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Summary

Ten timbers were sampled at the Church of St Matthew, Harlaston, Staffordshire : five from the nave and five from the tower bell frame. Four samples from the nave combined to form the 116-ring site master STMNAVE that dated, spanning the years AD 1289-1404. Absence of sapwood precluded the production of a precise felling date, but an estimated felling date range of AD 1415-1438 has been obtained. This supports the suggestion that the roof is not original.

Only a single post dated from the tower frame, spanning the years AD 1341-1456. A detached section of sapwood allowed a narrow felling date range of circa AD 1480-85 to be given for this timber. This represents a late use of an archaic lap-jointed form of timber framing. However, as this timber was clearly reused, it provides a *terminus post quem* date of after circa AD 1485 for the present frame.

Keywords

Dendrochronology
Standing Building

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THE TREE-RING DATING OF THE CHURCH OF ST MATTHEW, HARLASTON, STAFFORDSHIRE

Description of building

The Church of St Matthew, Harlaston, Staffordshire (SK 2150 1095) is situated between the core of the village and its medieval manorial moated site (Fig 1). It consists of the usual arrangement of a nave with a chancel to the east, and a tower to the west, and a small timber framed porch to the south door.

Between AD 1838 and AD 1882 the nave and chancel were rebuilt largely in brick above what look like thirteenth-century foundations of coursed and squared sandstone blocks. There is speculation that the nave roof has been imported from another building, possibly the adjoining manor house (now demolished), on mass during the AD 1838/9 rebuild. Then the new north and south walls were built to accommodate it. These new walls were also located either intentionally or accidentally on the line of a possible timber-framed nave with narrow aisles. The south wall over the south arcade and the north wall reflect the original line of the north wall (Meeson unpubl). Accordingly, the tower arch is offset to the south of the central axis of the nave. The main tie-beam roof truss across the nave has a single collar, curved raking strut and curved V-struts.

The west tower is sub-rectangular in plan. The exterior face of the west wall was rebuilt in AD 1882-3 using brick on a low stone plinth. The other wall is constructed of large blocks of evenly-coursed rubble sandstone. The lower masonry is circa AD 1200, with the exception of the brick west wall. The ringing chamber in the tower and the turret above are carried by two timber trusses. Each truss comprises substantial posts rising from a plate. The angles are stiffened by long curved braces. Although the posts and braces are inserted, indicated by redundant mortices, it is unknown if they relate to an earlier tower frame, or whether they are reused from another building which was potentially aisled (Meeson unpubl). The plates are later than both the posts and the braces.

Objectives of dating

There were two primary objectives of the dendrochronological analysis of this building. Firstly in the tower, it was hoped to ascertain the date of construction of the substantial inserted timber trusses, also providing a typological parallel for lap joints in the West Midland area.

Secondly, dating the nave roof would help to determine whether it is a piece of nineteenth-century conscious antiquarianism or a re-used medieval structure. Thus, the dating would help in the understanding of the development of the church.

Commissioners

The work to the nave was commissioned by the English Heritage Centre for Archaeology following a request from Mr Alan Taylor, Historic Buildings Architect for the English Heritage West Midlands Regional Team. This analysis formed part of a dendrochronology training programme at Oxford University, funded by English Heritage and supervised by the second author.

Methodology

The samples were taken using a 16mm hollow auger powered by an electric drill. The samples were sanded on a linisher using 60 to 1000 grit abrasive paper. These were then measured to an accuracy of 0.01mm using a travelling stage attached to a microcomputer-based measuring system (Reynolds pers comm 1998).

The samples were compared with each other using dendrochronological techniques as outlined in English Heritage (1998). This involved both visual comparisons using semi-logarithmic graphs as well as statistical cross-correlations using a computer. This utilised cross-correlation algorithms (Baillie and Pilcher 1973) which have been implemented using computer software written for Windows in Visual Basic by M R Allwright and P A Parker. In comparing two individual samples, a *t*-value of 3.5 or higher is usually indicative of a good match, whilst *t*-values of 10 and above often suggest that samples have originated from the same parent tree. All individual samples showing a match with consistently high correlation during cross-matching are averaged together to form a mean site master. On comparing this site master with dated reference chronologies, *t*-values of 5 and above are normally expected. A conclusive match should also exhibit the highest cross-matches with reference chronologies of local origin to where the trees used grow as well as with well-replicated regional chronologies from the area where the trees used grow. Matching positions suggested by computer are confirmed by satisfactory visual matching.

On some occasions duplicate samples are taken, usually when the sapwood rings break up during coring. A second core retaining complete sapwood is vital in determining a precise felling date. Occasionally, two cores are taken from a timber, the first extending nearer the pith or centre of the tree, and the second extending nearer or to the bark edge. When these are combined, a longer sequence is produced, which is more likely to cross-match successfully.

Once a ring sequence has been dated chronologically, the date of felling needs to be interpreted. When the sapwood is complete on a sample, the determination of a felling date is relatively straight-forward. Each growth ring is comprised of one or more rows of open spring vessels, or early wood, followed by a band of dense summer growth or late-wood. During the winter months the tree remains dormant. If both the spring and summer growth are present and thought to be complete, then the tree would have been felled during the winter period. If only the spring vessels are present beneath the bark, then the tree can be said to have died or been felled during the spring period. If only a few vessels are present, then it is possible to further refine the time of felling to *early spring*. If some dense wood or summer growth is present, then a *summer or autumn* felling period can be determined. However, as it is not known how wide the summer

growth band should be for that particular tree, it cannot be stated conclusively whether the tree was felled in early or late summer, or if indeed it was felled at some point in the winter. For instance, a severe May frost can suddenly halt their growth, which would produce a very narrow ring with little or no summer wood (Baillie 1982, plate 2c). Therefore, a certain degree of caution should be used in interpreting felling seasons between summer and autumn, or even winter seasons in some instances. Only apparently complete rings indicating felling during the winter months are measured, samples exhibiting spring or summer growth would give a felling date during the year following the last measured ring.

If the outer most rings are missing but the heartwood sapwood boundary survives, then the number of missing sapwood rings can be estimated using an empirically derived sapwood estimate. The sapwood estimate used in this report is 12 to 45 rings, the 95% confidence range calculated for Staffordshire and the North. Samples only having heartwood but without any indication of a heartwood/ sapwood transition are given a *terminus post quem* or felled after date which is calculated by adding a minimum of 12 years to the last ring present on the sample (Miles 1997).

Where a group of samples have been dated from the same phase, the average heartwood/sapwood boundary date is derived from the individual heartwood/ sapwood boundary dates from the individual samples. This average heartwood/sapwood boundary date is then used to calculate a felling date range, in the same manner as an individual sample. When an individual heartwood/sapwood boundary date is nearer to the earliest part of the average felling date range by less than the minimum number of rings of the estimate (ie 12 years) the early part of the range is adjusted by adding the minimum *absolute* range (ie 11 years) to the latest individual heartwood/ sapwood boundary to reduce the range respectively.

It should be remembered that dendrochronology can only date when the tree died, not the date of construction for a building or artefact. The interpretation of a felling date relies on having a good number of precise felling dates rather than just one or two. Nevertheless, it was common practice to build timber-framed structures with green or unseasoned timber, and construction usually took place within twelve months of felling (Miles 1997).

Assessment and Sampling Strategy

The aim of the assessment was to find a number of timbers, ideally a minimum six to ten per building phase or area, containing at least fifty annual rings. Samples with fewer than fifty annual rings are less likely to date, making them unsuitable for dendrochronological analysis. Samples with complete sapwood were also sought as these would allow precise dates to be assigned for the time of the tree's felling.

The nave roof was assessed but large areas were found to be inaccessible due to the locations of the pews, making it impractical to use a scaffold tower. However access to the tiebeams and a number of studs was gained using a long extension ladder. All three tiebeams and two studs from the first truss were found to have heartwood/sapwood transition and sufficient rings to make sampling them worth while.

The trusses in the west tower had relatively poor dendrochronological potential and accessibility precluded sampling any higher timbers safely. The plates and their braces did not have sufficient ring counts to warrant sampling. From the lower bell-frame supports located in the ground floor of the tower, three of the posts had more than 50 annual rings but one of these had only just over 50 rings. The braces connecting the top of the posts to the plates looked borderline for analysis. As this bell frame possibly could be thirteenth century, all four posst and a brace were sampled, with three of the timbers retaining complete sapwood. Details of the samples and their locations can be seen in Table 1 and Figures 2 and 3.

Cross-matching and site chronology

Of the five timbers from the tower, samples ***smhn1b*** and ***smhn1c*** with complete sapwood were taken to complement ***smhn1a***. Multiple samples were taken to enable a longer ring sequence with bark edge to be obtained. Only samples ***smhn1a*** and ***smhn1c*** match each other with a *t*-value of 6.93 and were combined together to form the mean ***smhn1***. Samples ***smhn2a*** and ***smhn2b*** were rejected at this point as they both contained too few annual rings for analysis. Samples ***smhn3a*** and ***smhn3b*** were found to match with a *t*-value of 6.93 and were combined to form ***smhn3***. Multiple samples were taken in the hope that more sapwood wood could be retained during coring; unfortunately this was not the case.

None of the suitable samples from the tower were found to cross-match each other, nor did they match with any of the samples from the nave or site master ***STMNAVE***.

Samples ***smhn11***, ***smhn13***, ***smhn14***, and ***smhn15*** were found to match with sufficiently good and consistent correlation between them to be combined at the positions given in Table 2 to form the 116-year site master ***STMNAVE*** (Table 3).

Absolute dating

Each individual sample from the tower was compared with the reference chronologies but only sample ***smhn3*** was found to date conclusively, spanning the years AD 1441-1456 (Table 4 and 5). Once the 19 sapwood rings from sample ***smhn3b2*** had been added to this, a date range of AD 1480-85 was assigned to this sample (Fig 4, Table1).

The site master ***STMNAVE*** from the nave roof was then compared with over 1200 dated reference chronologies from the British Isles and was found to date, spanning the years AD 1289 to 1404 (Table 6). Sample ***smhn13*** was also compared with the reference chronologies but was found not to date (Fig 4, Table1).

All four dated samples from the nave retained their heartwood/sapwood boundaries, although no sapwood remained. These produced felling date ranges of AD 1401-34, 1397-1430, 1416-49, and 1404-38 for samples ***smhn11***, ***smhn12***, ***smhn14***, and ***smhn15*** respectively (Fig 4, Table 1). To determine a felling date range for the group of nave roof timbers, the average heartwood/sapwood boundary date of AD 1393 was used to produce a felling date range of AD 1405-38. Given that sample ***smhn14*** had a heartwood/sapwood boundary date finishing in AD 1404, the earlier end of the range

was adjusted by adding the minimum absolute range of 12 years the minimum number of sapwood rings found on timbers from this area (Miles 1997) to AD 1416, giving a revised felling date range of AD 1415-38 for the nave roof timbers as a group.

Interpretation and discussion

Although none of the timbers dated are primary to the construction of the church, the dates produced are nevertheless helpful to further understanding of the architectural development of the nave and tower. One post from the massive timber frame supporting the bell frame was felled AD 1480-85. Clear evidence in the form of redundant mortices suggests that this has been reused, thus the date range relates to an earlier use and context. However, this dating is useful in that it shows that the present structure must post-date AD 1480-85. This clearly demonstrates that the tower-bell support frame is neither fourteenth nor fifteenth century, and unlikely to be early-sixteenth century. Whilst the possibility exists that the posts are relics of an earlier support frame from the tower, the positioning of the redundant mortices suggest that this would be extremely unlikely. However, it is plausible that the timbers were originally employed in an aisled frame or spere truss (Meeson *pers comm*).

Similarly, the felling date range of AD 1415-38 for the nave roof demonstrates that this cannot be the original roof of the nave. Although there are no signs of reuse, the roof is over four feet (1.3m) wider than the medieval footprint of the nave walls. Furthermore, the tower and its arch are no longer central to the axis of the nave. Therefore this roof must have been imported to the site during the Victorian rebuilding from another building (Meeson pers comm).

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Table 1: Summary of tree-ring dating

CHURCH OF ST MATTHEW, HARLASTON, STAFFORDSHIRE

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)
Tower Bell Support Frame									
smhn1a	North-west post	-		HW only	90	2.37	0.69	0.179	
smhn1b	ditto	-		HW only	43	2.18	0.57	0.163	
smhn1c	ditto	-		18C	70	1.44	0.60	0.218	
smhn1	Mean of ***smhn1a*** and ***smhn1c***	-		*18C*	*108*	*1.98*	*0.73*	*0.193*	
smhn2a	North-east post	-		H/S	33	4.11	1.37	0.300	
smhn2b	ditto	-		H/S	33	3.26	0.94	0.297	
smhn2	Mean of ***smhn2a*** and ***smhn2c***	-		21C	34	3.71	1.16	0.288	
smhn3a	South-east post	1341-1452		HW only	112	1.70	1.37	0.160	
smhn3b1	ditto	1342-1456	1455	1	115	1.33	0.94	0.166	
smhn3b2	ditto	-		19C	19	0.67	0.12	0.137	
smhn3	Mean of ***smhn3a*** and ***smhn3b***	*1341-1456*		*+19*	*116*	*1.51*	*1.15*	*0.146*	*1480-85*
smhn4	SW post	-		1	65	3.40	1.24	0.198	
smhn5a1	NW brace	-		7	44	2.75	1.05	0.234	
smhn5a2	ditto	-		20 ¼C	20	0.70	0.24	0.236	
Nave Roof									
* ***smhn11***	Stud 1st right hand side	1299-1389	1389	H/S	91	1.56	1.14	0.178	1401-34
smhn12	Stud 2nd from right hand side	-		H/S	51	1.49	1.17	0.244	
* ***smhn13***	West tiebeam	1291-1385	1385	H/S	95	1.05	0.43	0.219	1397-1430
* ***smhn14***	Centre tiebeam	1302-1404	1404	H/S	103	1.96	0.96	0.240	1416-49
* ***smhn15***	East tiebeam	1289-1392	1392	H/S	104	2.57	1.79	0.214	1404-37
* = **STMNAVE Site Master**		1289-1404	1393	Avg H/S	116	1.94	1.14	0.179	1415-1438

Key: * = sample included in site-master; ⊖ = pith included in sample; ¼C,½C,C = bark edge present, partial or complete ring: ¼C = spring (ring not measured), ½C = summer/autumn (ring not measured), or C = winter felling (ring measured); H/S bdry = heartwood/sapwood boundary - last heartwood ring date Hw only = heartwood only; std devn = standard deviation; mean sens = mean sensitivity, Sapwood estimate 12 - 45 rings for North (Miles 1997).

Table 2: Matrix of *t*-values and overlaps for components of ***STMNAVE***

Sample:	***Smhn13***	***smhn14***	***smhn15***
Last ring date AD:	1385	1404	1392
smhn11 1389	2.24 / 87	2.38 / 88	5.34 / 91
Smhn13		4.89 / 84	4.24 / 95
		smhn14	2.87 / 91

Table 3: Ring-width data for site master curve
STMNAVE AD 1289-1404, the Church of St Matthews, Harlaston, Staffordshire - mean of samples ***smhn11*** + ***smhn13*** + ***smhn14*** + ***smhn15***
116 rings, starting date AD 1289

ring widths (0.01mm)	***number of samples in master***
742 550 443 442 458 325 278 291 340 316	1 1 2 2 2 2 2 2 2 2
301 300 407 378 284 428 402 286 352 305	3 3 3 4 4 4 4 4 4 4
300 265 253 268 231 288 334 321 288 276	4 4 4 4 4 4 4 4 4 4
296 244 282 208 189 130 155 128 174 263	4 4 4 4 4 4 4 4 4 4
200 132 096 119 138 161 141 152 122 132	4 4 4 4 4 4 4 4 4 4
176 155 144 139 114 109 156 112 109 121	4 4 4 4 4 4 4 4 4 4
118 081 114 118 180 143 120 112 123 112	4 4 4 4 4 4 4 4 4 4
112 136 133 148 126 111 102 104 117 078	4 4 4 4 4 4 4 4 4 4
086 096 096 066 077 077 092 091 112 130	4 4 4 4 4 4 4 4 4 4
134 120 104 108 105 084 102 135 103 102	4 4 4 4 4 4 4 3 3 3
070 100 140 178 243 238 175 271 177 144	3 2 2 2 1 1 1 1 1 1
224 267 136 126 172 226	1 1 1 1 1 1

Table 4: Dating of ***smhn3*** against reference chronologies at AD 1456.

	Site name and location	Reference chronology	Spanning	Overlap	t-value
*	St Cuthbert's, Wick, Worcestershire	WICK (Bridge 1983)	1255-1496	116	5.25
†	House of Prayer Barn, Burnham, Buckinghamshire	BURNHAM (Miles and Haddon-Reece 1995)	1300-1505	116	5.26
*	East Midlands Master	**EASTMID** (Laxton and Litton 1988)	882-1981	116	5.32
	Mamble, Worcestershire	MAMBLE_B (Tyers 1996)	1348-1582	109	5.37
	Chicksands Priory, Bedfordshire	CHKSPQ01 (Howard *et al* 1998)	1200-1541	116	5.38
	Shropshire Master Chronology	**SALOP95** (Miles 1995)	881-1745	116	5.39
*	Southern England Master	**SENGLAND** (Bridge 1988)	1083-1589	116	5.41
*†	Upwich salt making site, Worcestershire	UPWICH2 (Groves and Hillam 1997)	946-1415	75	5.44
	Broad Street, Leominster, Herefordshire	LEOMSTR2 (Miles 2001)	1349-1499	108	5.49
	Kingswood Abbey, Gloucestershire	KGWASQ01 (Arnold, *et al* 2003)	1307-1428	88	5.55
	British Isles Master Chronology	**MASTERAL** (Haddon-Reece and Miles 1993)	404-1987	116	6.13
	Whitestaunton Manor, Somerset	wstn1 (Miles and Worthington 1997)	1343-1437	95	6.55
	150 High Street, Henley-in-Arden, Warwickshire	HIARDEN2 (Miles and Worthington 2002)	1293-1439	99	6.87

* Component of MASTERAL
† Component of SALOP95

Chronologies in bold denote regional masters

Table 5: Ring-width data for individual timber sequence

smhn3 AD 1341-1456, Nave SE post of Church of St. Matthew, Harlaston, Staffordshire
116 rings, starting date AD 1341

ring widths (0.01mm)	*number of samples in master*
371 450 513 419 436 374 398 458 469 414	1 2 2 2 2 2 2 2 2 2
417 322 348 313 326 284 295 304 311 210	2 2 2 2 2 2 2 2 2 2
184 188 254 252 204 200 188 160 160 114	2 2 2 2 2 2 2 2 2 2
094 118 108 108 114 086 096 096 135 096	2 2 2 2 2 2 2 2 2 2
099 100 092 070 084 099 115 124 111 116	2 2 2 2 2 2 2 2 2 2
105 108 092 100 110 136 190 220 218 242	2 2 2 2 2 2 2 2 2 2
226 151 171 142 121 126 112 122 124 108	2 2 2 2 2 2 2 2 2 2
103 080 092 070 078 064 074 077 066 056	2 2 2 2 2 2 2 2 2 2
090 082 099 084 076 051 058 074 062 073	2 2 2 2 2 2 2 2 2 2
054 096 064 065 080 067 059 056 041 058	2 2 2 2 2 2 2 2 2 2
044 060 062 062 052 062 056 060 068 069	2 2 2 2 2 2 2 2 2 2
074 063 074 072 063 066	2 2 1 1 1 1

Table 6: Dating of ***STMNAVE*** against reference chronologies at AD 1404.

	Site Name and location	Reference chronology	Spanning	Overlap	t-value
	Nostell Priory, Yorkshire	NOSTELL1 *(Tyers 1998)*	1263-1536	116	4.87
	The Peach Tree, Shrewsbury	PEACH2 *(Miles and Worthington 2000)*	1300-1430	105	4.89
ф	Welsh Master Chronology	**WALES97** *(Miles 1997)*	404-1981	116	4.89
‡	35 High Street, Winchester	BOOTS *(Miles and Haddon-Reece 1996)*	1263-1339	51	4.94
ф	Northern England Master	**NORTH** *(Hillam and Groves 1994)*	440-1742	116	5.02
	Shropshire Master Chronology	**SALOP95** *(Miles 1995)*	881-1745	116	5.08
	London Master Chronology	**LONDON** *(Tyers pers comm)*	413-1728	116	5.22
*	Windsor Castle kitchen, Berkshire	WINDSOR *(Haddon-Reece et al 1990)*	1231-1354	66	5.26
	Godfrey's Farm, East Hendred, Oxfordshire	eahc10 *(Miles and Worthington 2002)*	1301-1419	104	5.38
	Lane End, Muckleton, Shropshire	MUCKLTON *(Miles and Worthington 2002)*	1225-1371	83	5.44
	Claybrooke Parva, Leicestershire	CBPASQ01 *(Arnold, et al 2003b)*	1271-1416	116	5.87
	Hampshire Master Chronology	**HANTS02** *(Miles 2003)*	443-1972	116	5.91
ф	British Isles Master Chronology	**MASTERAL** *(Haddon-Reece and Miles 1993)*	404-1987	116	6.03
	Old Vicarage, Odiham, Hampshire	ODIHAMOV *(Miles and Worthington 2000)*	1295-1395	101	6.05
‡	King Street, Odiham, Hampshire	KINGST1 *(Miles and Haddon-Reece 1996)*	1169-1447	116	6.22
	Priory Barn, Lt Wymondley, Hertfordshire	LWYMON1 *(Bridge 2001)*	1283-1364	76	7.01

* Component of MASTERAL
‡ Component of HANTS02

ф Contain some of the same components

Chronologies in **bold** denote regional master

Figure 1: Map showing location of the Church of St. Matthew (No 62)

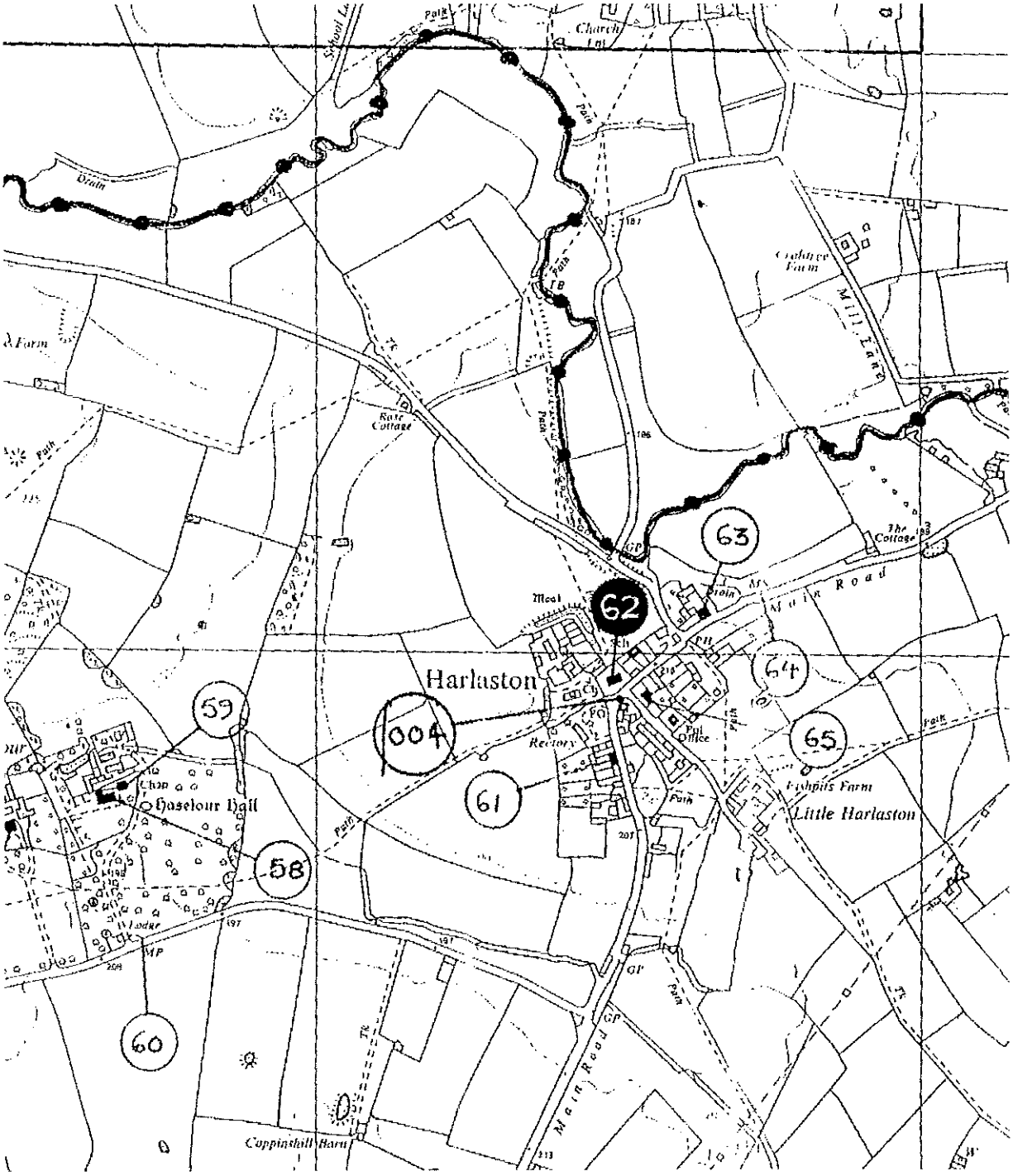

Figure 2: Floor plan showing locations of samples (After Meeson unpubl)

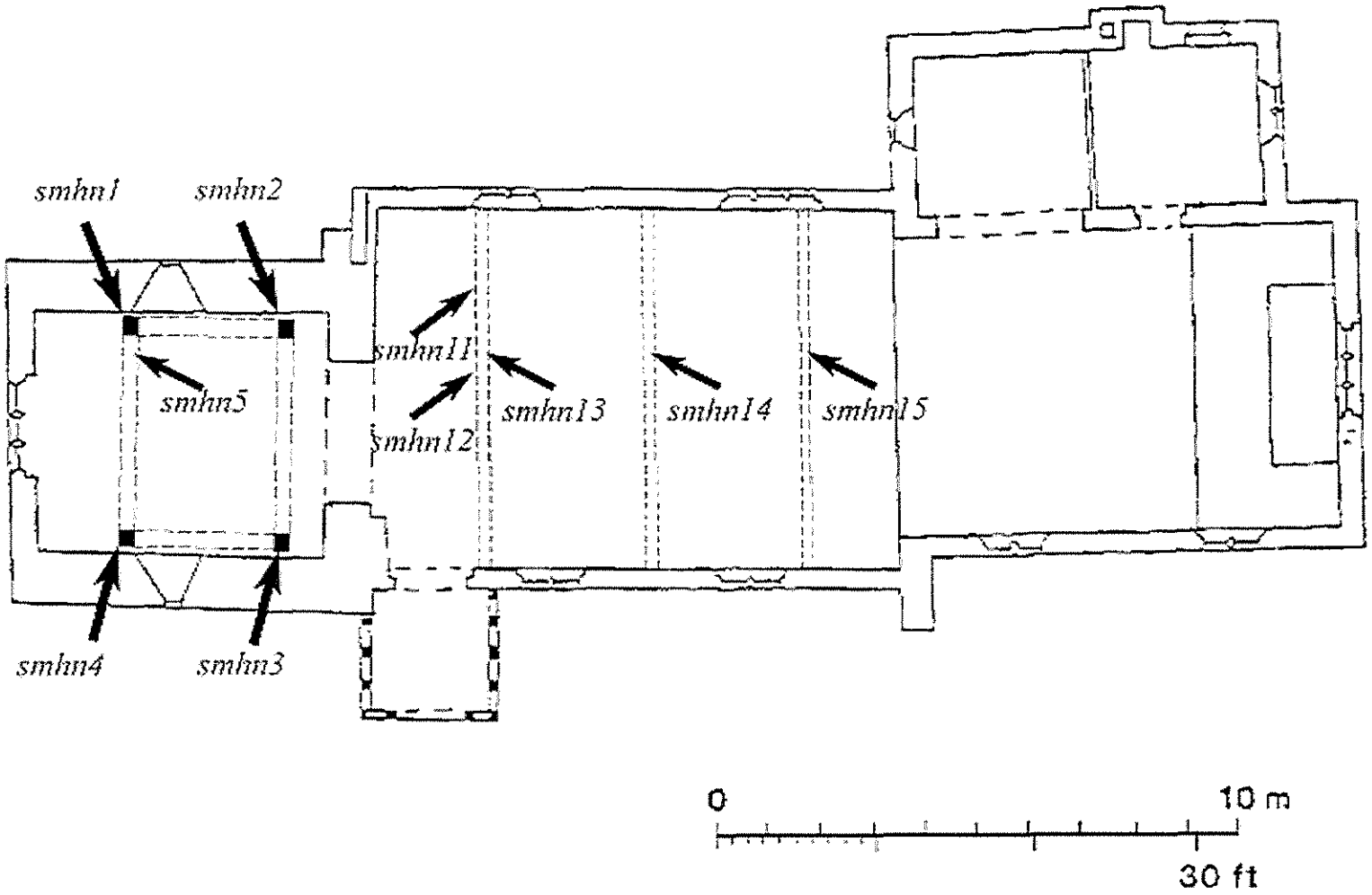

Figure 3: Sections through bell tower showing locations of samples (After Meeson unpubl)

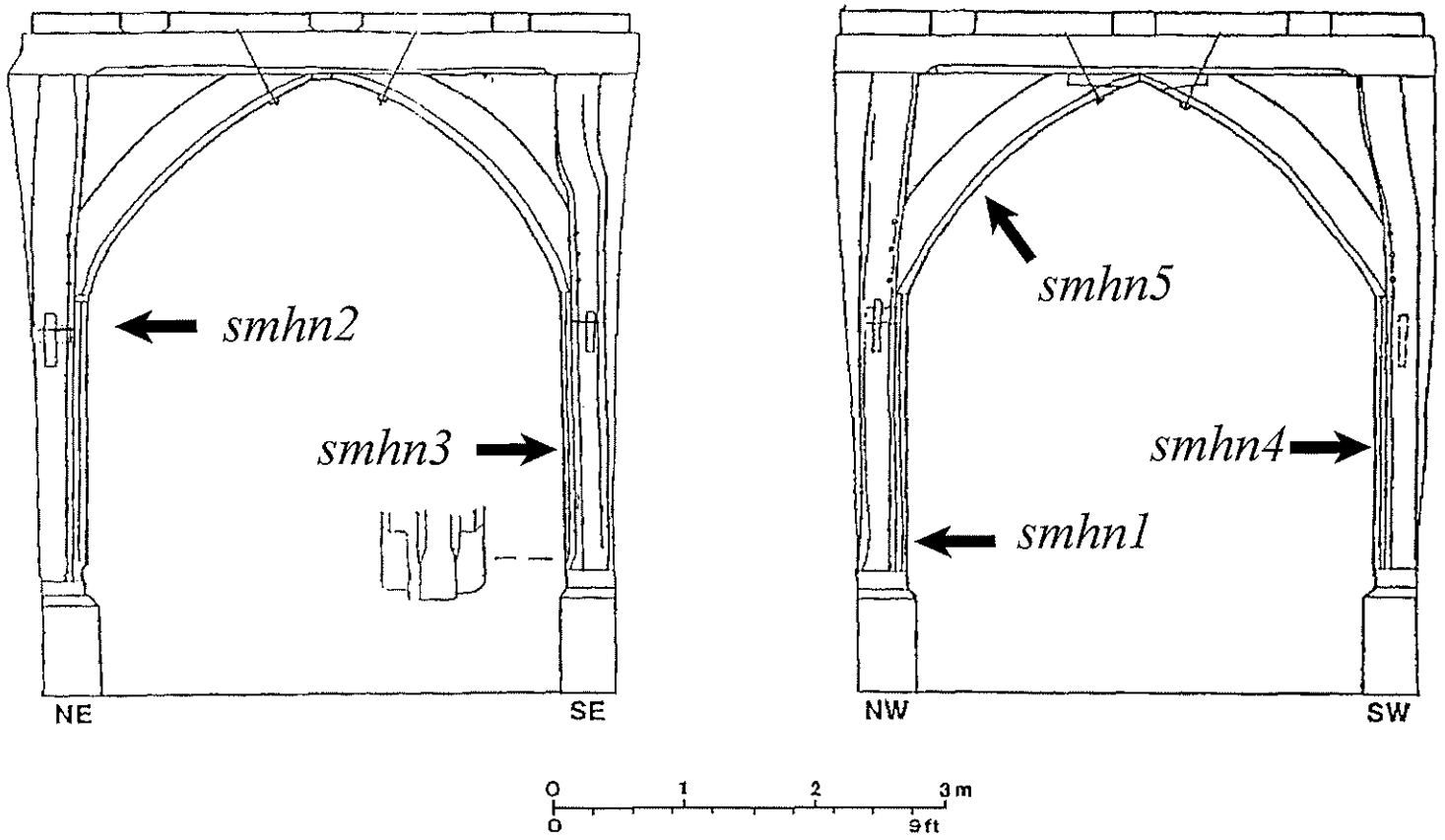

Figure 4: Bar diagram showing relative positions of dated samples