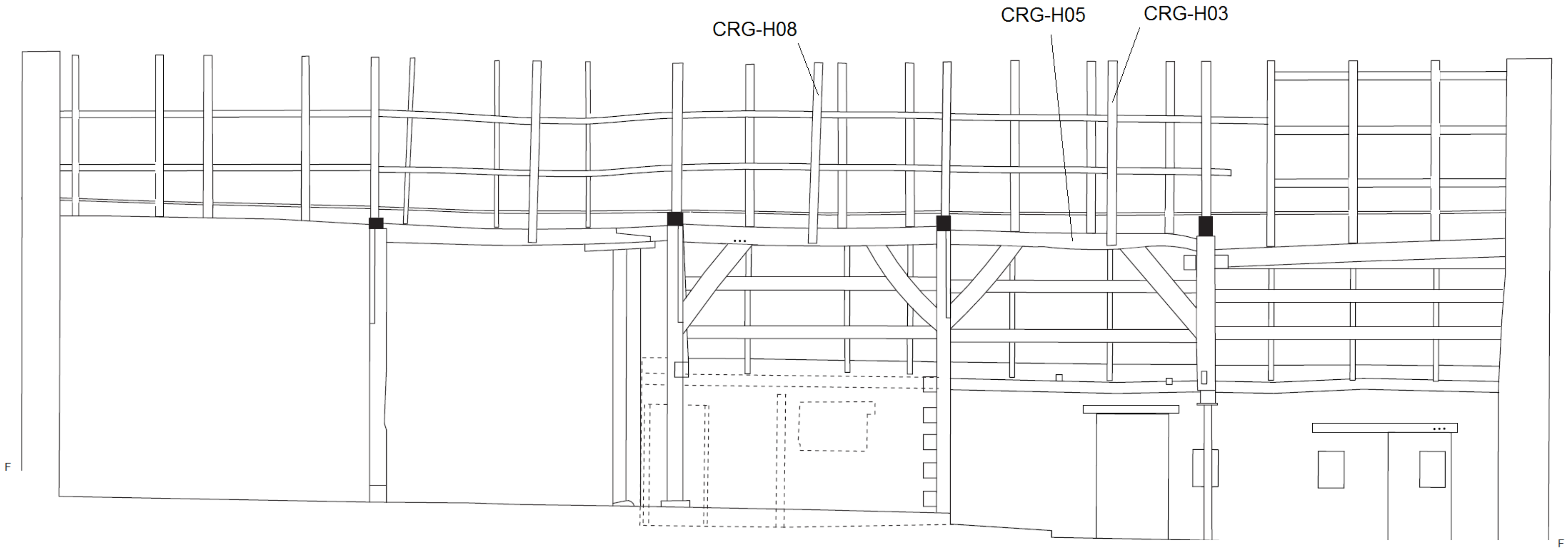

Figure 10: Section F–F, showing the location of samples CRG-H03, CRG-H05, and CRG-H08 (Archaeological Services WYAS)

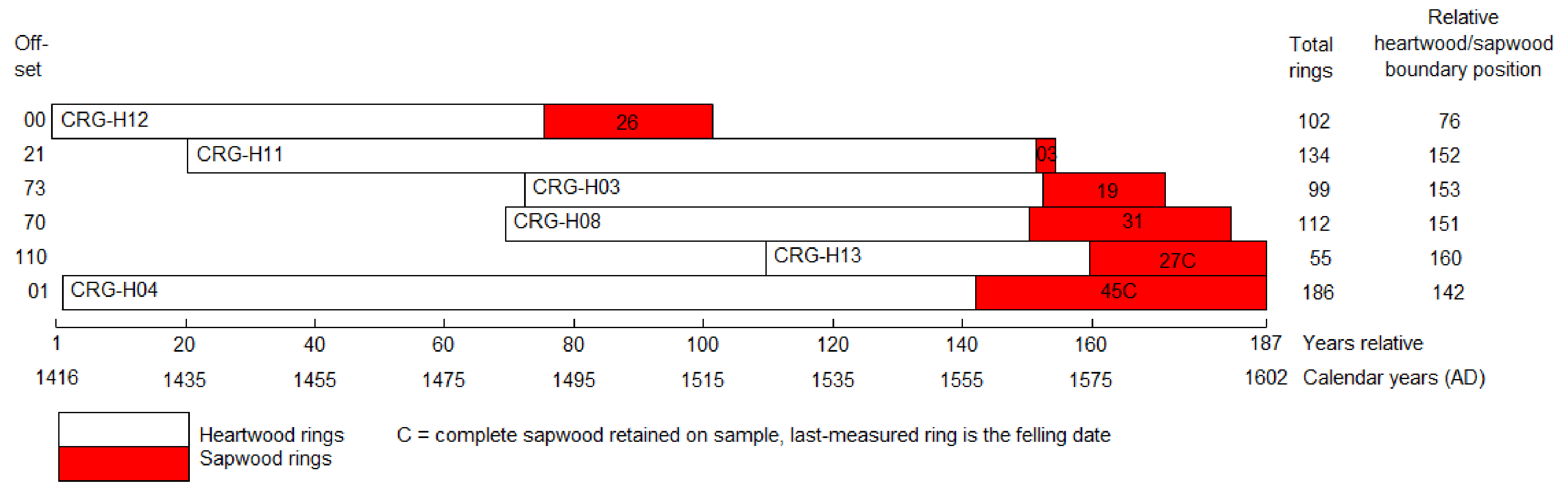

Figure 11: Bar diagram of samples in site sequence CRGHSQ01

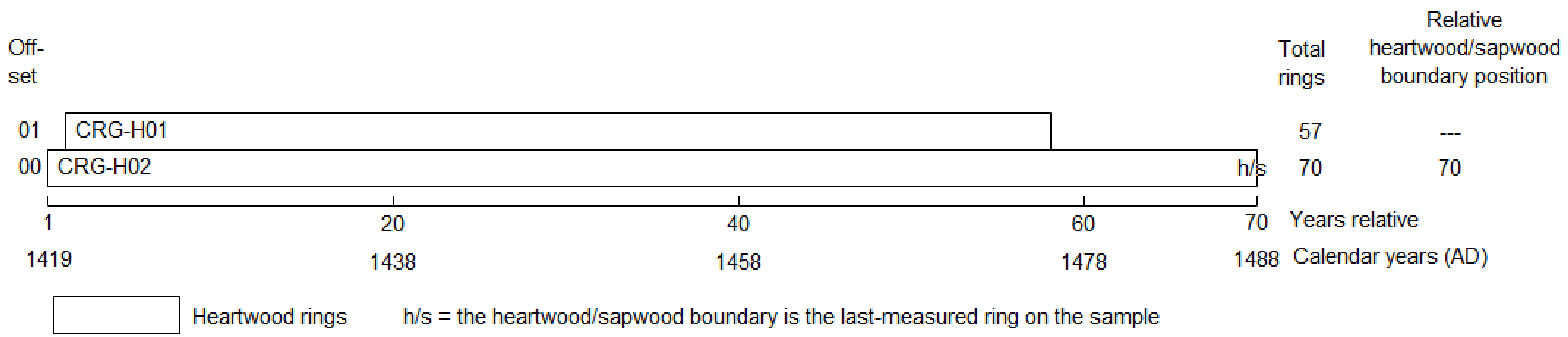

Figure 12: Bar diagram of samples in site sequence CRGHSQ02

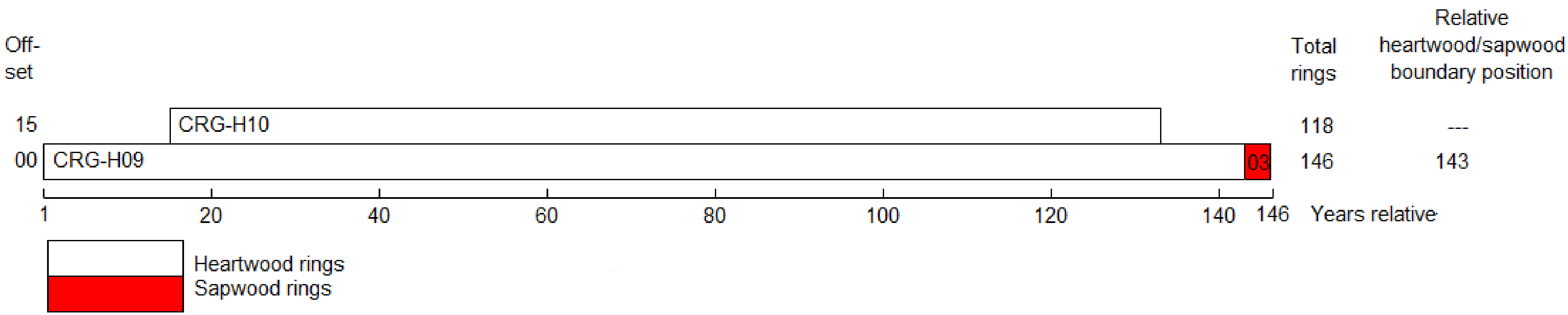

Figure 13: Bar diagram of samples in undated site sequence CRGHSQ03