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Oxford Dendrochronology Laboratory
Report 2014/25

THE TREE-RING DATING OF MAENAN HALL, LLANRWST, CAERNARVONSHIRE (NGR SH 794 650)

Summary

Five timbers from the Hall and adjoining ground-floor room were from trees found to have been felled over the period spring 1508 to summer 1509, suggesting that construction most likely took place in **1509**, or within a year or two after this date. An arch-brace to the east Hall truss was found to have been made from a much older timber (1450–75) and was either re-used, or a stockpiled timber. The fine plasterwork in the Hall carries the date 1582, so this dates the Hall some seven decades before that work.

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A report commissioned by Dating Old Welsh Houses Project in partnership with
The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

The Tree-Ring Dating of Maenan Hall, Llanrwst, Caernarvonshire
(NGR SH 794 650)

BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

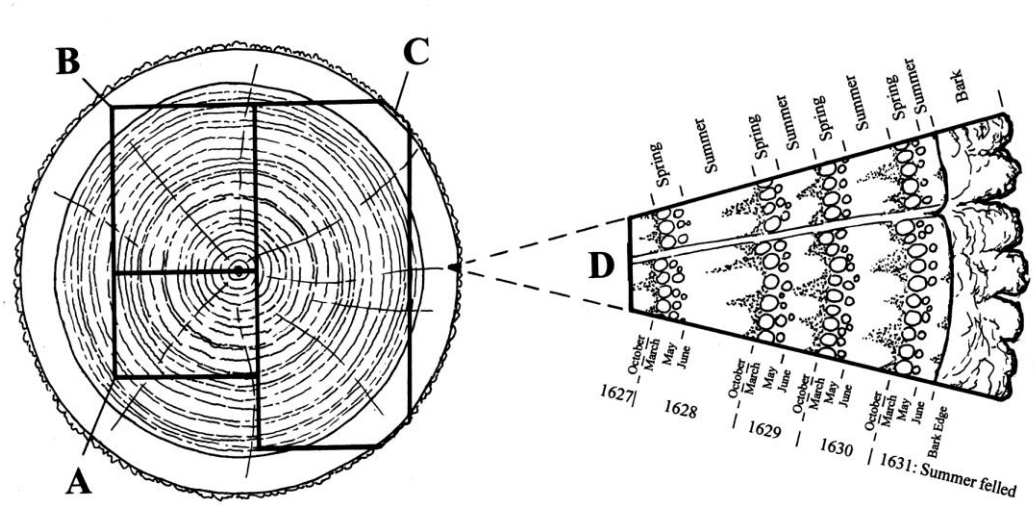
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal

resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 11 – 41 (Miles 1997).



Section of tree with conversion methods showing three types of sapwood retention resulting in **A** *terminus post quem*, **B** a felling date range, and **C** a precise felling date. Enlarged area **D** shows the outermost rings of the sapwood with growing seasons (Miles 1997a, 42)

MAENAN HALL (notes by Richard Suggett)

Maenan is a substantial gentry house associated with the Kyffin family and notable for the late Elizabethan plasterwork, dated 1582, which enriches the hall, encasing the timber detail of the late-medieval house. The pre-Elizabethan house was a substantial box-framed hall-house with three-tier framing, still partially visible on the west side of the cross-passage. The box-framed trusses have large curved braces below the tie-beam. The hall of two large bays, including the fully-screened cross-passage, was set between storeyed inner and outer rooms (latterly a heated parlour). The two-door dais-end partition with Tudor door-heads shows that there were formerly twin inner-rooms but the house has

been rebuilt beyond the partition. The hall remains open to the roof and retains the dramatic pointed arch of the central cruck-truss and two tiers of cusped windbraces and a louver, all covered in plaster in 1582. The louver shows that the lateral fireplace and associated stone walls are modifications, probably dating from the late Elizabethan revamping of the hall.

Survey by RCAHMW. Plan and account in RCAHMW, *An Inventory of the Ancient Monuments of Caernarvonshire, Volume I: East* (London, 1957), pp. 165-7; reconstructed plan in Smith, *Houses of the Welsh Countryside* (London, 1975 & 1988), p. 66 (fig. 29b). Coflein (RCAHMW's on-line database) entry: NPRN 26449. R.F. Suggett/RCAHMW/November 2014.

SAMPLING

Sampling took place in June 2014. All the samples were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were numbered using the prefix **mnn**. Locations of the samples are illustrated in Figs 1 and 2. The samples were removed for further preparation and analysis. Cores were mounted on wooden laths and then these were polished using progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. The ring-width series were compared on an IBM compatible computer for statistical cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973). A version of this and other programmes were written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker. Subsequent analyses were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1. Cross-matching between the series (Table 2) was rather weak in most cases, although samples 04 and 05 matched together well. For this reason, independent confirmation of the dating for the individual series was made by matching each against the dated reference material (Table 3a) – although samples 04 and 05 were combined for this exercise as they clearly matched each other. Having confirmed the cross-matching positions, which are shown in Fig. 3, the series were combined into a 135-year long site chronology, **MAENAN**, the dating evidence for which is shown in Table 3b.

One timber was found to be considerably older than the others, coming from a tree most likely felled in the period 1450–75. This is either a re-used, or stockpiled timber, and is a relatively small component. The other elements from the Hall and ground-floor ceiling were from trees felled over the period Spring 1508 to Summer 1509, suggesting that construction took place in **1509**, or within a year or two after this date.

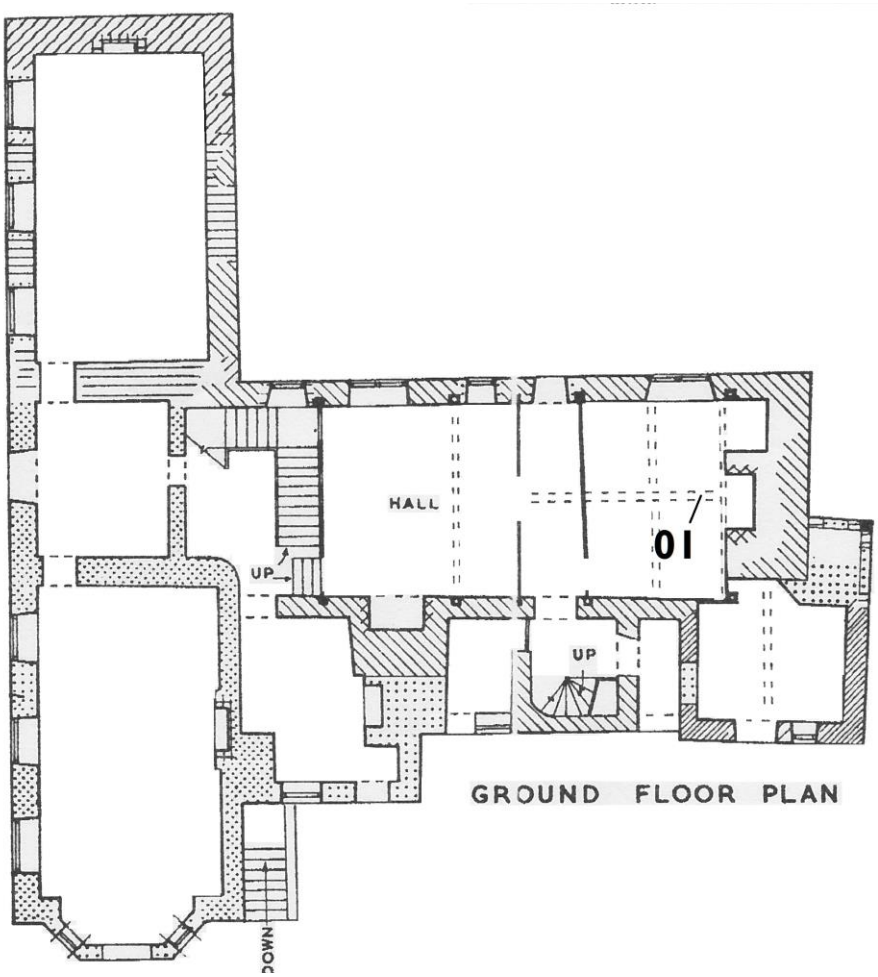


Figure 1: Ground Floor plan of Maenan Hall, showing the location of sample 01.
RCAHMW Inventory of the Ancient Monuments of Caernarvonshire, Part 1 (1956)

A report commissioned by Dating Old Welsh Houses Project in partnership with
The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

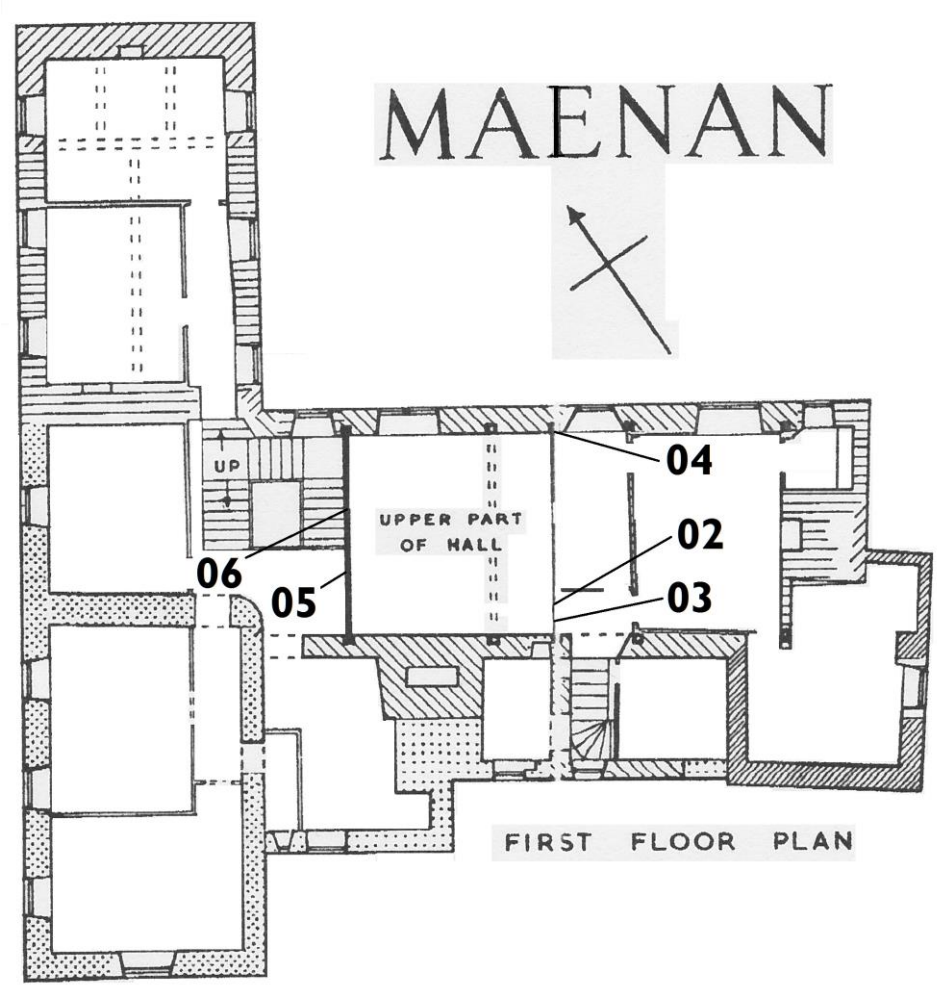


Figure 2: First Floor plan of Maenan Hall, showing the locations of samples 02 – 06. RCAHMW Inventory of the Ancient Monuments of Caernarvonshire, Part 1 (1956)

Table 1: Details of samples taken from Maenan Hall, Llanrwst.

Sample number	Timber and position	Date of series	H/S boundary date	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens	Felling date range
***mnn01**	Ground floor, E-W axial ceiling beam	1432-1507	1483	24¼C	76	1.40	0.42	0.22	Spring 1508
***mnn02**	First floor, Tie to east truss end wall	1453-1507	1492	15½C	55	2.01	0.67	0.27	Summer 1508
***mnn03**	South arch brace to east truss	1401-1447	1434	13	47	2.31	0.64	0.25	1450–75
***mnn04**	North post to east end Hall truss	1449-1503	1488	15	55	1.84	0.75	0.21	1503–10
***mnn05**	Tie at west end of Hall	1442-1508	1484	24½C	67	2.08	0.93	0.23	Summer 1509
***mnn06**	West partition head beam	1374-1506	1490	16	133	1.68	0.88	0.19	1506–09
* = incorporated in site chronology **MAENAN**		**1374-1508**			**135**	**2.03**	**0.66**	**0.17**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; ¼C = complete sapwood, felled the following spring; ½C = complete sapwood, felled the following summer; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured;

Table 2: Cross-matching between the samples (values over 3.5 are significant)

	***t*-values**				
Sample	**mnn02**	**mnn03**	**mnn04**	**mnn05**	**mnn06**
mnn01	1.8	*	1.7	1.2	1.5
mnn02		*	4.0	2.9	4.6
mnn03			*	*	4.0
mnn04				7.4	3.7
mnn05					3.2

* = overlap too short to calculate meaningful *t*-value

Table 3a: Dating evidence for series from Maenan Hall (with references for sites not used in Table 3b)

Sample	Strongest matches		
mnn01	5.9 BDGLRT2 (Miles *et al* 2006)	5.7 PLASMAWR1 (Miles & Haddon-Reece 1996)	5.4 PLASCOCH
mnn02	6.6 BENNAR (Bridge *et al* 2013)	6.2 PLASMAWR1	5.6 DURPSQ01 (Arnold *et al* 2007)
mnn03	6.9 WORDSQ01 (Arnold *et al* 2006)	6.2 ASHLEWTH (Bridge 2002)	6.0 STJLICH (Worthington & Miles 2002)
mnn45m	6.9 CWFM1 (Miles *et al* 2012)	6.1 OLP68M	6.1 GWYNEDD5 (Miles *et al* 2011)
mnn06	8.3 ALLSTRET	8.1 PLASMAWR	7.8 CWRTPLAS

Table 3b: Dating evidence for the site master **MAENAN AD 1374–1508** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Regional chronologies						
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404–1981	135	8.7
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	135	8.1
Somerset	Somerset Master Chronology	(Miles 2004)	**SOMRST04**	770–1979	135	7.5
Individual site chronologies						
Wales	Plas Mawr House	(Miles 1997c)	PLASMAWR	1360–1578	135	9.4
Wales	Cwrt Plas yn Dre	(Bridge *et al* 2013)	CWRTPLAS	1397–1508	112	9.1
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411–1571	98	9.0
Wales	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	121	8.7
Shropshire	St Swithin's Church, Clunby	(Tyers 2000)	CLUNBY	1239–1494	121	8.5
Kent	Old Leigh Place, North Leigh	(Miles *et al* 2007)	OLP68m	1411–1533	98	8.4
Shropshire	Roseleigh, All Stretton	(Miles *et al* 2007)	ALLSTRET	1386–1509	123	8.2
Shropshire	Old Hall Farm, All Stretton	(Miles and Haddon-Reece 1996)	OLDHLLFM	1379–1630	130	8.0
Wales	Plas Coch, Anglesey	(Miles *et al* 2011)	PLASCOCH	1402–1591	107	8.0
Wales	Cefn Caer Pennal	(Miles and Worthington 1999)	CEFNCAR1	1404–1525	105	7.5
Wales	Tydynn Lwydion	(Miles and Haddon-Reece 1996)	TYDDYN	1385–1601	124	7.5

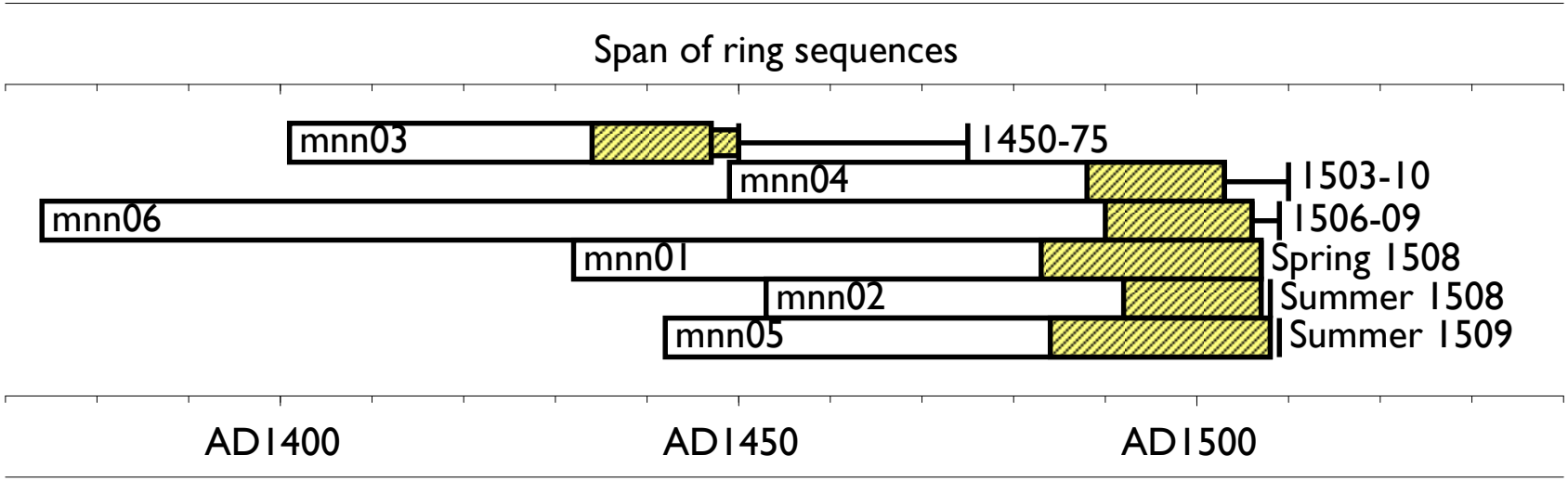


Figure 3: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely, or actual, felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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