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Summary

A total of 32 timbers was sampled in the Hall range of Shrewsbury Castle. The earliest felling date identified was for a reset timber over a doorway between the east tower and Hall balcony which forms part of the current roof structure over the Hall. This was most likely felled in the period AD 1184-1214. Nine timbers were dated from the stairways at either end of the Hall and these were most likely felled in the period AD 1234-49. Five floor beams from the Hall and three timbers from the screen form a single group of timbers with similar felling date ranges, one of which retained complete sapwood and was felled in the winter of AD 1647/8.

Keywords

Dendrochronology
Standing Building

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Introduction

Shrewsbury Castle (NGR SJ 495 128; Fig 1) was founded shortly after the Norman conquest (Morriss 2001 unpubl). After the pacification of the Welsh in the late-thirteenth century it fell into decline. It was refortified in the Civil War, and then became a private dwelling in the eighteenth century, being largely remodelled by Thomas Telford. It became a regimental museum for the Shropshire Light Infantry in the 1980s. Surprisingly little is known about the history of the existing fabric, and dendrochronological investigation of the Hall range was requested in order to inform ongoing conservation plans. Construction of the Hall was thought to have begun in AD 1164, although it is commonly accepted that the Castle was rebuilt *c* AD 1280 by Edward I as part of his campaign to fortify the Welsh Border (M Moran pers comm). It was subsequently enlarged in AD 1596. It was not clear whether any of the original twelfth-century timbers remain. This work was commissioned by English Heritage to inform future conservation.

Methodology

The site was sampled in February 2004 following a preliminary assessment some months previously. Accessible oak timbers with more than 50 rings and traces of sapwood were sought in the initial assessment. Those timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. 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 rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (1999). Cross-matching and dating was accomplished by a combination of visual matching and a process of qualified statistical comparison by 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). Ring sequences were plotted to allow visual comparisons to be made between sequences on a light table. This method provides a measure of quality control in identifying any errors in the measurements when the samples cross-match. In comparing one sequence or site sequence against another, *t*-values over 3.5 are considered significant, although in reality it is common to find *t*-values of 4 or 5 which are demonstrably spurious because more than one matching position is indicated. For this reason, it is necessary to obtain some *t*-values of 5, 6, and higher, and for these to be well replicated from different, independent chronologies and with local and regional chronologies well represented, unless the timber is imported. Where two individual sequences match with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they most likely came from the same parent tree.

When cross-matching between samples is found, their ring-width sequences are averaged to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established. This is then compared with a number of reference chronologies (multi-

site chronologies from a region) and dated individual site masters in an attempt to date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the rings available on each sample. These dates require interpretation for the construction date of the phase under investigation to be determined. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. The sapwood estimates used here are based on those proposed for this area by Miles (1997a), in which 95% of oaks contain 9–41 rings. Where complete sapwood or bark is present, the exact date of tree felling may be determined.

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

Sampling

In order to inform ongoing conservation plans dendrochronological analysis was requested for various parts of the Hall range: the roof, the floor beams, and screen in the Hall; the stairwells in the towers at either end of the Hall.

The earliest timbers appeared to be the large timbers supporting the stonework over the staircases in the east and west towers. Most of these were easily accessible from the stairs below, and many appeared to have good ring counts. These were clearly part of the original fabric of the towers as they could not have been inserted subsequently. Thirteen samples were taken in total from these timbers – five from the west tower (**shc08** – **shc12**) and eight from the east tower (**shc18** – **shc20** and **shc23** – **shc27**). In addition, a reset timber adjacent to the east tower, acting as a lintel over a doorway, and forming part of the present hall roof, was also sampled (**shc16**).

The floor structure of the Hall consisted of ten transverse beams and a door lintel at the south-east corner. Seven samples (**shc01** – **shc07**) were taken from these timbers, one of which retained complete sapwood.

The Hall roof was sampled at both the east and west ends where accessible from the galleries, but the timbers were all very fast grown, with none having more than 55 rings. Nevertheless, with the number of samples from elsewhere in the building to match against, it was felt worthwhile to sample these, and four samples were obtained (**shc13** – **shc15** and **shc17**).

Two later roof timbers were also sampled in the roof to the east tower adjacent to the roof access door (**shc21** and **shc22**). These rafters retain some sapwood and it is not known what phase of construction they relate to, except that that they are post-medieval. Again it was felt that with so much other material from various phases of the building being available, it was worthwhile to sample these as they may cross-match against other material.

Finally, five samples were taken from the hall screen (**shc28** – **shc32**). The screen has had historic repairs carried out which has included the introduction of some re-

used material. Also, the top centre of the screen had been badly damaged by an incendiary bomb and the subsequent fire, which devastated the hall in August 1992. Nevertheless, some of the samples had reasonable ring counts and would help to relate the screen chronologically to the development of the Castle.

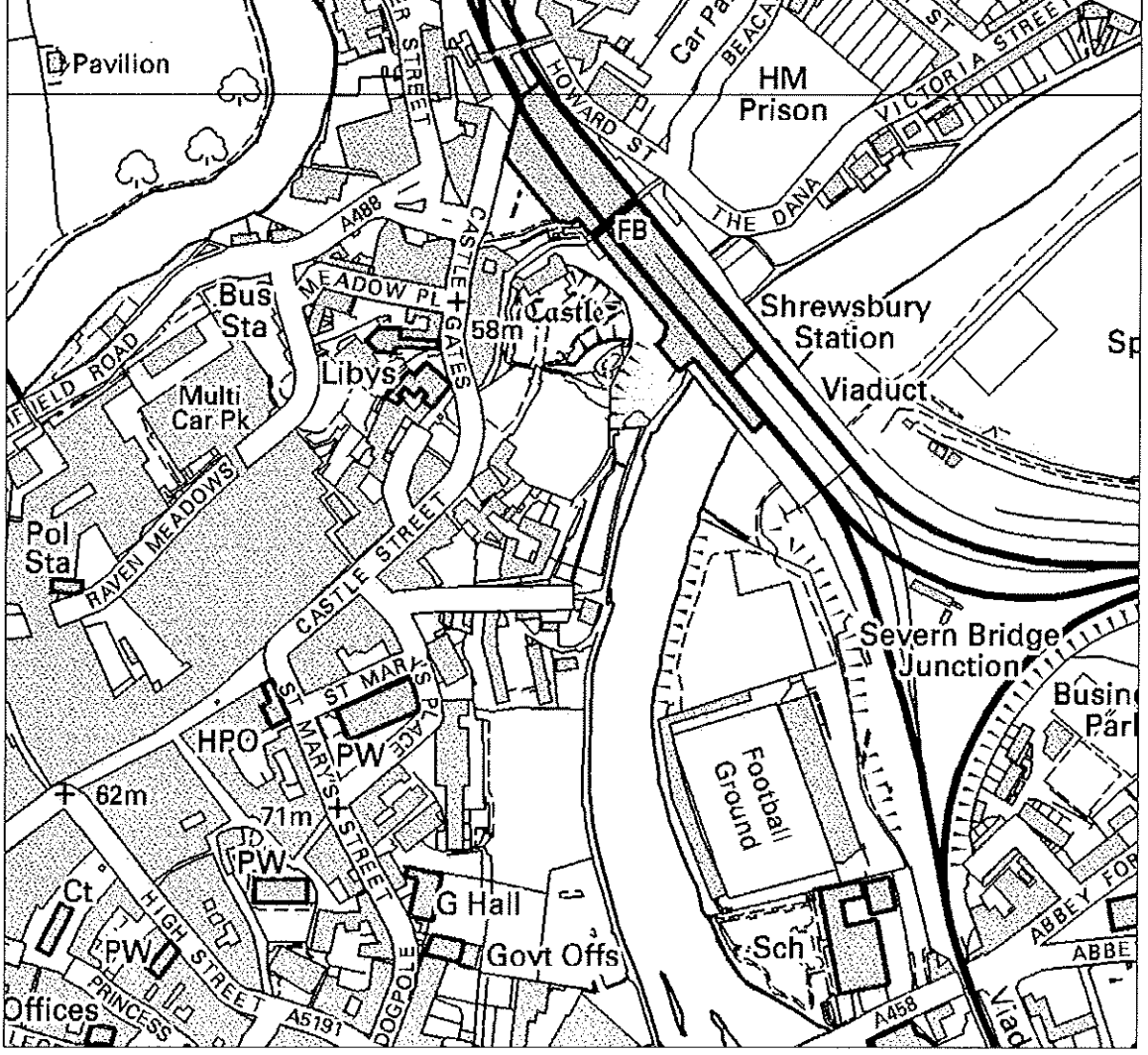

Figure 1: Map showing the location of Shrewsbury Castle, Shrewsbury.

Results

All the timbers investigated were of oak (*Quercus* spp.). Details of those timbers sampled are given in Tables 1 and 2, and illustrated in Figures 2 – 5, with Figure 6 showing the form of the Hall roof.

First, all individual duplicate samples (from the same timbers) were combined to form same-timber means. Thus, samples **shc07a** and **shc07b** were matched with a *t*-value of 11.4 (108 years of overlap) to form the mean **shc07**, **shc09a** and **shc09b** were matched with a *t*-value of 11.4 (108 years overlap) to form the mean **shc09**, **shc11a** and **shc11b** did not match satisfactorily and were left as separate sequences, **shc18a** and **shc18b** formed **shc18** with a *t*-value of 11.6 (62 years overlap), and **shc27a** and **shc27b** formed the mean **shc27** with a *t*-value of 10.0 (61 years overlap). Sample **shc25** contained many narrow rings, especially in the early part of the sequence, and only the outer 80 years were used, where the sequence matched other samples well.

Second, the individual timbers samples were compared with each other to determine whether two or more timbers originated from the same tree. Samples **shc08** and **shc09** from the west tower, and sample **shc25** from the east tower, which matched with consistently-high results, as shown in Table 3, were considered to have originated from the same parent tree and were combined to form the mean **shc8925**. Similarly, samples **shc18** and **shc19** were found to match extremely well, as shown in Table 4, and were combined to form the mean **shc1819**. These means were subsequently used in all further analysis.

A number of the samples cross-matched with each other. These formed two groups, the *t*-values for the cross-matching being given in Tables 5 and 6. The first group of timbers consists of five stair lintels and a window lintel from the east tower, and three lintels from the west tower, along with a diagonal beam over the doorway into the balcony over the Hall from the east tower which now supports some Hall roof timbers. The second group of timbers comprises of five beams in the ground floor that support the Hall floor and three elements of the screen in the Hall. Two site chronologies **SHRWCST1** and **SHRWCST2** were formed from these groups, and were dated by comparison with reference material, a selection of results being shown in Tables 7 and 8 respectively. **SHRWCST1** was dated to AD 1058–1223, and **SHRWCST2** to AD 1498–1647. The data for these site chronologies is given in Table 9. The relative positions of overlap of the dated samples are shown, along with their interpreted felling dates in Figures 7 and 8.

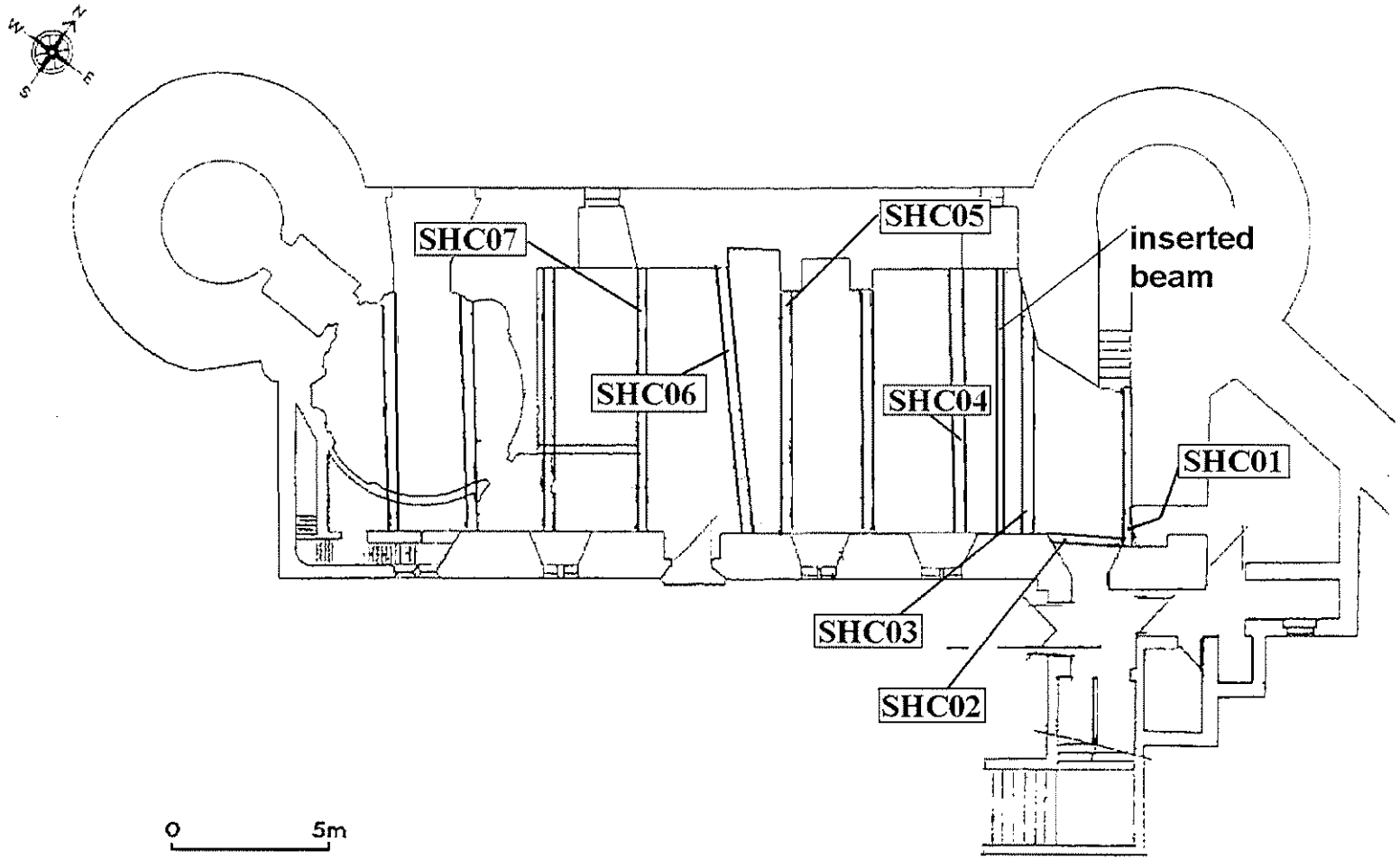

Figure 2: Ground-floor plan of the Hall range, showing the timbers sampled for dendrochronology, adapted from an original drawing in Morriss (2001 unpubl, fig 6)

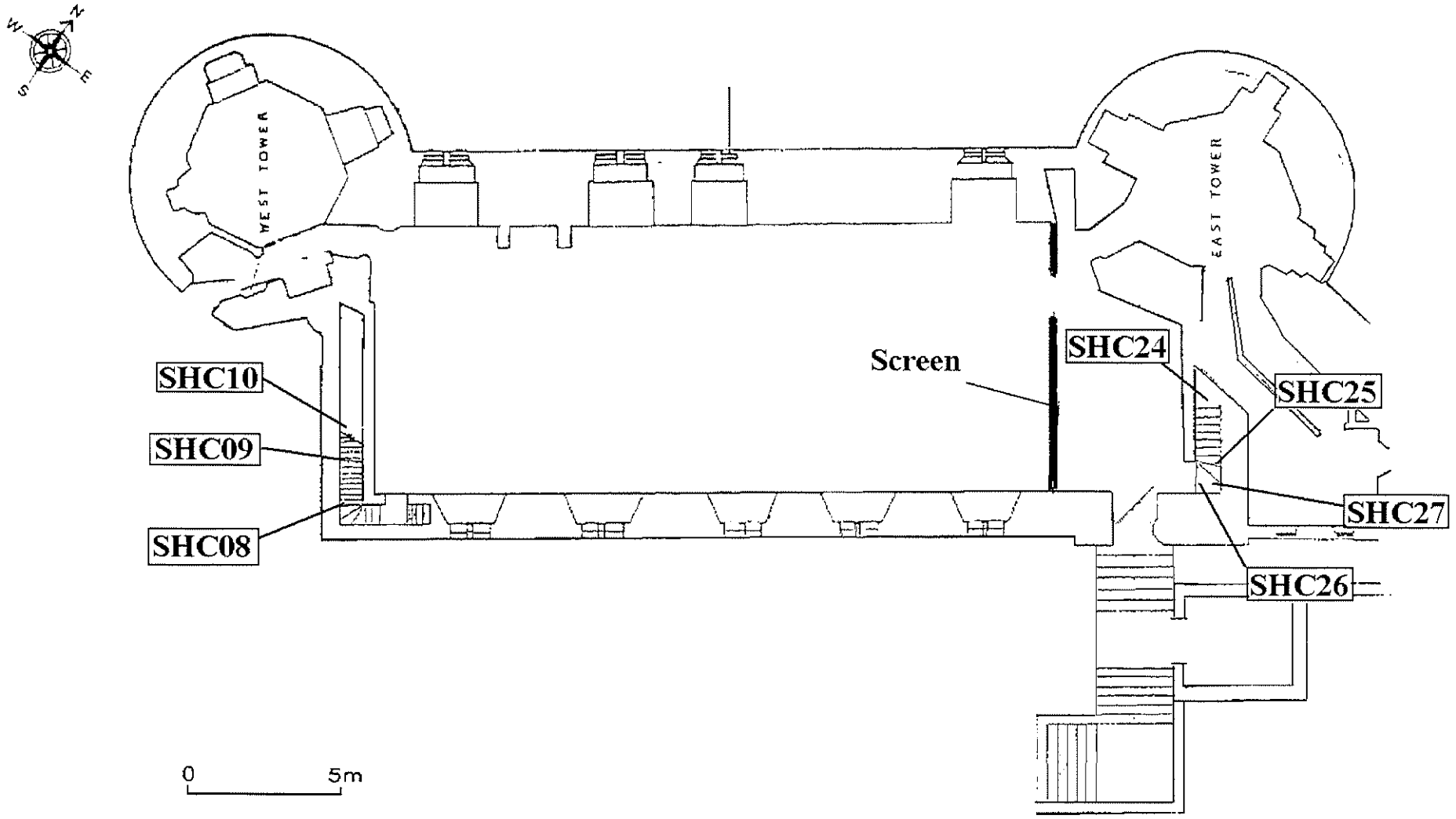

Figure 3: First-floor plan of the Hall range, showing the timbers sampled for dendrochronology, adapted from an original drawing in Morriss (2001 unpubl, fig 7)

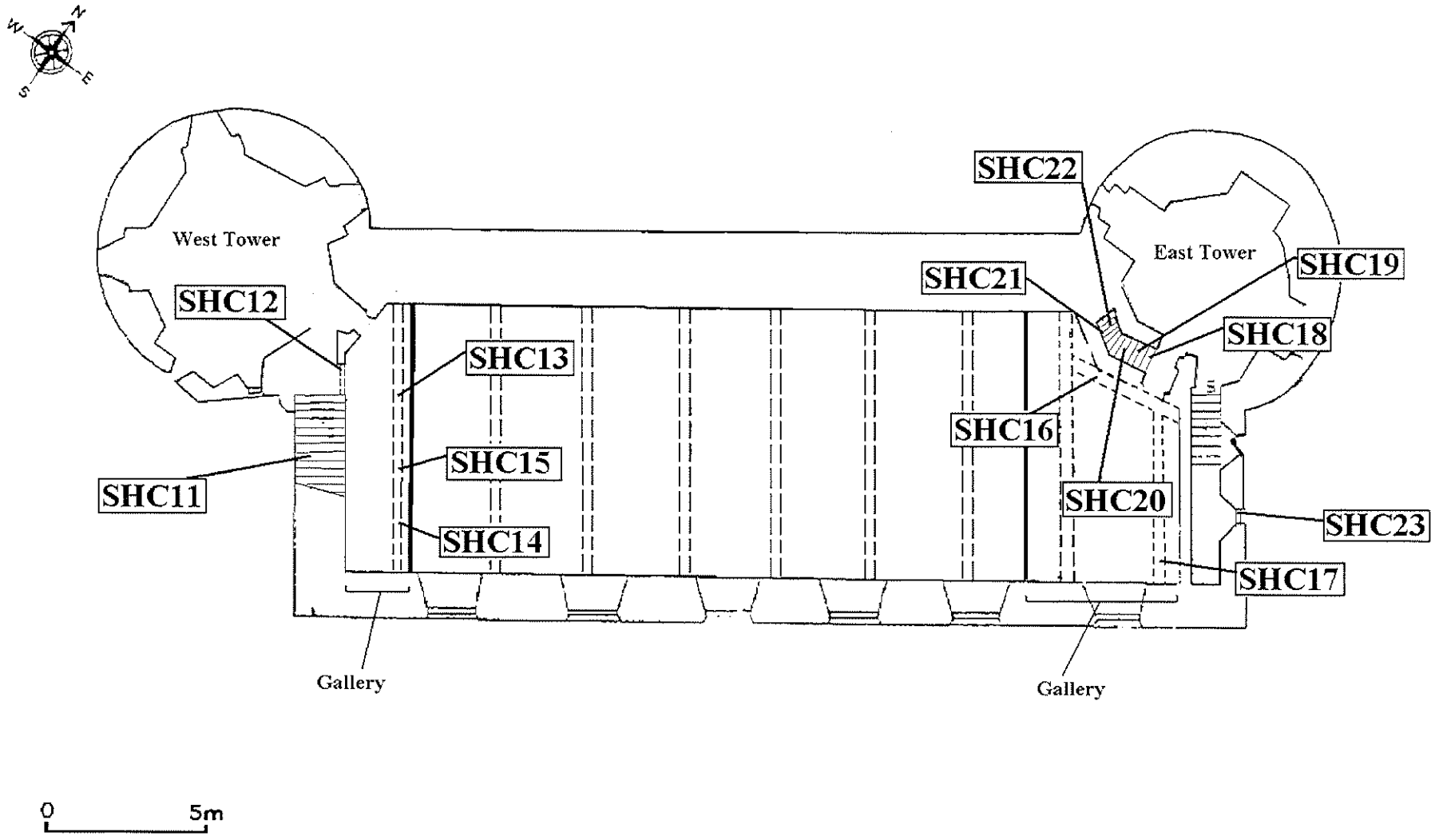

Figure 4: Second-floor plan of the Hall range, showing the timbers sampled for dendrochronology, adapted from an original drawing in Morriss (2001 unpubl, fig 8)

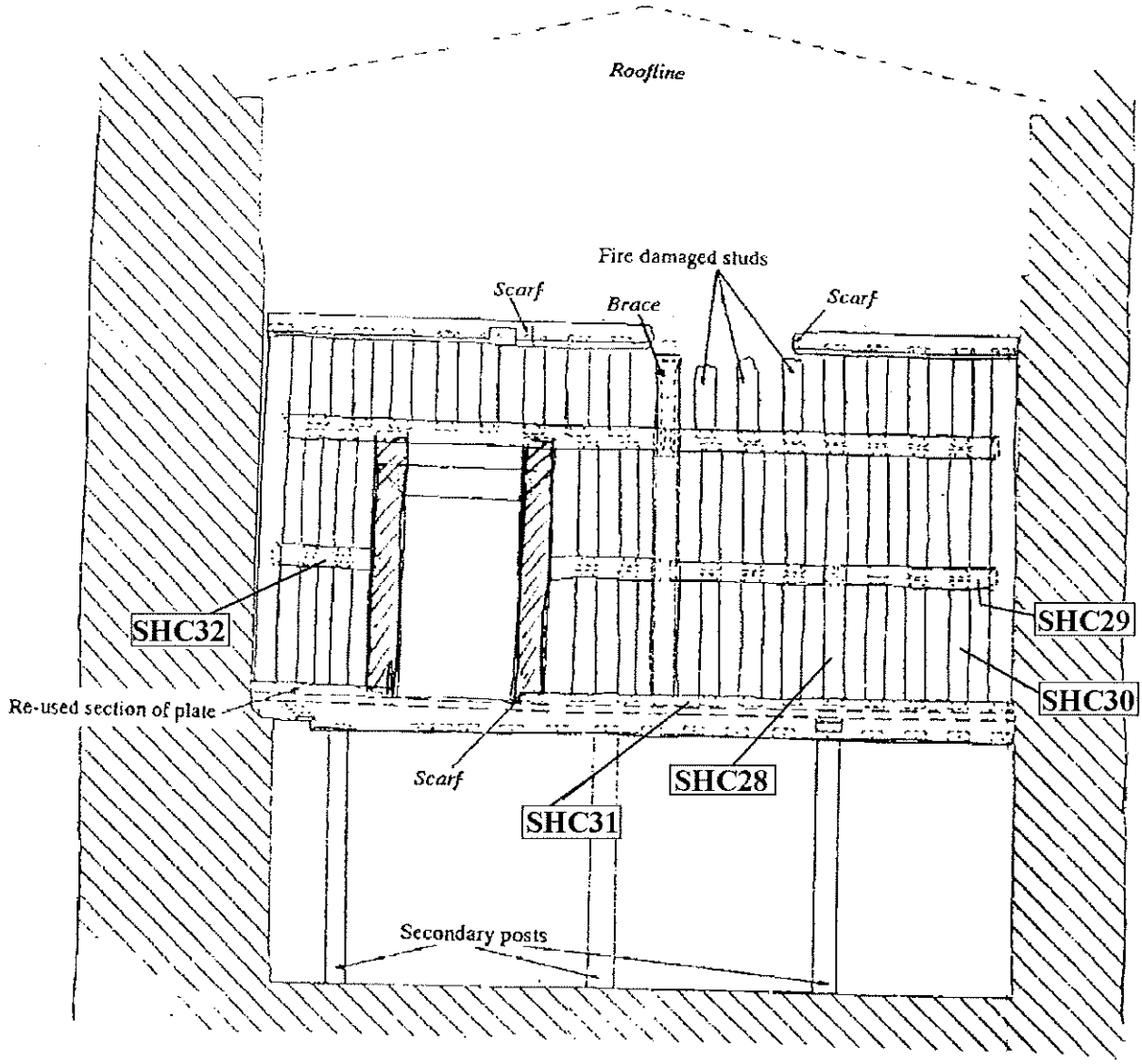

Figure 5: West elevation of the screen in the Hall range, showing the timbers sampled for dendrochronology, adapted from an original drawing in Morriss (2001 unpubl, fig 13)

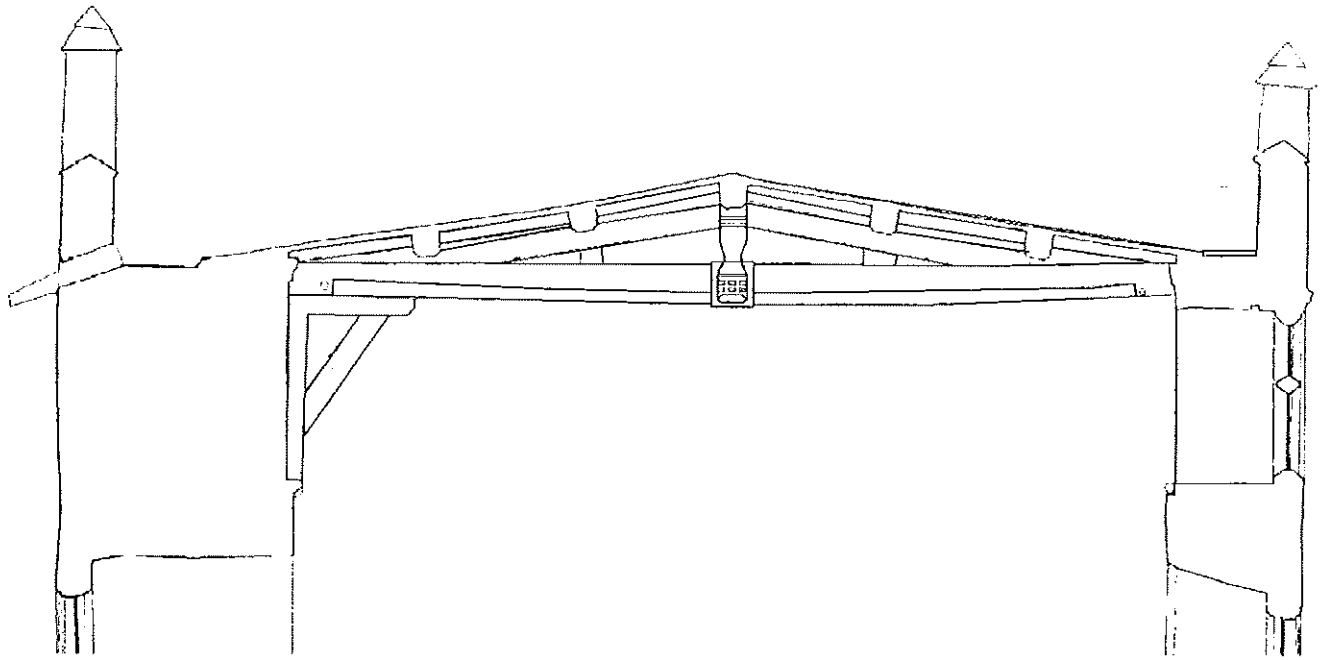

Figure 6: Cross-section showing the general form of the roof of the Hall, adapted from an original drawing by Russell Geomatics Ltd

Table 1: Summary of tree-ring dating for primary phase timbers sampled from Shrewsbury Castle, Shropshire

Sample number & type		Timber and position	Dates AD spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges (AD)
West Tower										
shc08	c	Lintel over stairs	1142–1216	1216	-	75	1.68	0.44	0.181	(1225–55)
shc09a	*c*	*Lintel over stairs*	*1161–1213*	*1213*		*53*	*1.07*	*0.33*	*0.237*	
shc09b	*c*	*Lintel over stairs*	*1111–1213*	*1213*	-	*103*	*1.44*	*0.64*	*0.247*	
shc09		Mean of **shc09a + shc09b**	1111–1213	1213	-	103	1.43	0.63	0.235	(1225–55)
* **shc10**	c	Lintel over stairs	1119–1193	-	-	75	0.92	0.37	0.226	after 1204
shc11a	c	Lintel over stairs	unknown	-	-	78	1.41	0.66	0.277	unknown
shc11b	c	Lintel over stairs	unknown	-	8½C	93	1.69	0.70	0.264	unknown
shc12	c	Door head	unknown	-	-	<40	NM	-	-	unknown
* **shc8925**		Mean of **shc08 + shc09 + shc25**	1061–1216	1214	Avg. H/S	156	1.29	0.41	0.201	1225–55
East Tower										
* **shc16**	c	Lintel over door, east bay	1092–1180	1173	7	89	2.41	0.62	0.218	1184–1214
shc18a	*c*	*Lintel over stairs*	*1075–1168*	-	-	*94*	*1.06*	*0.55*	*0.276*	
shc18b	*c*	*Lintel over stairs*	*1107–1168*	-	-	*62*	*1.24*	*0.68*	*0.226*	
shc18		Mean of **shc18a + shc18b**	1075–1168	-	-	94	1.10	0.57	0.249	(1234–64)
shc19	c	Lintel over stairs	1113–1223	1223	H/S	111	2.45	1.18	0.274	1234–64
* **shc1819**		Mean of **shc18 + shc19**	1075-1223	1223	H/S	149	1.78	0.95	0.263	1234–64
shc20	c	Lintel over stairs	unknown	-	-	84	0.96	0.36	0.242	unknown
shc21	c	West rafter over stairs	unknown	-	28	148	0.94	0.42	0.190	unknown
shc22	c	Middle rafter over stairs	unknown	-	+33NM	130	0.93	0.58	0.265	unknown
* **shc23**	c	Window lintel	1103–1192	-	-	90	1.74	0.62	0.184	after 1203
shc24	c	Lintel over stairs	unknown	-	-	46	1.82	0.39	0.209	unknown
shc25	c	Lintel over stairs	1135–1214	1214	H/S	80(+74NM)	1.32	0.49	0.241	1225–55
* **shc26**	c	Bottom lintel over stairs	1154–1215	1215	-	62	1.63	0.66	0.258	1226–56
shc27a	*c*	*Roof lintel over stairs*	*1147–1208*	*1208*	*H/S*	*62*	*0.98*	*0.32*	*0.219*	
shc27b	*c*	*Roof lintel over stairs*	*1058–1207*	*1207*	*H/S*	*150*	*1.07*	*0.61*	*0.252*	
* **shc27**		Mean of **shc27a + shc27b**	1058–1208	1208	H/S	151	1.06	0.61	0.251	1219–49
*** = SHRWCST1 Site Master**			**1058–1223**			**166**	**1.54**	**0.59**	**0.183**	

NM = not measured H/S = heartwood-sapwood boundary C = complete sapwood (winter felling), ½C = complete sapwood with additional incomplete

Table 2: Summary of tree-ring dating for seventeenth-century hall reconstruction at Shrewsbury Castle, Shropshire

Sample number & type		Timber and position	Dates AD spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges (AD)
Ground Floor Beams										
shc01	c	Beam at east end	unknown		H/S?	36	NM	-	-	unknown
shc02	c	Lintel over doorway	unknown		H/S?	73	1.87	0.74	0.236	unknown
* **shc03**	c	Beam 2	1508–1626	1626	H/S	119	2.13	0.90	0.288	1637–67
* **shc04**	c	Beam 3	1501–1625	1625	H/S	125	1.81	0.57	0.185	1636–66
* **shc05**	c	Beam 5	1536–1622	1622	H/S	87	2.17	0.95	0.197	1633–63
* **shc06**	c	Beam 6	1498–1631	1620	11	134	1.90	1.08	0.202	1631–61
shc07a	c	Beam 7	1510–1647	1630	17C	138	1.64	0.81	0.228	Winter 1647/8
shc07b	c	Beam 7	1510–1617	-	-	108	1.32	0.69	0.212	after 1628
* **shc07**		**shc07a + shc07b**	1510–1647	1630	17C	138	1.47	0.70	0.209	Winter 1647/8
Hall Roof										
shc13	c	North upper purlin, west bay	unknown	-	H/S	50	2.71	1.19	0.226	unknown
shc14	c	South lower purlin, east bay	unknown	-	-	<40	NM	-	-	unknown
shc15	c	South upper purlin, east bay	unknown	-	-	42	4.18	1.47	0.222	
shc17	c	East tie	unknown	-	-	54	4.22	1.61	0.193	unknown
Hall Screen										
shc28	c	Internal post	unknown	-	-	43	3.31	0.72	0.208	unknown
* **shc29**	c	Lower rail	1532–1636	1622	14	105	1.84	0.50	0.151	1636–63
* **shc30**	c	Lower stud	1571–1626	1626	-	56	2.81	0.53	0.178	1637–67
shc31	c	Sill beam	unknown	-	5	39	2.92	0.81	0.320	unknown
* **shc32**	c	Lower rail	1561–1632	1624	8	72	2.33	0.53	0.150	1635–65
*** = SHRWCST2 Site Master**			**1498–1647**			**150**	**2.01**	**0.59**	**0.165**	

NM = not measured
H/S = heartwood-sapwood boundary
C = complete sapwood (winter felling)

Table 3: Matrix of *t* -values and overlaps for components of **shc8925**

Sample:	**shc09**	**shc25**
Last ring date AD:	1213	1214
shc08	9.71	9.64
	72	73
shc09		9.76
		103

Table 4: Matrix of *t* -values and overlaps for components of **shc1819**

Sample:	**shc19**
Last ring date AD:	1223
shc18	11.46
	56

Table 5: Matrix of *t*-values and overlaps for components of chronology **SHRWCST1**

Sample:	**shc10**	**shc16**	**shc1819**	**shc23**	**shc26**	**shc27**
Last ring date AD:	1193	1180	1223	1192	1215	1208
shc8925	3.42	0.12	5.65	7.09	3.85	1.79
	75	89	142	90	62	148
shc10		4.74	6.24	4.48	0.73	6.45
		62	75	74	40	75
shc16			5.34	2.11	0.27	4.93
			89	78	27	89
shc1819				6.54	2.91	6.84
				90	62	134
shc23					0.15	4.04
					39	90
shc26						1.68
						55

Table 6: Matrix of *t*-values and overlaps for components of chronology **SHRWCST2**

Sample:	**shc04**	**shc05**	**shc06**	**shc07**	**shc29**	**shc30**	**shc32**
Last ring date AD:	1625	1622	1631	1647	1636	1626	1632
shc03	6.35	4.57	3.09	5.87	5.78	3.04	5.26
	118	87	119	117	95	56	66
	shc04	4.06	6.37	4.50	3.82	3.93	2.95
		87	125	116	94	55	65
		shc05	2.08	2.80	3.32	0.05	3.11
			87	87	87	52	62
			shc06	6.85	2.26	3.20	2.31
				122	100	56	71
				shc07	2.03	2.43	3.55
					105	56	72
					shc29	2.36	4.12
						56	72
						shc30	3.73
							56

Table 7: Dating evidence for the site chronology **SHRWCST1**, AD 1058–1223
Regional multi-site chronologies have the file name in **bold**

	County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	England	English Master Chronology	*(Baillie and Pilcher 1982 unpubl)*	**ENGLAND**	404–1981	166	7.7
	Cheshire	Nantwich	*(Leggett* et al *1982)*	NANTWICH	930–1330	166	7.4
	Wales	Welsh Master Chronology	*(Miles 1997b unpubl)*	**WALES97**	404–1981	166	7.1
	Shropshire	Shropshire Master Chronology	*(Miles 1995 unpubl)*	**SALOP95**	881–1745	166	6.5
	Southern England	Southern England Master	*(Hillam and Groves 1994b unpubl)*	**SOUTH**	406–1594	166	6.3
	Northern England	Northern England Master	*(Hillam and Groves 1994a unpubl)*	**NORTH**	440–1972	166	6.2
	London	Swan Lane	*(Groves and Hillam 1987)*	SWANMED	938–1192	135	6.2
	Bristol	Bristol Master Chronology	*(Hillam 1994 unpubl)*	**BRISTOL**	770–1320	166	5.8
	Southern England	Southern England Master	*(Bridge 1998 unpubl)*	**SENG98**	944–1790	166	5.4
‡	Shropshire	Great Oxonbold	*(Miles and Haddon-Reece 1993)*	GTOXNBLD	1081–1246	143	5.3
	Oxfordshire	Great Coxwell Barn	*(Siebenlist-Kerner 1978)*	COXWELL	1043–1267	166	5.2
	Cambridgeshire	Peterborough Cathedral	*(Tyers 1999)*	PETERC	887–1225	166	5.2
	East Midlands	East Midlands Master Chronology	*(Laxton and Litton 1988)*	**EASTMID**	882–1981	166	5.2
	Yorkshire	York Medieval Chronology	*(Groves pers comm)*	**YORKMEDX**	695–1567	166	5.1
	London	London Master Chronology	*(Tyers pers comm)*	**LONDON**	413–1728	166	5.0

‡ component of SALOP95

Table 8: Dating evidence for the site chronology **SHRWCST2**, AD 1498–1647
Regional multi-site chronologies have the file name in **bold**

	County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
‡	Shropshire	Golding Farmhouse	*(Miles and Haddon-Reece 1994)*	GOLDING	1491–1666	150	9.5
	East Midlands	East Midlands Master Chronology	*(Laxton and Litton 1988)*	**EASTMID**	882–1981	150	9.3
	Shropshire	Shropshire Master Chronology	*(Miles 1995 unpubl)*	**SALOP95**	881–1745	150	9.0
	Shropshire	Old Hall Farm, All Stretton	*(Miles and Haddon-Reece 1996)*	OLDHLLFM	1379–1630	133	8.8
	Shropshire	Langley Gatehouse	*(Hillam and Groves 1993)*	LANGLEY	1491–1600	103	8.5
	Shropshire	Clungunford Master Chronology	*(Miles 2002 unpubl)*	**CLNGNFRD**	1273–1653	150	8.4
	Buckinghamshire	Pitstone Windmill	*(Bridge 2004 unpubl)*	PITSTN2	1489–1669	150	8.2
	Yorkshire	York Medieval Chronology	*(Groves pers comm)*	**YORKMED**	1320–1696	150	8.1
	Northern England	Northern England Master	*(Hillam and Groves 1994a unpubl)*	**NORTH**	440–1972	150	8.1
	Wales	Welsh Master Chronology	*(Miles 1997 unpubl)*	**WALES97**	404–1981	150	7.7
	Shropshire	Ightfield Hall barn, Whitchurch	*(Groves 1997)*	IGHTFELD	1341–1566	69	7.6
	Shropshire	High Ercall Hall	*(Miles and Worthington 2002)*	HIERCALL	1390–1607	110	7.1
	Northamptonshire	Dower House, Fawsley Park	*(Howard* et al *1999)*	FAWSLEY1	1427–1575	78	7.0
	Southern England	Southern England Master	*(Bridge 1998 unpubl)*	**SENG98**	944–1790	150	7.0
	Welsh borders	Hillside oaks	*(Siebenlist-Kerner 1978)*	**GIERTZ**	1341–1636	139	6.9
	Shropshire	Bear Steps, Fish Street	*(Miles and Worthington 1997)*	BEARSTP2	1478–1607	110	6.6
	Shropshire	Hudsons, Shrewsbury	*(Miles and Worthington 2000)*	HUDSON	1511–1609	99	6.6

‡ Component of SALOP95

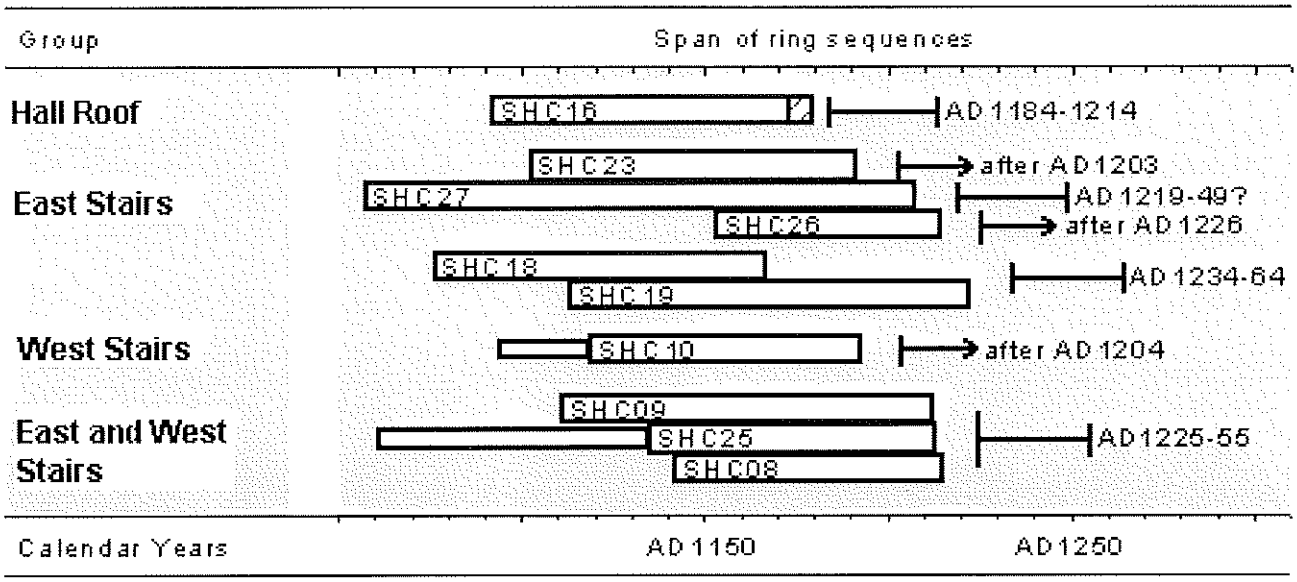

Figure 7: Bar diagram showing the origin, relative positions of overlap, and interpreted felling dates of timbers in the site chronology **SHRWCST1**. Hatched sections represent sapwood, and narrow sections represent additional unmeasured rings

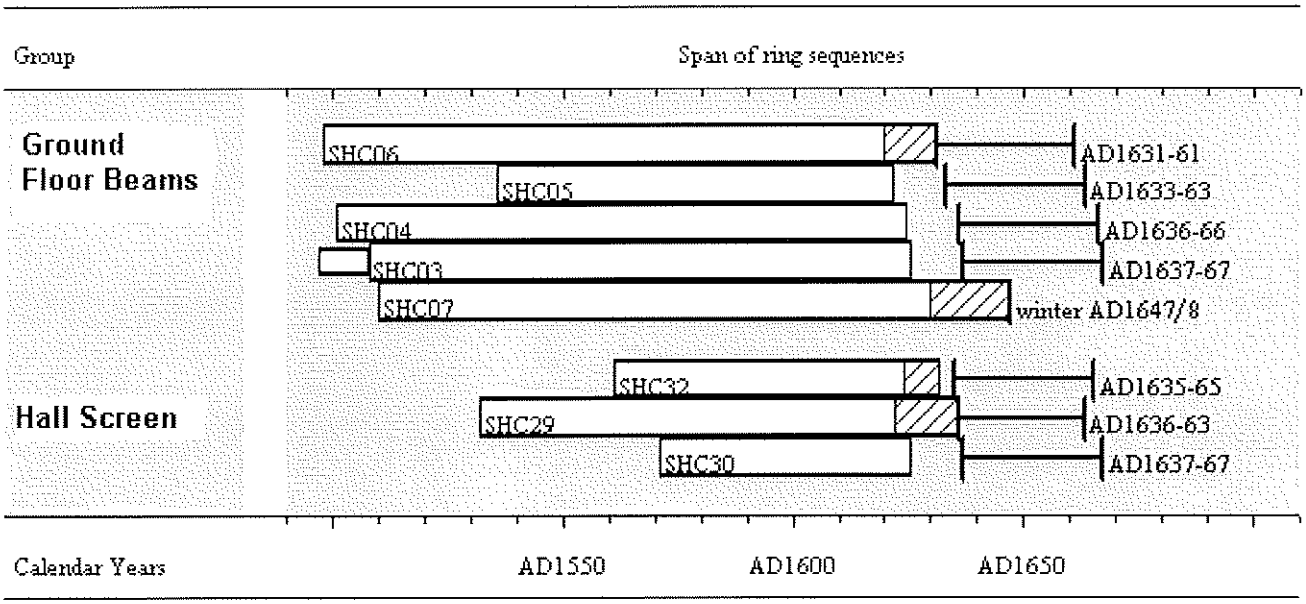

Figure 8: Bar diagram showing the origin, relative positions of overlap, and interpreted felling dates of timbers in the site chronology **SHRWCST2**. Hatched sections represent sapwood, and narrow sections represent additional unmeasured rings

Interpretation and Discussion

The earliest felled timber identified in this study was the reset diagonal timber by the entrance into the east balcony of the Hall, most likely felled in the period AD 1184–1214. Several of the lintels forming the roof to the stairs at either end of this building dated, along with a window lintel from the east stair area, and when taken as a group, the most likely felling period for these timbers is AD 1234–49. That **SHC08, SHC09,** and **SHC25** appear to have come from the same tree is of interest, since they are at about the same vertical level at either end of the Hall, perhaps suggesting that both stairways were being constructed at the same time and rate.

Although it is generally believed that the present castle was built by Edward I in the AD 1280s (M Moran pers comm), the dating here is clearly earlier. This would suggest that the Hall and adjoining east and west towers were reconstructed at least a generation earlier, probably during the reign of Henry III. This is supported by one documentary reference that '...Henry III came here four times between 1220 and 1241 and in whose reign the town walls and castle were built' (Priestley 1982). Therefore, dendrochronology has pushed the known history of Shrewsbury Castle to the reign of Henry III, predating Edward I's fortification of the Welsh border.

Five of the large beams forming the ceiling to the ground floor and the floor to the Hall form a group of timbers with similar felling date ranges. One of these timbers had complete sapwood and was felled in the winter of AD 1647/8, suggesting construction in AD 1648 or a few years thereafter. None of the screen timbers retained complete sapwood, although they seem likely to be exactly contemporaneous with the floor beams.

During the Civil War, the castle was held for the King, and was the centre of Royalist operations. In 1643 a Royalist noted that the castle was ruinous and put repairs in hand (Owen and Blakeway 1825, 436). However, it was captured by the Parliamentarian forces on 22 February 1645, although it was not by siege, but through a defector within the Royalist camp (M Moran pers comm). Again, the dendrochronology contradicts the generally perceived wisdom that the new floor and screens in the hall were built by the Royalists in readiness for war, and has shown that they were in fact built by the Parliamentarians during their control of the castle. The castle reverted to the King at the Restoration in AD 1660.

Further Recommendations

If the hall roof becomes more readily accessible in the future then serious consideration should be given to the possibility of undertaking further dendrochronological work. This analysis has shown the marginal nature of the timber used but extensive sampling may well increase the possibility of obtaining a date for this roof. Similarly, should any of the decorative finishes be removed in the lower levels of the west tower, this would provide the opportunity to assess the dendrochronological potential of the timbers. Finally, the eastern gateway at the top of the cliff was noted to have some tree-ring potential, though this would most likely require the micro-boring equipment to obtain an adequate number of samples.

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Table 9: Ring width data for the site chronologies from Shrewsbury Castle, Shrewsbury, Shropshire

ring widths (0.01mm)										no of trees									
SHRWCST1 Dated AD1058 to AD1223																			
522	366	379	232	150	179	142	125	130	141	1	1	1	2	2	2	2	2	2	2
133	125	104	72	78	107	95	215	112	120	2	2	2	2	2	2	2	3	3	3
122	106	112	82	86	99	106	104	128	102	3	3	3	3	3	3	3	3	3	3
87	96	53	96	139	177	148	145	124	132	3	3	3	3	4	4	4	4	4	4
124	121	102	95	130	196	177	196	167	143	4	4	4	4	4	5	5	5	5	5
143	161	148	156	155	187	180	184	147	136	5	5	5	5	5	5	5	5	5	5
135	129	172	198	213	216	198	189	158	109	5	6	6	6	6	6	6	6	6	6
98	112	126	133	145	101	121	182	117	90	6	6	6	6	6	6	6	6	6	6
138	125	154	173	190	142	141	145	162	142	6	6	6	6	6	6	6	6	6	6
175	211	188	174	165	215	169	202	181	188	6	6	6	6	6	6	7	7	7	7
178	159	194	173	165	156	125	132	154	173	7	7	7	7	7	7	7	7	7	7
197	224	184	127	124	167	205	179	198	161	7	7	7	7	7	7	7	7	7	7
178	169	146	118	169	98	83	138	119	184	7	7	7	6	6	6	6	6	6	6
109	129	171	142	113	103	121	163	205	161	6	6	6	6	6	5	4	4	4	4
182	156	165	176	141	109	98	111	150	97	4	4	4	4	4	4	4	4	4	4
122	117	133	84	76	100	99	110	149	362	4	3	3	3	3	3	3	3	2	1
336	283	289	236	164	146					1	1	1	1	1	1				
SHRWCST2 Dated AD1498 to AD1647																			
88	216	407	269	314	296	344	406	307	253	1	1	1	2	2	2	2	2	2	2
257	314	262	262	312	305	278	254	280	215	3	3	4	4	4	4	4	4	4	4
222	309	270	314	332	246	252	188	225	266	4	4	4	4	4	4	4	4	4	4
264	230	131	250	177	205	184	216	292	272	4	4	4	4	5	5	5	5	6	6
243	228	260	198	141	183	165	175	175	167	6	6	6	6	6	6	6	6	6	6
203	209	217	215	174	179	157	137	110	113	6	6	6	6	6	6	6	6	6	6
129	156	192	174	161	157	154	137	120	158	6	6	6	7	7	7	7	7	7	7
183	208	220	209	174	213	278	247	176	179	7	7	7	8	8	8	8	8	8	8
160	185	249	224	178	204	207	246	258	218	8	8	8	8	8	8	8	8	8	8
191	227	167	178	181	199	234	205	166	169	8	8	8	8	8	8	8	8	8	8
188	169	154	188	214	226	182	129	181	215	8	8	8	8	8	8	8	8	8	8
221	211	188	142	136	151	127	158	203	216	8	8	8	8	8	8	8	8	8	8
221	176	208	184	174	147	133	141	189	174	8	8	8	8	8	7	7	7	6	4
159	162	144	113	133	135	120	121	134	97	4	4	4	4	3	2	2	2	2	1
158	133	174	205	92	160	147	187	213	150	1	1	1	1	1	1	1	1	1	1