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Dendrochronology, timber analysis, and historic building consultants

TREE-RING ANALYSIS OF TIMBERS FROM
NETHER ALDERLEY MILL,
NETHER ALDERLEY,
CHESHIRE

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TREE-RING ANALYSIS OF TIMBERS FROM NETHER ALDERLEY MILL, NETHER ALDERLEY, CHESHIRE

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SUMMARY

Dendrochronological analysis was undertaken on timbers removed from this building, resulting in the construction of two dated site sequences and one individually dated sample.
Site sequence NAMASQ01 contains three samples and spans the period 1531–96 and NAMASQ02, again containing three samples, spans the period 1533–96. Sample NAM-A04 was dated individually to the period 1504–94.
Four of these samples are known to have been felled in the summer of 1596, with interpretation of the sapwood on the other dated samples demonstrating that they were also likely to have been at this time.
Prior to tree-ring dating being undertaken it had been suggested that Nether Alderley Mill was the structure referred to in documentary evidence as having been constructed in *c* 1595–7. Timber included within the construction of the mill has now been dated to summer 1596, further confirmation that this is indeed the mill referred to in the documents.
A third site sequence is undated.

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The building under investigation is located in the village of Nether Alderley, to the south of the town of Alderley Edge and 7km to the west of Macclesfield (SJ 843 762; Figs 1–3). Although documents suggest that there has been a mill at this spot since 1391, no physical evidence of this early structure survives. The present mill is believed to have its origins in the late-sixteenth century. This is based on documents which exist, including court records dating to 1598, which note a cancelled site visit to inspect works undertaken at the mill which was due to have taken place the previous year. Another document states that works were begun on the mill in 1595 and finished by Christmas 1597. Further enlargement and alterations to the mill were undertaken from the mid-eighteenth century up until the end of the nineteenth century.

The mill was closed in or shortly after 1939 and later donated to the National Trust in 1950 by the then owners, Major and Mrs Shelmerdine. A number of detailed surveys and descriptions have been undertaken on the mill, the most recent by Matrix Archaeology who produced a report, on behalf of the National Trust, commissioned in advance of proposed repair and refurbishment of the building. The dendrochronological research was commissioned as part of this comprehensive programme of archaeological building recording. This brief description of the mill within this report is based on the Matrix Archaeology survey (2012) but for further information and a more comprehensive description reference should be made to the report itself or one of the previous ones (eg, Redfern 2004, 2011).

The present building is aligned north-west/south-east (for the purpose of this report hereafter north-south). It is divided internally by a north-south cross-wall with a western lower mill to one side and eastern upper mill to the other. The lower mill comprises a basement level, entrance level, and upper level whilst the upper mill consists of entrance level, upper level, and top/roof level (Fig 4). The lower mill is thought to represent the sixteenth-century structure with the upper mill relating to the eighteenth century enlargement.

The north and south gable trusses consist of principal rafters, tiebeam, king post and raking struts. Internally, the roof level is divided by two trusses of principal rafters, tiebeam, and queen posts, sitting on large oak posts. Archbraces run from these posts to the tiebeams and to the purlins (Fig 5). Further principal rafters run from the west face of these posts over the lower mill; there are two sets of purlins on this pitch. A number of empty mortices and peg holes were noted, suggesting a degree of reuse amongst the timbers, potentially from another building or an earlier. Other timbers, most notably in the gable trusses, appear to be later repairs.

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

During the investigations of the mill undertaken by Matrix Archaeology, a total of 15 timbers had been retrieved and put to one side; these were passed to the Nottingham Tree-Ring Dating Laboratory. A description of the timber and a context number had been written on the beam. Additionally, each timber was photographed prior to a slice being taken from it (Figs 6 and 7). Each

slice was given the code NAM-A (for Nether Alderley Mill) and numbered 01–15. Further details relating to these samples can be found in Table 1.

ANALYSIS & RESULTS

On examination, it could be seen that several of these samples had less than the usual desired number of growth rings (55 rings). However, due to the survival of complete sapwood on many of these samples and the similarity in growth pattern noted on some of them, the decision was made to measure all samples with more than 40 growth rings. It was hoped that intra-site grouping would occur and a site sequence of reasonable length and replication could be constructed which could then be compared more securely against the reference material.

One of the samples (NAM-A12), taken from a windbrace, was seen to have less than 40 rings and so was discarded prior to measurement. Two further samples are not oak, one (NAM-A14) is extremely degraded to the point that its species could not be identified securely or ring pattern measured. The second (NAM-A15) is softwood and the decision was taken to measure and analyse it separately, although the chances of successfully dating a single softwood sample are extremely small. Therefore a total of 13 samples were prepared by sanding and polishing and their growth-ring widths measured. The growth-ring widths of the 12 oak samples were then compared with each other, resulting in eight samples forming three groups.

Firstly, three samples, all taken from wallplates, matched each other and were combined at the relevant offset positions to form NAMASQ01, a site sequence of 66 rings (Fig 8). This site sequence was then 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 1531 and a last-measured ring date of 1596. The evidence for this dating is given by the *t*-values in Table 2.

Secondly, three further samples, all taken from principal rafters, grouped to form a site sequence of 64 rings (Fig 9). When compared against the reference material this site sequence matched at a first-ring date of 1533 and a last-measured ring date of 1596. The evidence for this dating is given by the *t*-values in Table 3.

Finally, two samples, both taken from blocks, matched each other and were combined to form NAMASQ03, a site sequence of 86 rings (Fig 10). Attempts to date this site sequence were unsuccessful and it remains undated.

Attempts to date the remaining ungrouped samples by comparing them individually against the reference chronologies resulted in sample NAM-A04 being found to span the period 1504–1594. The evidence for this dating is given by the *t*-values in Table 4. The other ungrouped, oak samples could not be matched and are undated. The softwood sample (NAM-A15) was then compared against a series of pine chronologies from this country and further afield but no secure match could be found and this sample also remains undated.

INTERPRETATION

Seven of the samples taken from timbers associated with the roof have been successfully dated. Four of these have complete sapwood and the last-measured ring date of 1596, the felling date of the timbers represented. Furthermore, it can be seen that the summer growth cells of 1596 are not complete, pointing towards felling in the summer of 1596. The heartwood/sapwood boundary ring of all dated samples can be seen to be broadly contemporary (Fig 11), making it likely that all seven timbers were felled at the same time, in the summer of 1596.

DISCUSSION

Prior to tree-ring analysis being undertaken it had been suggested that the Nether Alderley Mill seen today had its origins in the late-sixteenth century, with documents giving a construction date of *c* 1595–7. This suggestion has now been confirmed by the dendrochronological results which have dated a number of the timbers incorporated within the structure of the mill roof to the summer of 1596. It is unclear whether these dated timber members were salvaged from their original locations or from a later re-organisation and/or modification of the mill but this is something that further investigation by those involved with the survey and collection of the timber should be able to clarify.

Although undated, it is possible to make some comment about site sequence NAMASQ03. Both samples contained within it (NAM-A10 and NAM-A11) retain complete sapwood and have the same end position, thus demonstrating that the two timbers represented would have been felled at the same time (although it is not possible to say when that might have been). The lack of dating may be due to the poor replication of this site sequence (only two samples) or it may be that they are from a period in history for which there is a paucity of reference material. Work is known to have taken place on the mill into the nineteenth century and this is one of those periods of poor representation within the reference data.

It is also unfortunate, although unsurprising, that despite cross-matching against a series of national and international pine reference chronologies, the single softwood sample could not be dated. Although there have been some successes recently in the dating of pine timbers (eg, Arnold and Howard 2010a; Arnold and Howard forthcoming), dating of softwood is still in its infancy in the British Isles. Additionally, dating of individual samples, even oak, is acknowledged to be extremely difficult, so the chances of success were always slight. However, it is hoped that as more softwood data is gathered and incorporated within our reference material the situation will improve and more and more softwood timber will be successfully dated.

Acknowledgements

This work was commissioned by Mark Fletcher of Matrix Archaeology on behalf of the National Trust, who funded the research. The Laboratory would like to thank Matrix Archaeology for retrieving the timbers, for use of photographs and drawings of the mill (frontispiece and figures 4 and 5) and allowing sight of their report for a description of the building(2012).

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Table 1: Details of sliced samples from Nether Alderley Mill, Alderley, Cheshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
NAM-A01	Principal rafter (S) [06]	46	15C	1551	1581	1596
NAM-A02	Principal rafter (N) [08]	48	h/s	1533	1580	1580
NAM-A03	Principal rafter (S) [07]	44	13C	1553	1583	1596
NAM-A04	Purlin [01]	91	20	1504	1574	1594
NAM-A05	Wallplate [04]	51	12C	1546	1584	1596
NAM-A06	Floor beam [09]	43	09	----	----	----
NAM-A07	Wallplate [11]	51	h/s	1531	1581	1581
NAM-A08	Wallplate [13]	58	12C	1539	1584	1596
NAM-A09	Floor beam [10]	107	04	----	----	----
NAM-A10	Block [14]	54	20C	----	----	----
NAM-A11	Block [15]	86	25C	----	----	----
NAM-A12	Windbrace [02]	NM	--	----	----	----
NAM-A13	Windbrace [03]	54	h/s	----	----	----
NAM-A14	Block – not oak	NM	--	----	----	----
NAM-A15	Wallplate [12] – softwood	60	h/s	----	----	----

*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 measured ring is the felling date

Table 2: Results of the cross-matching of site sequence NAMASQ01 and relevant reference chronologies when the first-ring date is 1531 and the last-measured ring date is 1596

Reference chronology	*t*-value	Span of chronology	Reference
Whithough, Ipstones, Staffordshire	6.5	1496–1594	Howard *et al* 1998
Fair Flats Farm, Bradfield, South Yorkshire	5.7	1492–1633	Howard *et al* 1994
Sandiacre Tithe Barn, Derbyshire	5.4	1427–1611	Howard 2004 unpubl
Raynor House, Bradfield, South Yorkshire	5.2	1468–1593	Howard *et al* 1994
Astley Hospital, Astley, Manchester	4.8	1507–1650	Howard *et al* 2001
Low Farmhouse, Maplebeck, Nottinghamshire	4.8	1385–1587	Arnold *et al* 2008
Monk's Hall, Eccles, Salford, Greater Manchester	4.7	1416–1585	Arnold and Howard 2010b

Table 3: Results of the cross-matching of site sequence NAMASQ02 and relevant reference chronologies when the first-ring date is 1533 and the last-measured ring date is 1596

Reference chronology	*t*-value	Span of chronology	Reference
Upper Hall, Hartshorne, Derbyshire	4.9	1448–1611	Arnold *et al* 2008
Sherwood trees, Nottinghamshire	4.6	1426–1981	Laxton and Litton, 1988
Yew Tree Farm, Kirton, Nottinghamshire	4.5	1443–1688	Arnold *et al* 2001
Kirk Ireton Church, Derbyshire	4,5	1512–1601	Howard *et al* 1995
Unthank Hall, Holmesfield, Derbyshire	4,3	1359–1589	Howard *et al* 1993
Raynor House, Bradfield, South Yorkshire	4.3	1468–1593	Howard *et al* 1994
Frith Hall, Brampton, Derbyshire	4.1	1480–1602	Howard *et al* 1993

Table 4: Results of the cross-matching of sample NAM-A04 and relevant reference chronologies when the first-ring date is 1504 and the last-measured ring date is 1594

Reference chronology	*t*-value	Span of chronology	Reference
Whithough, Ipstones, Staffordshire	6.0	1496–1594	Howard *et al* 1998
West Bromwich Manor House, West Midlands	5.5	1418–1590	Arnold and Howard 2009a
Dovebridge, Derbyshire	5.4	1502–1617	Howard *et al* 1998 unpubl
Bentley Hall, Hungry Bentley, Derbyshire	5.1	1444–1675	Arnold and Howard, 2009b
Monk's Hall, Eccles, Salford, Greater Manchester	4.8	1416–1585	Arnold and Howard 2010b
Tean Hall, Tean, Staffordshire	4.8	1373–1613	Arnold and Howard 2007
Church Farm House, Ockbrook, Derbyshire	4.7	1491–1631	Arnold and Howard 2009c

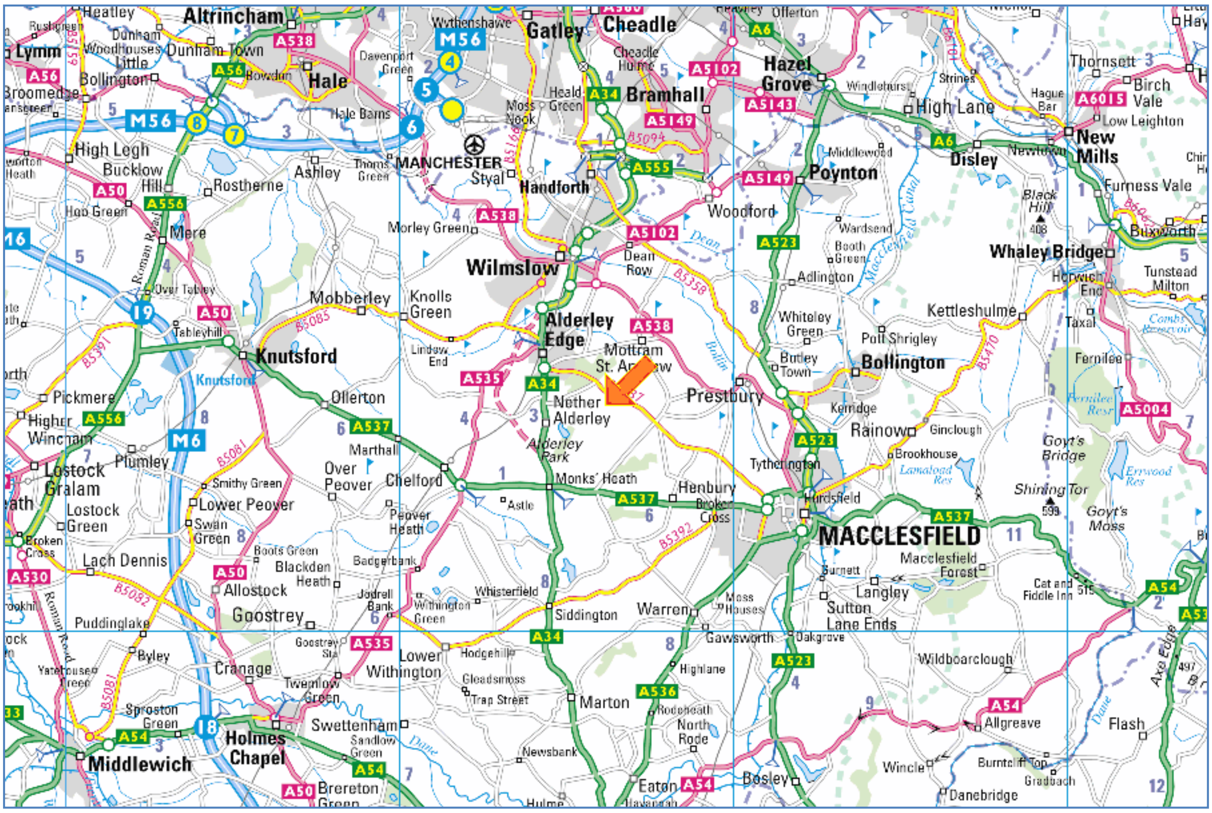


Figure 1: Map to show the general location of Nether Alderley, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

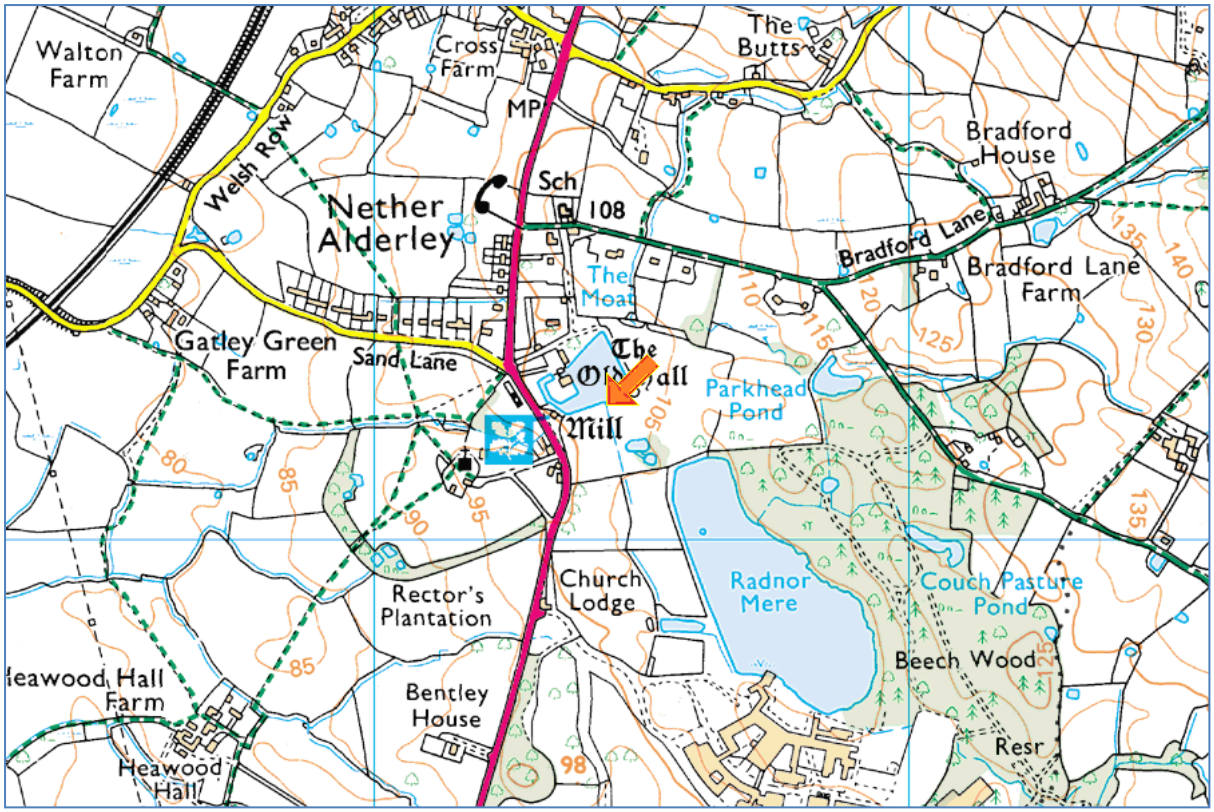
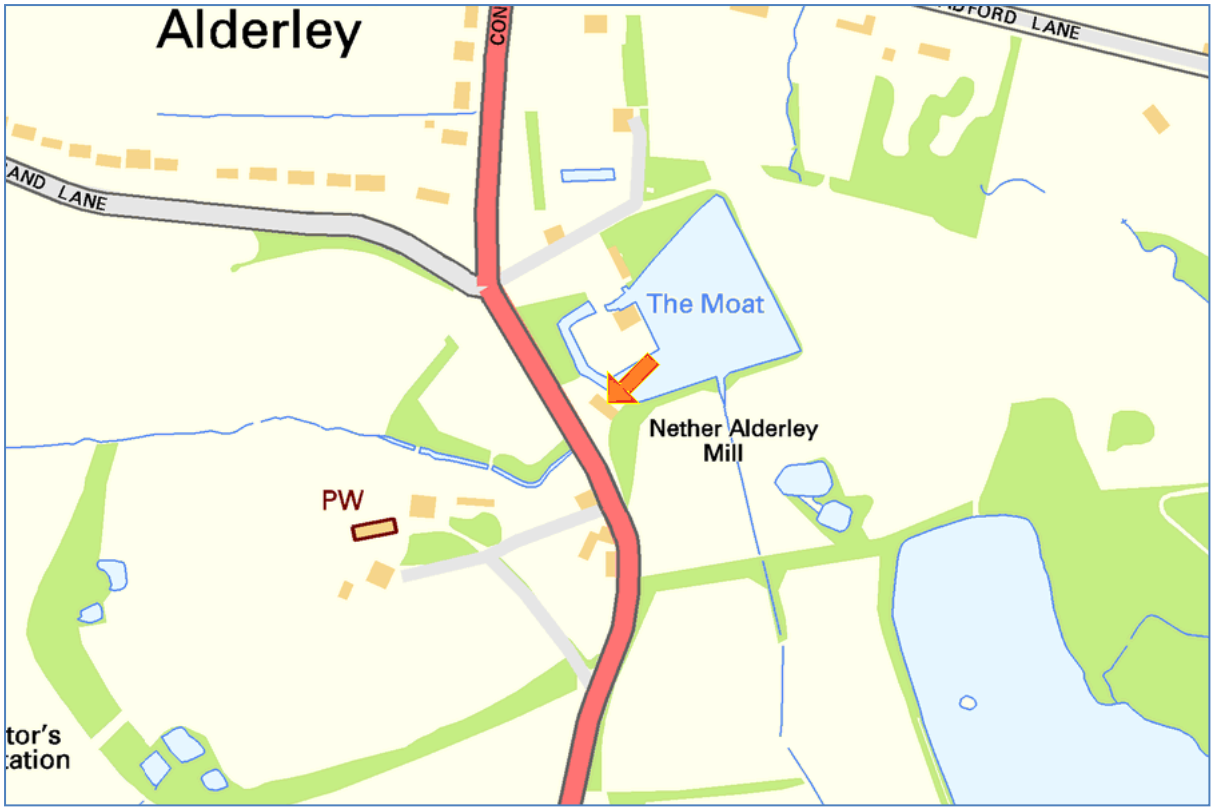


Figure 2: Map to show the general location of Nether Alderley Mill, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)



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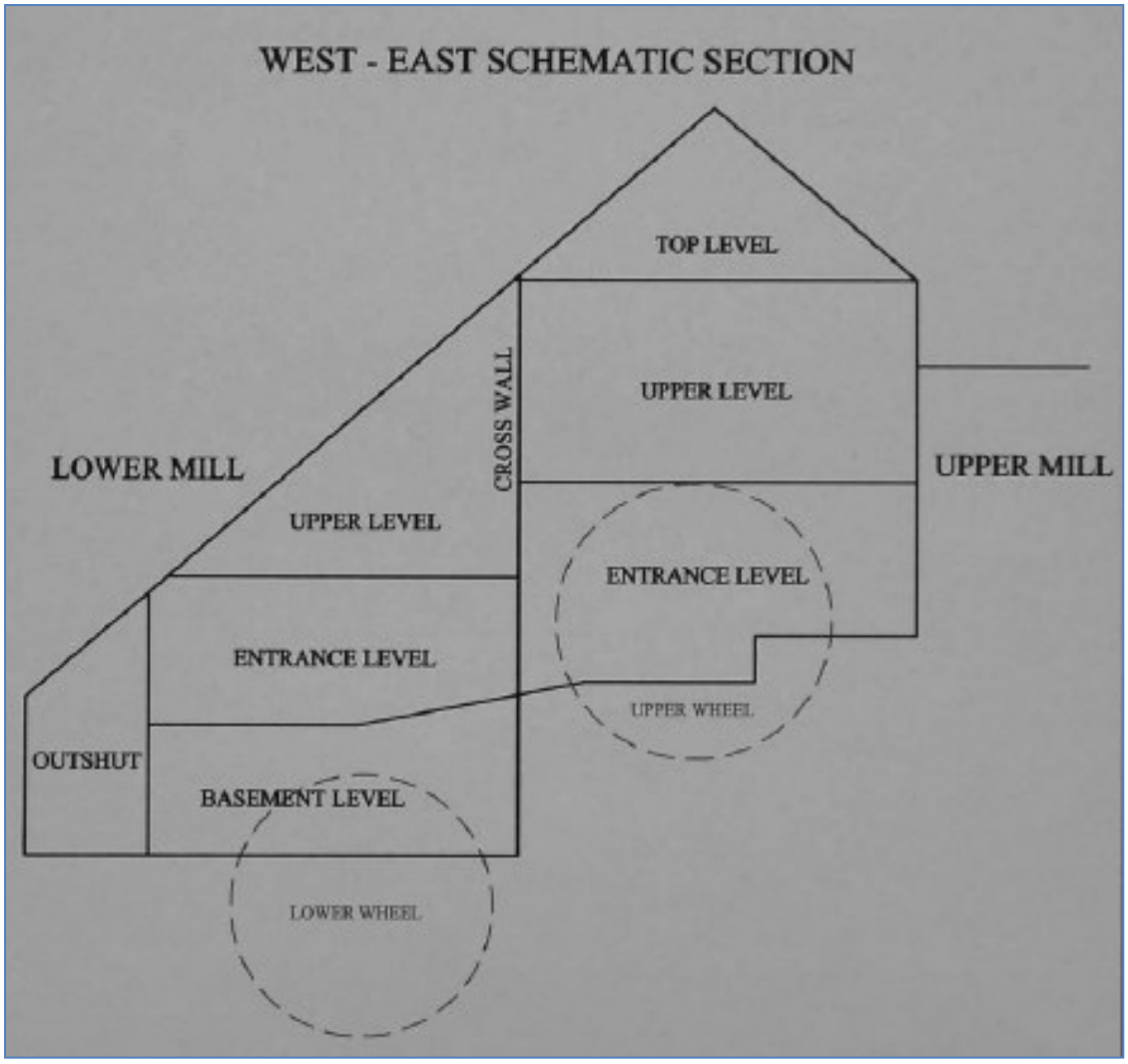
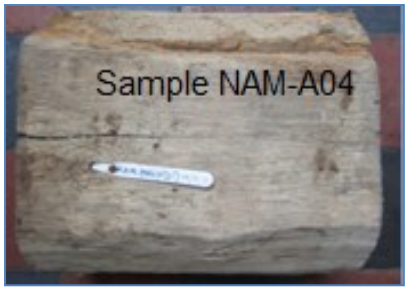


Figure 4: Schematic west-east section, showing the division on the north-south axis (Matrix Archaeology 2012)

Figure 5: Upper mill, upper /roof level, viewed from north (Matrix Archaeology)



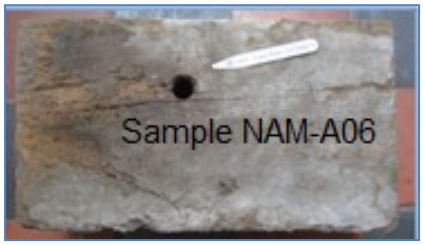
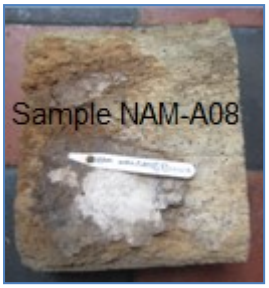
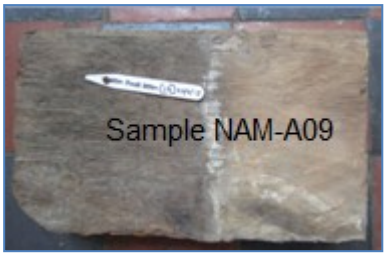
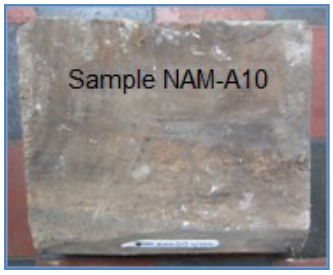
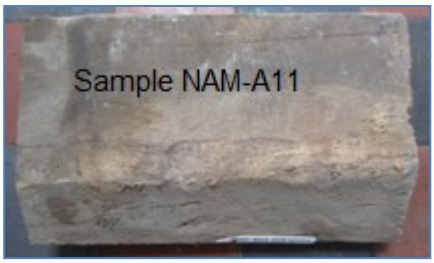


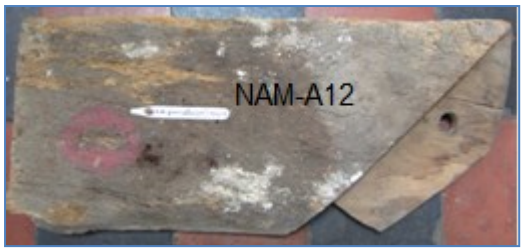
Figure 6: Photographs of timbers sampled

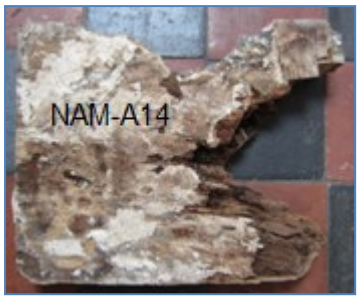












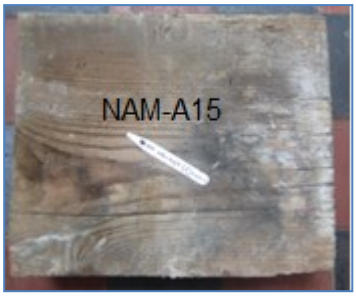


Figure 7: Photographs of timbers sampled

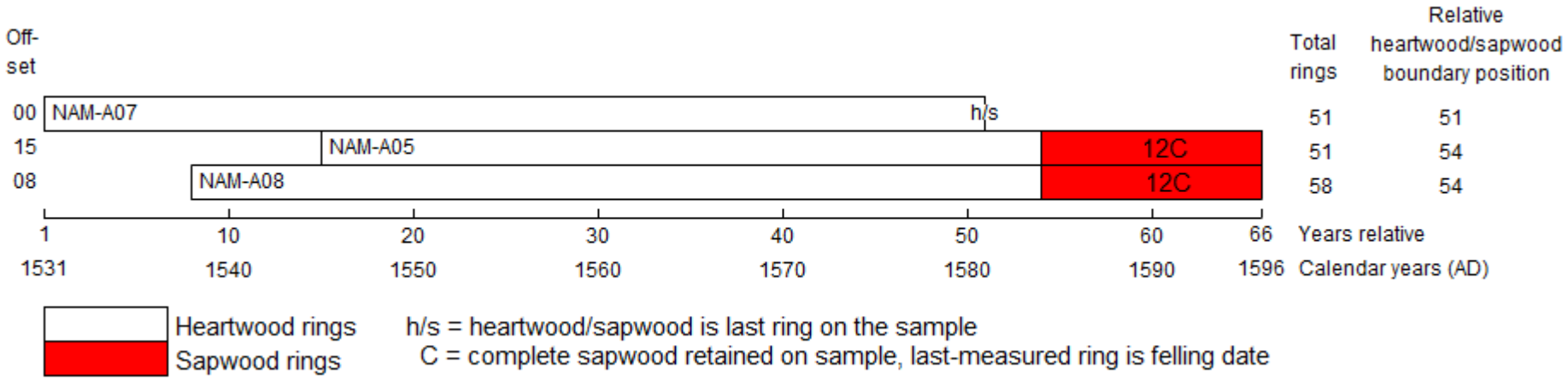


Figure 8: Bar diagram of samples in site sequence NAMASQ01

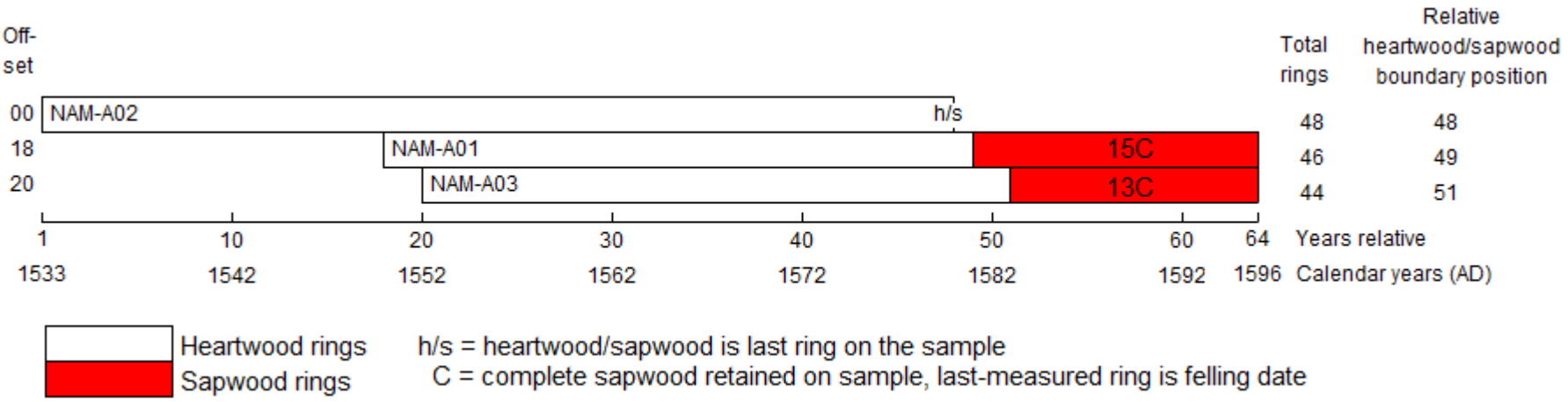


Figure 9: Bar diagram of samples in site sequence NAMASQ02

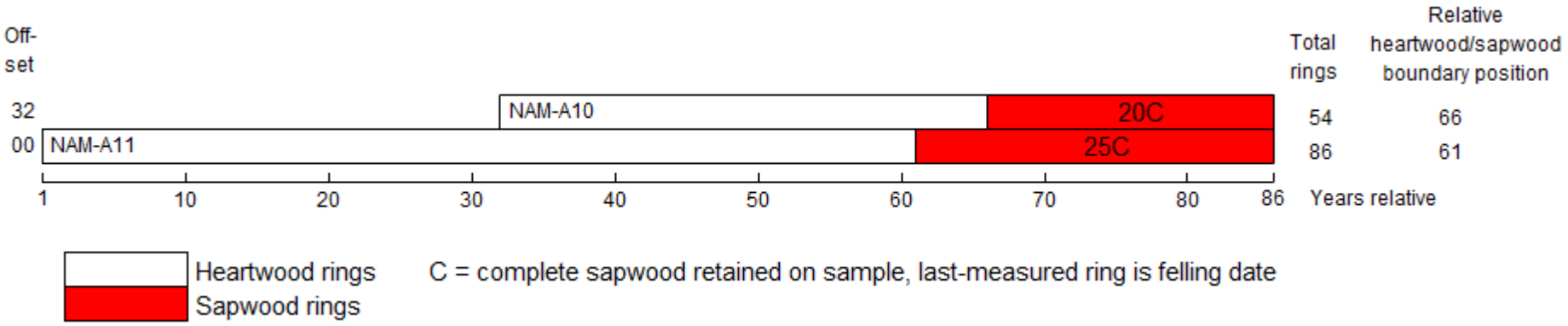


Figure 10: Bar diagram of samples in undated site sequence NAMASQ03

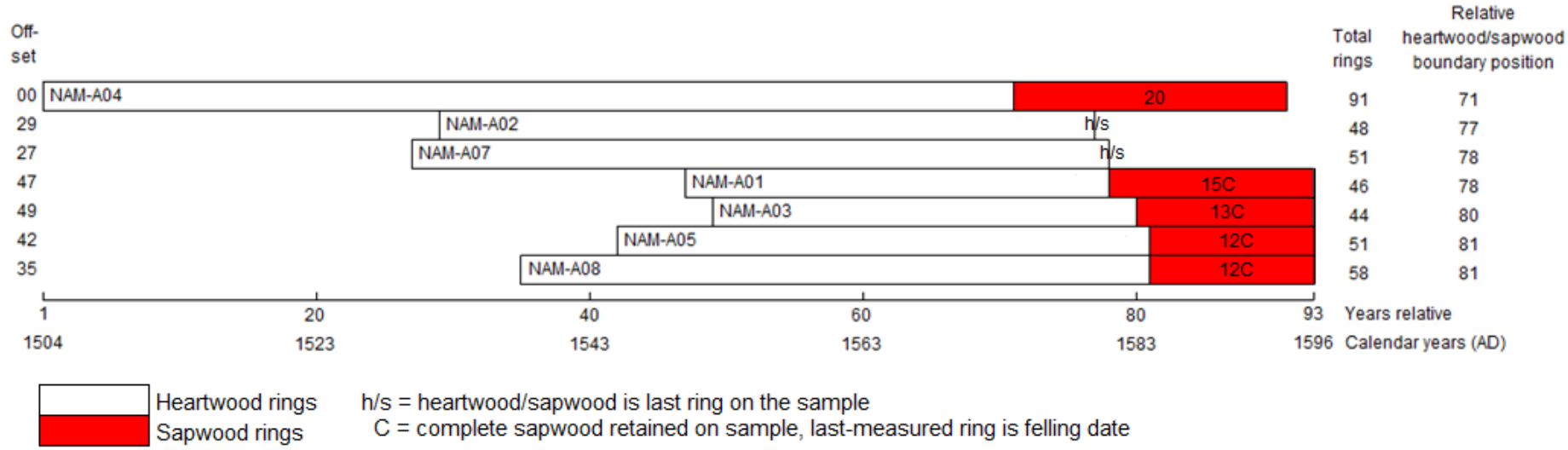


Figure 11: Bar diagram of all dated samples