Ancient Monuments Laboratory
Report 11/96

THE TREE-RING DATING OF THE OLD FARMHOUSE AT CULLACOTT, WERRINGTON, CORNWALL

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Summary

Thirty-three samples were taken from five main and two intermediate phases at the old farmhouse at Cullacott (SX 303 880). All but one of the samples extracted had complete sapwood and contained between 26 and 115 rings. Despite this, positive dates could only be obtained for three samples from the first phase, that being the Hall and Lower End. This phase produced three felling dates which were the spring of AD 1472, the spring of AD 1478, and the summer or autumn of AD 1481. Nevertheless, the dendrochronology has confirmed that the parlour and the north-east wing are coeval, the west porch was ceiled over upstairs originally, and that the Hall was ceiled over 35 years before the south-east porch was constructed. Although no firm dates could be found for the later phases, it is possible that they may date against future sites in the south-west, and as such the data contain great potential.

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THE TREE-RING DATING OF THE OLD FARMHOUSE, CULLACOTT

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Table 1: CULLACOTT - SUMMARY OF TREE-RING DATING

Sample number		timber & position	dates AD spanning	H/S bdry	sap-wood	no of rings	mean width mm	std devn mm	mean sens mm	felling seasons and dates
Hall and Lower End										
* *c11a*	c	Principals T2	1415-1481	1460	21½C	67	1.77	0.47	0.225	summer/autumn 1481
b	c	(matched *t*=10.98)	1394-1481	1455	25½C	88	1.65	0.53	0.208	
† *c12*	c	E lower purlin b VI	6-46		11¼C	41	2.47	0.73	0.203	
* *c13*	c	Principals T5	1408-1477	1458	18¼C	70	2.48	0.78	0.220	spring 1478
† *c14*	c	W upper purlin b VI	1-46		14¼C	46	1.85	0.72	0.194	
* *c15*	c	Principals T3	1402-1471	1461	10¼C	70	2.24	0.96	0.251	spring 1472
† *c16*	c	E rafter bay V	5-46		14¼C	42	2.03	0.95	0.233	
c17	c	Floor joist bay IV	-		19¼C	52	2.13	1.31	0.253	
c18	c	Floor joist bay IV	-		12¼C	28	3.50	0.86	0.247	
† = *c1246*		site sequence	1-46			46	2.09	0.68	0.188	
* = *CULACOT1* **site master**			**1394-1481**			**88**	**2.05**	**0.52**	**0.190**	
Parlour End and North-east Wing										
† *c21a*	c	Floor joist	2-61			60	0.90	0.52	0.241	
b	c	(matched *t*=9.32)	2-84		18¼C	83	1.42	0.63	0.213	
c22a	c	Floor joist	-			34	1.10	0.29	0.227	
b	c	(matched *t*=5.86)	-		12	54	1.50	0.53	0.198	
c23	c	Floor joist	-		22½C	82	2.38	1.16	0.148	
c31a	c	Floor joist	-		4	24	2.32	0.71	0.196	
b	c	(matched *t*=5.27)	-		15¼C	35	2.28	0.74	0.199	
c32a	c	Floor joist	-		14¼C	82	1.13	0.58	0.245	
b	c	(matched *t*=5.05)	-			43	1.53	0.73	0.238	
† *c33a*	c	Floor joist	1-65		9	65	1.41	0.66	0.271	
b	c	(matched *t*=8.8)	1-50			50	1.46	0.48	0.305	
† = *c2133*		site sequence	1-84			84	1.24	0.46	0.210	
West Porch										
c41	c	W outer doorhead	-		11¼C	65	2.84	0.90	0.229	
c42	c	Floor joist	-		20¼C	82	1.19	0.89	0.254	
† *c43a*	c	Floor joist	6-53		16¼C	48	1.81	0.70	0.179	
b	c	(matched *t*=9.33)	6-36		h/s	31	1.81	0.53	0.225	
† *c44a*	c	Floor joist	1-42		1	42	3.08	0.63	0.165	
b	c	(matched *t*=8.97)	3-54		13C	52	2.33	0.48	0.179	
† *c45*	s	Ceiling joist	5-54		19C	50	1.26	0.47	0.281	
c46	s	Ceiling joist	-		17C	62	1.14	0.57	0.252	
† = *c43-45*		site sequence	1-54			54	1.92	0.39	0.189	
Miscellaneous Phases										
c51	s	Lower End stave	-		19¼C	26	2.31	0.77	0.291	
Jettied room and cross passage in Hall										
† *c52*	c	Hall jetty stud	1-46		16½C	46	1.36	0.64	0.307	
c53	c	Hall jetty stud	-		23¼C	52	1.11	0.63	0.270	
† *c54a*	c	Hall jetty stud	4-36		3	33	1.93	0.78	0.256	
b	c	(matched *t*=8.91)	22-45		11½C	42	1.47	0.46	0.240	
c55	c	Hall jetty joist	-		11	54	1.73	0.94	0.373	
† = *c524*		site sequence	1-46			46	1.54	0.63	0.234	
Inserted ceiling to Hall										
c56	c	Hall ceiling joist *(with SE Porch)*	12-79		25¼C	68	1.12	0.48	0.246	
South-east Porch										
† *c61*	s	N purlin	9-115		24½C	107	1.03	0.73	0.316	
† *c62*	c	W principal rafter	39-107		18	69	1.72	0.58	0.219	
† *c63*	c	W collar	6-87		7	82	1.43	0.88	0.259	
† *c64*	c	Jetty joist	25-115		24½C	91	1.43	0.60	0.210	
† *c65*	c	Jetty joist	4-115		29½C	112	1.12	0.78	0.182	
† *c66*	c	Jetty joist	1-115		30½C	115	0.88	0.72	0.223	
† = *c61-66*		site sequence	1-115			115	1.41	0.74	0.186	

Key: * = sample included in site-master; † = in site sequence; c,s = core, slice;
¼C,½C,C = bark edge present, partial or complete ring: ¼ = spring (ring not measured), ½ = summer/autumn, or C = winter felling (ring measured);
H/S bdry = heartwood/sapwood boundary - last heartwood ring date;
std devn = standard deviation; mean sens = mean sensitivity

THE TREE-RING DATING OF THE OLD FARMHOUSE AT CULLACOTT

1. Introduction and objectives

Cullacott is a Grade I listed farmhouse of outstanding regional and national importance. Despite its state of semi-dereliction, the retention of its many features, and the absence of modern improvements, makes its survival of considerable importance.

This cob and stone built house comprises an open three-bay hall, the third bay having a screen and an internal jetty with room above, with a floored lower end encompassing four bays. Recent investigations have revealed that it originally was constructed as a long house. To the north is a two-storey chamber end with another to the north-east, together they form a cross-wing. Both the first two phases have roofs constructed of principals with short curving feet set into the stone walls. To the west of the hall cross-passage is a two-storey stone-built porch with garderobe, and to the south-east is a timber-framed two-storied jettied porch clad in enormous slates which is open below. Further information on the historical and architectural history of the house can be found in Cox and Thorp (1991).

The intention of the dendrochronology was to firmly date each of these phases so that a precise chronological framework of the house's development could be outlined. In all, this entailed the sampling of all four main phases and two minor phases. Sampling was initially carried out on the 5th, 6th, and 7th of May 1992, and the samples processed during the ensuing year.

During 1994, consolidation work on the wallpaintings in the hall brought to light a painting of St George fighting the Dragon on the south wall of the Hall above an inserted cross-passage. It immediately became a priority to make another more serious attempt to date the inserted floor and jettied partition above the cross-passage in order to date the new wall paintings. During the initial 1992 work, two samples with complete sapwood were taken from the partition in question but the samples failed to date, match any other elements within the house, or match each other. Therefore, the site was revisited during March 1995 and three further samples were taken. One was from another joist with complete sapwood which had subsequently become exposed in the kitchen, another was from a jetty joist, and a third sample was taken from another stud from the partition over the cross passage. No other samples were considered suitable for sampling.

2. Methods of sample collection, preparation and dating

Normal practice in tree-ring sampling offers a choice of three possible methods: measurements *in situ* on a well-polished beam end (normally by sanding); cores drilled with a hollow auger; or slices cut from the timbers. At Cullacott, cores were

universally taken from all phases with the exception of the collapsed ceiling joists from the west porch, a purlin end from the roof space of the south-east porch, and a stave end. Several samples required two cores from each to either obtain complete sapwood or to bridge a broken section of core. All timbers sampled were of oak, *Quercus* sp.

As all timbers were dry, the samples could be sanded without pretreatment on a linisher through several grades of abrasive paper ranging from 60 grit to 1200 grit. This prepared a sufficiently clean view of the transverse section of the wood for the ring boundaries to be distinguished and for the ring-widths to be measured. Once polished, all samples were measured under a x10/x30 microscope using a travelling stage electronically displaying displacement to a precision of 0.001mm. Where they contained breaks, cores were measured in sections for eventual alignment against other samples.

Dendrochronology is based on the principal that the annual growth rings of trees reflect regional climatic conditions and because of this it is possible to match a sequence of growth rings from a sample of wood against regional reference chronologies to establish the date of the last measured ring in calendar years. If the sample has its sapwood complete, ie to the underside of the bark, then the date of when the tree was felled can be determined to the year and in many instances the season. The usual procedure is to match two or more individual samples from a phase together, make a mean of these, and then try to match any other matched samples, repeating the process of intermediate means until all of the samples from a phase have either been dated together relatively into a floating chronology or have failed to match. The resulting site master or sub-master is then compared with other reference chronologies which have been unequivocally dated in time, thereby dating the floating chronology or sample.

This is accomplished by using a combination of both visual matching and a process of qualified statistical comparison by computer. The ring-width series are recorded on an Amstrad PC2386 computer for statistical cross-matching using a variant of the Baillie and Pilcher (1973) CROS program. A version of this and other programs were written in BASIC by D Haddon-Reece, late of the Ancient Monuments Laboratory. The programs measure the amount of correlation between two sequences and the Student's '*t*' test is then used as a significance test on the correlation coefficient. Generally a '*t*'-value of 3.5 or over represents a match, provided that the visual match between the tree-ring graphs is acceptable. In addition to our own databank, the site data has been compared against the databank at the Dendrochronology Laboratory of Sheffield University.

After measurement, the ring-width series for each sample are drawn in the usual fashion as a graph of width against year on log-linear graph paper. This paper is translucent so that graphs ("curves") can be visually compared by overlaying. Samples which originated from the same tree are first combined into a single

sequence for the purposes of the analysis. Although there is no precisely defined limit, studies on modern samples suggest that those which cross-match with '*t*' values over approximately 10.0 are likely to have been derived from the same tree. However, here at Cullacot a number of samples from the same trees (c22 and c32) have not matched very well and this may indicate distress within the tree and thus its unsuitability for reliable dating. All pairs of tree-ring curves in the group are then compared visually at the positions indicated by the computer matching and, if found satisfactory and consistent, are averaged to form a mean of the two. This operation removes 'noise' due to the individual behaviour of the trees such as their response to pollarding or thinning out of their woodland neighbours, and reinforces the common climatic signal.

As previously mentioned, once a tree-ring sequence has been firmly dated in time, a felling date needs to be ascribed. With samples which have sapwood complete to the underside or including bark, this process is relatively simple. In measuring, if the whole ring is complete, ie both spring-wood and summer-wood has been fully formed, then the tree was felled in the winter from
the October of the last measured ring date to the March of the following year. If the spring vessels only have formed, signified by a '¼' (this is not measured), then the tree was felled from between March and May of the year following the last measured ring. If there is some summer-wood but this is not complete, then this is signified by a '½' (this is measured) and the tree was felled between June and September of the year of the last measured ring date (Baillie 1982, 46-51). Care must be taken to not misread the 'dates spanned' or 'last measured ring' as a *felling date*. These are two very different things. Also, months can only be used a guide, as there is considerable variation in the complex relationships between climate and the changes in wood growth.

If the sapwood is partially missing, or if only a heartwood/sapwood boundary survives, then an *estimated felling date range* can be given for each sample. The number of sapwood rings can be estimated by using the accepted national sapwood estimate of between 10 and 55 rings. This is within the 95% confidence range for British oaks as determined by Hillam *et al* (1987). If more than one estimated felling date range has been given for a phase, then the area of common overlap of these ranges might be given to effect a reduced felling date range. However, this relies on the assumption that the samples have a common felling year, which may or may not be true. Whilst most structural phases tend to have trees which have been felled within a year or two of each other, this is not always the case and examples of some timbers having been felled ten or fifteen years previous to the main felling date have been known, the first phase at Cullacott being a good example. It should also be noted that no probability estimate can be advanced for such a reduced felling date range.

As it was common practice to build timber-framed structures with green or unseasoned wood, it therefore follows that construction would generally commence within a year or so of felling.

However, dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure which is being sampled. But apart from reuse, a timber can generally be identified as having been fashioned green by the distinctive shakes and deformed surfaces which would have been straight and square when initially cut by the saw. When these characteristics are present, one can be reasonably certain that construction would have taken place prior to seasoning which is generally accepted to be one year per inch in thickness.

3. Timbers sampled and analysis

The Cullacott tree-ring samples are designated as *c11*, *c21*, *c41*, etc, the first integer designating the phase or intermediate sub-phase. The cores were drilled with a 5/8" hollow auger with hardened steel teeth. Figure 1 shows the location of timbers sampled *in situ*. The plans were prepared by Mr John Thorp of Keystone Historic Buildings Consultants and were separately commissioned by English Heritage.

In all, thirty samples were taken over the period 5-7th May 1992, with a further three timbers sampled during March 1995. Generally, the exposed condition of many of the structural elements caused by the dereliction aided the process of obtaining all thirty samples with complete sapwood. Despite this, it was necessary in a few samples to have the last 10 to 20 rings omitted from the site measurements due to very distressed and narrow sapwood rings.

A summary of the timbers sampled and their relative dating is shown in Table 1.

3a. Hall and Lower End - first phase (samples *c11* - *c18*)

Sample *c11* was taken from the Hall itself, and was actually two cores, one from each of the pair of principal rafters in truss 2. As the principals were clearly paired (t=10.98), ie both being cut from the same tree, the two samples were averaged together to represent one tree, *c11*. Other samples were taken from the Lower End which included two other principals, two purlins, a rafter, and two floor joists. Samples *c11*, *c13*, and *c15* matched together to form site sub-master ***'CULACOT1'*** for the first phase.

	c13	*c15*
	AD1477	AD1471
c11	4.46	7.21
	70	70
c13		5.30
		64

Table 2: Matrix of t-values and overlaps for ***CULACOT1***.

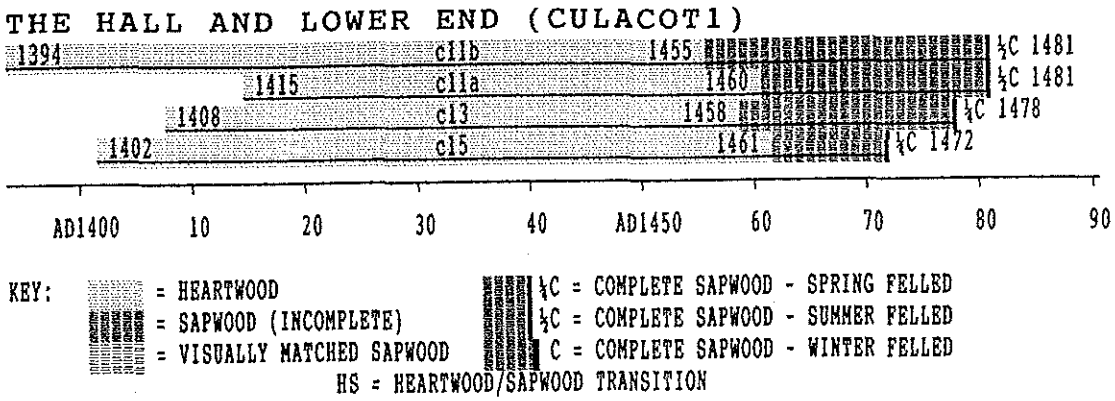

Figure 1: Bar diagram of samples comprising CULACOT1

Reference chronology	Spanning	Overlap	t-value
BOWHILL *(Hillam 1991)*	1292-1468	75	3.66
ENGLAND *(Baillie and Pilcher 1982)*	404-1981	88	3.71
EXMED *(Mills 1988)*	1367-1616	88	3.83
DUBLIN2 *(Baillie 1977a)*	1357-1556	88	4.06
WOLVERTN *(Haddon-Reece and Miles 1992)*	1325-1580	88	4.13
YORKS2 *(Hillam pers comm)*	1192-1663	88	4.13
ELLAND *(Hillam 1984)*	1374-1574	88	4.32
BISHOP *(Morgan 1977)*	1359-1591	88	5.04
ESTLEIGH *(Miles 1994)*	1405-1474	70	5.09
MDM10 *(Miles 1992)*	1381-1445	52	5.37
BELFAST *(Baillie 1977b)*	1001-1970	88	5.46
HAFOTY1 *(Hillam and Groves 1991)*	1372-1499	88	5.86
HALDEN *(Bridge pers comm)*	1299-1462	69	7.17

Table 3: Dating of ***CULACOT1*** (1394-1481) at AD 1481.

The first site sequence was then cross-matched against the regional and national reference chronologies and dated at AD 1481 which was the last measured ring of sample ***c11***. This also dated sample ***c13*** to the spring of AD 1478 and sample ***c15*** to the spring of AD 1472.

Samples ***c12***, ***c14,*** and ***c16*** also matched together to form a second site sequence of 46 rings. Due to the small number of rings, this failed to date conclusively with other samples from Cullacott, and more first phase samples would be required to advance any future possibility of dating this second site sequence. The two samples from the floor joists failed to match each other or any of the individual phase I samples or the resulting site sequences.

	c14	*c16*
	46	46
c12	5.02	4.64
	41	41
c14		3.50
		42

Table 4: Matrix of *t*-values and overlaps for ***c1246***.

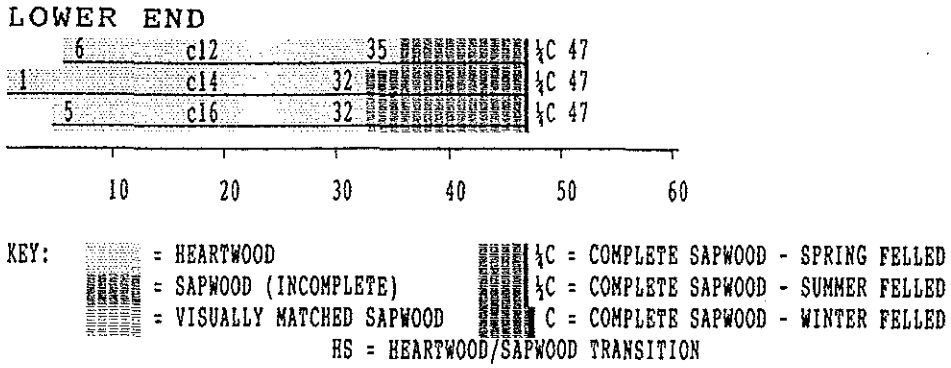

Figure 2: Bar diagram of samples comprising c1246

3b. Parlour End and north-east wing - second phase (samples *c21-c23* and *c31-c33*)

In both of these areas, little of the timber was suitable for sampling as all of the timber in the roofs were both wide ringed and with little or no sapwood. In each part, only three joists were found with complete sapwood and these were sampled. All but one were sampled twice to ensure complete sapwood. The sapwood on sample ***c22b*** as well as that on ***c33a*** had complete sapwood but the last 8 and 19 rings respectively were too narrow and distressed to be measured accurately so these were omitted.

Only samples ***c21*** and ***c33*** matched together conclusively at t=6.05, further confirmation would be required before the other four samples can be positively matched. However, both ***c21*** and ***c33*** (allowing for the 19 rings omitted) showed they were probably felled within a year of each other. Both ***c21*** and ***c33*** were formed into a third site sequence which was cross-matched with the other samples from Cullacott as well as the national and regional reference chronologies but there was no consistent match at any date.

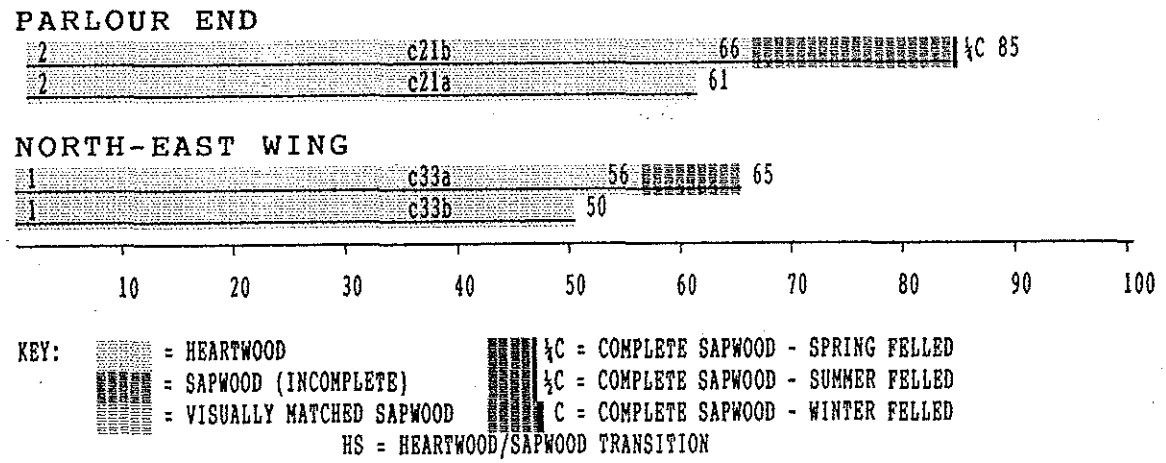

Figure 3: Bar diagram of samples comprising c2133

3c. West Porch - third phase (samples *c41 - c47*)

In all, six samples were taken from various parts of the West Porch, again all with complete sapwood. Downstairs, one sample was taken from the head of the outer west door, while three samples were from the first floor joists. Upstairs, two sections were taken from collapsed and decayed ceiling joists. Additionally nine sections of close-ringed oak ceiling lath were also salvaged from the remains. Despite having complete sapwood, the laths had insufficient numbers of rings to be suitable for further analysis.

Samples *c43 - c45* matched together to form a fourth site sequence with one sample being felled in the spring of relative year 54, while the other two samples were felled in the winter of relative year 54/5. Despite the good matches of the three samples between themselves, this site sequence also failed to date against any of the regional or national reference chronologies. Samples *c41*, *c42*, and *c46* failed to match conclusively each other, any of the site sequences, or any of the reference chronologies. It should be noted, however, that sample *c41*, the west door-head, could possibly be from a different phase.

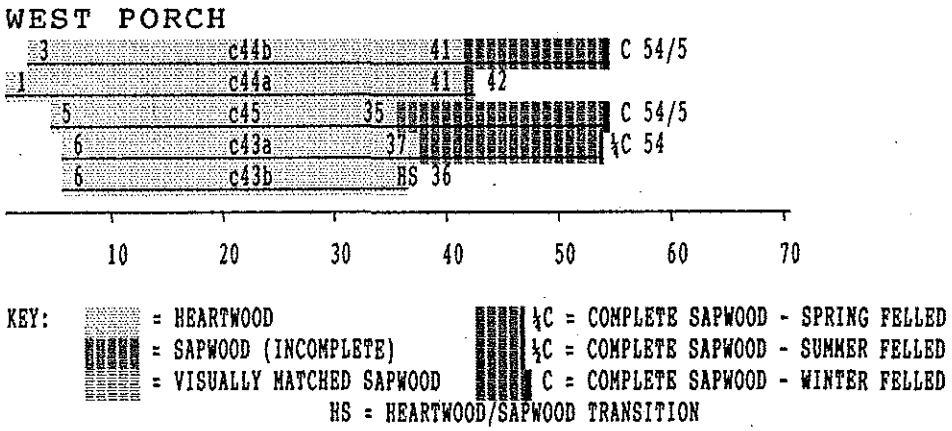

Figure 4: Bar diagram of samples comprising c43-45

	c44	*c45*
	54	54
c43	4.23	6.59
	48	48
c44		5.08
		50

Table 5: Matrix of *t*-values and overlaps for *c43-46*.

3d. Intermediate phases (samples *c51* - *c56*)

Sample ***c51*** was a slice, with complete sapwood, taken from a protruding stave end of a wattle and daub partition in line with the central chimney stack adjacent to T4. However, it had less than 30 rings and was therefore unsuitable for dating.

The first floor screen partition above the internal jetty (in line with the Hall open truss T2) had three studs sampled. Although both samples ***c52*** and ***c53*** had complete sapwood, they did not match each other at all well and failed to match with any of the site sequences. The shortness of the ring sequences would not have help their chances either. Sample ***c54*** from a third stud sampled in 1995 matched with sample ***c52*** with a *t*-value of 5.38 with a relative felling date of sample 54 being one year before sample ***c52***. The two samples were combined to form a site sequence of 46 rings. This was compared against the reference chronologies as well as the other samples from the site, but no matches whatsoever were found.

The jetty joists were inspected during the 1995 sampling session and most seemed to be of small scantling, of boxed heart timbers with fairly wide rings. The best of these for dating purposes was sampled, but had only 54 rings including 11 sapwood rings which were not complete. This sample failed to match any samples within the site, or any of the reference chronologies. None of the other timbers from the jetty or partition above were considered worth sampling.

Sample ***c56*** was taken from one of the remaining hall ceiling joists adjacent to T2, and this had 68 rings. Although this failed to date individually, it did match well against the site sequence for the south-east Porch.

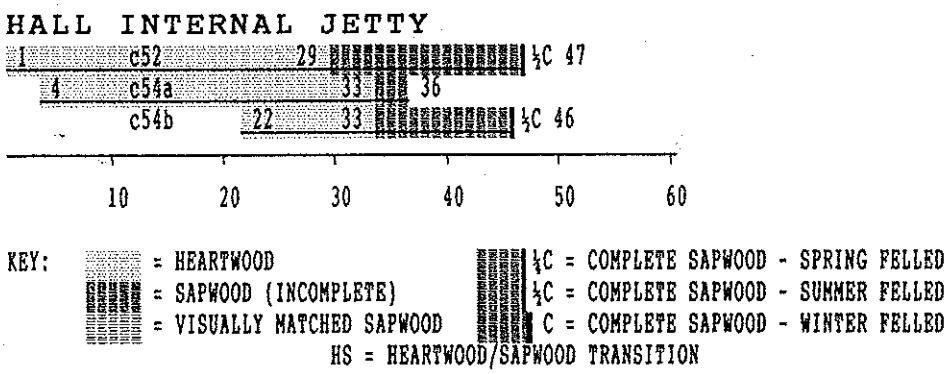

Figure 5: Bar diagram of samples comprising c524

3e. South-east Porch - fourth phase (samples *c61 - c66*)

Of all the phases sampled at Cullacott, this one appeared to have the most promise. The rings were relatively narrow and the timbers of sufficient size to allow several to have over 100 rings. In fact, some of the rings were so distressed in samples ***c62*** and ***c63*** that it was necessary to omit the last (approximately) 8 and 25 sapwood rings respectively. Samples ***c65*** and ***c66*** matched with t=10.17 and as these were considered to have been from the same tree, they were combined to form ***c656***. Once this had been done, all five samples from the porch matched together and was formed into the fifth site sequence. All three samples with measurable sapwood were found to have been cut down in the summer or autumn of the relative year 115. Despite the formation of a well replicated site sequence of 115 years, this too failed to date with any of the reference chronologies or any other samples from the site with the sole exception of sample ***c56***. Here this matched with a t-value of 5.71 with a relative felling date of the spring of year 80.

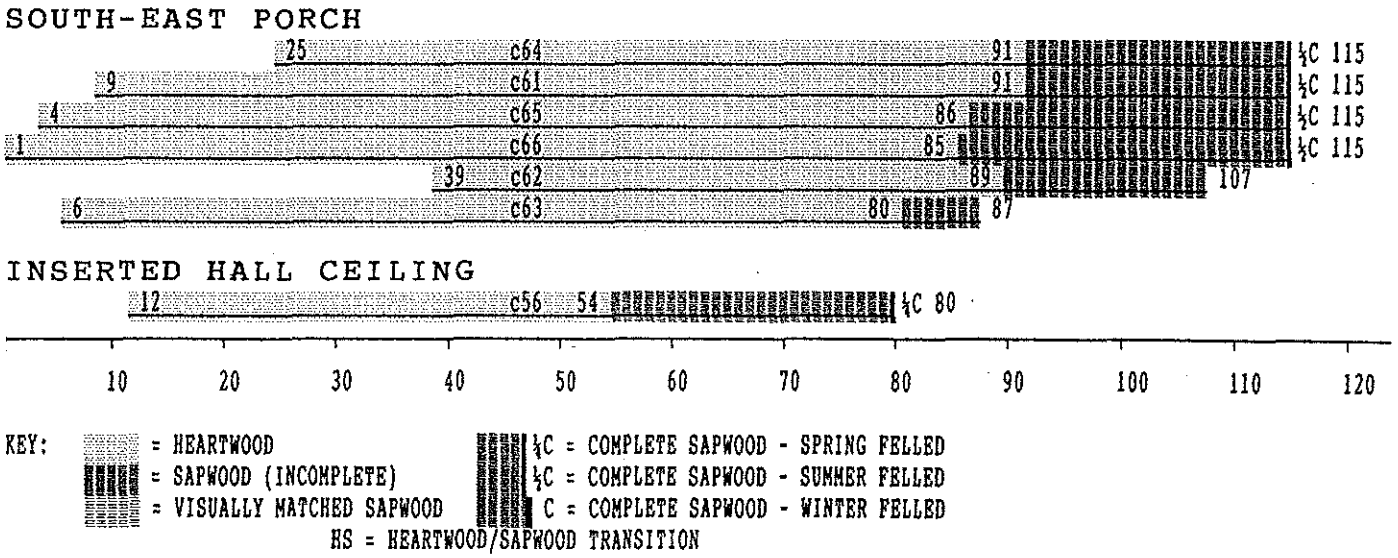

Figure 6: Bar diagram of samples comprising c61-66 + c56

	c62	*c63*	*c64*	*c656*
	107	87	115	115
c61	3.24	5.56	1.30	3.17
	69	79	91	107
c62		4.06	3.50	2.91
		49	69	69
c63			3.62	4.04
			63	82
c64				5.96
				91

Table 6: Matrix of t-values and overlaps for ***c61-66.***

4. Dating results and conclusion

In all, Cullacott produced six site sequences (see Appendix), only the first being securely dated to the period AD 1394-1481. This had a last measured ring of AD 1481 (***c11***) and as this was a partially complete sapwood ring, this tree would have been felled sometime in the summer or autumn of AD 1481. The other two dated samples from this phase were felled in the spring of AD 1478 (***c13***) and the spring of AD 1472 (***c15***). It must be stressed that these are the *felling dates* for the trees, not the construction dates, and the latter must be determined in the light of other architectural or archaeological factors in addition to these felling dates. As the three dated samples from this phase have inconsistent felling dates ranging over ten years, it may be postulated that some of the trees were dead, windfalls or felled previously to the commencement of the building operations which would presumably have begun immediately after the autumn of AD 1481, assuming of course the Hall and the Lower End are of one build.

The other five site sequences of 46 (2), 84, 54, and 115 rings in length remain floating but the longer of these remain potentially datable in the future should other work in the locality be undertaken. It should be borne in mind that in Devon, and Cornwall in particular, very little dendrochronology has been carried out and this coupled with the disparate climatic effects and the probable existence of micro-climates, initial work will prove extremely difficult. The only key to this problem will lie in more ground work in the area, plus looking more towards Ireland and Normandy for additional reference chronologies. The ring width data for these six sequences plus ***c56*** is located in the Appendix.

Despite the failure of the other five site sequences to date, the dendrochronology programme has nevertheless provided several useful pieces of information. Firstly, the Parlour End and the north-east wing have been proved to be coeval despite the differences in their window moulding profiles. Secondly the first floor room in the west porch was ceiled at the same time as the floor joists were laid, despite the chamfered purlins giving evidence to the contrary. And thirdly it has shown that the Hall was ceiled over at just below purlin level about 35 years before the construction of the south-east porch.

Summary results of the tree-ring dating have been published in *Vernacular Architecture* (Miles 1995).

5. Acknowledgements

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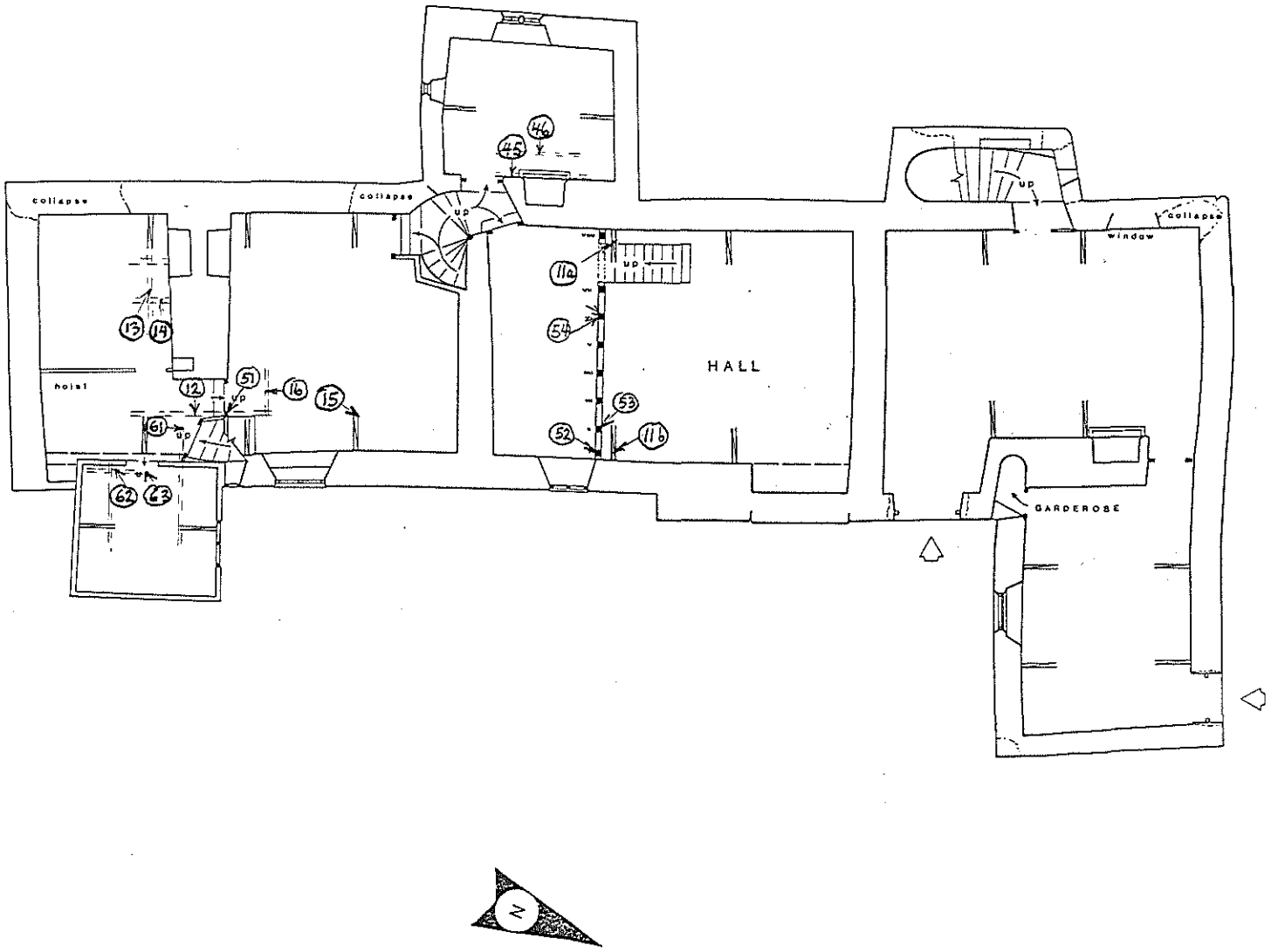
collapse
collapse
up
46
45
up
collapse
window
11a
up
54
HALL
53
52
11b
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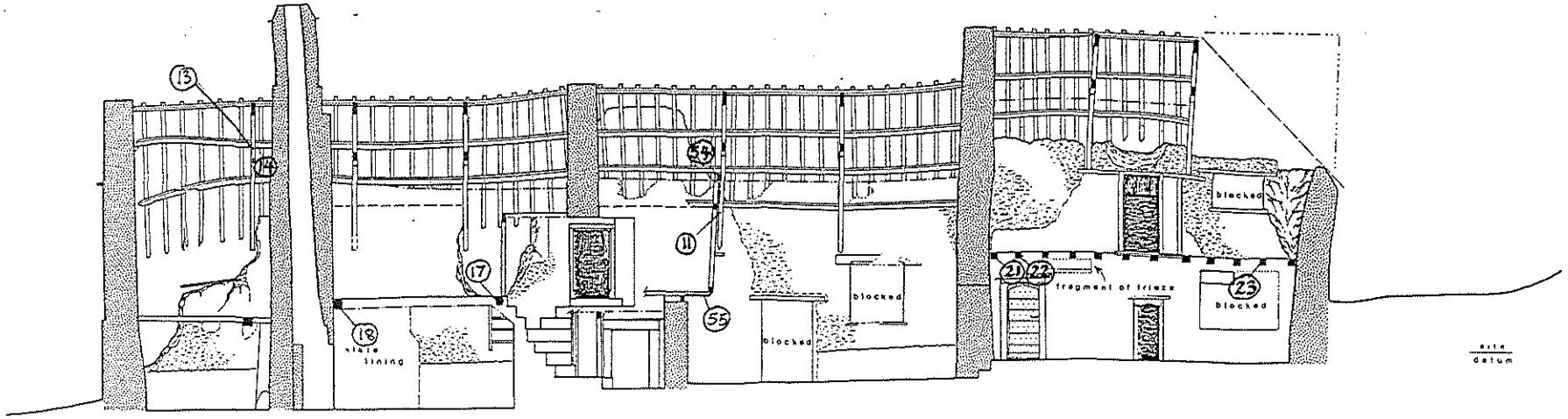
14
hoist
12
51
16
15
61
up
62
63
GARDEROBE
N

A

DAIRY | KITCHEN | PASSAGE | HALL | PARLOUR

B



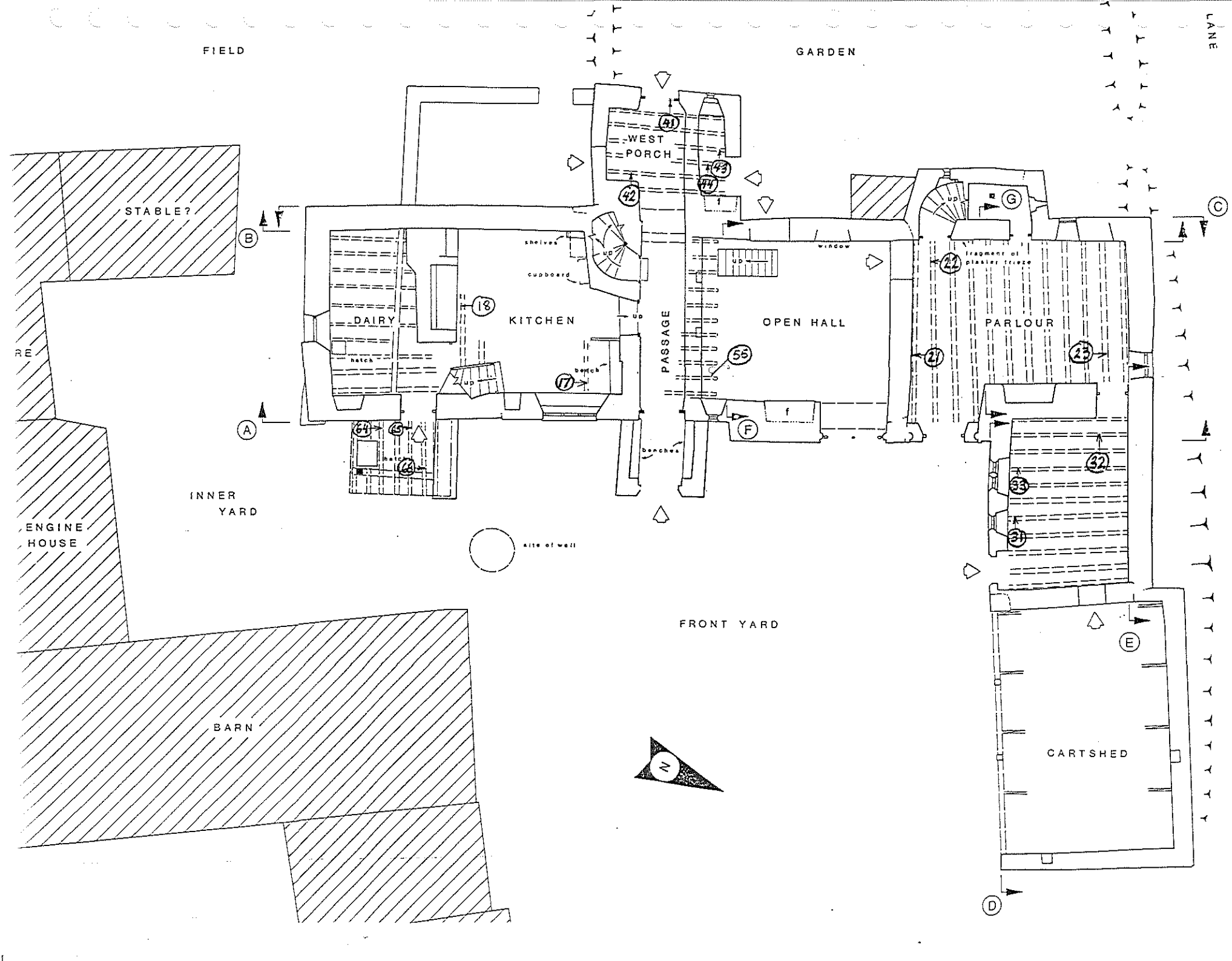

FIELD
GARDEN
LANE
STABLE?
WEST PORCH
DAIRY
KITCHEN
PASSAGE
OPEN HALL
PARLOUR
shelves
cupboard
window
fragment of plaster frieze
hatch
bench
benches
up
INNER YARD
ENGINE HOUSE
site of well
FRONT YARD
BARN
CARTSHED
N
A
B
C
D
E
F
G
41
42
43
44
18
17
64
45
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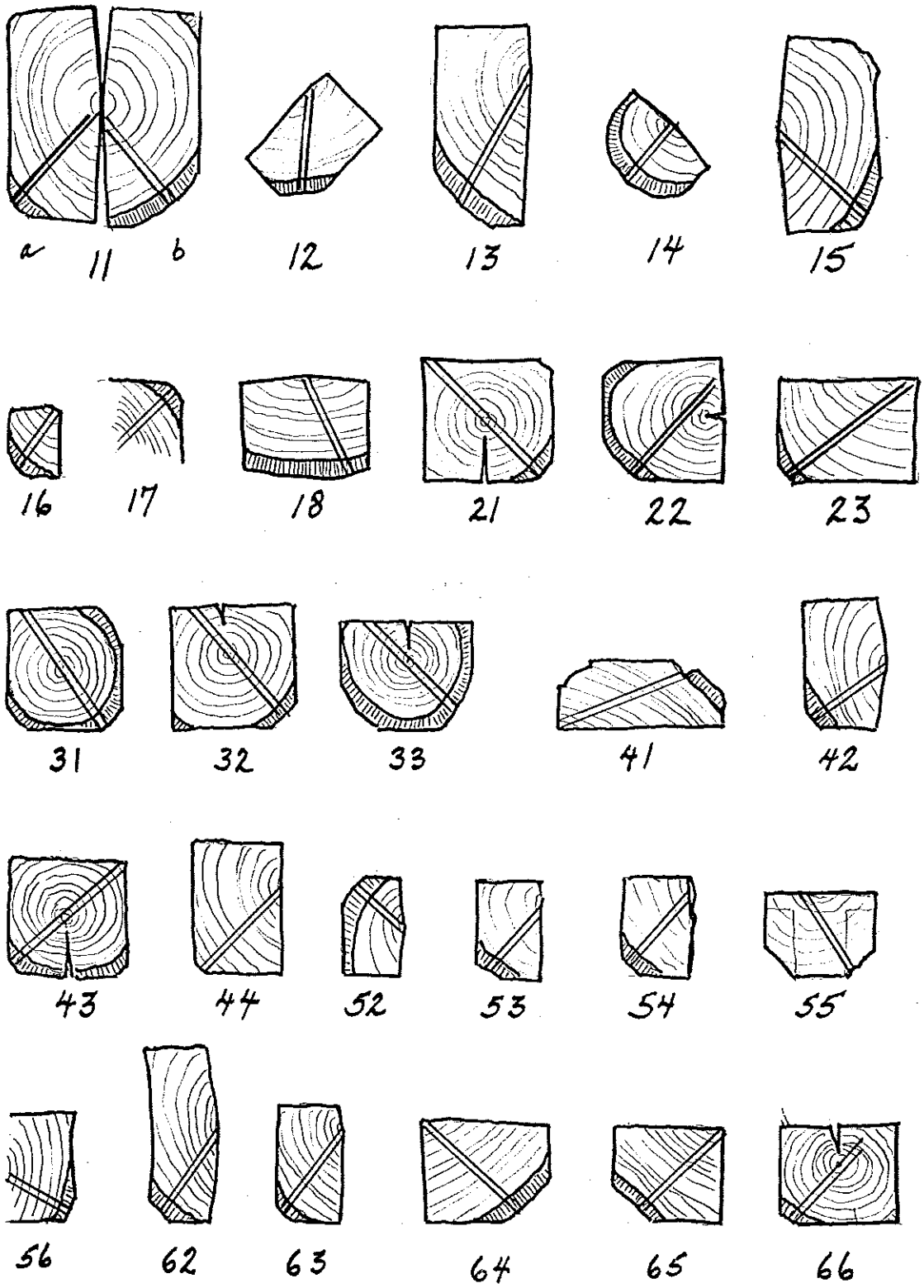
Figure 10: Sections of timbers sampled



APPENDIX - RING WIDTH DATA OF SITE SEQUENCES

CULACOT1 <1394-1481> mean of c11+c15+c13
88 rings, starting in AD 1394

ring widths (0.01mm)										number of trees per year									
192	262	157	102	149	166	175	179	169	269	1	1	1	1	1	1	1	1	2	2
292	172	180	147	238	266	238	251	254	286	2	2	2	2	3	3	3	3	3	3
275	232	225	227	186	178	307	175	165	277	3	3	3	3	3	3	3	3	3	3
244	263	262	159	203	202	189	241	237	194	3	3	3	3	3	3	3	3	3	3
224	272	200	145	116	124	164	202	206	269	3	3	3	3	3	3	3	3	3	3
236	243	243	254	369	338	217	189	216	195	3	3	3	3	3	3	3	3	3	3
254	196	207	214	235	177	224	209	223	222	3	3	3	3	3	3	3	3	3	3
179	131	171	245	189	105	148	171	183	158	3	3	3	3	3	3	3	3	2	2
182	161	172	148	108	129	148	110			2	2	2	2	1	1	1	1		

c1246 Cullacott c12+c14+c16
46 rings

256	234	134	115	242	273	306	198	329	315	1	1	1	1	2	3	3	3	3	3
337	276	274	372	339	273	253	264	205	223	3	3	3	3	3	3	3	3	3	3
206	242	216	223	173	198	206	186	171	116	3	3	3	3	3	3	3	3	3	3
147	171	200	176	137	179	153	100	113	169	3	3	3	3	3	3	3	3	3	3
203	173	141	138	143	125					3	3	3	3	3	3				

c2133 Cullacott Phase 2 Parlour End & NE Wing c21+c33
84 rings

247	305	156	119	220	237	186	126	155	216	1	2	2	2	2	2	2	2	2	2
199	218	187	178	207	147	180	166	129	195	2	2	2	2	2	2	2	2	2	2
117	101	125	110	109	96	113	131	106	112	2	2	2	2	2	2	2	2	2	2
98	101	116	116	86	51	103	99	100	100	2	2	2	2	2	2	2	2	2	2
171	66	118	114	132	137	121	114	129	89	2	2	2	2	2	2	2	2	2	2
70	64	77	98	90	100	103	67	140	130	2	2	2	2	2	2	2	2	2	2
106	108	113	105	115	150	112	93	64	84	2	2	2	2	2	1	1	1	1	1
103	89	113	80	84	114	109	105	116	122	1	1	1	1	1	1	1	1	1	1
105	84	76	99							1	1	1	1						

c43-45 Cullacott Phase 3 W Porch c43+c44+c45
54 rings

189	177	147	212	144	254	238	260	237	180	1	1	1	1	2	3	3	3	3	3
220	223	118	155	155	178	231	190	232	210	3	3	3	3	3	3	3	3	3	3
194	179	228	220	144	164	215	215	169	189	3	3	3	3	3	3	3	3	3	3
235	218	168	187	173	203	211	176	172	229	3	3	3	3	3	3	3	3	3	3
206	207	166	127	158	191	103	129	125	133	3	3	3	3	3	3	3	3	3	3
187	158	166	135							3	3	3	2						

c524 Cullacott - Hall jetty studs c52+c54
46 rings

89	85	72	260	224	338	359	227	111	141	1	1	1	2	2	2	2	2	2	2
180	238	186	212	176	197	203	181	131	137	2	2	2	2	2	2	2	2	2	2
119	79	136	122	155	143	98	99	127	210	2	2	2	2	2	2	2	2	2	2
241	129	165	157	101	108	97	112	138	133	2	2	2	2	2	2	2	2	2	2
118	128	116	119	103	73					2	2	2	2	2	1				

c56 Cullacott Hall ceiling joist
68 rings

214	155	167	200	180	194	222	136	124	156
099	083	102	157	131	149	163	112	124	098
105	135	087	078	092	076	057	078	120	100
081	076	078	061	048	084	080	103	061	076
070	058	071	128	129	087	078	135	112	142
095	109	205	231	245	144	098	064	116	069
091	094	096	080	054	047	055	043		

c61-66 Cullacott Phase 4 SE Porch c61+c62+c63+c64+(c65+c66)
115 rings

ring widths (0.01mm)									
405	362	385	326	335	278	220	351	341	192
215	255	277	227	149	133	171	246	140	265
226	131	131	149	193	161	170	161	148	189
134	144	165	153	159	125	138	102	120	140
119	120	102	157	116	118	144	138	167	99
126	118	129	92	103	78	60	68	90	93
63	49	54	82	106	111	98	106	89	127
74	87	109	143	145	123	134	110	135	156
154	156	198	164	141	148	127	121	129	110
120	145	115	122	108	86	88	84	86	88
99	108	82	65	55	69	61	58	64	50
83	56	71	68	94					

number of trees per year									
1	1	1	1	1	2	2	2	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	4	4	4	4	4	4
4	4	4	4	4	4	4	4	5	5
5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	4	4	4
4	4	4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	3	3	3
3	3	3	3	3					