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# BOREHAM HENGE, OLD HALL, BOREHAM, NEAR CHELMSFORD, ESSEX
# DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS

## SCIENTIFIC DATING REPORT

Martin Bridge

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## SUMMARY

Three *ex situ* oak timbers removed from a timber circle and associated avenue were investigated. Their ring width sequences did not match each other, neither did the individual series give consistent acceptable matches when compared with the reference material available. Radiocarbon analysis showed that the three timbers represent at least two felling episodes in the first millennium cal AD.

## CONTRIBUTORS

Dr Martin Bridge

## ACKNOWLEDGEMENTS

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## ARCHIVE LOCATION

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## DATE OF INVESTIGATION

2009

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# CONTENTS

## INTRODUCTION

This document is a record of the analysis of three timbers removed from an archaeological site for tree-ring analysis. The site, near Chelmsford in Essex (Fig 1) is thought to be of Late Neolithic/Early Bronze Age date, based on assemblages of worked flint remains. The monument came to light during archaeological investigation ahead of and during the construction of an agricultural reservoir at this site, which lies on the lower slope and floodplain of the River Chelmer, about 3km east of Chelmsford. Descriptions of the site and its associated features can be found in Germany (2008) and Atkinson *et al* (2009), from which the following information is taken.

The major features consist of a 5m-wide ditch with opposing north-south entrances, enclosing a *c.* 28m-diameter ring of post-pits, with a 21m-long avenue of post-holes extending off to its south, towards the river. Three of the post-holes of the circle, and one of the avenue, contained surviving waterlogged remnants of *in situ* posts of substantial proportions. It has not been possible to determine through excavation whether the timber circle and henge ditch were in use at the same time, and it was hoped that dendrochronological dating of the timber remains might help resolve this issue.

## METHODOLOGY

A few timbers were examined on site in the summer of 2007 and identified as of oak. Although cores were extracted from the largest timber on that occasion, the cores broke up and no ring-width series were obtained. Sections of three *ex situ* timbers, 669 from pit 670, 619 from pit 612, and 650 from pit 649 (Fig 2) were collected from the Essex Field Archaeology Unit in February 2009. These waterlogged sections were first frozen and then a surface suitable for measuring was obtained by cutting with a scalpel as the sections partly defrosted. When the surface became too fragile, the sections were refrozen.

The samples had their tree-ring sequences measured to an accuracy of 0.01mm, 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 (2004). Cross-matching was accomplished by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared 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 potential errors in the measurements when the samples cross-match.

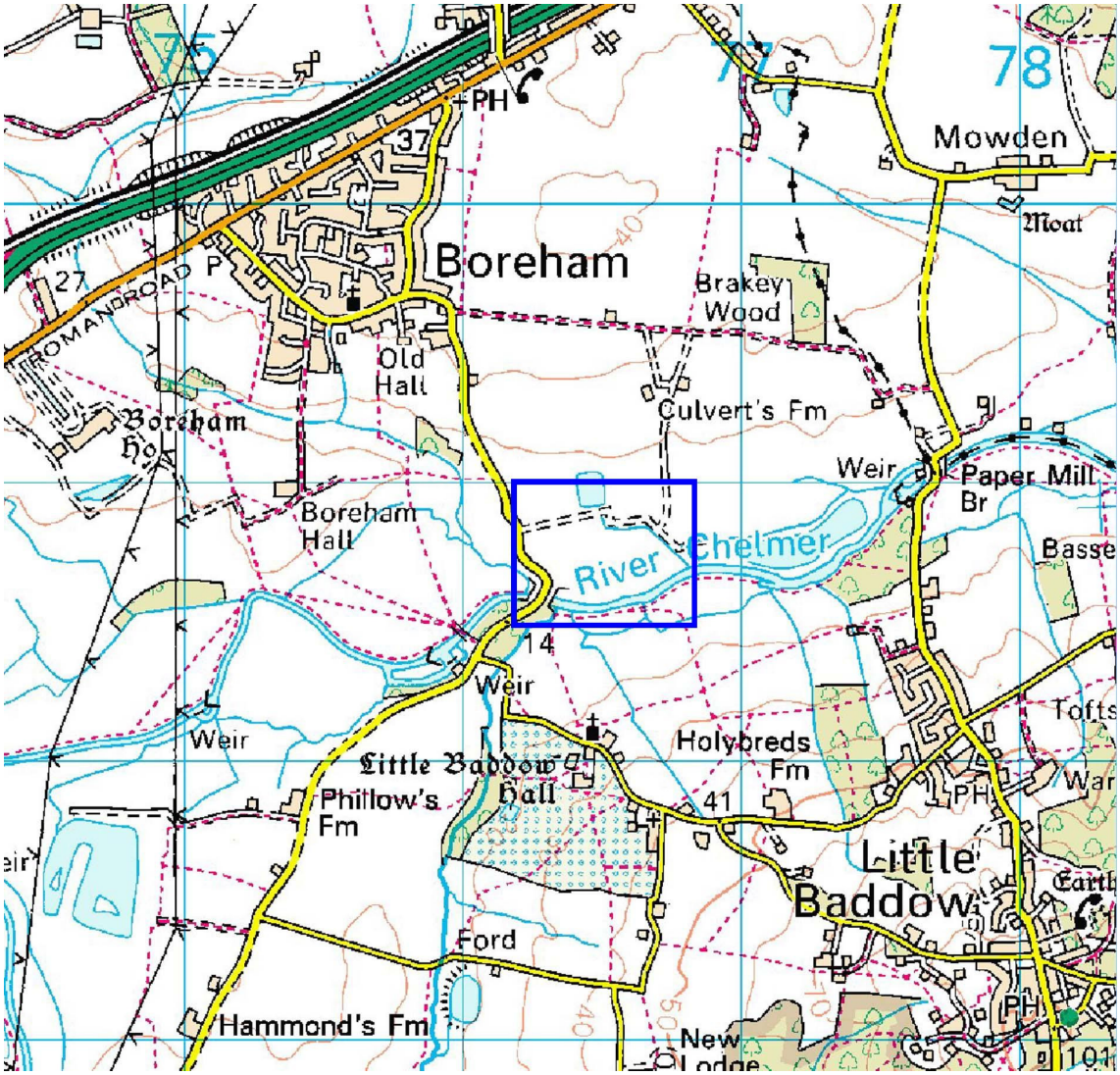


*Figure 1. Map to show the location of the site (*

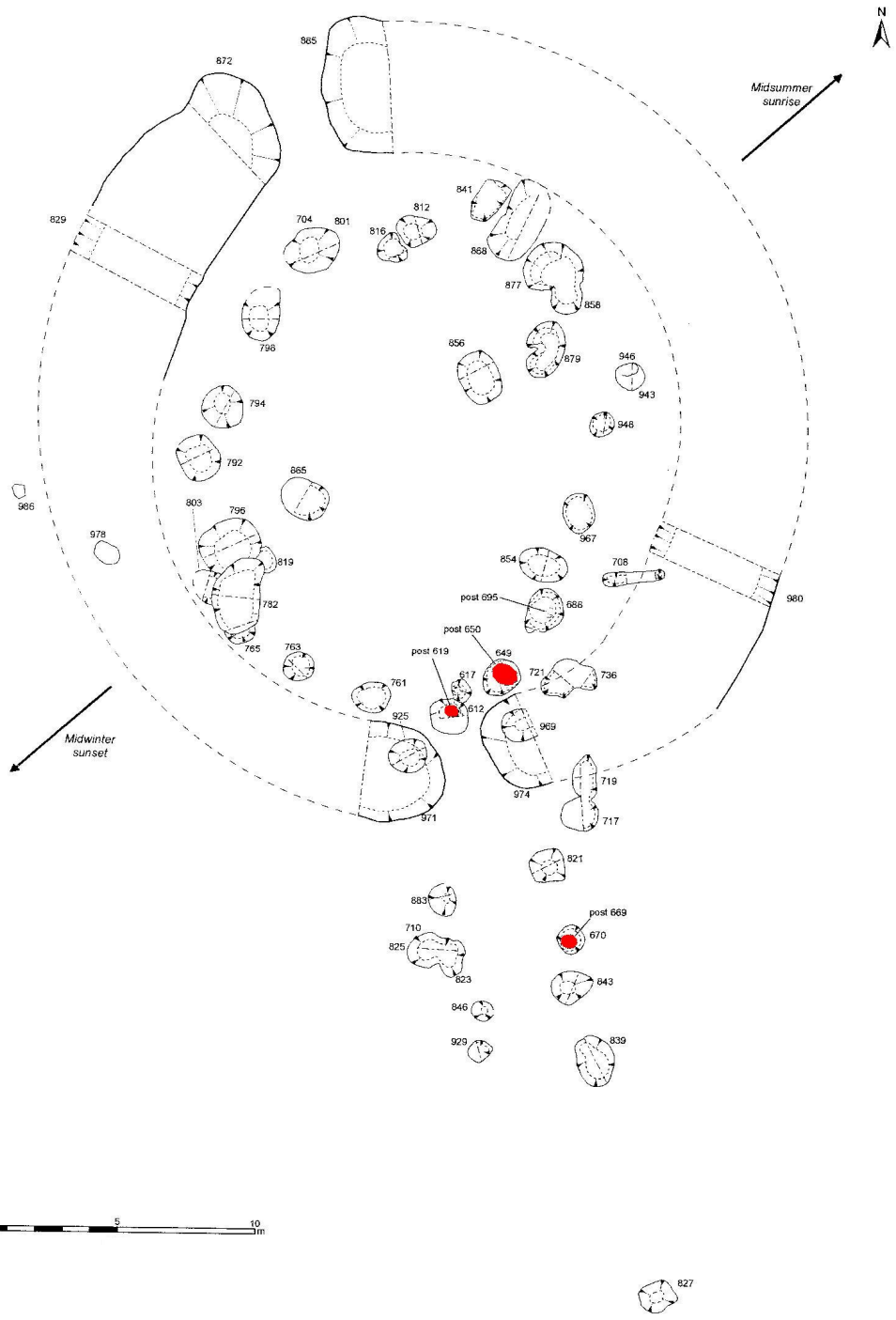


*Figure 2. Site plan showing the locations of the timbers sampled, adapted from Atkinson et al (2009)*

## RESULTS AND DISCUSSION

Basic information about the samples is given in Table 1, with the series themselves being presented in the Appendix. Post 650 contained more rings than the measured sequence, but these earlier rings were very distorted. No matching was found between the three individual series. This was disappointing, as it was hoped that the tree-ring series would at least show that the timbers were contemporaneous. The lack of matching does not rule this out, however, as the series were relatively short and with only three trees, each showing their own life histories, the lack of matching is not unexpected.

*Table 1. Details of the samples taken for dendrochronology*

| Sample | Rings | Mean ring width (mm) | Sapwood | Date of measured sequence |
|---|---|---|---|---|
| Post 669 | 92 | 1.97 | 18C | undated |
| Post 619 | 102 | 1.31 | - | undated |
| Post 650 | 82 | 1.20 | - | undated |

C = complete sapwood, winter felled tree

After unsuccessful attempts to match the sequences to each other, the series were compared with the total dataset of dated sequences available, including prehistoric, Roman, Saxon, medieval and post-medieval oak sequences. They failed to give replicated strong matches at any positions, meaning that they remain undated by dendrochronology.

## RADIOCARBON DATING

As tree-ring dating was unsuccessful, radiocarbon dating was used to attempt to clarify the site chronology. Only the three posts sampled for dendrochronology were available for dating. Initially, only Post 669 was considered a good candidate for radiocarbon dating, as it retained complete sapwood, whereas Posts 619 and 650 consisted of heartwood only and did not retain the heartwood/sapwood boundary. When Post 669 was found to be early medieval, it was decided to also date posts 619 and 650 to test whether these were prehistoric, as archaeological evidence implied, or early medieval.

Each sample, taken from the outermost decade of growth remaining on each post, was dated by Accelerator Mass Spectrometry (AMS) radiocarbon dating at the Scottish Universities Environmental Research Centre in East Kilbride (following Vandenputte *et al* (1996), Slota *et al* (1987), and Xu *et al* (2004)) and the Oxford Radiocarbon Accelerator Unit (following Bronk Ramsey *et al* (2002; 2004)). Internal quality assurance procedures and international inter-comparisons (Scott 2003) indicate no laboratory offsets, and validate the measurement precision given.

The results (Table 2) are conventional radiocarbon ages (Stuiver and Polach 1977), quoted according to the Trondheim convention (Stuiver and Kra 1986). Given the unexpected date of Post 669, the laboratory undertook three more measurements of the

same sample to confirm the original result, SUERC-25809. These results are all statistically consistent with a single radiocarbon age, so the best estimate of the date of this sample is given by the calibration of the weighted mean radiocarbon age (Ward and Wilson 1978).

*Table 2. Details of the samples dated by radiocarbon*

| Laboratory code | Sample | Identification | $\delta^{13}C$ (‰) | Radiocarbon age (BP) | Calibrated date (95% confidence) |
|---|---|---|---|---|---|
| SUERC-25809 | Post 669 years 83–92 | wood, oak sapwood | -26.5 | 1185 ±40 | cal AD 720–885 |
| SUERC-26230 | | | -26.5 | 1220 ±30 | |
| SUERC-26231 | | | -26.8 | 1220 ±30 | |
| SUERC-26229 | | | -27.2 | 1220 ±30 | |
| weighted mean of post 669 results: T'=0.6, T'(5%)=7.8, ν=3 | | | | 1215 ±16 | |
| OxA-22156 | Post 619 years 93–102 | wood, oak heartwood | -26.7 | 1659 ±27 | cal AD 260–430 |
| OxA-22157 | Post 650 years 73–82 | wood, oak heartwood | -24.5 | 1166 ±24 | cal AD 775–965 |

The calibrated date ranges in Table 2 were calculated by the maximum intercept method (Stuiver and Reimer 1986), using the program OxCal v4.1.5 (Bronk Ramsey 1995; 1998; 2001; 2009) and the IntCal09 data set (Reimer *et al* 2009), and are quoted in the form recommended by Mook (1986), rounded outwards to decadal endpoints, or to 5 years if the radiocarbon age error is smaller than ±25. Figure 3 shows the calibration of the radiocarbon results by the probability method (Stuiver and Reimer 1993), again using OxCal 4.1.0 and the IntCal09 calibration data.

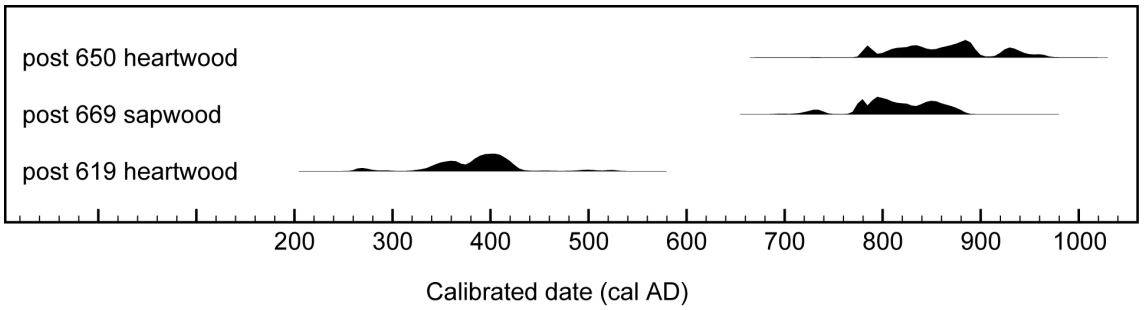


*Figure 3. Calibration of the Boreham Old Hall radiocarbon results by the probability method (Stuiver and Reimer 1993)*

Although the calibrated radiocarbon results accurately date the tree-rings sampled, and thus the final decade of each of the dendrochronological sequences measured, the absence of heartwood/sapwood transitions on Posts 619 and 650 means that these timbers were felled *at least* 9 years later than the calibrated dates, this being the mimimum estimated number of sapwood rings likely in this area (Miles 1997). The maximum wood-age offset applicable to these samples is more difficult to estimate, but it appears that whereas Post 665 might be broadly contemporary with Post 669, Post 619 must be significantly earlier. It is therefore clear that the posts represent at least two episodes of tree-felling in the first millennium cal AD.

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# APPENDIX

Tree-ring data (0.01mm) for the three timber series removed from Boreham

## Post 669

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 168 | 211 | 323 | 234 | 193 | 110 | 156 | 111 | 262 | 206 |
| 203 | 192 | 303 | 207 | 301 | 232 | 152 | 136 | 218 | 126 |
| 134 | 231 | 266 | 150 | 99 | 98 | 165 | 261 | 197 | 232 |
| 210 | 371 | 177 | 107 | 118 | 162 | 191 | 164 | 237 | 218 |
| 272 | 200 | 181 | 123 | 136 | 294 | 281 | 315 | 249 | 251 |
| 225 | 214 | 285 | 241 | 188 | 164 | 342 | 348 | 287 | 157 |
| 145 | 149 | 220 | 223 | 191 | 249 | 250 | 208 | 174 | 120 |
| 165 | 180 | 210 | 200 | 206 | 192 | 159 | 154 | 137 | 105 |
| 116 | 111 | 167 | 213 | 291 | 155 | 279 | 169 | 139 | 90 |
| 96 | 89 | | | | | | | | |

## Post 619

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 262 | 228 | 248 | 277 | 170 | 151 | 120 | 157 | 148 | 218 |
| 172 | 158 | 122 | 120 | 86 | 101 | 110 | 117 | 67 | 113 |
| 183 | 160 | 164 | 81 | 119 | 112 | 108 | 110 | 110 | 140 |
| 114 | 95 | 97 | 91 | 120 | 151 | 114 | 87 | 66 | 67 |
| 88 | 87 | 125 | 118 | 117 | 89 | 61 | 55 | 86 | 82 |
| 85 | 82 | 90 | 81 | 70 | 80 | 103 | 145 | 133 | 103 |
| 75 | 133 | 121 | 252 | 225 | 137 | 132 | 111 | 67 | 72 |
| 99 | 74 | 110 | 175 | 136 | 123 | 109 | 140 | 135 | 169 |
| 213 | 141 | 151 | 122 | 209 | 180 | 174 | 170 | 112 | 151 |
| 149 | 147 | 186 | 113 | 106 | 98 | 270 | 157 | 124 | 129 |
| 176 | 148 | | | | | | | | |

## Post 650

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 222 | 408 | 250 | 206 | 154 | 122 | 155 | 151 | 114 | 113 |
| 119 | 119 | 84 | 106 | 115 | 80 | 104 | 103 | 108 | 72 |
| 90 | 104 | 92 | 91 | 90 | 113 | 123 | 86 | 111 | 94 |
| 132 | 103 | 110 | 229 | 141 | 136 | 162 | 112 | 66 | 53 |
| 53 | 57 | 73 | 69 | 68 | 78 | 80 | 72 | 73 | 64 |
| 66 | 67 | 113 | 207 | 164 | 203 | 136 | 141 | 117 | 86 |
| 94 | 110 | 122 | 88 | 83 | 74 | 103 | 98 | 114 | 80 |
| 165 | 125 | 120 | 88 | 153 | 129 | 125 | 86 | 187 | 220 |
| 181 | 130 | | | | | | | | |