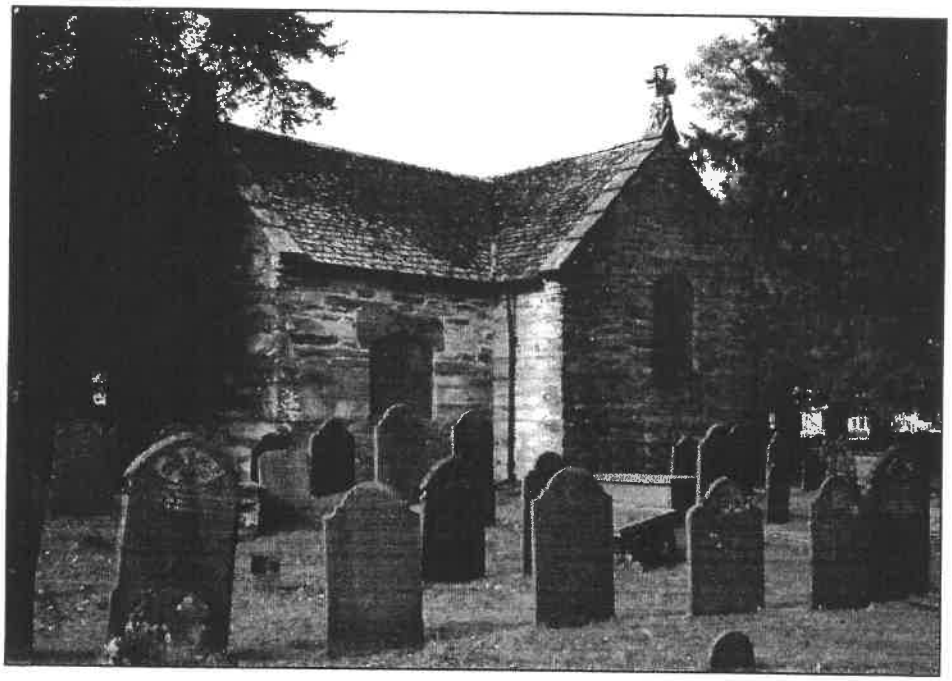
Oxford Dendrochronology Laboratory
Report 2011/39

THE TREE-RING DATING OF THE NAVE ROOF AT ST GWYDDELAN'S CHURCH, DOLWYDDELAN, CONWY (NGR SH 736 523)



Summary
Five roof timbers were cross-matched and dated. They appear to form a single group most likely felled between **1471 and 1501**, which fits with documentary evidence suggesting building around 1500.

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A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

The Tree-Ring Dating of the roof at St Gwyddelan's Church, Dolwyddelan, Conwy (NGR SH 736 523)

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.

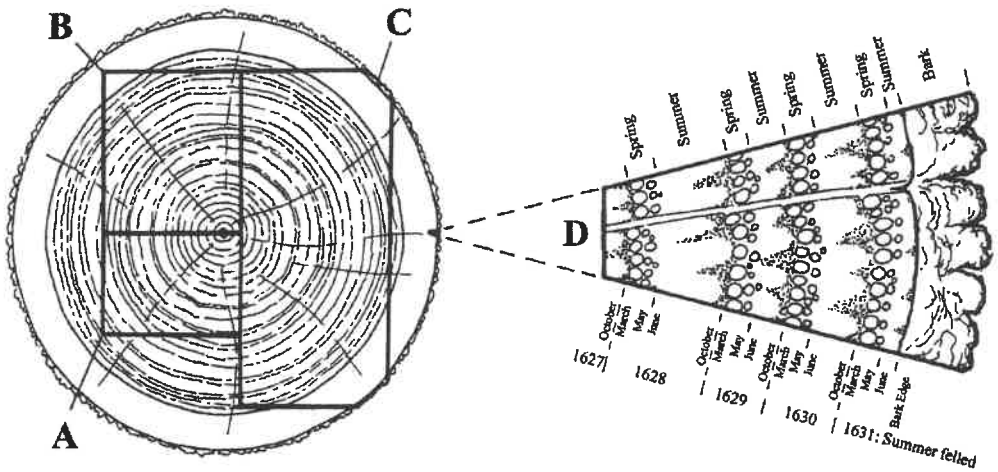
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence 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 1997a).



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)

ST GWYDDELAN'S CHURCH

St Gwyddelan's Church has a roof of arch-braced collar-beam trusses with cusped windbraces (Fig 1). The trusses over the chancel are boarded and painted. Documentary references suggest that the parish church was rebuilt on a new site in *c.*1500. According to Sir John Wynn of Gwydir (1553–1627), his ancestor Maredudd ap Ieuan, who acquired Dolwyddelan Castle in 1488, rebuilt it because he feared being ambushed at the more remote old church. The felling-date range is consistent with this tradition.

Plan and account in RCAHMW, *Caernarvonshire Inventory, Volume I: East* (1956), 76–80. Dating commissioned by RCAHMW. NPRN 43742.

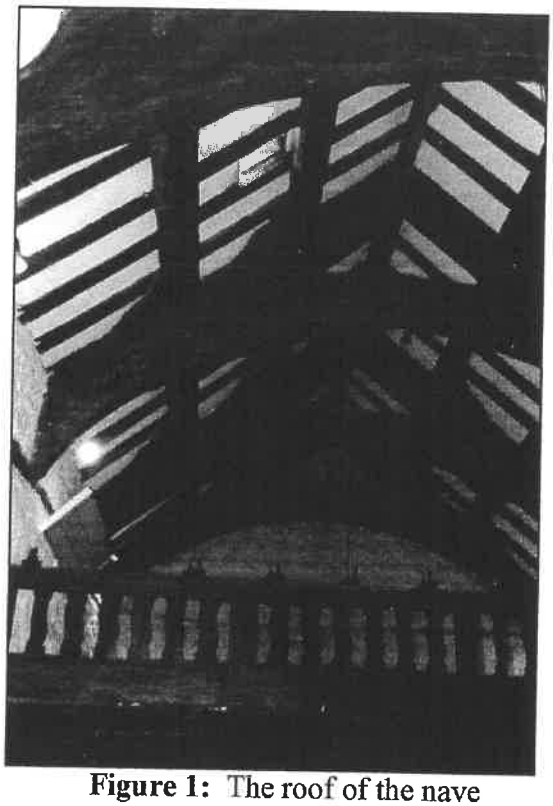


Figure 1: The roof of the nave

SAMPLING

Sampling took place in March 2011. 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 **stgwyd**. 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. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer allowing the measurement of ring-widths to the nearest 0.01 mm using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004), which was also used for subsequent analysis, along with other programs written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker.

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1, and the cross-matching between the dated timbers is shown in Table 2. One sample (**04**) could not be matched with the other samples, nor could it be dated independently. The dated samples appear to form a single group of timbers most likely felled at the same time (Fig 2). With a mean heartwood-sapwood boundary date of 1460, the likely felling date range for the group is 1471–1501.

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Table 1: Details of samples taken from the roof at St Gwyddelan's Church, Dolwyddelan.

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
stgwyd1a	South lower purlin, bay 2	1360-1400			41	2.90	0.78	0.21	
stgwyd1b	South lower purlin, bay 3	1366-1458	1458	H/S	93	1.40	0.72	0.20	1469-1499
* stgwyd1	Mean of 1a and 1b	1360-1458	1458	H/S	99	1.76	0.91	0.20	1469-1499
* stgwyd2	South upper purlin bay 2	1412-1459	1459	H/S	48	1.47	0.30	0.19	1470-1500
* stgwyd3	South archbrace, truss 2	1390-1453	1453	H/S	64	2.34	1.41	0.24	1464-1494
stgwyd4	South archbrace, truss 3	undated	-	H/S	82	1.83	0.83	0.16	-
* stgwyd5	South principal rafter, truss 3	1395-1466	1465	1	72	2.73	0.98	0.15	1476-1506
stgwyd6a	Collar, truss 3	1383-1463	1463	H/S	81	2.35	0.94	0.24	
stgwyd6b	*ditto*	1416-1467	1467	H/S	52	1.66	0.59	0.23	
* stgwyd6	Mean of 6a and 6b	1383-1467	1465	H/S	85	2.28	0.94	0.21	1476-1506
* = included in Site Master **STGWYD**		**1360-1467**	**1460**		**108**	**2.30**	**0.85**	**0.18**	**1471-1501**

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

Table 2: Cross-matching between the dated samples from St Gwyddelan's Church

	t-values			
Sample	**stgwyd2**	**stgwyd3**	**stgwyd5**	**stgwyd6**
stgwyd1	7.9	3.1	2.3	3.6
stgwyd2		5.1	3.6	4.0
stgwyd3			6.7	3.6
stgwyd5				5.5

Table 3: Dating evidence for the site master **STGWYD AD 1360–1467** against dated reference chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Dugoed, Penmachno	(Miles *et al* 2011)	DUGOED	1397-1593	71	7.4
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	108	7.2
Wales	Pengwern Old Hall	(Miles *et al* 2003)	PENGWERN	1353-1521	108	7.2
Worcestershire	St Cuthbert's, Wick	(Bridge 1983)	WICK	1255-1496	108	7.0
Cumbria	Dacre Hall	(Arnold *et al* 2004)	LCPASQ01	1350-1504	108	7.0
Wales	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS1	1363-1560	105	6.9
Shropshire	Pentre Hodre	(Miles and Worthington 2000) 2000)	PENTREH	1189-1465	106	6.9
Herefordshire	Wigmore Abbey	(Tyers 2002)	WIGALL46	1055-1729	108	6.6
Wales	Bodloesygad, Ffestiniog	(Miles *et al* 2012)	BODLSYGD	1368-1560	100	6.6
Ireland	Belfast Master Chronology	(Baillie 1977)	**BELFAST**	1001-1970	108	6.6
Shropshire	25 Kempton	(Miles and Haddon-Reece 1996)	kemp1	1362-1476	106	6.6
Wales	Cwm Farm, Cwm Cynfal	(Miles *et al* 2012)	CWMFM1	1364-1567	104	6.5
Wales	Aberconwy House	(Miles and Worthington 2001)	ABERCONWY	1227–1419	60	6.4

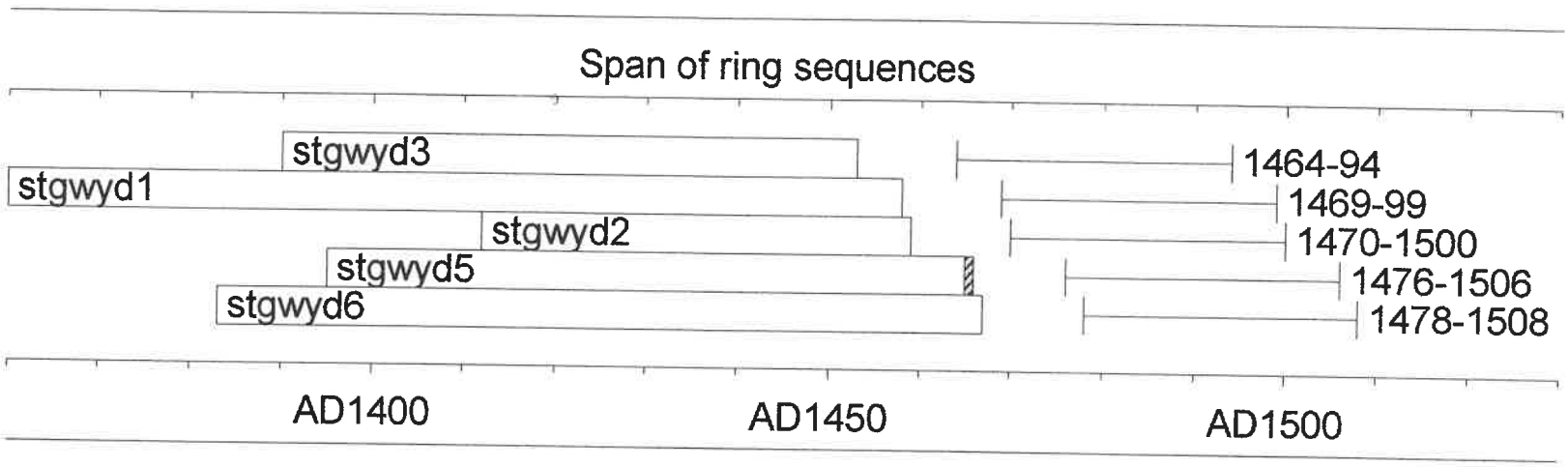

Figure 2: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings