Oxford Dendrochronology Laboratory
Report 2014/32

THE TREE-RING DATING OF GLODDAETH HALL (ST DAVID'S COLLEGE) LLANDUDNO, DENBIGHSHIRE (NGR SH 802 806)

Summary
Five roof timbers matched each other and their ring series were combined to form a 125-year site chronology, which was subsequently dated to the period 1401–1525. Two were found to have been felled in the summer, one in 1524 and one in 1526, the other timbers having likely felling dates in broad agreement with these times. Construction is therefore likely to have taken place in **1526**, or within a year or two after this date.

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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.

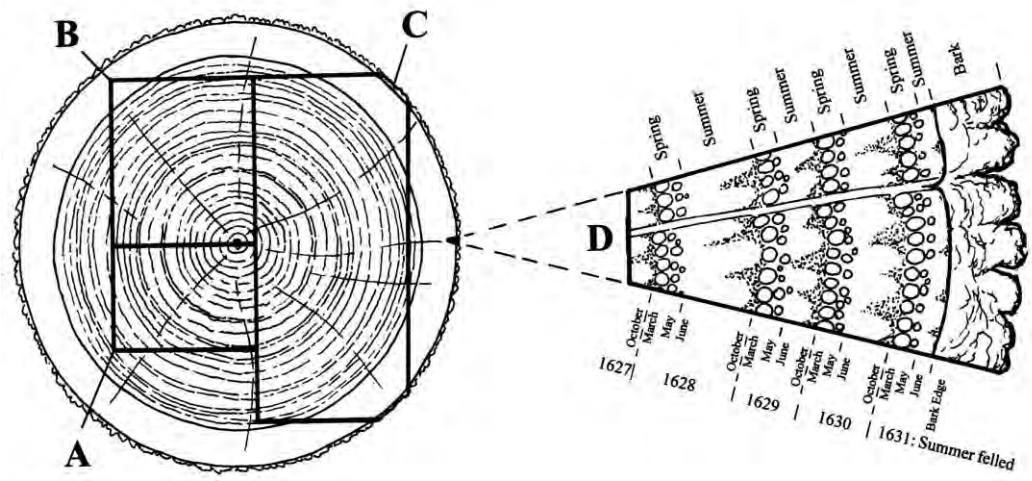
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence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

GLODDAETH HALL (notes by Richard Suggett)

Gloddaeth became the principal Caernarvonshire residence of an influential gentry family, the Mostyns of Mostyn, from the beginning of the sixteenth century. The core of the present stone-built house is an ambitious hall and solar cross-wing range. The original arrangements below the cross-passage are unclear but Smith considers that it was an 'end-passage house' without attached service-rooms. The hall is particularly impressive and has a three-bay hammer-beam roof terminating in enriched coving over the dais. Two large traceried windows light the hall, and in the opposite wall the lateral fireplace with

carved mottos is considered original. Description in RCAHMW, *Caernarvonshire, Vol. I: East* (London, 1956), pp. 178-9; reconstruction drawings in Smith, *Houses of the Welsh Countryside* (London, 1975 & 1988), figs 71-2. Coflein (RCAHMW's on-line database) entry: NPRN 26514. 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 **sdc**. 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. The five series from this roof matched each other (Table 2) and were combined into a 125-year site chronology, GLODDTH. This was dated to the period 1401–1525 by comparison with dated reference material (Table 3). Four of the timbers retained complete sapwood, and two were found to have been felled in the summer, one in 1524, the other in 1526. In the other two timbers with complete sapwood there were breaks between the sapwood and the main core, so allowance has been made in case some rings might have been lost. It seems likely that construction took place in **1526**, or within a year or two after this date. The tree-ring dates of 1524 & 1526 show that the hall must have been rebuilt by Richard ap Howell (d. 1539/40) whose mother was the heiress of Gloddaeth.

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Table 1: Details of samples taken from Gloddaeth Hall, Llandudno.

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
* **sdc1**	Collar to Hall end truss	1401-1523	1472	51½C	123	1.54	0.93	0.24	Summer 1524
* **sdc2**	Principal rafter, Hall end truss	1416-1496	1485	11	81	1.76	0.97	0.28	1496–1526
* **sdc3**	Collar, east end of Hall range	1411-1525	1495	30½C	115	1.46	0.77	0.26	Summer 1526
* **sdc4**	S. principal rafter, east end of hall range	1414-1499	1499	H/S (+26NM)	86	1.54	1.35	0.29	1525–27
* **sdc5**	N. principal rafter, east end of hall range	1429-1493	1493	H/S (+31NM)	65	1.29	1.12	0.22	1524–26
* = included in site master **GLODDTH**		**1401-1525**			**125**	**1.59**	**0.89**	**0.23**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, felled the following winter; ¼C = complete sapwood, felled the following spring; 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	**sdc2**	**sdc3**	**sdc4**	**sdc5**
sdc1	4.3	3.8	2.8	1.8
sdc2		3.5	4.3	2.2
sdc3			3.1	1.4
sdc4				4.8

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Table 3: Dating evidence for the site master **GLODDTH AD 1401–1525** 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	125	8.8
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	125	7.2
Individual site chronologies						
Denbighshire	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411–1571	115	10.5
Caernarvonshire	Plas Mawr House	(Miles 1997c)	PLASMAWR	1360–1578	125	9.9
Denbighshire	Llanelian-yn-Rhos church	(Miles *et al* 2011)	llnlnrs1	1410–1489	80	9.4
Denbighshire	Glas Hirfryn,	(Bridge *et al* 2014)	GHN	1404–1557	122	9.2
Anglesey	Plas Coch, Anglesey	(Miles *et al* 2011)	PLASCOCH	1402–1591	124	9.2
Denbighsh**ire**	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	125	8.5
Shropshire	Brookgate Farm	(Miles and Haddon-Reece 1993)	BROOKGT	1362–1611	125	7.8
Caernarvonshire	Maenan Hall, Llanrwst	(new ODL data, unpublished)	MAENAN	1374–1508	108	7.6
Devon	Holcombe Court, Holcombe Rogus	(Miles and Bridge 2012)	HOLCOMBE	1349–1536	125	7.4
Caernarvonshire	Llannerchyfelin, Rowen, Conwy	(Bridge *et al* 2013)	LLANNFEL	1419–1578	107	7.3
Anglesey	Hafoty Llansadwen	(Hillam and Groves 1991)	HAFOTY1	1372–1499	99	7.3

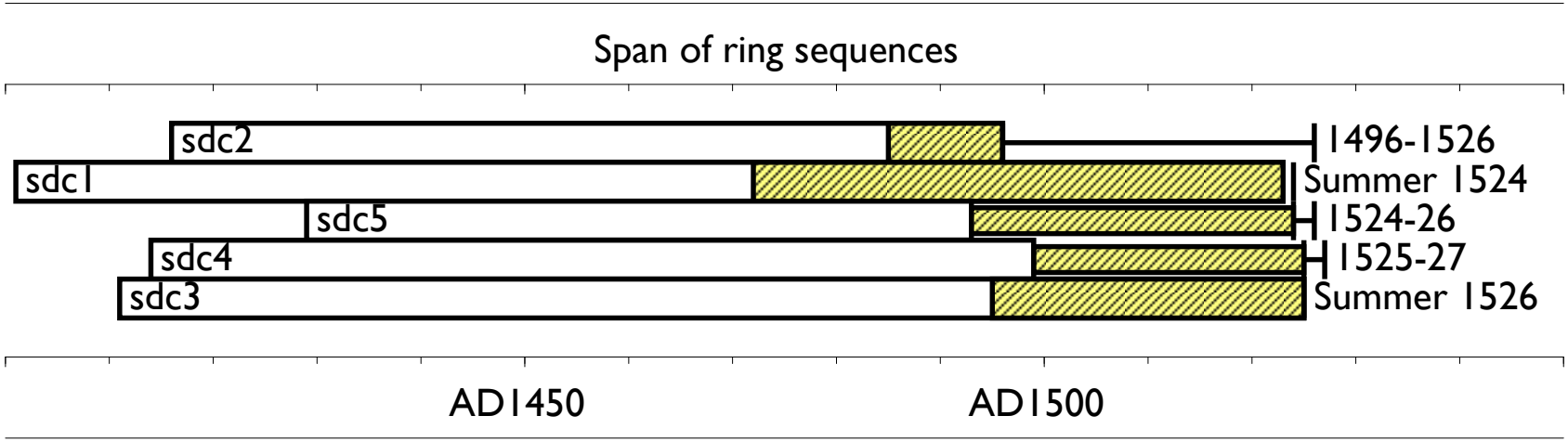

Figure 1: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely, or actual, felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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