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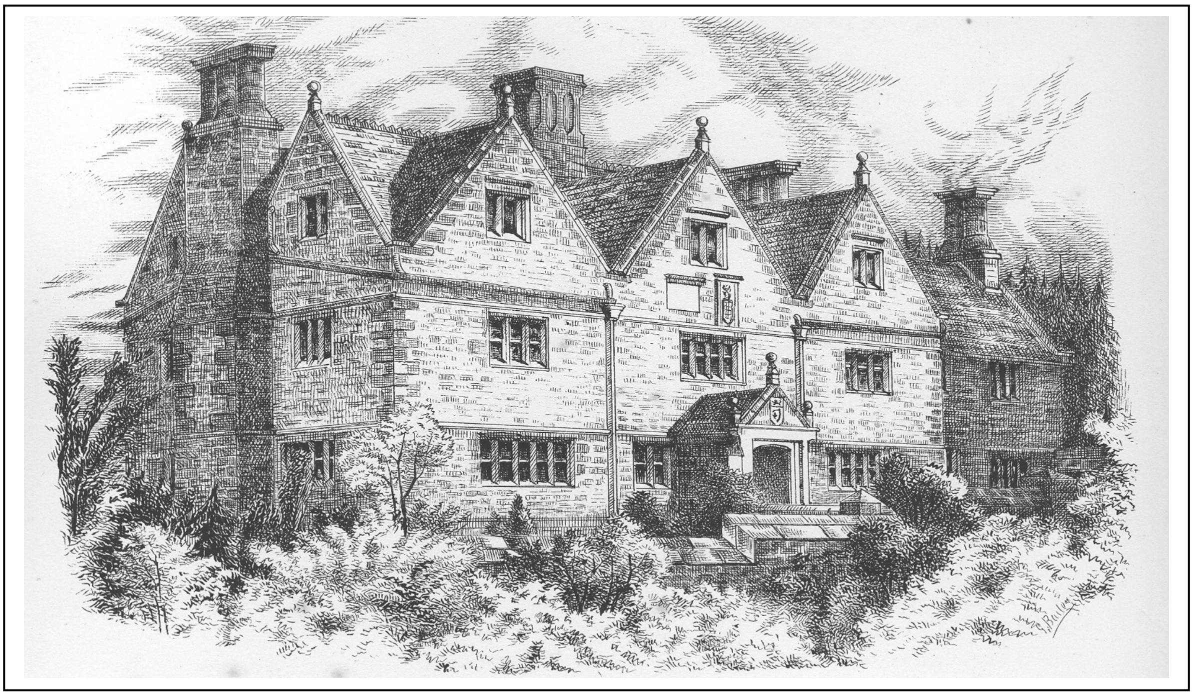

Nottingham Tree-ring Dating Laboratory
Dendrochronology, timber analysis, and historic building consultants

# TREE-RING ANALYSIS OF TIMBERS FROM SHARPCLIFFE HALL, SHARPCLIFFE, STAFFORDSHIRE

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**SUMMARY**

**Tree-ring analysis of a 22 samples from the roof and first-floor partition walls of Sharpcliffe Hall has produced two separate site chronologies.**

**The first site chronology, SPCASQ01, comprises 10 samples, all from what are believed to be primary or phase 1 timbers, and has an overall length of 182 rings. These rings can be dated as spanning the years 1466 to 1647. Interpretation of the sapwood on these dated samples would indicate that the timbers they represent were all felled between 1650 – 52.**

**The second site chronology, SPCASQ02, comprises six samples, all from what are considered to be inserted, secondary, or phase 2, timbers. This second site chronology has an overall length of 120 rings which can be dated as spanning the years 1512 to 1631. Interpretation of the sapwood on the six dated samples of this second site chronology would indicate that at least one timber was certainly felled in 1627, and another was certainly felled in 1631. It is likely that the other four dated timbers were felled at about his time too.**

**It would thus appear that the primary phase timbers of Sharpcliffe Hall date to 1650 – 55. The alterations, which must have been undertaken some time after this date, use timber felled *ca* 1627 – 31, which must, presumably, have been salvaged from somewhere else and reused here.**

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## Introduction

Sharpcliffe Hall (Fig 1) is a substantial Grade II* listed, stone-built double pile building constructed of local materials. To its front Sharpcliffe presents three short north-south gabled ranges of two-storeys-with attics, attached to a longer two-storey with attics east – west range. There is a further two storey extension to the east end. There are a number of fine mullioned windows to this frontage. A basic plan of the building is given in Figure 2.

Within the roof or attic spaces, and also the first floor, is a substantial amount of timber framing. The roof comprises four principal rafter trusses, each having, or at one time having, a tiebeam and a collar. Some of the trusses have been filled with vertical studs (many studs being lost in times past when chimneys and other attic insertions were made). At some time after their construction, the trusses were altered by having new, outer, rafters placed over the original inner ones, the space between them being filled with short struts or studs (Fig 3). To the first floor the trusses are filled by close-set vertical studs (Fig 4). Stylistically, the stone work, the mullion windows and the form of the timber-framing suggest a mid-seventeenth century date for this building. The date of the later alterations to the roof is unknown.

## Sampling

Sampling and analysis of timbers from Sharpcliffe Hall were commissioned by Faith Cleverdon, for Staffordshire Moorlands District Council, this being undertaken as part of the planning process during a programme of repair and conservation to the building. It was hoped that tree-ring analysis would establish the date of the primary timbers of the building, i.e., the phase 1 beams, and establish, if possible, the date at which later alterations were made.

Thus, from the timbers available at total of 22 core samples was obtained, each sample being given the code SPC-A (for Sharpcliffe, site "A"). Nine samples, SPC-A01 – A09, were obtained from what were believed to be secondary, phase 2, timbers, inserted during a programme of alteration and development; all these timbers are to be found in the roof space or attic rooms. A further 13 samples, SPC-A21 – A33, were obtained from what appeared to be primary or phase 1 timbers. These latter beams are found in both the roof/attic space and at first-floor level.

The positions of these samples were marked on plans made at the time of coring on plans made by Faith Cleverdon, these being reproduced here as Figure 5a-d. Details of the samples are given in Table 1. In this Table, all trusses and the individual timbers have been numbered and/or identified following the plans provided and further located on a north – south, or east – west basis, as appropriate.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank the owner of Sharpcliffe Hall, Mrs Cartwright, and her grandson Paul Taylor, for their enthusiasm for this programme of tree-ring analysis and for their help and cooperation during sampling. Sampling was generously funded by Staffordshire Moorlands District Council.

## 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 22 samples obtained from Sharpcliffe Hall was prepared by sanding and polishing. It was seen at this point that one sample, SPC-A05, had too few rings for reliable dating, i.e. less than 54, and this was rejected from this programme of analysis. The ring-widths of the remaining 21 samples were, however measured and then compared with each.

At a minimum value of *t=3.6* two separate groups, the first comprising 10 samples, the second comprising 6 samples, could be formed, cross-matching with each other at the positions indicated in the bar diagrams Figures 6 and 7. The samples of each respective group combined at their indicated off-set positions to form SPCASQ01, a site chronology of 182 rings, and SPCASQ02, a site chronology of 120 rings. Both site chronologies were then satisfactorily dated by repeated and consistent cross-matching with an extensive number of reference chronologies. Site chronology SPCASQ01 cross-matches when its first ring is dated to 1466 and its last ring is dated to 1647. Site chronology SPCASQ02 cross-matches when its first ring is dated to 1512 and its last ring is dated to 1631. The evidence for this dating is given in the *t*-values of Tables 2 and 3.

Both site chronologies were then compared with the five remaining measured but ungrouped single samples, but there was no further satisfactory cross-matching. The five single samples were then compared individually with the full range of reference chronologies but there was, again, no further cross-matching. These five samples must, therefore, remain undated.

## Interpretation and results

Analysis by dendrochronology of 22 samples from Sharpcliffe Hall has resulted in 16 of these being combined to form two separate site chronology, SPCASQ01 and

SPCASQ02. Site chronology SPCASQ01 (bar diagram Fig 6), comprising 10 samples and 182 rings long, spans the years 1466 – 1647. One sample, SPC-A32, in this site chronology, is from a timber which retains complete sapwood, that is, it has the last ring produced by the tree represented before it was felled. Unfortunately, a portion of the sapwood was lost from the sample during coring. However, given that the last existing ring on sample SPC-A32 dates to 1647, it is estimated that the lost element of sapwood (3 – 5 rings) would indicate that the timber was felled in the period 1650 – 52. It is likely that the other nine timbers represented by site chronology SPCASQ01 were felled at this time too.

Site chronology SPCASQ02 (bar diagram Fig 7), comprising 6 samples and 120 rings long, spans the years 1512 – 1631. Two of these six samples, SPC-A01 and A05, again come from timbers which retain complete sapwood; in this instance both samples retain all the sapwood. In the case of A01 the last ring date on the sample, and thus the felling date of the tree, is 1631. In the case of sample SPC-A05 the last ring date on the sample, and thus the felling date of the tree, is slightly earlier at 1627. Two other samples, SPC-A03 and A07 in site chronology SPCASQ02, also come from timbers which had complete sapwood, but from which larger portions of the sapwood have been lost from the cores. Although the lost amount is more difficult to assess accurately, there is no reason to suspect that these two samples do not also represent timbers felled sometime between 1627 – 31. There is also no reason to suspect that the final two timbers represented in this site chronology were not felled about this time too.

## Conclusion

It would appear, therefore, that Sharpcliffe Hall does indeed contain two phases of timber felling. The phase 1 beams of the primary trusses are made up of timbers felled in the period 1650 – 52. The next phase, although inserted later, appears to be made up of timbers felled earlier and at seemingly different times. At least one such timber was felled in 1627, and another in 1631. The others are also likely to have been felled about this time

It is not possible to be certain where the trees used at Sharpcliffe were originally growing. As indicated by Tables 2 and 3, which shows a selection of reference chronologies against which site chronologies SPCASQ01 and SPCSQ02 have been dated, the highest *t*-values are found against material from a varied range of locations, though most are based on sites in central England. This would suggest that the trees used were originally growing in this general area too, and it is unlikely that, even in the mid-seventeenth century, the timbers have been moved very far. In any case, it is very likely that the trees used for each phase of development are from two different woodlands.

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**Table 1:** Details of tree-ring samples from Sharpcliffe Hall

| Sample number | Sample location | Total rings | Sapwood rings* | First measured ring date (AD) | Last heartwood ring date (AD) | Last measured ring date (AD) |
|---|---|---|---|---|---|---|
| | Phase 2 timbers | | | | | |
| SPC-A01 | East principal rafter, truss C | 81 | 16C | 1551 | 1615 | 1631 |
| SPC-A02 | West principal rafter, truss C | 76 | 14 | ------ | ------ | ------ |
| SPC-A03 | South outer rafter, truss A | 73 | h/s | 1535 | 1607 | 1607 |
| SPC-A04 | South lower raking strut, truss A | nm | --- | ------ | ------ | ------ |
| SPC-A05 | North outer rafter, truss A | 90 | 20C | 1538 | 1607 | 1627 |
| SPC-A06 | North upper raking strut, truss A | 93 | h/s | ------ | ------ | ------ |
| SPC-A07 | Collar, truss A | 110 | 16c | 1512 | 1605 | 1621 |
| SPC-A08 | North outer rafter, truss D | 90 | h/s | 1517 | 1606 | 1606 |
| SPC-A09 | South outer rafter, truss D | 86 | 14c | 1533 | 1604 | 1618 |
| | Phase 1 timbers | | | | | |
| SPC-A21 | Upper south outer stud post, truss D | 102 | h/s | 1527 | 1628 | 1628 |
| SPC-A22 | Lower stud post 3, truss D | 84 | h/s | ------ | ------ | ------ |
| SPC-A23 | Lower stud post 5, truss D | 86 | 5 | 1554 | 1634 | 1639 |
| SPC-A24 | Stud post 1 (from east), truss B | 80 | no h/s | 1541 | ------ | 1620 |
| SPC-A25 | Stud post 2, truss B | 93 | 19 | 1549 | 1622 | 1641 |
| SPC-A26 | Stud post 3, truss B | 117 | 15 | ------ | ------ | ------ |
| SPC-A27 | Stud post 4, truss B | 60 | no h/s | ------ | ------ | ------ |
| SPC-A28 | Stud post 5, truss B | 90 | no h/s | 1502 | ------ | 1591 |
| SPC-A29 | Stud post 6, truss B | 56 | no h/s | 1552 | ------ | 1607 |
| SPC-A30 | Stud post 9 (from north), truss A | 147 | no h/s | 1470 | ------ | 1616 |
| SPC-A31 | Stud post 7, truss A | 113 | no h/s | 1492 | ------ | 1604 |
| SPC-A32 | Stud post 6, truss A | 143 | 25c | 1506 | 1622 | 1647 |
| SPC-A33 | West purlin, north gable at truss A – D | 127 | no h/s | 1466 | ------ | 1592 |

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

C = Complete sapwood is retained on the sample, the last measured ring date is the felling date of the timber

c = Complete sapwood is retained on the timber but all or part of it has been lost from the sample

**Table 2:** Results of the cross-matching of site chronology SPCASQ01 and relevant reference chronologies when the first-ring date is 1466 and the last-ring date is 1647

| Reference chronology | *t*-value | Reference |
|---|---|---|
| | | |
| England Master Chronology | 8.1 | ( Baillie and Pilcher 1982 unpubl ) |
| Staircase Cafe, Stockport, Gtr Manchester | 7.6 | ( Howard *et al* 2003 ) |
| Frith Hall, Brampton, Derbys | 7.3 | ( Howard *et al* 1993 ) |
| Middleton Hall, Warwicks | 6.6 | ( Arnold *et al* 2006 ) |
| Darley Abbey, Derbys | 6.0 | ( Laxton and Litton 1988 ) |
| Sinia House, Burton upon Trent, Staffs | 5.7 | ( Tyers 1997 ) |
| England London | 5.7 | ( Tyers and Groves 1999 unpubl ) |
| East Midlands Master Chronology | 5.3 | ( Laxton and Litton 1988 ) |

**Table 3:** Results of the cross-matching of site chronology SPCASQ02 and relevant reference chronologies when the first-ring date is 1512 and the last-ring date is 1631

| Reference chronology | *t*-value | Reference |
|---|---|---|
| | | |
| Hardwick Old Hall, Derbys | 4.9 | ( Howard *et al* 2002 ) |
| Rushall Hall Barn, Rushall, Walsall, W Mids | 4.8 | ( Howard 2004 unpubl ) |
| St John The Baptist, Grimstone, Leics | 4.7 | ( Arnold *et al* 2005 ) |
| Great Wilne Farm, Shardlow, Derbys | 4.2 | ( Howard *et al* 1994 ) |
| Moat House, Appleby Magna, Leics | 4.0 | ( Howard *et al* 2000 unpubl ) |
| Donnington-le-Heath Manor House, Leics | 3.9 | ( Esling *et al* 1989 ) |
| Old Hall, Church Broughton, Derbys | 3.7 | ( Howard *et al* 1993 unpub ) |
| Holy Trinity, Staunton Harrold (pews), Leics | 3.7 | ( Howard *et al* 1996 ) |