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Ancient Monuments Laboratory
Report 80/97

TREE-RING ANALYSIS OF TIMBERS FROM SINAI PARK, STAFFORDSHIRE

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Summary

Dendrochronological analysis of 28 samples from the building complex at Sinai Park, near Burton upon Trent, Staffordshire, has produced dates between the late fifteenth - and the mid seventeenth - centuries for the construction of various phases within the complex. As well as cores from in situ timbers, slices were also taken from some ex situ timbers, it was hoped these timbers would assist with the dating of the in situ assemblage. A number of potentially interesting groups of timbers within the building could not be sampled due to the general dilapidation of the structure. A tree-ring chronology dating from AD 1227 - 1750 inclusive was produced. Further work is recommended if the inaccessible parts of the building are renovated or demolished.

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TREE-RING ANALYSIS OF TIMBERS FROM SINAI PARK, STAFFORDSHIRE

Introduction

This document is a technical archive report on the tree-ring analysis of timbers from Sinai Park, near Burton upon Trent, Staffordshire (NGR SK223232). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. As part of a multifaceted and multidisciplinary study of the building, elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the building. The conclusions presented here may therefore have to be modified in the light of subsequent work, particularly as some groups of timbers could not be sampled for safety reasons.

Sinai Park is a large multi-period and mainly timber-framed house on a moated site overlooking Burton upon Trent. It has until recently been derelict, but a long-term restoration programme has now been initiated. As part of this programme the building has been the subject of an extensive analysis and survey report (Morriss 1995).

Sinai Park, in its present form, consists of a central range with two cross-wings. Morriss divides the structure into 11 component buildings, which he labels buildings A-K (Fig 1), and proposes an outline development of nine phases, which he labels phases one to nine. Morriss's component buildings and development phases are followed in this report, although it is inevitable, given the complexity of the structure and the poor survival of some of the phases, that any interpretative framework is a simplification.

During the period of the dendrochronological sampling programme any access to buildings G-K was forbidden on safety grounds, whilst the east end of building F was also out of bounds. The upper floor and roof of building C were also impossible to core whilst complying with safe working practises. Although it was hoped that safe access to this area would become available later, this has not yet happened. The sampling was concentrated on structures interpreted as belonging to development phases two to four inclusive. The tree-ring dating at Sinai Park was undertaken at the request of David Heath from English Heritage as part of the interpretative investigations on the site and so to inform repair decisions. The prime aim was to provide a more precise dating framework for the structure.

Methodology

Using plans and sections prepared by Richard Morriss the timbers in the accessible areas of the structure were carefully examined in an attempt to identify those timbers with the most suitable ring sequences for analysis. Those with more than 50 annual rings and some survival of the original sapwood and bark-edge were sought.

The twenty most promising timbers from buildings A-F were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken from the timbers in the most suitable direction for maximising the

numbers of rings for subsequent analysis. The core holes were left open. The ring sequences in the cores were revealed by sanding.

A second group of samples were obtained from some of the salvaged timbers stacked at the site, many of which are known to have been taken from the building during the initial stages of the restoration project. These wood piles were examined to try and identify material which would help with the construction of a well replicated local tree-ring sequence, and hence improve the chances of dating the *in situ* samples from the buildings. Eight selected timbers were sampled by cutting off 3cm thick slices with a bow-saw.

The complete sequences of growth rings in the samples that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These, and any remaining unmatched ring sequences were tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which may be missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Hillam *et al* 1987). The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence

concerning the reuse of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

The initial survey demonstrated that there were timbers suitable for analysis by dendrochronological methods present in several of the component buildings identified within the structure. The relative paucity of material with an abundance of rings, and the relatively small number of local reference chronologies for this area led to some concern over the chances of successfully dating all the elements, but the conviction that the wood piles included an interesting range of the material originally present in the buildings reduced those fears significantly. A total of twenty timbers within the structure, numbered **1-20** inclusive, were selected as most suitable for sampling (Table 1). Seven were from building A, two from building B, four from building C, five from building E, and two from building F. No suitable timbers survived in building D. Samples **2** and **3** were not successfully extracted, whilst sample **19** was in two sections. The eight timbers selected from the wood piles, numbered **101-108** inclusive, were all suitable. The origin and phasing of all the samples is summarised in Table 2.

Of the 26 usable samples, 20 were found to match (Table 3), and the sequences were combined to form a 524 year master curve, SINAI (Fig 2). This mean and the six unmatched sequences were tested against a comprehensive collection of dated tree-ring chronologies from England and elsewhere in Europe in an attempt to identify a date for the sequences. The mean chronology was found to date to the period AD 1227-1750 inclusive (Tables 4a and 4b). No dates were obtained for the six unmatched ring sequences since they failed to produce any visually and statistically acceptable matches. Twelve *in situ* timbers, and the eight *ex situ* timbers are dated by this analysis. The ring width data for the mean chronology is listed in Table 5.

Discussion

Building A

Three timbers from building A are dated, including sample **19** which includes some sapwood. Applying normal sapwood estimates suggests this timber was felled in the period AD 1494-1534. The other two dated samples contain only heartwood and the dates obtained for them are compatible with this estimate. This structure is assigned to Morriss's phase two (op cit 87-89), 'the later fifteenth century'. The results obtained from the timbers sampled here suggest this phase is likely to be either very late fifteenth century or early sixteenth century in date.

Building B

Only two timbers were identified as suitable for sampling in this entire structure. No dating was obtained.

Building C

Three timbers were dated from building C. None include sapwood but they all end at heartwood/sapwood boundaries. Combining the results gives a felling date range of AD 1597-1640. Samples **9** and **10** may be

derived from a single tree. The original construction of building C is assigned by Morriss to phase three (op cit 89-97), 'the late sixteenth / early seventeenth century'. The dendrochronological results from building C accord with this interpretation. No sampling was possible that would assist the interpretation of the date of the raising of the first floor in building C.

Building E

Four timbers were dated from building E, the east facing porch. None include sapwood (which is hardly surprising considering their exposed positions) but the reasonable clustering of the end-dates suggests they are derived from a single phase (Baillie 1982, 57). Combining the results indicates that they were felled some time later than AD 1579. Samples **13** and **14** are clearly derived from the same tree. Morriss (op cit 99-103) considers building E to be a part of phase four 'mid seventeenth century'. Other parts of this phase are characterised by being 'well built from new materials with little obvious signs of the re-use of salvaged materials. This is in marked contrast to the south wing' (op cit 99). The dendrochronological results, however, clearly indicate either that this structure is built with unrecognised re-used timbers or that the current assignment of this structure to phase four is incorrect. It is possible that the lower part of the structure is either part of phase three or a reconstruction of the phase three stair tower. It is perhaps also possible that this structure included modifications undertaken at the stage of the raising of the floor of building C (seen as part of phase four).

Building F

The two dated samples from building F are from the lower part of the jettied frame abutting building C. Both include sapwood and one, sample **7**, includes bark-edge. This dates the felling of this timber to the winter of AD 1572/3. The dating obtained for building F gives rise to the following interpretative problem. phase two, dated by samples from building A, includes timbers felled in the period AD 1494-1534, and phase three, dated by samples from building C, includes timbers felled in the period AD 1597-1640. The samples from the single accessible frame of building F, felled in AD 1572/3, are compatible with neither the hypothesised construction date of a phase three building, nor the hypothesised construction date of the most likely source of re-used timbers from the same site, namely phase two. Alternative scenarios must be considered, and additional sampling is undoubtedly required to clarify the situation. Morriss considers building F to be part of phase three (op cit 89-97) and thus of late sixteenth or early seventeenth century date but he notes that there is extensive use of salvaged materials in building F. Morriss considers the salvaged material to be from the demolition of other parts of the Sinai Park structure (eg op cit 89). The dendrochronology indicates that either the dated material in this lower frame is re-used from some entirely different structure or the dated material is not re-used and that there is another phase of construction at Sinai Park that is between phases two and three. Unfortunately, the extensive sampling programme required to elucidate the interpretation of this part of the structure has proven impossible to undertake due to access restrictions.

ex situ timbers

It is relatively unusual for the sampling of *ex situ* timbers to be undertaken during dendrochronological analyses since such material is not very helpful in any interpretation unless its original location can be properly identified. The timbers at Sinai Park seemed suitable for two major reasons. Given the isolation of its site it seems unlikely that a large number of timbers would have been moved to the site without very good reason, and there is also reasonably good evidence, verbal and stylistic, to suggest that most of this timber was salvaged during the initial stages of the reconstruction.

Four of the *ex situ* timbers are probably derived from phases that are amongst those sampled in the buildings. Sample **104** may be from phase two, whilst samples **103, 105,** and **107** are all potentially compatible with the material derived from phases three or four. The other four are clearly derived from a single later phase, with sample **108** suggesting that felling of this group occurred around AD 1750. Three appear to be very similar, though not necessarily derived from the same parent trees (Table 3). If this material really is from the property, there may be an unsampled timber component within the buildings of around this date, perhaps as part of Morriss's phase five (op cit 103-106) which involves a series of radical transformations to the exterior mostly involving brick or lath-and-plaster cladding.

The chronology produced

The Sinai Park tree-ring chronology is unusually long (524 years) for one derived from a sampling programme at a single building. It has relatively low sample replication across its entire length but it gives highly significant matches to many of the contemporary tree-ring sequences (Table 4a), as well as reasonable matches to almost every chronology which we use (there are more than 300 chronologies giving *t* values greater than 3.0 to this sequence). But it is difficult to use a *t* value table of the type normally incorporated into reports that shows the data matching a number of independent site sequences. There have been no other single site sequences produced that cover the entire contemporary period. Instead Table 4a uses a number of independent regional master sequences each of which overlaps a large section of the Sinai Park chronology. However, the Sinai Park chronology does not exhibit good cross-matching to an exceptionally number of chronologies just because of its length, it also exhibits good correlations with other data over relatively short segments, some examples of which are provided in Table 4b.

Conclusion

The results obtained from the tree-ring analysis of timbers from Sinai Park highlight areas where further survey and interpretation are needed to refine the building analysis undertaken by Morriss. Additional tree-ring work is still considered vital if the development of the structure is to be understood more clearly.

Acknowledgements

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Figure 1

Plan of Sinai Park showing buildings A-K (after Morriss 1995)

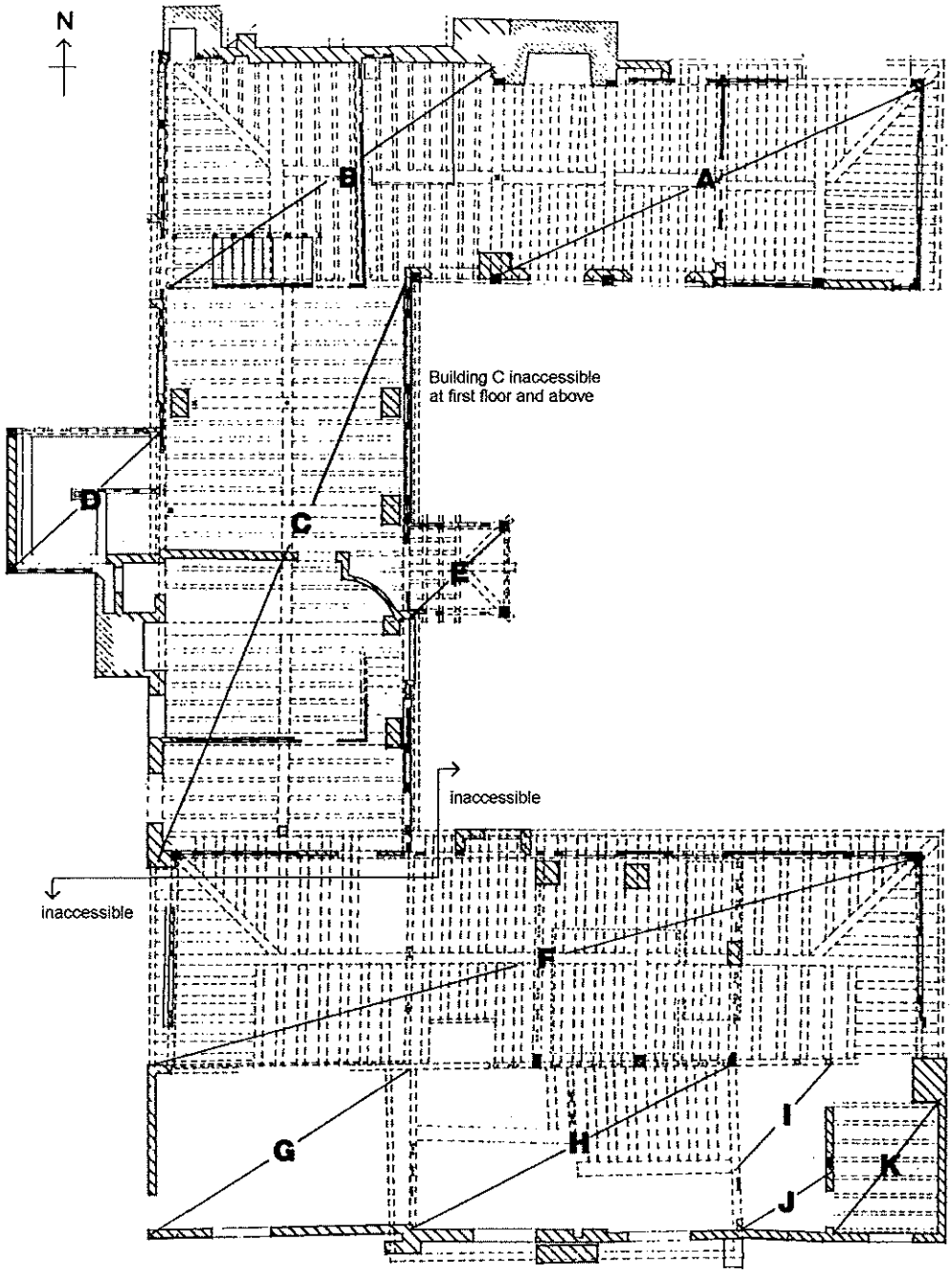
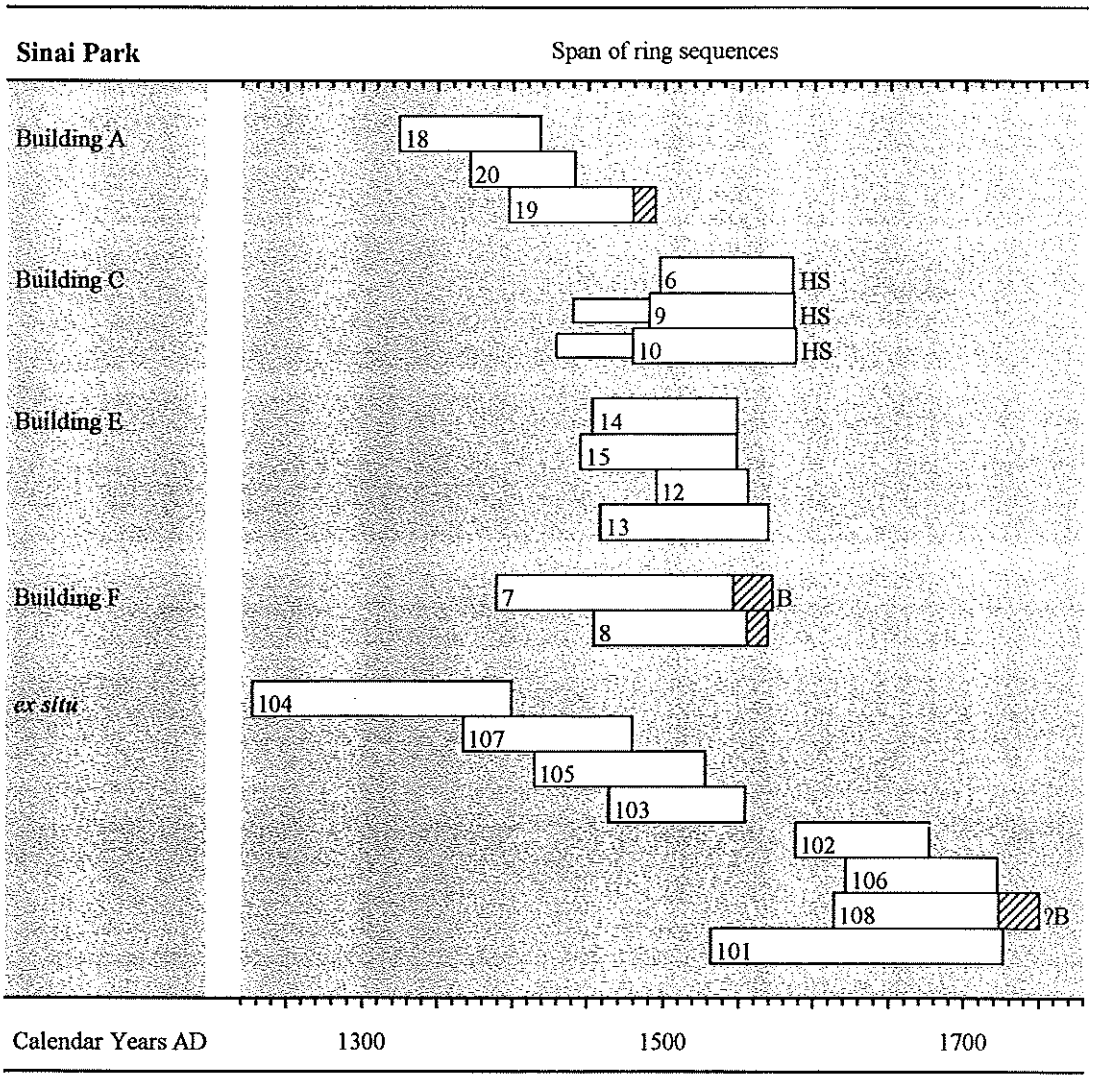


Figure 2

Bar diagram showing the position of the dated sequences from Sinai Park



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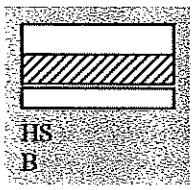

heartwood
sapwood
unmeasured heartwood
HS heartwood/sapwood boundary
B bark boundary

Table 1

List of samples

Sample	Building: Origin	Total rings	Sapwood rings	Average mm/year	Date of sequence	Felling date
1	A: Frame A4 north post	65	HS	1.88	undated	-
2	A: south storey post	-	-	-	undated	-
3	B: south sill	-	-	-	undated	-
4	B: south stud	79	-	1.95	undated	-
5	C: west fireplace	89	-	2.27	undated	-
6	C: north-south tiebeam	89	HS	2.69	AD 1497-AD 1585	AD 1595-AD 1640
7	F: Frame F1 plate	184	26+B	1.34	AD 1389-AD 1572	AD 1572/3
8	F: Frame F1 west post	116	14	1.67	AD 1454-AD 1569	AD 1569-AD 1610
9	C: joist	97	HS	1.23	AD 1490-AD 1586	AD 1596-AD 1641
10	C: joist	109	HS	1.18	AD 1479-AD 1587	AD 1597-AD 1642
11	E: south-east post	105	14	2.70	undated	-
12	E: north-east post	61	-	3.42	AD 1495-AD 1555	AD 1565+
13	E: north stud	112	-	1.70	AD 1458-AD 1569	AD 1579+
14	E: north stud	96	-	1.90	AD 1453-AD 1548	AD 1579+ [1]
15	E: north stud	104	-	2.07	AD 1445-AD 1548	AD 1558+
16	A: Frame A5 stud	97	3	2.10	undated	-
17	A: Frame A5 north door post	93	20	1.81	undated	-
18	A: Frame A2 north post	95	-	1.77	AD 1324-AD 1418	AD 1428+
19	A: joist	98	15	2.00	AD 1397-AD 1494	AD 1494-AD 1534
20	A: joist	71	-	2.28	AD 1371-AD 1441	AD 1451+
101	?: *ex situ*	195	-	1.08	AD 1532-AD 1726	AD 1736+
102	?: *ex situ*	90	-	1.61	AD 1588-AD 1677	AD 1687+
103	?: *ex situ*	91	-	1.91	AD 1464-AD 1544	AD 1554+
104	?: *ex situ*	173	-	1.40	AD 1227-AD 1399	AD 1409+
105	?: *ex situ*	114	-	1.51	AD 1415-AD 1528	AD 1538+
106	?: *ex situ*	101	-	2.16	AD 1622-AD 1722	AD 1732+
107	?: *ex situ*	113	-	1.55	AD 1367-AD 1479	AD 1489+
108	?: *ex situ*	137	27+?B	1.05	AD 1614-AD 1750	AD 1750/1?

Key: 'Sap rings' column: HS heartwood/sapwood boundary; B bark edge.

[1] Note that since samples **13** and **14** are derived from the same tree they have the same interpreted date.

Table 2

Summary of samples from Sinai Park, giving building code, phasing number, and building description after Morriss (1995)

Building	Phase	Samples	Description of building and samples
A	Two (later fifteenth-century)	**1-2, 16-20**	Two-storey jettied two-bay close-studded remnant of a longer range, some later alterations. Comprehensively sampled.
B	Three (late sixteenth- or early seventeenth-century)	**3-4**	Two-storey jettied two-bay range on the site of earlier building. No other suitable original timbers.
C	Three (late sixteenth- or early seventeenth-century)	**5-6, 9-10**	Two-storey hall range, first floor raised and new roof added in mid seventeenth century (phase four). Joists and a tiebeam on the first floor were sampled and a fireplace lintel; the rest of the structure particularly the roof was not safely accessible.
D	Four (mid seventeenth-century)	-	Remains of a timber-framed stair-tower. No suitable timbers.
E	Four (mid seventeenth-century)	**11-15**	Timber-framed two-storey porch. Comprehensively sampled.
F	Three (late sixteenth- or early seventeeth-century)	**7-8**	Two-storey jettied wing built mainly with re-used timbers. Access restricted to one frame.
G	Eight (twentieth-century)	-	Lean-to. Access denied. No suitable timbers.
H	Four (twentieth-century)	-	Two-storey jettied two-bay extension. Access denied.
I	Four (mid seventeenth-century)	-	Remains of a timber-framed stair-tower. Access denied.
J and K	Five (mid or late eigthteenth-century)	-	Access denied. No suitable timbers.
-	-	**101-108**	*ex situ* timbers taken for chronology development; original provenance unknown

Table 3

t-value matrix for the matching sequences. - value less than 3.0. \ non-overlapping sequence.

	7	8	9	10	12	13	14	15	18	19	20	101	102	103	104	105	106	107	108
6	4.92	-	4.14	-	-	5.77	-	-	\	\	\	-	\	3.29	\	5.09	\	\	\
7		3.40	3.89	3.69	3.20	4.27	-	6.04	-	-	-	-	\	4.32	\	6.82	\	-	\
8			5.81	-	4.81	4.70	3.18	4.61	\	3.32	\	-	\	5.46	\	-	\	-	\
9				7.83	4.30	4.95	4.47	3.66	\	\	\	-	\	4.02	\	-	\	\	\
10					5.13	-	-	-	\	-	\	4.49	\	-	\	-	\	\	\
12						3.94	-	4.03	\	\	\	-	\	4.91	\	-	\	\	\
13							13.93	3.85	\	-	\	-	\	6.23	\	-	\	3.65	\
14								-	\	-	\	-	\	4.38	\	-	\	-	\
15									\	-	\	-	\	5.44	\	-	\	-	\
18										3.34	-	\	\	\	3.11	\	\	-	\
19											6.60	\	\	-	\	3.06	\	-	\
20												\	\	\	-	-	\	-	\
101													-	-	\	\	3.34	\	-
102														\	\	\	5.35	\	7.61
103															\	4.01	\	-	\
104																\	\	3.63	\
105																	\	-	\
106																		\	9.50
107																			\

Table 4a

Dating the Sinai Park chronology, AD 1227-1750. *t*-values with independent reference chronologies. Note that due to the exceptional length of the master curve produced from the Sinai Park timbers a range of regional master chronologies or other multi-period master curves have been used to illustrate the cross-matching.

Area	Reference chronology	*t*-values
East Midlands	AD 882-AD 1981 (Laxton and Litton 1988)	14.97
Yorkshire	AD 1192-AD 1663 Yorkshire buildings (Hillam pers comm)	10.40
Essex	AD 878-AD 1622 Essex buildings (author unpubl)	10.24
London	AD 1248-AD 1647 Southwark excavations (Tyers 1996a; 1996b)	9.70
Devon	AD 1124-AD 1536 Devon buildings (Groves pers comm)	8.09
Windsor Castle	AD 1331-AD 1573 Great Kitchen (Hillam forthcoming)	7.81
Kent	AD 1158-AD 1540 Kent buildings (Laxton and Litton 1989)	7.26
Hereford	AD 915-AD 1617 Hereford City buildings (Tyers 1996c)	6.29
Belfast	AD 1001-AD 1970 (Baillie 1977a)	7.18
Scotland	AD 946-AD 1975 (Baillie 1977b)	6.87
Germany	546 BC-AD 1975 (Hollstein 1980)	6.75

Table 4b

Dating the Sinai Park chronology, AD 1227-1750. *t*-values with independent site chronologies illustrating the matching of shorter sections of the resultant chronology.

County	Reference chronology	overlapping segment	*t*-value
Essex	Netteswellbury Barn (Tyers 1997)	AD 1245-AD 1439	6.41
Herefordshire	Hereford Cathedral Barn 2 (Tyers 1996c)	AD 1359-AD 1491	8.84
Greater Manchester	Lightshaw Hall (Groves forthcoming)	AD 1414-AD 1552	9.25
Nottinghamshire	Sherwood Forest (Briffa *et al* 1986)	AD 1426-AD 1750	6.53

Table 5

Ring-width data from site master SINAI, dated AD 1227 to 1750 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD 1227							320	343	385	180							1	1	1	1
	176	148	148	176	247	145	252	272	206	192	1	1	1	1	1	1	1	1	1	1
	173	177	265	242	155	169	177	174	177	161	1	1	1	1	1	1	1	1	1	1
AD 1251	160	124	124	171	198	182	193	160	199	213	1	1	1	1	1	1	1	1	1	1
	184	222	113	104	71	75	93	149	200	198	1	1	1	1	1	1	1	1	1	1
	206	125	126	131	103	108	71	97	125	193	1	1	1	1	1	1	1	1	1	1
	223	151	161	141	120	157	114	106	137	217	1	1	1	1	1	1	1	1	1	1
	137	210	171	187	88	130	129	108	102	94	1	1	1	1	1	1	1	1	1	1
AD 1301	130	83	67	84	139	102	83	96	115	102	1	1	1	1	1	1	1	1	1	1
	88	82	92	162	189	135	124	139	148	129	1	1	1	1	1	1	1	1	1	1
	155	167	173	86	75	79	155	136	127	161	1	1	1	2	2	2	2	2	2	2
	99	120	147	118	210	150	146	129	196	148	2	2	2	2	2	2	2	2	2	2
	130	128	141	113	197	124	120	172	168	138	2	2	2	2	2	2	2	2	2	2
AD 1351	167	102	150	127	128	117	122	118	133	99	2	2	2	2	2	2	2	2	2	2
	102	160	135	106	92	100	99	124	186	131	2	2	2	2	2	2	3	3	3	3
	104	119	109	118	91	72	107	140	187	151	4	4	4	4	4	4	4	4	4	4
	151	228	148	153	175	261	298	232	174	156	4	4	4	4	4	4	4	4	5	5
	178	123	140	136	145	164	154	175	205	266	5	5	5	5	5	5	6	6	6	5
AD 1401	256	216	269	234	196	222	193	235	276	214	5	5	5	5	5	5	5	5	5	5
	205	205	198	190	182	194	174	193	152	287	5	5	5	5	6	6	6	6	5	5
	246	205	262	235	209	166	191	210	182	186	5	5	5	5	5	5	5	5	5	5
	229	256	188	221	193	168	169	145	126	167	5	5	5	5	5	5	5	5	5	5
	182	135	166	165	189	164	134	163	159	138	5	4	4	4	5	5	5	5	5	5
AD 1451	188	162	160	197	169	181	158	160	162	207	5	5	6	7	7	7	7	8	8	8
	173	180	217	172	170	169	225	195	231	211	8	8	8	9	9	9	9	9	9	9
	196	177	170	194	264	218	175	159	189	181	9	9	9	9	9	9	9	9	10	9
	194	141	164	152	158	143	173	162	142	153	9	9	9	9	9	9	9	9	9	10
	128	122	141	137	161	235	199	144	201	199	10	10	10	10	10	10	11	11	11	11
AD 1501	141	178	176	201	219	207	168	156	207	201	11	11	11	11	11	11	11	11	11	11
	201	213	187	150	146	147	128	159	226	163	11	11	11	11	11	11	11	11	11	11
	207	208	189	242	140	172	174	179	168	150	11	11	11	11	11	11	11	11	10	10
	224	176	180	183	224	216	222	225	198	211	10	11	11	11	11	11	11	11	11	11
	215	129	179	139	169	144	115	168	209	191	11	11	11	11	11	11	11	11	9	9
AD 1551	189	178	183	177	212	144	130	130	183	178	9	9	9	9	8	7	7	7	7	7
	165	146	132	155	117	116	120	136	166	155	7	7	7	7	7	7	7	7	7	5
	144	122	141	150	165	150	152	119	155	174	5	5	4	4	4	4	4	4	4	4
	128	123	138	166	132	127	87	204	237	202	4	4	4	4	4	3	2	2	2	2
	181	195	207	226	189	194	181	153	147	141	2	2	2	2	2	2	2	2	2	2

AD 1601	154	125	201	203	160	133	152	148	175	138	2	2	2	2	2	2	2	2	2	2
	150	125	172	167	181	156	148	134	130	140	2	2	2	3	3	3	3	3	3	3
	126	196	196	206	148	115	143	166	221	184	3	4	4	4	4	4	4	4	4	4
	107	157	155	91	120	160	172	175	150	188	4	4	4	4	4	4	4	4	4	4
	143	92	118	96	181	186	137	161	161	122	4	4	4	4	4	4	4	4	4	4
AD 1651	118	96	93	159	248	206	175	163	162	186	4	4	4	4	4	4	4	4	4	4
	182	131	137	129	147	210	138	140	145	158	4	4	4	4	4	4	4	4	4	4
	146	120	108	122	99	105	119	113	108	114	4	4	4	4	4	4	4	3	3	3
	116	144	130	91	90	166	177	154	126	96	3	3	3	3	3	3	3	3	3	3
	103	82	116	127	119	120	127	135	120	134	3	3	3	3	3	3	3	3	3	3
AD 1701	144	93	114	156	84	96	100	120	133	79	3	3	3	3	3	3	3	3	3	3
	87	99	116	82	119	122	138	105	108	67	3	3	3	3	3	3	3	3	3	3
	86	85	79	72	67	96	102	93	76	85	3	3	2	2	2	2	1	1	1	1
	91	79	63	69	50	38	43	44	53	62	1	1	1	1	1	1	1	1	1	1
	58	48	56	49	58	52	69	50	35	40	1	1	1	1	1	1	1	1	1	1