Ancient Monuments Laboratory
Report 19/98

TREE-RING ANALYSIS OF TIMBERS FROM GOSFIELD HALL, ESSEX

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Summary

The attic gallery of the west range survives without any major alteration since its first construction. Timbers from a contemporaneous north range roof, built in a different style, also survive, though this range has been much altered. Stylistically the west range roof has been dated to mid-sixteenth century and there are parallels with other sites. The dendrochronological study shows both roofs to be made from young trees and dates the felling of these trees to the period AD 1547 to 1583.

Author's address :-

Dr M C Bridge
Institute of Archaeology
University College London
31-34 Gordon Square
LONDON
WC1H OPY

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Introduction

This report details the dendrochronological work carried out on the roof timbers of the west and north ranges at Gosfield Hall, Essex (NGR TL 776297). The work was requested by Andrew Wittrick of English Heritage in an attempt to get a firm date for the roof to aid in comparisons of period and methods of construction with other buildings currently being researched, notably Sutton House, Hackney, which has already been dendrochronologically dated (Tyers and Hibberd 1993). It is not the purpose of this report to give a definitive document on the roof structures discussed, and its conclusions may need modification in the light of other studies.

The history of Gosfield Hall has been described by Gorton and Bates (1988) and the roof structure above the long gallery of the west range is described in an unpublished report by Wittrick (1997). These have been used as the sources for the information which follows.

Gosfield Hall was built by Sir John Wentworth *c*AD1540 and is referred to in an itinerary of Essex houses in AD1594. It is one of few surviving courtyard houses from this period, though like most houses of its age, it has been extensively altered over time. The west range remains largely intact, with easy access to the timber roof structure above the brick building.

Eight complete principal trusses with interrupted ties and clasped purlin construction are exposed. The bay widths are irregular (Fig 1). The principal rafters, diminished above the purlins, are joined and tied together at the apex by a thickened, jowelled, double-pegged joint (Fig 2). Substantial vertical posts rise from the dropped tie beam, these offered support to the original wall lining. The wall-plate on the east elevation has been joined by what appears to be a shortened version of a face-halved and bladed scarf joint and has two diagonally-set face pegs (Wittrick unpubl).

Comparable roof types in the south-east of England include Bruce Castle, Tottenham (Bridge 1997) and Eastbury Manor, Barking (Tyers 1997) both of which have recently been the subject of dendrochronological investigation.

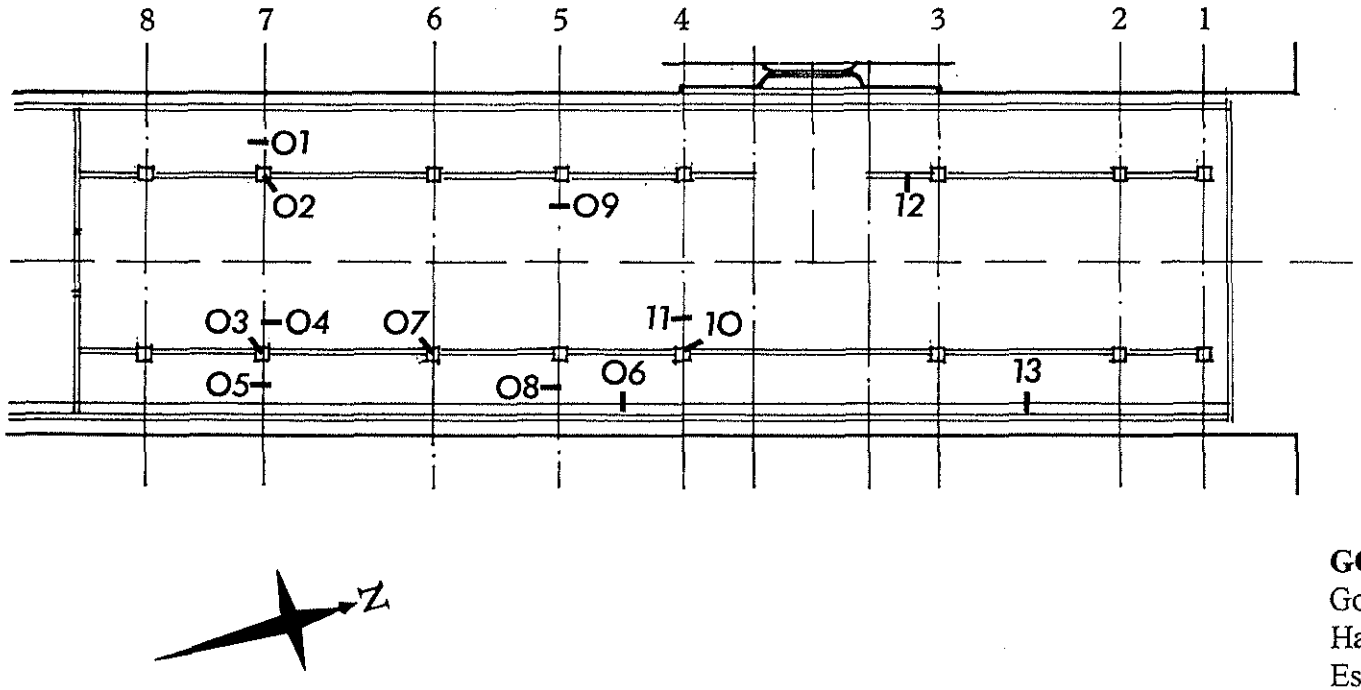
Methodology

Sampling of the *in situ* timbers took place on 19th March 1997, immediately following an assessment of their suitability for dendrochronological study. The timbers appeared to have sufficient numbers of rings, and several also showed sapwood surviving. Samples were removed using purpose-made 15mm diameter corers attached to an electric drill (a system developed from commercially available corers by Don Shewan at London Guildhall University). The remaining holes were plugged with softwood dowels held in position with Evostick wood adhesive.

Most of timbers sampled were from the roof over the west range, although three timbers in the north range, thought to be contemporaneous, were also sampled (Table 1; Figs 1, 2, and 3). Samples GSF14 and GSF15 were from a truss (fourth from west end) to the east of a later window, whilst GSF16 was taken from the principal rafter in the second truss from the west end.

The cores were glued to wooden laths, labelled, and stored for subsequent analysis. The cores were prepared for measuring by sanding using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow

Figure 1. Floor plan of the West Range showing the approximate locations of the dendrochronological samples (see also Fig 2)



GOSFIELD HALL
Gosfield
Halstead
Essex

WEST RANGE
Garret Floor Plan (North)

Scale 1:100

A R Wittrick
March 1997

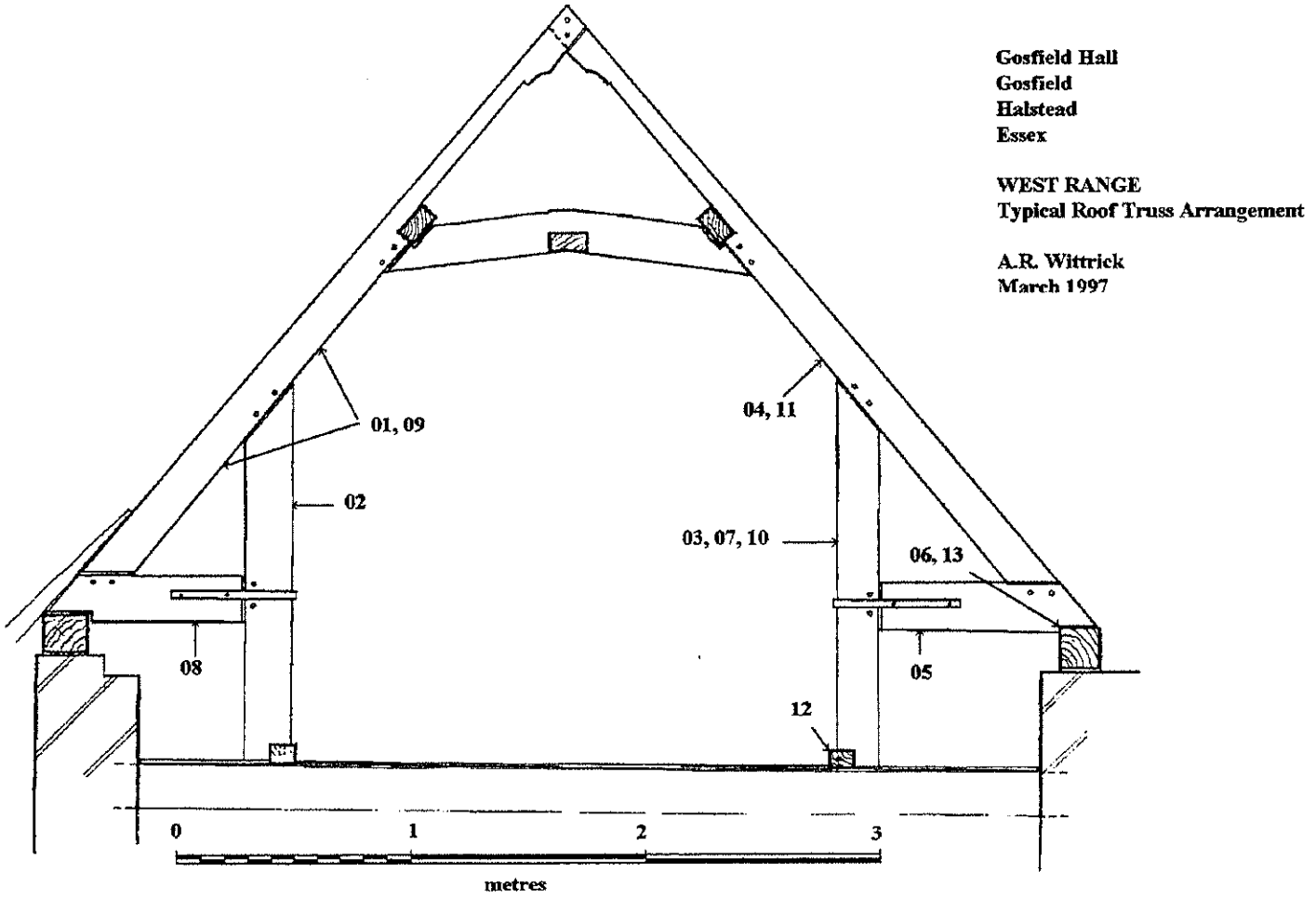
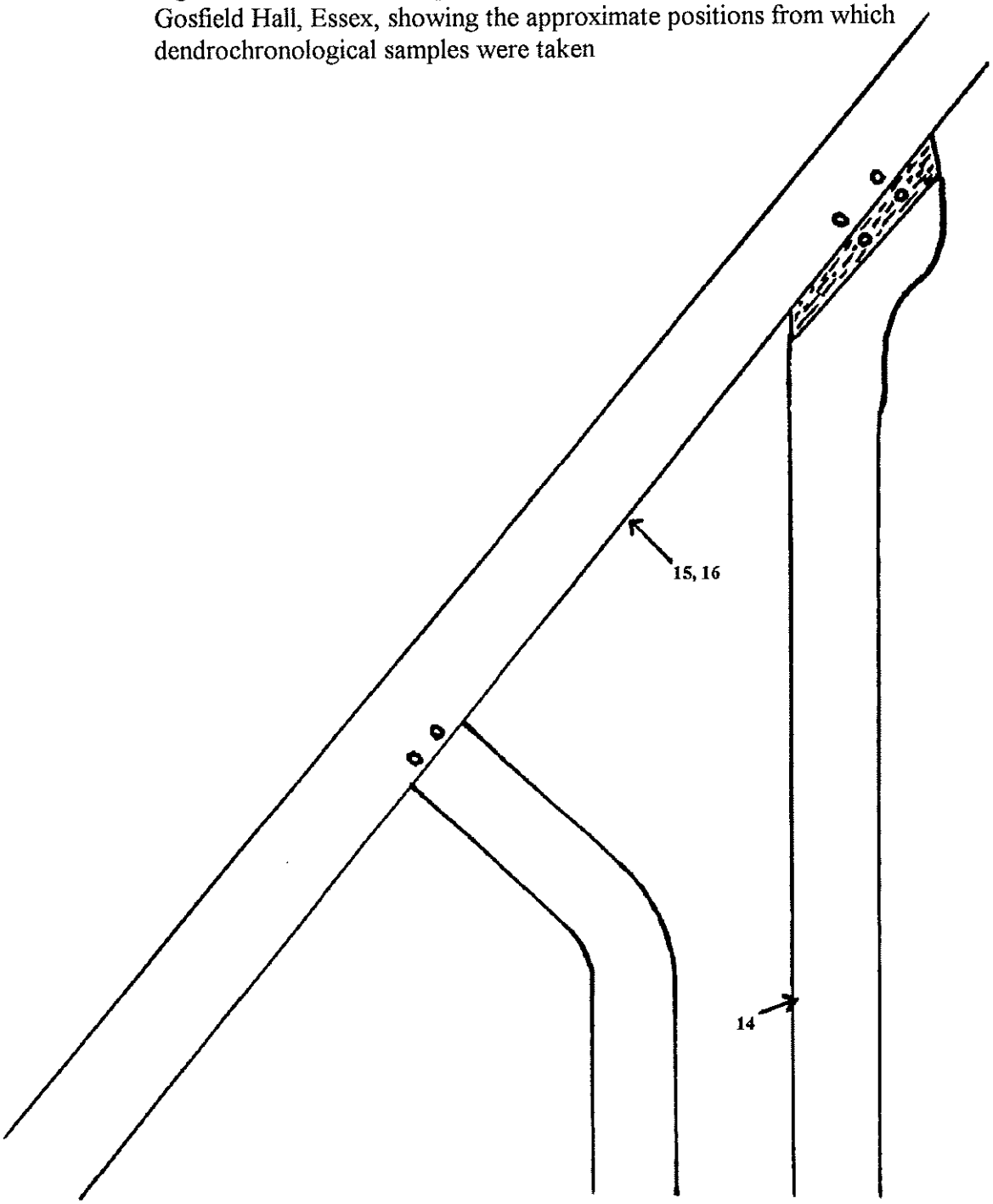


Figure 2: Roof truss configuration of the West Range showing approximate positions from which dendrochronological samples were taken (see also Fig 1)

Figure 3: Sketch of the exposed roof timbers of the North Range of Gosfield Hall, Essex, showing the approximate positions from which dendrochronological samples were taken



rings occurred, was done manually. Those samples with more than 50 annual rings had their ring-widths measured to an accuracy of 0.01 mm using a specially constructed system utilizing a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to an Atari desktop computer. Shorter sequences rarely give reliable crossmatches. The software used in measuring and subsequent analysis was written by Ian Tyers (pers comm 1992).

Suitably long ring sequences were plotted on translucent semi-log graph paper to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements. Statistical comparisons were made using standard dendrochronological software employing the Student's *t* statistic (Baillie and Pilcher 1973; Munro 1984). Where crossmatching is demonstrated between individual series, site mean sequences (site masters) are produced which emphasise the common variation between trees and reduce the variation unique to each tree. Any internal site masters produced are then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date them. The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973) in which *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches (Baillie 1982, 82-5).

The dates thus obtained represent the time of formation of the rings available on each sample; interpretation of these dates then has to be undertaken to relate these findings to the likely felling dates of the trees used and then relate these in turn to the construction date of the phase under investigation. Where only heartwood is found on the sample, one can make allowances for the expected number of sapwood rings on the tree and add this to the date of the last available ring to give a date after which felling took place; one does not know how many heartwood rings may be missing in these cases. Where the heartwood/sapwood boundary is found, or some sapwood rings survive, a felling date range can be calculated using the best available estimate of the number of sapwood rings likely to have been on the original tree (Baillie 1982).

In this report, the sapwood estimate employed is a minimum of 10 rings and a maximum of 55 rings, representing the 95% confidence limits derived by Hillam *et al* (1987). Where bark is present, the year of felling will be the date of the last surviving ring. In such cases it is often possible to determine the season of cutting by looking at how much of the ring has been formed.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the roof. Evidence suggests that, except in the case of re-used timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

Results

Information regarding the timbers sampled is given in Table 1. All timbers were of oak (*Quercus* spp.). The level of crossmatching between individual samples is shown in Table 2 - thirteen of the sixteen samples taken were successfully crossmatched and subsequently combined to form a site master GOSFIELD. The relative positions of overlap of the samples is illustrated in Fig 4.

The results for the strongest crossmatches between this site master and several regional and individual site chronologies are shown in Table 3, and the site mean data is given in Table 4.

Table 1. List of samples taken from Gosfield Hall, Essex. h/s = heartwood/sapwood boundary

Sample No.	Origin of sample	Total number of years	Sapwood details	Average growth rate (mm yr^{-1})	Date of sequence	Felling date of sequence
WEST RANGE						
GSF01	Principal rafter 7 west	69	-	0.55	1456 - 1524	after 1534
GSF02	Post 7 west	56	-	0.71	1478 - 1533	after 1543
GSF03	Post 7 east	72	7	0.82	1464 - 1535	1538 - 1583
GSF04	Principal rafter 7 east	76	h/s	0.66	1462 - 1537	1547 - 1592
GSF05	Interrupted tie 7 east	68	-	0.73	1468 - 1535	after 1545
GSF06	Wall-plate, bay 6 east	49	-	1.19	unknown	-
GSF07	Post 6 east	74	-	0.84	1449 - 1522	after 1532
GSF08	Interrupted tie 5 west	69	-	0.90	1450 - 1518	after 1528
GSF09	Principal rafter 5 west	69	-	0.98	1460 - 1528	after 1538
GSF10	Post 4 east	53	-	1.01	unknown	-
GSF11	Principal rafter 4 east	84	h/s	0.66	1451 - 1534	1544 - 1589
GSF12	Floor rail, bay 3 west	68	h/s	0.53	1466 - 1533	1543 - 1588
GSF13	Wall-plate, bay 2 east	54	h/s	0.70	unknown	-
NORTH RANGE						
GSF14	Post	75	h/s	0.72	1458 - 1532	1542 - 1587
GSF15	Principal rafter 3 north	68	h/s	0.93	1466 - 1533	1543 - 1588
GSF16	Principal rafter 2 north	58	-	0.98	1469 - 1526	after 1536

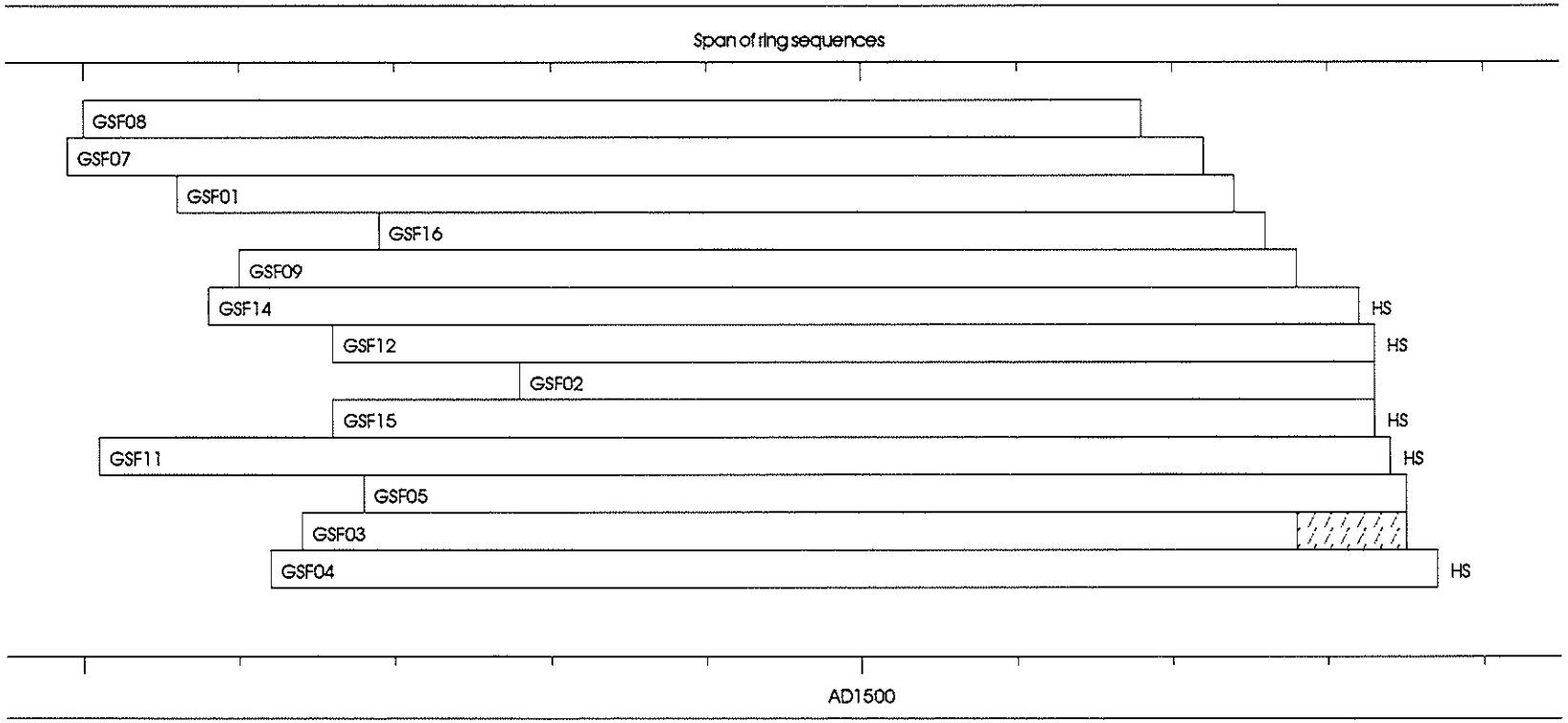


Figure 4. Bar diagram showing the relative positions of the dated ring sequences from Gosfield Hall, Essex.
HS = heartwood/sapwood boundary, hatched bar denotes sapwood.

Table 2. Correlation between the dated series from the west and north ranges of Gosfield Hall, Essex. The values are *t*-values derived from CROS 73 (Baillie and Pilcher 1973). Dashes indicate values of *t* of 3.0 or less.

	GSF 02	GSF 03	GSF 04	GSF 05	GSF 07	GSF 08	GSF 09	GSF 11	GSF 12	GSF 14	GSF 15	GSF 16
GSF01	-	4.5	4.3	3.6	5.3	4.5	4.3	4.6	-	-	-	-
GSF02		4.6	5.1	6.0	6.1	-	7.4	6.3	6.0	4.2	5.6	6.2
GSF03		-	6.0	5.3	4.3	4.0	4.5	7.0	4.8	3.8	5.6	4.4
GSF04			-	5.1	6.0	3.7	7.0	4.5	4.8	3.7	5.7	3.6
GSF05				-	7.4	5.5	7.3	5.0	7.6	5.6	4.9	4.9
GSF07					-	5.1	7.7	5.0	7.2	5.5	5.3	6.7
GSF08						-	3.6	4.5	5.8	3.6	-	-
GSF09							-	3.8	7.4	4.4	4.6	5.2
GSF11								-	5.6	-	6.4	4.7
GSF12									-	4.5	4.4	4.6
GSF14										-	5.4	5.9
GSF15											-	7.6

Table 3. Dating of the site master chronology for oak timbers from Gosfield Hall, Essex

	GOSFIELD HALL AD 1449 - 1537	
Dated reference or site master chronology	*t*-value	Overlap (yrs)
London1175 (Tyers pers comm)	5.8	89
Kent (Laxton and Litton 1989)	5.6	89
East Midlands (Laxton and Litton 1988)	4.9	89
Hereford and Worcs. (Siebenlist-Kerner 1978)	4.7	89
Oxon93 (Miles pers comm)	4.7	89
Brittany 3 (Pilcher pers comm)	4.5	89
Trees2 (Miles pers comm)	7.3	89
Windsor Castle kitchen (Hillam pers comm)	6.2	89
Mary Rose refit (Bridge unpubl)	5.9	87
Nuffield (Miles pers comm)	5.2	89
Bruce2 (Bridge 1997)	5.0	89
Basing barn roof (Bridge unpubl)	5.0	87

Interpretation

Of the sixteen timbers sampled, the longest sequence of annual rings found was 84 years. Most principal rafters utilised halved squared-off trunks whilst the remaining principal rafters, posts, interrupted ties, and wall-plates all appear to made from boxed-heart timbers. This means that the ring-width sequences in nearly all cases represented almost the total radius of the trees from which the roof was constructed. Some timbers had remains of sapwood on them, others showed the heartwood-sapwood boundary. Allowing for missing sapwood rings it is possible therefore to demonstrate that the roof timbers came from trees of around one hundred years old.

It can be quite difficult to crossmatch relatively short sequences such as these, although the degree of crossmatching in this group is relatively high (Table 2). Another sample (GFS10) exhibited a weak statistical match with the site chronology, but after studying the ring-width plots and bearing in mind the weak statistical match, it was decided not to include this timber in further analysis. A high proportion (thirteen out of a total of sixteen) of the samples did give satisfactory crossmatches.

The final site chronology dates to the period AD 1449 to 1537. This chronology crossmatches well with reference material from an extensive area, including the East Midlands, Oxfordshire, the English - Welsh borders, London, Kent, and Brittany. The timbers therefore may have come from anywhere within this large region. The chronology gives the strongest matches with individual site chronologies from central southern England, perhaps indicating that the trees used originally grew in this region, although great caution needs to be exercised in this interpretation (Bridge forthcoming).

Many of the samples ended at the heartwood-sapwood boundary, the sapwood having disintegrated on coring. It is therefore possible to produce a probable felling date range for the timbers used, assuming that this group represents a single group of trees, from one source, likely to have been felled at the same time. These assumptions seem reasonable given that the crossmatching between these relatively short sequences (Table 2) is similar to that experienced in living oaks from single woodlands, and that the last heartwood ring on several cores falls within a period of only a few years. The latest measured ring was formed in AD 1537, this representing the last heartwood ring on the sample. Applying the accepted sapwood allowance (Hillam *et al* 1987) this would make the earliest possible felling date AD 1547. The earliest date for a sample with the maximum expected 55 rings of sapwood is AD 1583. In fact, from what could be seen of the timbers in the roof construction, it is unlikely that any of these young trees would have had as many as 55 sapwood rings, but without the presence of bark on the samples it is not possible to give any more accurate felling-date range than **AD 1547 to 1583**.

One point of interest is that the dendrochronological samples suggest the felling dates for the roof timbers in both the west and north ranges are contemporaneous. The different styles of these two roofs (Figs 2 and 3) might suggest that they were constructed at different times. This unusual finding might prompt building historians to investigate this point further.

Conclusion

The preceeding information suggests a likely construction date for the roofs of the West and North Ranges of the hall soon after AD 1547. This result accords well with the documentary evidence for the existence of the building by AD 1594 but suggests a slightly later date than that which had been suggested on stylistic evidence. This may have implications for dating comparable examples.

Acknowledgements

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Table 4. Ring-width data for the site chronology for oak from Gosfield Hall, Essex, showing how many samples contribute to the final chronology in each year.

GOSFIELD

Year	ring widths (0.01mm)										number of trees per year									
AD1449									231	234									1	2
AD1451	156	155	158	174	124	166	177	184	134	118	3	3	3	3	3	4	4	5	5	6
	118	124	133	128	164	157	135	123	126	135	6	7	7	8	8	10	10	11	12	12
	118	141	107	122	138	92	68	82	99	101	12	12	12	12	12	12	12	13	13	13
	105	90	74	65	67	73	96	75	80	73	13	13	13	13	13	13	13	13	13	13
	47	52	54	61	58	86	69	44	47	41	13	13	13	13	13	13	13	13	13	13
AD1501	47	44	45	42	53	56	46	51	47	38	13	13	13	13	13	13	13	13	13	13
	41	44	47	41	51	53	37	51	66	57	13	13	13	13	13	13	13	13	12	12
	49	53	57	69	47	63	68	75	62	64	12	12	11	11	10	10	9	9	8	8
	78	51	53	59	96	125	98				8	8	7	4	3	1	1			