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TREE-RING ANALYSIS OF FRAMING TIMBERS FROM THE PRINCES CHANNEL WRECK, THAMES ESTUARY

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Summary

This report describes the results of tree-ring analysis of samples taken from sections of hull recovered from a carvel-built vessel encountered during dredging operations by the Port of London Authority in the Princes Channel of the Thames Estuary. The study was commissioned by Wessex Archaeology on behalf of the Port of London Authority.

A total of twelve samples were taken from the lifted sections of hull, from oak framing timbers which, on inspection, appeared to have sufficient rings for analysis. Tree-ring width sequences from ten of these samples cross-matched to form a 306-year mean which has been dated against regional tree-ring chronologies and site masters for sites in the east of England. The results are consistent with the vessel having been constructed from oak from eastern England, soon after AD 1574.

Poor sapwood survival on the recovered sections of the vessel meant that only three samples retained possible bark edge, and possible felling dates of AD 1573 and 1574 were recorded. Should further work allow access to additional, better preserved, material, then consideration should be given to retrieval of additional samples with bark edge to clarify felling dates. Given the construction of a substantial tree-ring sequence for timbers from this vessel, questions about the nature of any structural remains on the seabed in the vicinity of proposed dredging could readily be resolved through additional dendrochronological survey and analysis.

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Introduction

This document is a technical archive report on the tree-ring analysis of samples from oak framing timbers from two, formerly adjoining, sections of hull recovered from the Thames at Princes Channel, and presently held in store the wharf of the Port of London Authority at Denton. The study was commissioned by Wessex Archaeology as part of a Princes Channel Wreck evaluation (Project No: 56470). The aim of the study was to determine the date of the vessel's construction, and the geographical origin of the timbers used in its construction.

The report is structured with reference to English Heritage recommendations on the format and content of dendrochronological reports (EH 1998).

Methodology

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (EH 1998). Details of the methods used in the investigation of this vessel are described below.

A detailed examination of the timbers in store was carried out in the company of Hanna Steyne from Wessex Archaeology; one of the team employed to record and subsequently evaluate the wreck. The primary objective was the recovery of tree-ring samples from oak timbers with suitable ring sequences for analysis. Those with more than 50 annual rings and some survival of the original sapwood and bark-edge were sought. As the timbers were still damp, coring was not possible, and slices were recovered using a chainsaw, following standard practice for waterlogged timbers.

The slice samples were cleaned by paring the surface with traditional razor blades to define each successive annual ring. The complete sequences of growth rings in the samples were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 1999). Cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The ring sequences were plotted electronically and exported to a computer graphics software package (Coreldraw™ v.8) to enable visual comparisons to be made between sequences at the positions indicated 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 satisfactory visual matching supports these positions.

All the measured sequences from this assemblage were compared with each other and those 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 are 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. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Tyers 1998). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. 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 re-use 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

All of the twelve samples taken had sufficient rings to merit analysis and were cleaned to reveal the tree-ring sequences (see Table 1 for details, Figures 1 and 2 for location of samples). All the samples were measured and the resultant ring sequences compared. Ten of the sequences were cross-matched with significant computer correlations and satisfactory visual matching. Table 2 shows the computer correlations between the synchronised tree-ring sequences and the chronological positions of the sequences are shown in Figure 3. A ten-timber mean was calculated and then compared with dated reference chronologies from throughout the British Isles and northern Europe. Table 3 shows the correlation of this mean with dated series at the dating position identified of AD 1296-AD 1514. Table 4 lists the dated sequence.

Discussion

The survey has proved successful in two key respects – indicating a date for construction of the vessel, and also pointing to a domestic origin for the timber employed in its construction. Three samples had final rings dating to AD 1573, two of which were thought to have surviving bark edge. The final ring of a further sample which appeared to retain bark edge was dated to AD 1514 (Figure 3). These apparent variations in felling date could relate to stockpiling of timber with the construction of the vessel occurring in, or soon after AD1574. The relatively poor condition of the sapwood on the samples, caused by drying

out following recovery of the hull sections from the sea bed, makes clarification of this issue problematic. This ambiguity could be resolved by recovering additional samples from *in situ* material where sapwood is likely to survive in better condition.

The provenance of the sampled timbers is suggested by varying computer correlations with contemporary regional chronologies (Table 3). There appears to be a clear bias towards eastern England, particularly East Anglia and Essex. Caution should be employed when interpreting the results given the absence of contemporary sequences from some possible shipbuilding areas, particularly in the Iberian Peninsula. Nonetheless, the high computer correlations against English sequences, and only relatively low correlations against available continental datasets do point to an East coast, English origin.

Acknowledgements

I am most grateful for the assistance of Hanna Steyne of Wessex Archaeology during the sampling of timbers in Gravesend, to Capt. Peter Steen of the Port of London Authority for providing access, and to Deanna Groom of Wessex Archaeology for making arrangements for the sampling and analysis to go forward. Ian Tyers and Cathy Groves kindly gave access to unpublished data. Figures 1 and 2 are based on AutoCAD drawings provided by Wessex Archaeology.

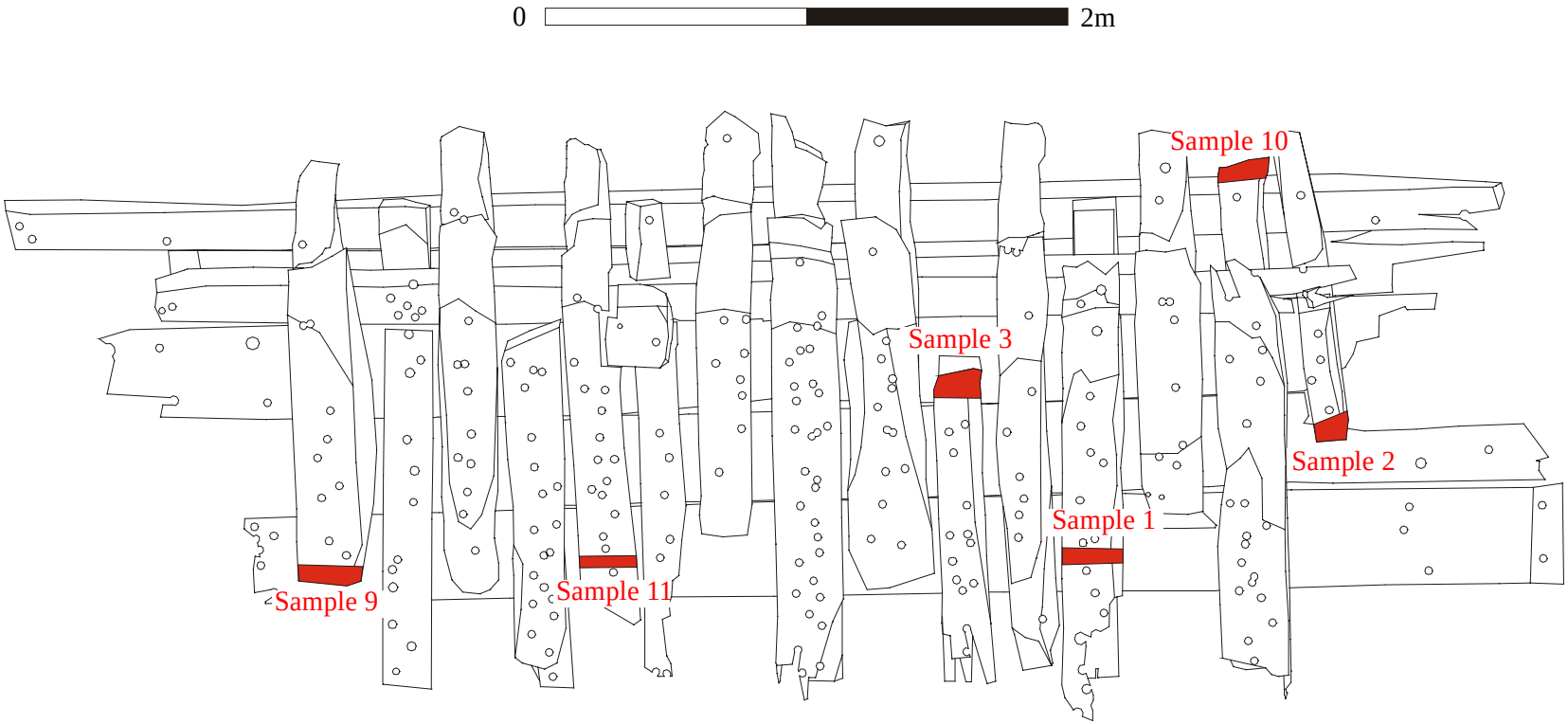

Figure 1 Locations of dendrochronology samples taken from ‘piece two’. Inboard face shown (cf Wessex Archaeology 2004, fig 13a)

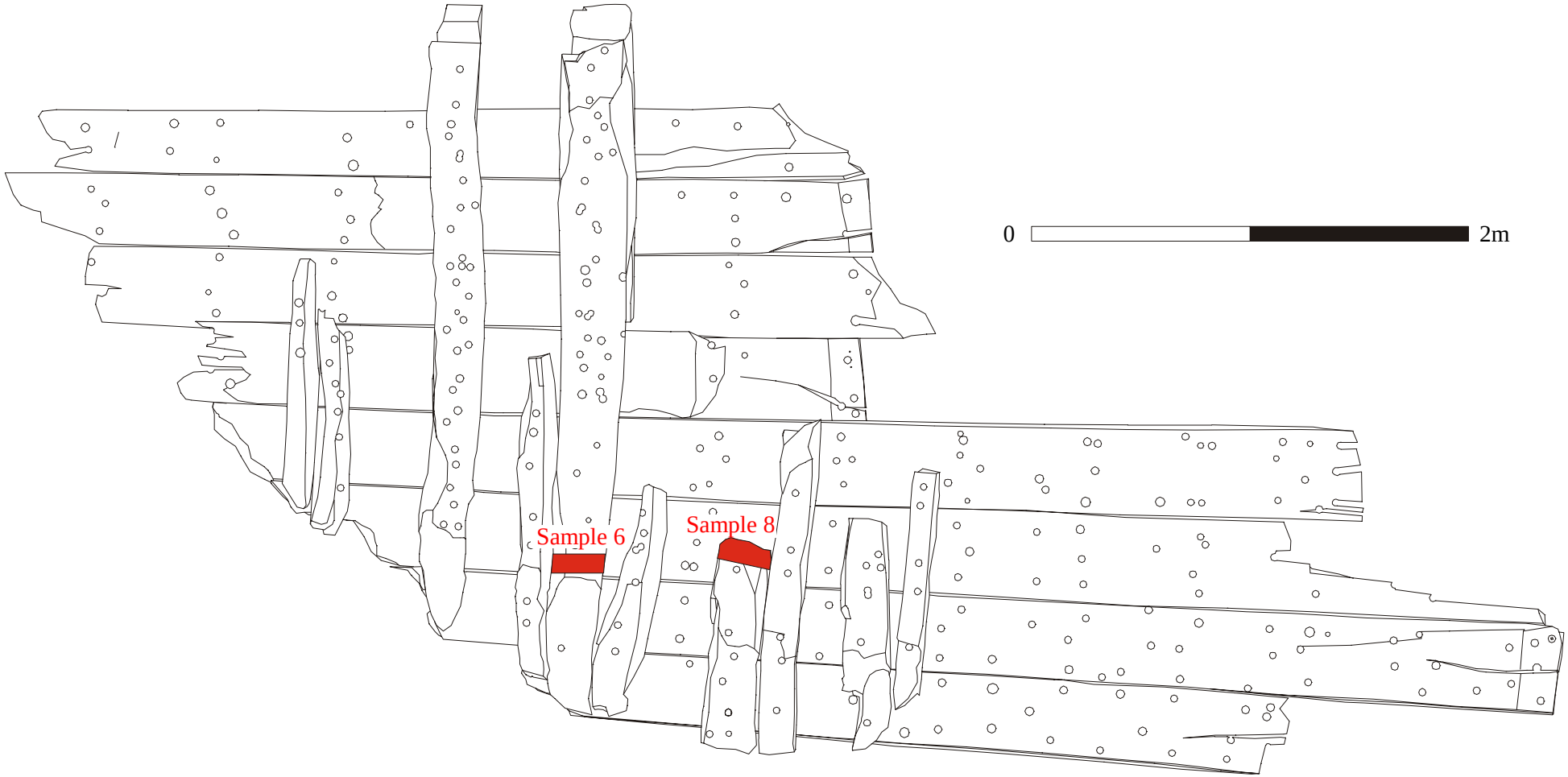

Figure 2 Locations of dendrochronology samples taken from ‘piece one’. Inboard face shown (cf Wessex Archaeology 2004, fig 7a)

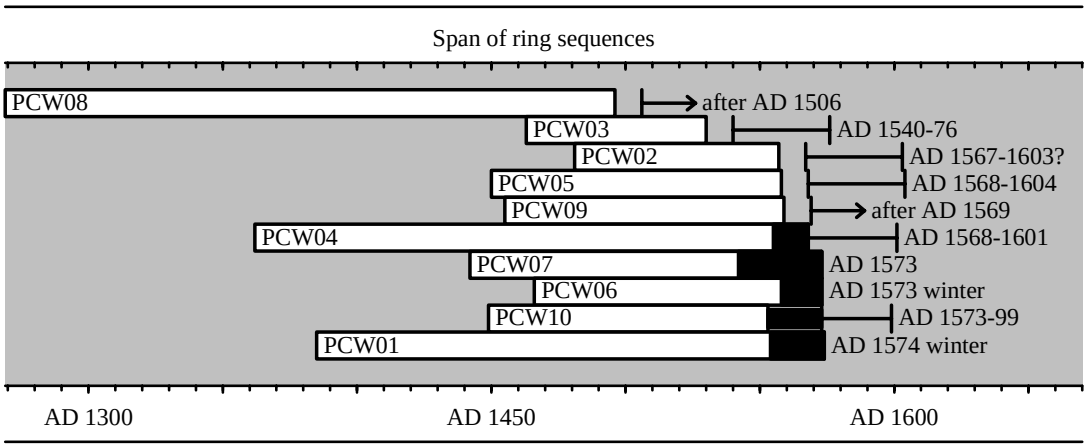

Figure 3 Bar diagram showing the chronological positions of the dated timbers from the Princes Channel Wreck. Sapwood is shaded and the estimated felling period for each sequence is also shown

Table 1

List of samples from Princes Channel Wreck

Sample Code	Origin of sample	Cross-section of tree	Cross-section size (mm)	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period/ Comment
PCW01	F62-02	Quarter	200 x 180	190	20+Bw	1.06	AD 1385-AD 1574	AD 1574 winter
PCW02	F65-01	Quarter	170 x 140	77	+?HS	2.61	AD 1481-AD 1557	AD 1567-1603?
PCW03	F60-02	Half	205 x 130	68	+HS	1.38	AD 1463-AD 1530	AD 1540-76
PCW04	F102-01	Quarter	255 x 175	207	13	1.13	AD 1362-AD 1568	AD 1568-1601
PCW05	F1-02	Whole	205 x 130	109	+HS	1.17	AD 1450-AD 1558	AD 1568-1604
PCW06	F2-02	Whole	280 x 205	108	15+B	1.20	AD 1466-AD 1573	AD 1573
PCW07	LF208a	Quarter	175 x 170	132	31+B	1.43	AD 1442-AD 1573	AD 1573
PCW08	F1-03	Half	210 x 185	228	-	0.98	AD 1269-AD 1496	after AD 1506
PCW09	F51-02	Half	265 x 170	105	-	1.43	AD 1455-AD 1559	after AD 1569
PCW10	F64-01	Quarter	190 x 130	105	+20s	1.49	AD 1449-AD 1553	AD 1573-99
PCW11	F55-02	Half	225 x 185	113	-	1.95	undated	
PCW12	unlabelled stringer	Quarter	150 x 140	76	+HS	1.92	undated	

Total rings = all measured rings Sapwood rings: HS heartwood sapwood boundary, *n*s number of sapwood rings, B bark edge, Bw bark edge winter felled
ARW = average ring width of the measured rings

Table 2 *t*-value matrix for correlations between samples. \ = overlap < 15 years, - = t-values less than 3.00, * = empty triangle

Samples	PCW02	PCW03	PCW04	PCW05	PCW06	PCW07	PCW08	PCW09	PCW10
PCW01	3.16	3.61	7.99	3.20	4.38	3.36	6.89	-	3.71
PCW02	*	-	3.79	3.63	5.97	5.86	-	3.27	3.09
PCW03	*	*	3.16	5.25	-	-	-	-	3.31
PCW04	*	*	*	3.39	3.84	3.29	4.82	3.24	4.36
PCW05	*	*	*	*	5.03	5.02	-	4.16	5.75
PCW06	*	*	*	*	*	6.13	-	3.64	4.27
PCW07	*	*	*	*	*	*	-	3.61	3.87
PCW08	*	*	*	*	*	*	*	-	-

Table 3

Dating the mean sequence Princes_t10, AD 1296-1514 inclusive. *t*-values with independent reference chronologies (regional chronologies and site masters)

Area	**Reference chronology**	***t*-value**
England	East Midlands (Laxton and Litton 1988)	7.29
England	East Anglia 121 chronology mean (Ian Tyers pers comm)	12.53
England	London region 86 chronology/1475 timber mean (Ian Tyers pers comm)	8.89
England	West Midlands 89 chronology mean (Ian Tyers pers comm)	5.96
England	South East 75 chron/566 timber mean (Ian Tyers pers comm)	10.08
England	South West 101 chronology mean (Ian Tyers pers comm)	7.58
East Anglia	Chicksands Priory, Bedfordshire (Howard *et al* 1998)	9.58
East Anglia	Croxley Hall Farm Barn, Rickmansworth, Hertfordshire (Bridge 2000)	5.35
East Anglia	Ely, Cambridgeshire (Groves pers comm)	9.22
Essex	Gosfield Hall, nr Halstead (Bridge 1998)	11.34
Essex	Netteswellbury Barn, Harlow (Tyers 1997)	8.19
London	Hays Wharf, Southwark (Tyers 1996; Tyers 1996)	8.49
South East England	Mary Rose Original build/Hampshire timber (Bridge and Dobbs 1994)	7.43
South East England	Mary Rose refit/Kent timber (Bridge and Dobbs 1994)	6.12

Table 4

Ring-width data from site master Princes_t10, dated to AD 1269-1514 inclusive.

Date	Ring widths (0.01mm)										No of samples									
AD 1269									267	263									1	1
-	221	157	161	81	96	64	148	106	41	161	1	1	1	1	1	1	1	1	1	1
-	134	257	244	124	185	223	129	105	128	152	1	1	1	1	1	1	1	1	1	1
-	108	180	187	267	203	127	139	133	132	79	1	1	1	1	1	1	1	1	1	1
AD 1301	134	170	70	72	75	86	101	66	75	55	1	1	1	1	1	1	1	1	1	1
-	45	52	50	86	107	118	67	65	74	95	1	1	1	1	1	1	1	1	1	1
-	131	123	79	95	61	51	72	70	68	62	1	1	1	1	1	1	1	1	1	1
-	39	47	42	44	73	45	37	31	46	44	1	1	1	1	1	1	1	1	1	1
-	43	40	36	33	44	61	107	68	111	69	1	1	1	1	1	1	1	1	1	1
AD 1351	79	52	62	69	67	52	73	60	88	76	1	1	1	1	1	1	1	1	1	1
-	54	69	85	74	100	73	74	82	131	125	1	2	2	2	2	2	2	2	2	2
-	118	168	170	173	143	153	174	274	173	153	2	2	2	2	2	2	2	2	2	2
-	225	178	138	92	133	143	118	159	162	162	2	2	2	2	3	3	3	3	3	3
-	133	92	119	98	125	132	115	150	150	108	3	3	3	3	3	3	3	3	3	3
AD 1401	105	77	89	119	91	164	112	125	105	86	3	3	3	3	3	3	3	3	3	3
-	96	110	124	109	127	96	90	89	78	88	3	3	3	3	3	3	3	3	3	3
-	110	83	102	111	73	55	64	73	87	74	3	3	3	3	3	3	3	3	3	3
-	84	127	99	100	116	86	87	110	118	95	3	3	3	3	3	3	3	3	3	3
-	68	239	233	166	137	134	131	122	172	151	3	4	4	4	4	4	4	4	5	6
AD 1451	140	147	156	188	180	190	185	219	202	192	6	6	6	6	7	7	7	7	7	7
-	186	202	173	159	205	218	182	181	188	201	7	7	8	8	8	9	9	9	9	9
-	171	166	135	130	162	126	95	118	136	147	9	9	9	9	9	9	9	9	9	9
-	207	191	166	157	134	143	196	174	172	174	10	10	10	10	10	10	10	10	10	10
-	121	116	98	122	107	189	163	105	94	91	10	10	10	10	10	10	9	9	9	9
AD 1501	83	96	98	100	86	100	84	84	90	85	9	9	9	9	9	9	9	9	9	9
-	85	92	88	91	115	126	83	107	124	106	9	9	9	9	9	9	9	9	9	9
-	95	121	105	116	101	109	128	120	117	106	9	9	9	9	9	9	9	9	9	9
-	153	104	111	104	171	154	153	135	143	124	8	8	8	8	8	8	8	8	8	8
-	124	84	105	97	137	108	89	126	132	116	8	8	8	8	8	8	8	8	8	8
AD 1551	133	95	121	126	128	122	102	68	98	145	8	8	8	7	7	7	7	6	5	4
-	136	163	129	121	129	117	108	119	125	150	4	4	4	4	4	4	4	4	3	3
-	131	119	127	219							3	3	3	1						

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