PART II

CROMFORD BRIDGE HOUSE, CROMFORD, DERBYSHIRE

TREE-RING DATING AND TIMBER ANALYSIS

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TREE-RING ANALYSIS OF TIMBERS FROM CROMFORD BRIDGE HOUSE, CROMFORD, DERBYSHIRE

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Summary

Core samples were obtained from 37 different oak timbers within Cromford Bridge House, Cromford, Derbyshire. Analysis of 34 of these samples (three having too few rings for reliable dating) produced five dated site chronologies.

Interpretation of the dates obtained for 29 of the 34 measured samples indicates that the earliest part of the present building is the two-bays of one of the north–south ranges gable-end on to the road. This was constructed of timber felled in 1524. A further large single-bay extension was added to the north side of this original two bay hall in 1655.

A few years later, in 1662, a major development saw the addition of an east– west range, added to the west of the two earlier stages of building. This new work appears to have been a two-storey-with-attic domestic building at its east end (where it attached to the existing building), and a one-and-a-half storey, possibly agricultural building, at the west end.

Within a less than a hundred years, almost certainly by 1735, the one-and-a-half storey portion of the east–west range was raised in height to make it a two- storey-with-attic building, matching the rest of this range. This work reused much of the timber felled in 1662, but incorporated and reused some salvaged timbers originally felled in 1586, and some new timbers specifically felled for the mid-eighteenth century work. Other, minor, alterations were made to some parts of the building during these years. The exact date of these works cannot be determined.

It is likely that within a generation of the east–west range having been built, say by 1780, a superior Georgian range was attached to the east of, and parallel to, the primary 1524 build, as a north–south gable range.

Introduction

The exterior

Cromford Bridge House (Figure 1) presents two north–south ranges, gable-end on to the front and rear of the building, with, to the west and almost, but not quite, at right angles to these, a further, long, east–west range (Figure 2). The eastern, or right-hand part of this range (as viewed from the front), having a gabled dormer window. The east-most north–south range, here described as 'gable range 1', appears typically Georgian in style, the machined stonework, the sash windows, the finial to the roof, and the door, all suggesting a late-eighteenth-century date, perhaps *c*.1780. The internal fittings and features likewise all point toward such a date. The northern gable of this range is only visible from the rear.

To the left, or west, of this Georgian portion, is a further north–south range, 'gable range 2'. Here, the stonework is less well worked and displays greater variety in size, shape and regularity of bonding, particularly to the lower courses. To a certain extent, the upper courses appear to be better worked, and it is possible that some of this stonework has been replaced or patched, particularly to the short western flank as it runs towards the east–west range (Figure 3). The northern gable of this range is again only visible from the rear.

The long, east–west range, to the west again of gable range 2, also presents some variety. Here we first see a two storey, single bay building (a hidden portion linking it to gable range 2), with a double light gabled dormer window. The stonework to this portion all looks very similar, there being an identical decorative drip moulding above the windows of the dormer, as well as to the first and ground floors. The windows of this portion show some variety of style with those to the dormer having carved stone reveals and stone mullions (vertical dividers), whilst one window to the first floor also has carved stone reveals, stone mullions, as well as stone transoms (horizontal dividers).The second window to the first floor looks like it might be a relatively modern repair, having carved stone reveals but only a single squared stone mullion. The window to the ground floor has square, machine worked stone reveals and no mullion.

The doors to this portion are also of some interest. That to the east, originally rather narrow, now blocked and filled in part with a window, has a larger square stone lintel, chamfered to its underside to match the jambs. The door to the west has a much larger stone lintel, with a shallow decorative arched head, again chamfered to match the jambs.

The east–west range continues westwards uninterrupted at ground floor level for a further two bays. This portion contains two plain ground floor windows with simple squared stone reveals but not mullions or transoms. The door lintel is large and square without decoration. The ground-floor level shows one, and possibly two, narrow ventilation slits of the type usually seen in barns or other similar agricultural buildings (Figure 4).

Despite the variety of door and window features the impression given by the two-storey eastern portion and the lower levels of the western portion of this east–west range is that it is all of one build. To the upper level of the western part of this range where there is a noticeable change in the stonework at the top of what are now the first-floor windows. This is still more clearly seen at the west gable end of this range, where there is a distinct change between raggstone rubble walling of the lower levels and the worked blocks of the courses placed above these (Figure 5). There is also a distinct break between the quoins of the upper level of what was once the gable end of the two-storey section, and what are now the upper, second floor, course of the western end. The structural evidence strongly suggests that the walls and roof of the western end have been raised in height to match those of the eastern end.

The timberwork (north–south gable range 2)

The timberwork within Cromford Bridge House, as with the stonework without, again presents varying degrees of complexity. That to the two 'gable-end' ranges is reasonably straight forward, the timberwork of each respective section appearing to represent single, though different, phases of construction, the timbers of each respective element appearing internally integral, being properly jointed, pegged, and with some timbers being numbered sequentially. There is no evidence, by way of empty mortices or peg holes, of redundancy and reuse. The beams of gable range 1 are all of pine, while the majority of those to gable range 2 are of oak (the exceptions, all common rafters, are almost certainly twentieth-century replacements).

It would appear likely that the earliest phase of this part of the building was a simple north–south, two-bay hall, now represented by bays 1 and 2 between trusses 1 and 3 (see Figure 1). This was formed by truss '1' in the south gable wall (although now lost, its existence is evidenced by empty mortices at the south end of the purlins here which would have taken braces from its principal rafters), truss 2 in the middle (which shows no evidence of originally having been closed), and truss 3 to the north. The purlins of bays 1 and 2 do not continue through into bay three and there were never any braces from the north side of the principal rafters of truss 3 in to bay 3.

The wall formed by truss 3 was probably originally solid or closed both above and below the tiebeam. The remains of studding is now only visible internally in the attic, above the tiebeam, the herring-bone framing here almost certainly meant to be decorative, fashionable, and thus visible. The framing is filled by stone which is then covered by plaster. There appears to be no evidence of mortices or peg holes for vertical studs to the underside of the tiebeam of this truss, and thus it is not certain that the lower part of the wall was timber framed. It is possible that the walls below tiebeam level were always of stone. Taken together this evidence suggests that what is now the partition wall between bay 2, and bay 3 to its north, was almost certainly an exposed external wall.

That at one time no bay existed to the north of this original two-bay structure is further evidenced by a mullioned window punched through one side of the studding

of truss 3 in the attic. It is unlikely that such a window would have been made just to look in to another room; it is much more likely that it had an external prospect. The very fact that this window is punched through the studding, however, rather than formed or framed by it, indicates that it is not original, as part of the studding to this side of the attic remains, and mortices for the removed studs can also be seen (Figure 6).

The presence of the window also indicates the existence of a floored room at this attic level and some means of access to it. This might suggest that as originally constructed the primary building was of two bays with a ceiled ground floor and a first-floor open to the rafters above. It is likely, given that there is no evidence of smoke blackening, that there was some form of chimney, or perhaps a smoke hood, perhaps above the area where the fire in the parlour room on the ground floor (bay 1) now exists. This would suggest that this part of the building is later than, say, 1500, when open halls were no longer built. Had the building been earlier than 1500, it might have been an 'open hall' type structure, with no first floor, with a central hearth, the smoke from which would have stained the timbers above.

The date at which the attic window was punched through and the floor put in can probably not be determined through tree-ring dating. No timbers from this floor structure were available for sampling, and those of the window are unsuitable for dendrochronology. The window and floor could have been formed between the time that truss 3 was put in, possibly even as a change of plan during construction, up to the time when the bay to the north, bay 3, was added. It is of course possible that the attic floor was put in before the window in truss 3 was formed, but this is unlikely as the attic would then have been completely dark (assuming there was no window formed through truss 1 in the south gable).

At some time, truss 2, which was originally open, was closed by its present infill. This closing comprises a collar with two vertical posts and a number of other smaller poles supporting a hard, well formed, gypsum plaster fill. The collar and vertical posts form a lintel and door jambs respectively, there being a 'pin' type hinge to the left (or east) door jamb indicating that the room to bay 1 was meant to be more private (Figure 7). The closing of truss 2 could possibly have been done when the window in truss 3 and the attic floor were put in. However, given that all the closing timbers of truss 2 are fixed with nails, it is likely to be a later development.

In any case, once the bay to the north of the primary structure, bay 3, was constructed, it appears that the attic window was blocked up and a doorway formed between the existing room in bay 2 and what was a new room at this level in bay 3. A cob and stud chimney stack was built in to this new north bay, attached to the north side of truss 3. Although it is unlikely that there ever was a timber-framed truss put in at the new north gable wall, for the purposes of this report this is designated truss '4'.

It is unclear whether or not the lower walls of this new north bay were originally of timber framing or of stone. This latter is perhaps more likely as there is no evidence

to the underside of the wall plates of mortices for studs or posts. It is possible that, if they were originally timber-framed, it was at this time that the walls of the primary two-bay hall were replaced in stone.

The timberwork (east–west range)

Whilst the timbers of the north–south gable ranges are reasonably clear, those of the east–west range, again mostly of oak , presenting its long façade to the road, appear to represent a confusion of possibly different phases, many of the timbers here having empty mortices and redundant peg holes. Although there are some carpenters marks to these timbers, there appears to be less consistency and integrity amongst them again suggesting some alterations here. Some pine beams are found in this section forming the ceiling of the west-most first floor room. The developmental stages of this east–west range and its sequential relationship with north–south gable range 2 are not entirely clear, and it is possible that the stone and timberwork represent more than one period of development.

The timbers and carpentry

In general, the principal timbers used in the construction of the building are of good size and quality, particularly those of bays 1 and 2 (trusses 1–3) of gable range 2. Here the beams are either almost whole trees, the purlins for example, trimmed down and squared slightly by sawing and adzing (Figure 8), or are formed of trees split in half, the principal rafters for example. Again these beams have been trimmed and squared into neat timbers by adzing and sawing, some timbers showing evidence of both tools.

Some of these timbers are laid out with carpenter's marks, these being found on the backs of the wind braces, and on the principal rafters where the wind braces join them. These take the form of 'I', 'I' (one-with a tag to it), 'II' and 'II' (two, with a tag to it) (Figure 9). There are also possible scribe lines to some of the timbers marking out the positions of mortices and tenons. It is possible, however, that a mistake with some of these might have been made; to the underside of the purlins between trusses 1 and 2 of gable range 2 there are shallow starts made for mortices, possibly for wind braces. These mortices were never completed.

The timbers of bay 3, between truss 3 and truss '4' (the purlins, the ridge and the timbers of the daub chimney) are less well worked and squared, and show a greater degree of twisting and warping. There is some evidence of sawing and rather rough adzing or chopping, but the timbers are still quite round. There appear to be no carpenter's marks on these timbers.

The timbers to the east–west range are again well worked for the most part, these again usually being squared-up. The evidence of tool marks on these timbers is less clear but it again looks like they were sawn. Some timbers are less well squared, the purlins for example, and these show evidence of adzing and chopping. There appear

to be some carpenter's marks on these timbers, very similar to those seen on trusses 1–3 of gable range 2. There is little evidence of scribe marks showing the positions of joints.

One unusual point is the existence of a delicate rosette pattern on the west face of the north principal rafter of truss 7. This is found in the attic and consists of a series of intersecting lines obviously scribed out with a compass (Figure 10). Although patterns of this type are seen reasonably often, they are not overly common. They appear to have no particular function and may simple be 'doodles' or a form of graffiti.

Sampling

Sampling and analysis by tree-ring dating of timbers within Cromford Bridge House were commissioned by the owners Mr and Mrs Rivers. This analysis was undertaken out of personal interest, and as part of a general enquiry into the background history and development of the site, the various features of the site having engendered much discussion and debate. It is known from documentary research, particularly the hearth tax return of the 1660s, that a building with four fireplaces stood here at that time. It was hoped that tree-ring analysis might indicate the dates at which certain timbers had been felled and, if possible, establish a likely primary construction date for the building and demonstrate something of its developmental history.

Thus, from the extensive amount of material available a total of 37 samples was obtained, each sample being given the code CRM-B (for Cromford, site "B"). Nine samples, CRM-B01–B09, were obtained from the front two roof bays of gable range 2 between trusses 1 and 3, with a further five samples, CRM-B21–B25, being obtained from the roof of bay 3 to the rear (between trusses 3 '4'). Nine samples, CRM-B31–B39 were then taken from the roof of the eastern half of the east–west range, from between where it joins gable range 2 to truss 7, with a further five samples, CRM-B41–B45 being taken from the smaller number of timbers available in the western between truss 7 and 'truss 8' in the west gable wall (some gaps having been left in the sampling sequence).

Five samples, CRM-B46–B50 were then taken from various ceiling beams and posts of the ground floor rooms, with, finally, four samples, CRM-B51–B54, being taken from the oak floor-boards of the rear attic bay of gable range 2 (bay 3).

The position of the cores, and other relevant information about the timber, was carefully recorded at the time of sampling, the position of the samples also being marked on sketch plans made at the time. These have been worked-up to those reproduced here as Figure 11a–c. Details of the samples are given in Table 1. In these figures, and in Table 1, the timbers have been numbered from site east to site west and identified on a north–south basis as appropriate.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to

firstly thank Mr and Mrs Rivers for taking such an enthusiastic interest in the building and for commissioning and funding this programme of tree-ring analysis. We would also like to thank Anthony Short, architect, and Dr Pat Strange of the Derbyshire Archaeological Society for their assistance in interpreting this building.

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 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 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 sequence 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 sequence with less than about 55 rings is generally too short for satisfactory analysis. Having obtained a date for a site sequence as a whole it is then usually possible to determine the felling date for the timbers represented by the individual samples contained within that site sequence and use these felling dates to demonstrate the development of the building under consideration.

Analysis

Thus, in the case of Cromford Bridge House, each of the 37 samples obtained was prepared by sanding and polishing. It was seen at this time that three samples, CRM-B36, B37 and B39 had less than 50 rings, too few for reliable dating, and these were rejected from this programme of analysis. The annual growth-ring widths of the remaining 34 samples were, however, all measured. The data of these measurements, that is the ring pattern of each sample, were then compared with all the other sample, the degree of similarity, and indeed any dissimilarity, between all samples being expressed by the '*t-value*'. By this process, at a minimum value of t=4.0, five groups of cross-matching samples could be formed, these five groups accounting for a total of 29 samples. The positions at which the samples of each group cross-matching with each other are shown in the bar diagrams, Figures 12–16.

The samples of each cross-matching group were combined at their indicated off-set positions to form five separate site sequences, CRMBSQ01–CRMBSQ05. Each of the five site sequences was then compared with a large number of reference chronologies for oak, each respective site sequence repeatedly cross-matching at a consistent date span. The evidence for the dating of each site sequence is seen in Tables 2–6

respectively where a small selection of the reference chronologies against which each site sequence has been dated, is given.

Each of the five site sequences was then compared with the other four, and with the remaining five measured but ungrouped samples. There was, however, no further satisfactory cross-matching. The five ungrouped samples were then compared individually with the reference chronologies, but again there was no further cross-matching, and these samples remain undated.

This analysis can be summarized as below:

Site sequence	Number of samples	Number of rings	Date span
CRMBSQ01	8	129	1396 – 1524
CRMBSQ02	3	92	1495 – 1586
CRMBSQ03	11	113	1550 – 1662
CRMBSQ04	4	198	1416 – 1613
CRMBSQ05	3	57	1652 – 1708
---	5	---	undated
---	3	---	unmeasured

Interpretation

Analysis by dendrochronology has produced five dated site sequences from the material obtained at this site. As intimated by the complex structural evidence, and the evidence of the carpentry, Interpretation of the dated samples would indicate that the timber found represents more than one phase of felling.

The earliest material is represented by samples CRM-B01–B08, all of which are from the front two bays (bays 1 and 2) of gable range 2, and most of which (the exception being sample CRM-B06 which does not date) group together as site sequence CRMBSQ01 (Figure 12). The latest ring in this group is 1524, found on sample CRM-B07. Given that this sample retains complete sapwood, ie, only the bark of the tree is missing, this is the felling date of the timber represented. The relative positions of the heartwood/sapwood boundary, where it exists, on the other samples in this group is consistent with trees all being felled at the same time and this, along with the integral nature of this roof would, suggest that all the timbers of this roof were felled in 1524.

The next phase of felling is represented by the three samples, CRM-B31, B32, and B45, in site chronology CRMBSQ02 (Figure 13). One sample in this group, B31, which has a last ring date of 1586, again retains complete sapwood, and this is thus the felling date of the timber represented. The relative position of the heartwood/sapwood boundary on the other two samples in this group is consistent with the trees these represent being felled in 1586 too.
The timbers represented by samples CRM-B31, B32, and B45, however, may not form a coherent, integral, structural phase. All three timbers have empty mortices and/or

peg holes and all would thus appear to be reused in their present locations. It may be seen from Table 1 that the timbers are all reused as purlins, two in bay 4, the link between gable range 2 and the east–west range, and one in bay 7, at the west end. It is possible that as purlins they could quite easily have been inserted into an existing building. It is not possible to be certain, but it is unlikely that these timbers alone represent a separate developmental stage of Cromford Bridge House, but have been salvaged from another building and have simply been reused here during one of the alteration phases.

The next phase of timber felling, which almost certainly signifies the first redevelopment of the primary Hall construction, is represented by samples CRM-B21–B25, all of them from the rear bay (bay 3) of gable range 2, and all of them found in site sequence CRMBSQ03 (Figure 14). Four of these five samples (the exception being CRM-B23) retains complete sapwood and all four have the same last measured ring date, 1655. This is thus the felling date of the timbers represented.

It is likely that the samples, CRM-B51– B54, found in site chronology CRMBSQ04 (Figure 15), are also related to this first period of redevelopment, all four samples being from the floorboards of this rear attic bay (bay 3). Given that the timbers used for the boards have been heavily trimmed to remove the softer sapwood, only the heartwood/sapwood boundary remains on them, this being dated on three samples to 1609 and on the fourth to 1613. Given that complete sapwood is not found on any of these four samples, it is not possible to be certain as to their precise felling date. However, given that bay 3 had a window in its gable from the start, and thus must have been floored, and given that the amount of sapwood on oak trees only rarely exceeds 45 rings, the latest the trees used for these boards are likely to have been felled is 1658 (1613+45 missing sapwood rings). This upper limit would encompass the known felling date, 1655, of the roof timbers of this bay.

In addition to samples CRM-B21–B25 from bay 3 (trusses 3 and '4'), site chronology CRMBSQ03 also includes a number of other samples which are likely to be from timbers felled later still, and which probably represent a second addition to the Hall. This change appears to be represented by samples CRM-B33, B41–B44, and B49, from purlins, principal rafters, or a ground-floor ceiling beam of the east–west range. The latest date of any of these timbers is 1662, found on sample CRM-B41. The sapwood being complete on sample B41 this is thus the felling date of the timber represented. The heartwood/sapwood boundaries on these samples is slightly more varied than that seen on others from this site and it is thus possible that these timbers were felled as slightly different times. It is more likely, structurally, however, that they too were felled in 1662. Many, but not all, of these timbers show empty mortices suggesting that they are reused in their present locations.

The final phase of felling detected in the timbers analysed here appears to be represented by samples CRM-B34, B46 and B47, in site chronology CRMBSQ05 (Figure 16). These samples are from a purlin in bay 5 (at the east end of the east–west range), and the two main beams forming the ceiling of the ground floor room of same range, respectively. One of these samples, CRM-B34 retains complete sapwood

with a last measured ring date of 1708. This is thus the felling date of the timber. The other two samples, B46 and B47, have last measured heartwood/sapwood boundary dates of 1696 and 1694, respectively. Allowing for the minimum number of sapwood rings oak timbers usually have (15), and, as mentioned above, a usual maximum of 40 rings, this would suggest that these two timbers are likely to have been felled, in round terms, between, say, 1710 and 1735. It is quite possibly, however, that the oaks from which these timbers were taken had less than the usual number of sapwood rings (a phenomenon seen in 1 in 20 oak trees), and that they were felled in 1708 too.

Discussion

It would therefore appear that some five main phases of development are represented in the timberwork at Cromford Bridge House (Phasing Summary Figure). The earliest phase detected in this analysis was almost certainly the simple north–south, two-bay hall with a first floor open to the rafters, now represented by bays 1 and 2 (trusses 1–3), constructed of timber felled in 1524. At some unknown time after this a floor was put in at attic level and a window made through the external, at least partly timber-framed north wall. This minor development is likely to have been undertaken before a third bay was added, attached to the north of the original structure in 1655.

It would appear that shortly after this work was completed a further major development of Cromford Bridge House was begun, this new development comprising an east–west range attached to the west side of the primary phase two-bay hall of 1524 and its northward extension of 1655. As originally built this most recent development was probably formed at its east end by a two-storey-with-attic, one bay structure, and a two-bay, single, or perhaps more correctly, one-and-a-half-storey structure, at its west end. Judging by the tree-ring dating it is likely that this work was undertaken in 1662, and possibly included some timbers originally felled in 1586. As can be seen on the face of the building, there is a line of quoins marking the upper level of the west gable of the two-storey-with-attic portion of this building.

Judging by the tree-ring evidence, it was in the early-eighteenth century, perhaps no later than 1735, that the walls of the two-bay, one-and-a-half storey portion at the west end of the east–west range were raised to form a full height two-storey with attic range, matching the east end of this part of the building. This work would may have involved largely dismantling the roof of the entire east–west range, raising the walls and then simply reusing the 1662 timbers in the new build along with some salvaged timbers originally cut in 1586 (if they had not already been used in the 1662 build) and some new, early-eighteenth century timbers cut specifically for the new work. It is probably to this early-eighteenth century work that the pine timbers forming the ceiling of the western first-floor rooms relate.

It is likely that within a generation or two of the east–west range having been built, say after 1780 but probably by c 1800, a superior Georgian range was added to the east of, and parallel to, the primary 1524 build, as a second north–south gable range.

The development of the site discussed here can best be summarised as below:

1524 Primary timber-framed 2-bay hall with first floor open to the rafters is built. Possibly includes chimney stack or some form of smoke hood, possibly attached to south side of truss 3 (ie, where chimney is now).

Attic floor is inserted into two-bay structure. Window made in truss 3 to north (and truss 1 to south?).

1655 New large stone-built single bay is added to north of truss 3. Window in truss 3 is blocked, and a doorway is formed in it between bay 2 and new room in bay 3. Cob and daub chimney stack through attic, attic floored from the start.

1662 Three-bay east–west range is constructed. Two-storey-with-attic, one-bay section at east end, with two-bay, one-and-a-half storey section at west end (some salvaged timbers originally felled in 1586 reused?).

Truss 2 is closed.

1708 to 1735 Roof of western end of east–west range is dismantled. Walls and roof are raised to match height of east end of this range (timbers originally felled in 1586 also reused in this phase of construction).

1780 Georgian addition made to east side of original 1524 building.

Judging by the values of the cross-matches between some of the individual samples of each site chronology, that is the measure of the similarity of their growth-ring patterns, it is likely that the trees represented in each site chronology were growing in the same woodland. Indeed, in some cases the trees may have been in closer proximity to each other than others. Those trees used in the primary 1524 build, for example, are probably all from the same copse or stand. Amongst these we find values in excess of t=7.0, 8.0, and even 10.0. Between the samples from the floorboards of bay 3 we find values as high as t=12.0, values high enough to suggest, in fact, that all four boards are derived from the same tree.

The t-values of the matches between the samples in the other site chronologies, mainly made up of timbers in the east–west range, all tend to be slightly lower, although some values of t=6.0 and 7.0 are seen. This would suggest that the trees used for these timbers were growing in the same general area, although slightly further apart. It is possible that timbers used for different parts of the building (the 1655 and 1662 elements for example) were growing in different woodlands.

It is not possible to be exact as to where these source woodlands were located, but in most cases it would appear that they were all reasonably local. This is perhaps to be

expected given that the long distance transport of timber was difficult, slow, and therefore expensive. It will be seen from Tables 2–6 that the best cross-matches, ie the highest *t*-values or the greatest degree of similarity, are generally found with reference chronologies from other sites in the midlands, particularly Derbyshire, Leicestershire, Nottinghamshire, and Staffordshire (although cross-matches are found with many other reference chronologies much further afield as well).

Five of the 34 measured and analysed samples remain undated, CRM-B06, B35, B38, B48 and B50. All these samples have sufficient rings for reliable analysis and none appear to have distorted, compressed, or otherwise problem rings, that usually make cross-matching and dating difficult. It is possible, given the number of alteration and development stages seen at this site, that these undated timbers are 'singletons', each of a different date, and each possibly from a different location to all the others. Such timbers are often more difficult to date. It is a very common feature of dendrochronology that some samples remain ungrouped and undated.