TREE-RING ANALYSIS OF TIMBERS FROM ST GILES' CHURCH, ELKESLEY, NOTTINGHAMSHIRE

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Analysis of ten samples taken from timbers of the bellframe at this church resulted in the production of a single site chronology. This site chronology spans the period AD 1628-1722, with at least eight of the timbers having been felled in AD 1726-46.

Tree-ring analysis has shown this bellframe to have been constructed from timbers felled in AD 1726-46.

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Introduction

St Giles' Church is situated in north Nottinghamshire, just south of Retford (Fig 1). The earliest surviving part of the church is the north wall of the Chancel, with its thirteenth century lancet window. The stonework of the East window and of the tower is fourteenth century. The Nave roof is well preserved with large roof beams and carved bosses and is thought to date to about AD 1450. It is similar to the nave roof at St Peter's Church in Claybrooke Parva, Leicestershire, dendrochronologically dated by this Laboratory to AD 1425-50.

The three bells in the bellframe were probably cast some time between AD 1420-50 and have the inscriptions:

1. I have the name of Gabriel, who was sent from Heaven
2. This bell sounds for the praise of Holy Mary
3. This bell bears the name of the Holy Apostles

Because of the poor condition of the bellframe the bells can no longer be rung although it is hoped that planned restoration work will allow this to happen again.

Sampling

Fourteen core samples were taken from a selection of timbers of this bellframe. Each sample was given the code NBF-E (for Nottinghamshire, Bellframe, Elkesley) and numbered 01-14. Sketch drawings of the bellframe were made at the time of sampling and the location of all samples has been marked on these (Figs 2-8). Details of these samples are given in Table 1.

Tree-ring dating

Tree-ring dating relies on a few simple, but quite fundamental, principals. Firstly, as is commonly known, trees (particularly oak trees, the most frequently used building timber in England) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March – September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically determined pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way.

Secondly, because the weather over any number of consecutive years is unique, so too is the growth pattern of the tree. The pattern of a short period of growth, 20, 30 or even 40 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything is excess of 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal of tree-ring dating is that, until the early- to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimeter. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which *is* known. When a sample “cross-matches” repeatedly at the same date against a series of different relevant reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference, is denoted by a “*t*-value”; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of samples and references have been produced by growing under the same conditions *at the same time*. The statistically accepted fully reliable minimum *t*-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phases of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a “site chronology”. As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for satisfactory analysis.

Analysis and Results

Four of the samples, NBF-E02, NBF-E04, NBF-E13, and NBF-E14, had less than the minimum number of rings required for secure dating and so were not measured. The remaining samples were prepared by sanding and polishing and their growth-ring widths measured. These growth-ring widths were then compared with each other.

This resulted in all ten samples matching each other at the relative positions shown in the bar diagram (Fig 9). The growth-ring widths of these ten samples were then combined at these offset positions to form a site chronology, NBFESQ01, 95 rings long. This site chronology was then compared with a series of relevant reference chronologies for oak. It was consistently and reliably matched at a first-ring date of AD 1628 and a last-ring date of AD 1722. The evidence for this dating is contained in Table 2.

Interpretation

Tree-ring analysis of samples from this building has resulted in the production of a single site chronology, NBFESQ01. This site chronology, contains ten samples, and spans the period AD 1628-1722. Eight of the samples contained within this site sequence have the heartwood/sapwood boundary ring. The average of this is AD 1711, giving an estimated felling date, for the timbers represented, within the range AD 1726-46. The remaining two dated samples do not have the heartwood/sapwood boundary ring and so an estimated felling date range cannot be calculated for them. However, with last measured ring dates of AD 1702 (NBF-E09) and AD 1704 (NBF-E06) this is estimated to be at the earliest AD 1718 and AD 1720, respectively. Therefore, it is possible that these two timbers were felled at the same time as the rest of them.

All felling date ranges are calculated using the estimate that 95% of mature oak trees in this area have between 15-35 sapwood rings.

Discussion

Tree-ring analysis of the timbers of this bellframe has resulted in ten of them being dated. At least eight of these timbers (and probably ten of them) are now known to have been felled some time between AD 1726-46, with construction thought to have occurred soon after.

The *t*-value matching between all ten samples was very high, with a number of them matching each other of values of more than *t*=11. This is suggestive of the trees used all coming from the same source.

Acknowledgements

This work was commissioned by Inigo Woolf. Thanks are given to Clive Andrews of Elkesley Church for his assistance with access to the bellframe.

Figure 1: Map showing the location of Elkesley, Nottinghamshire, (based upon the Ordnance Survey map with the permission of The Controller of Her Majesty's Stationery Office, ©Crown Copyright).

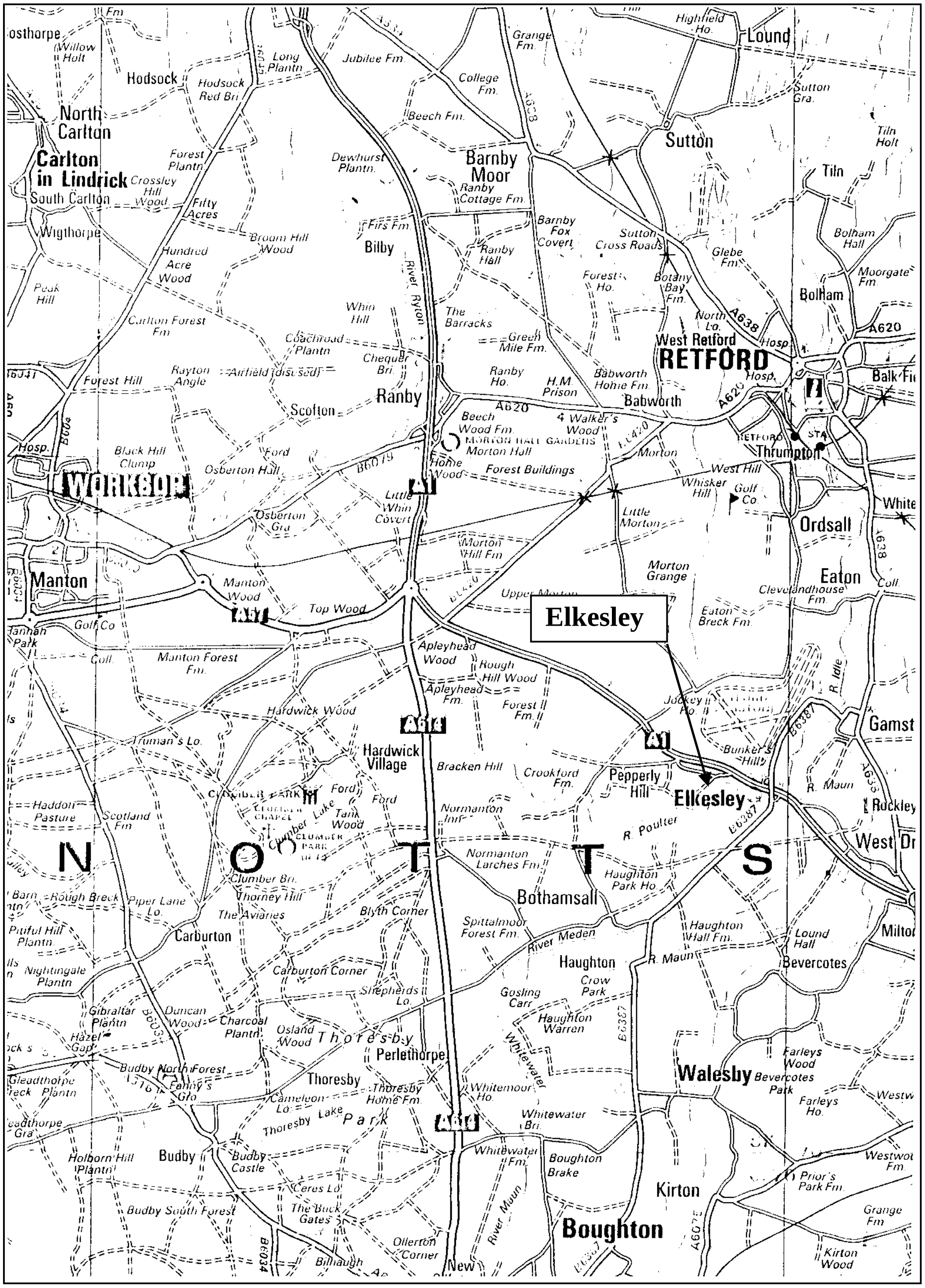

Figure 2: Sketch plan of bellframe

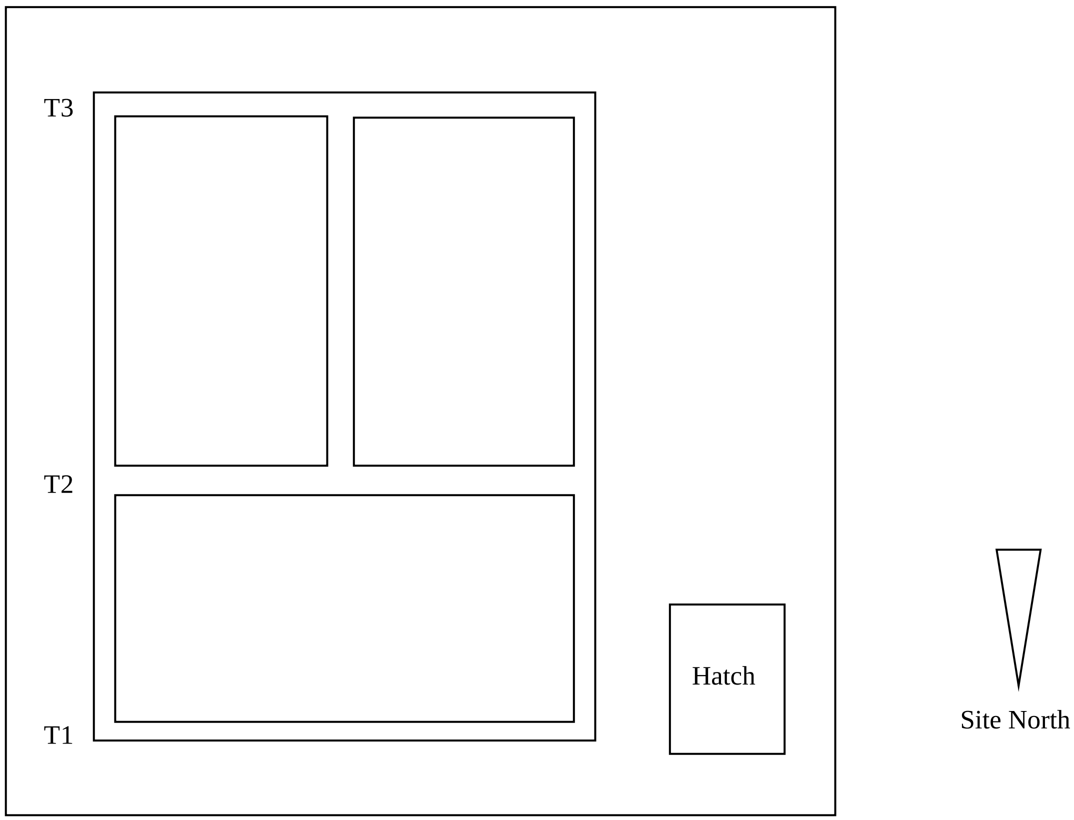

Figure 3: Sketch drawing of the west endframe (viewed from the west looking east), showing the location of samples NBF-E07-11

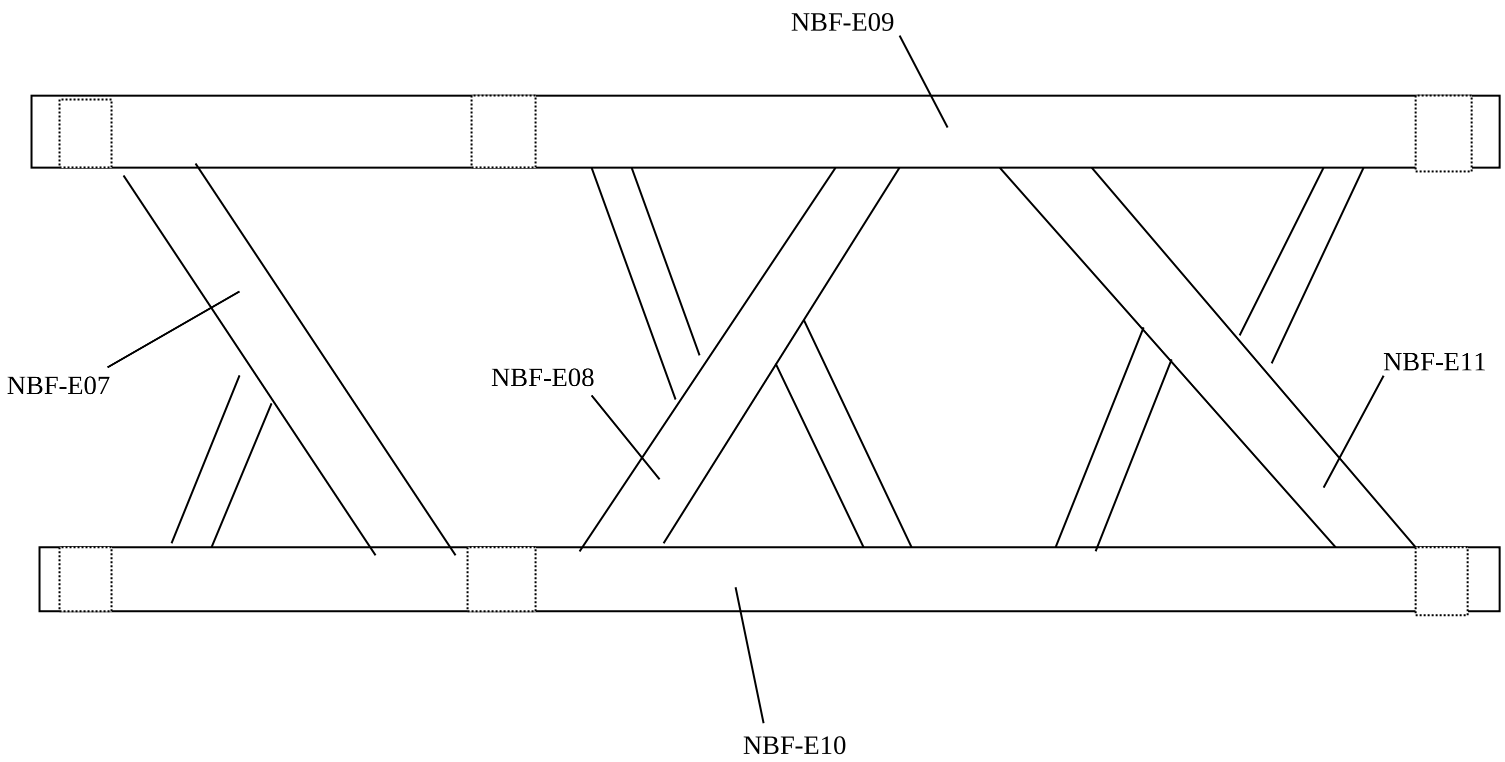

Figure 4: Sketch drawing of the east endframe (viewed from the west looking east), showing the location of samples NBF-E03-04, NBF-E10, and NBF-E12

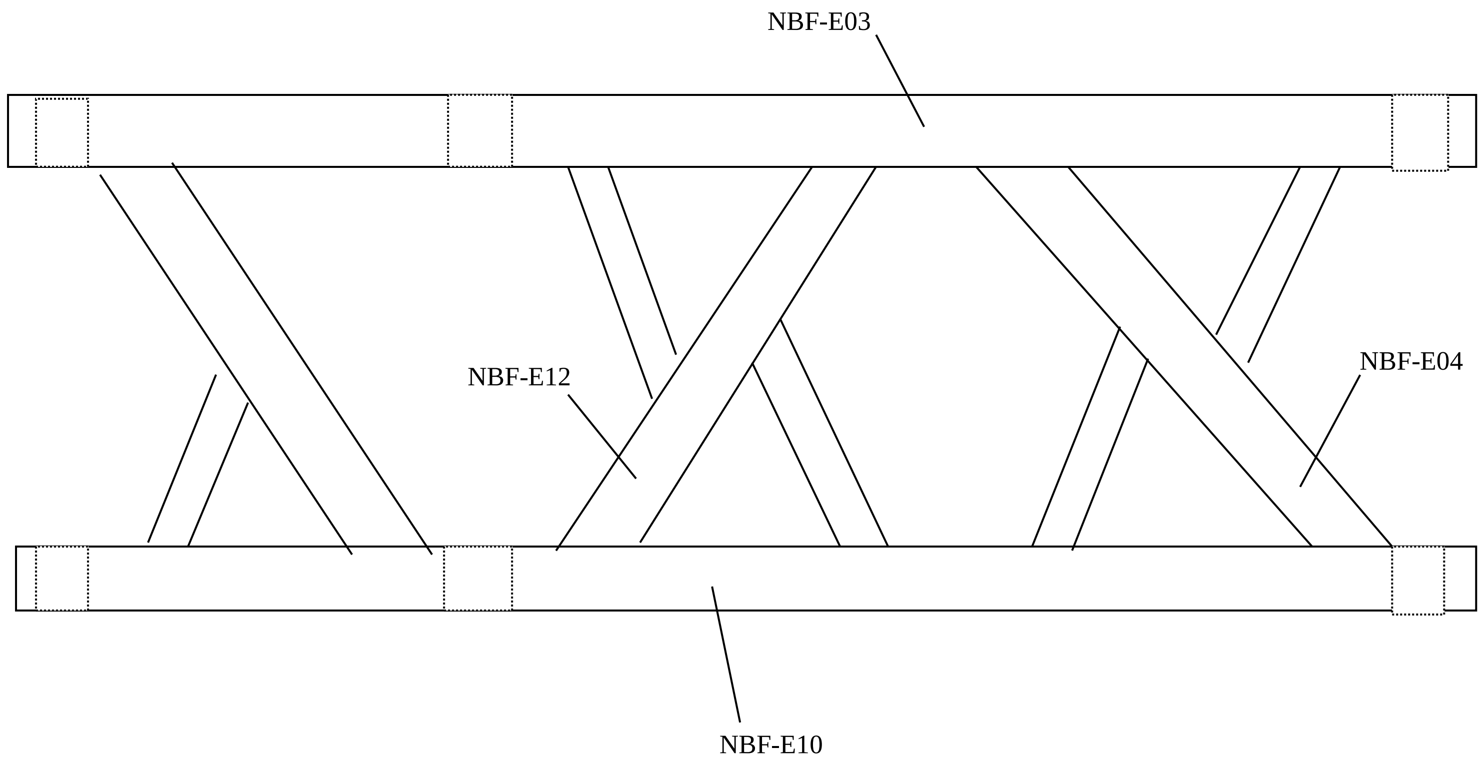

Figure 5: Sketch drawing of the middle frame (viewed from the west looking east), showing the location of samples NBF-E02, NBF-E05, and NBF-E14

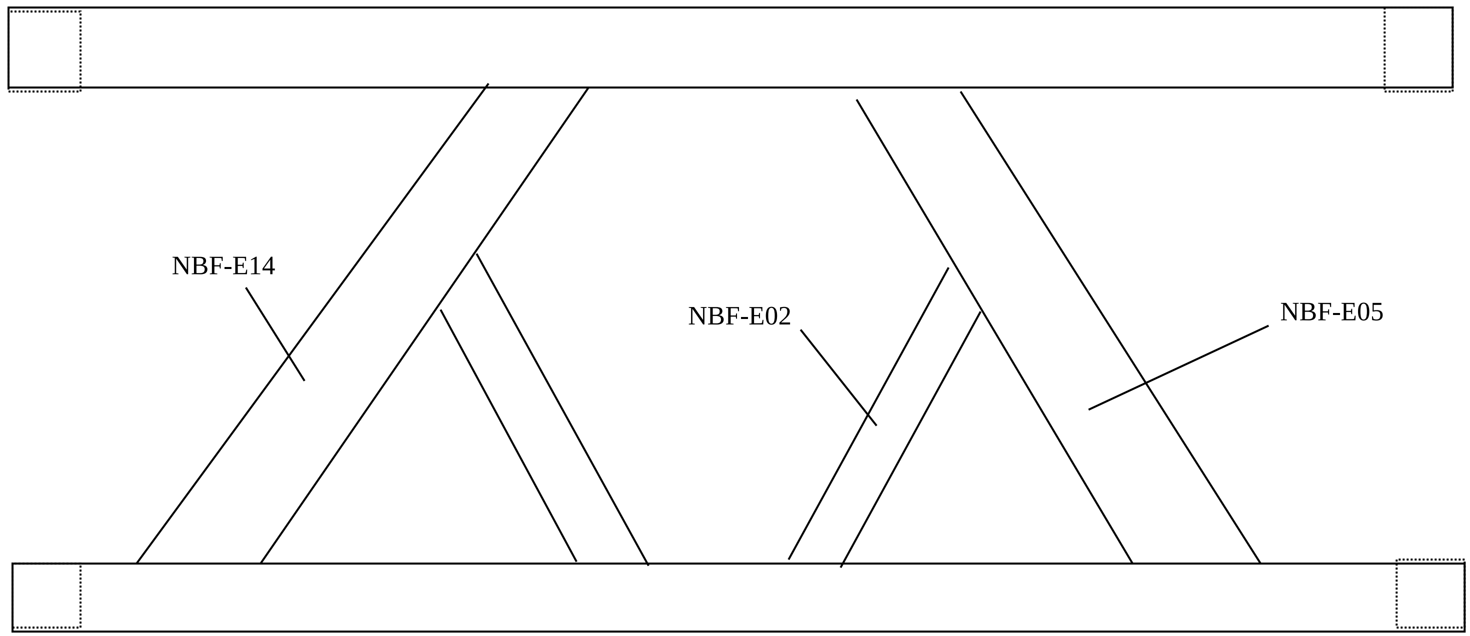

Figure 6: Sketch drawing of truss 1 (from south looking north), showing the location of samples NBF-E06 and NBF-E13

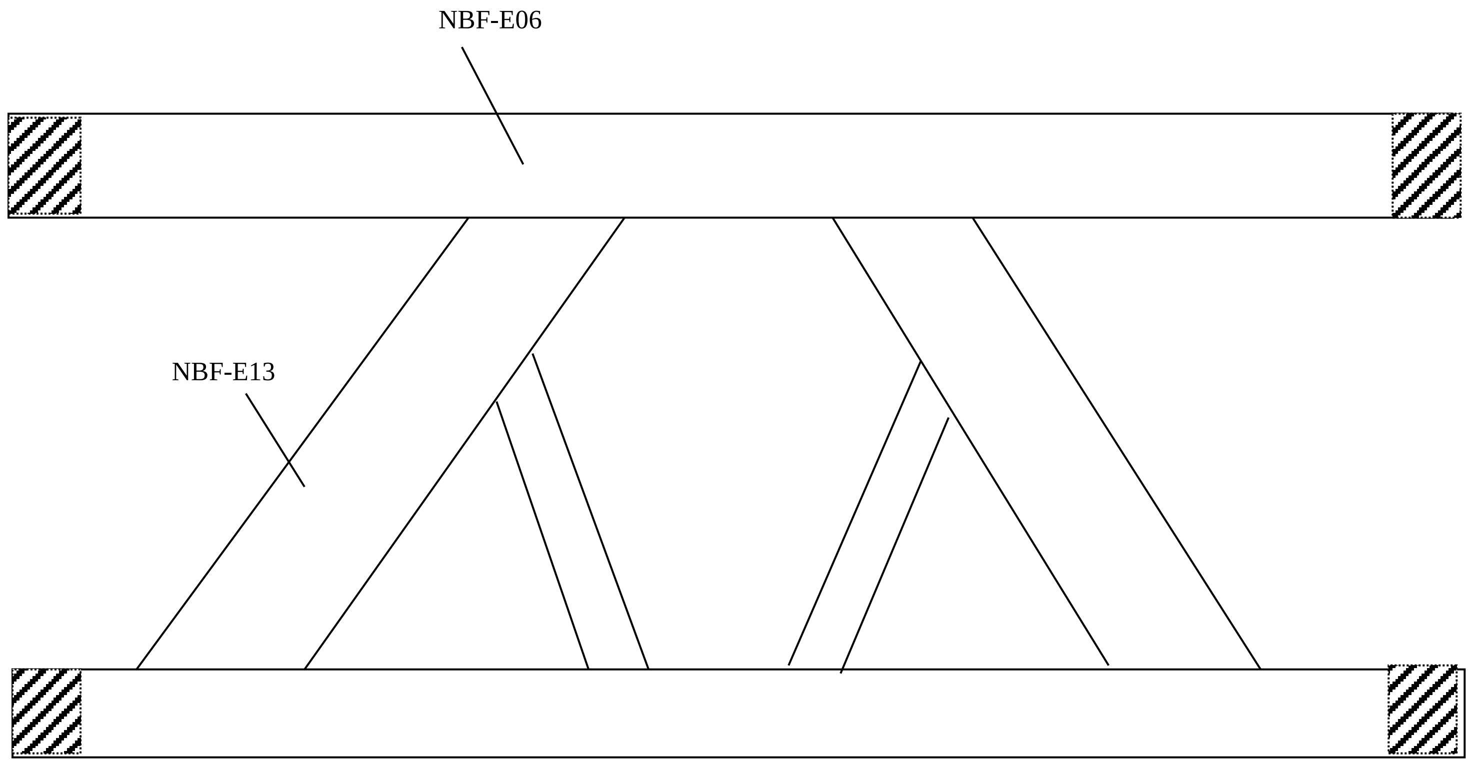

Figure 7: Sketch drawing of truss 2 (from south looking north)

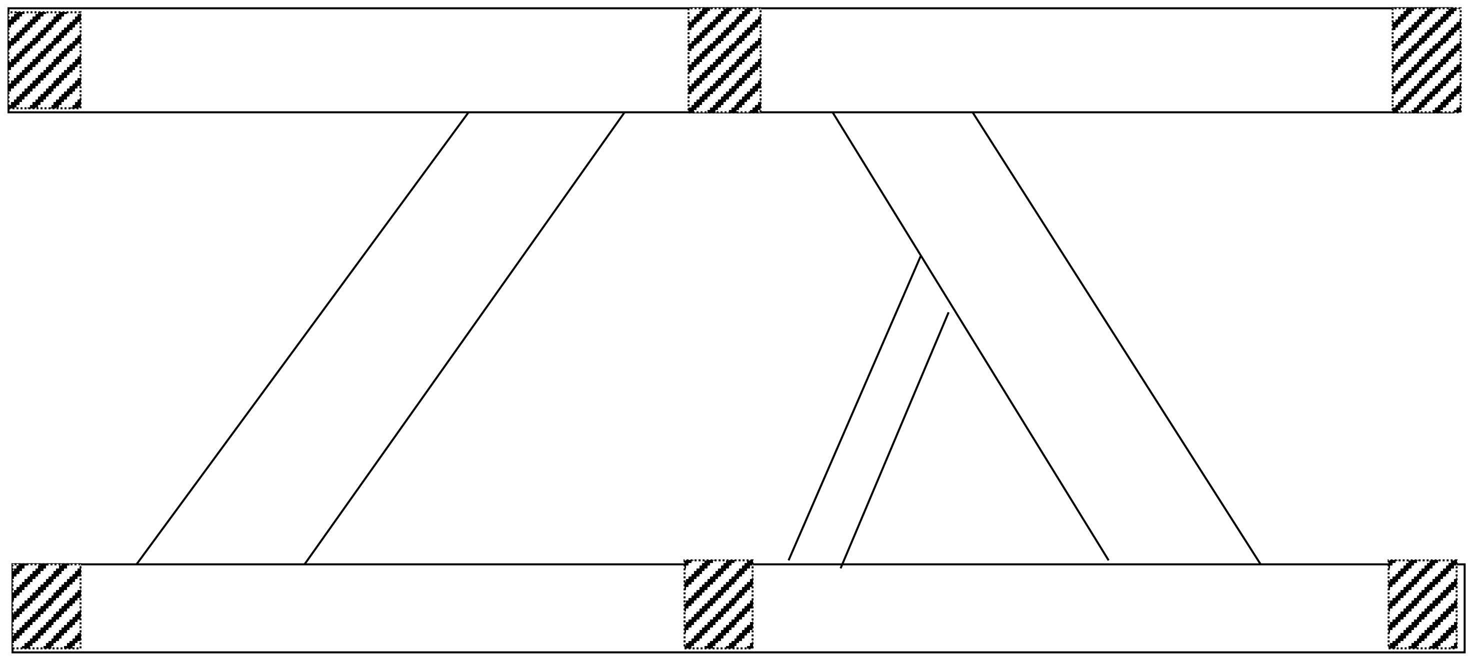

Figure 8: Sketch drawing of truss 3 showing the location of sample NBF-E01

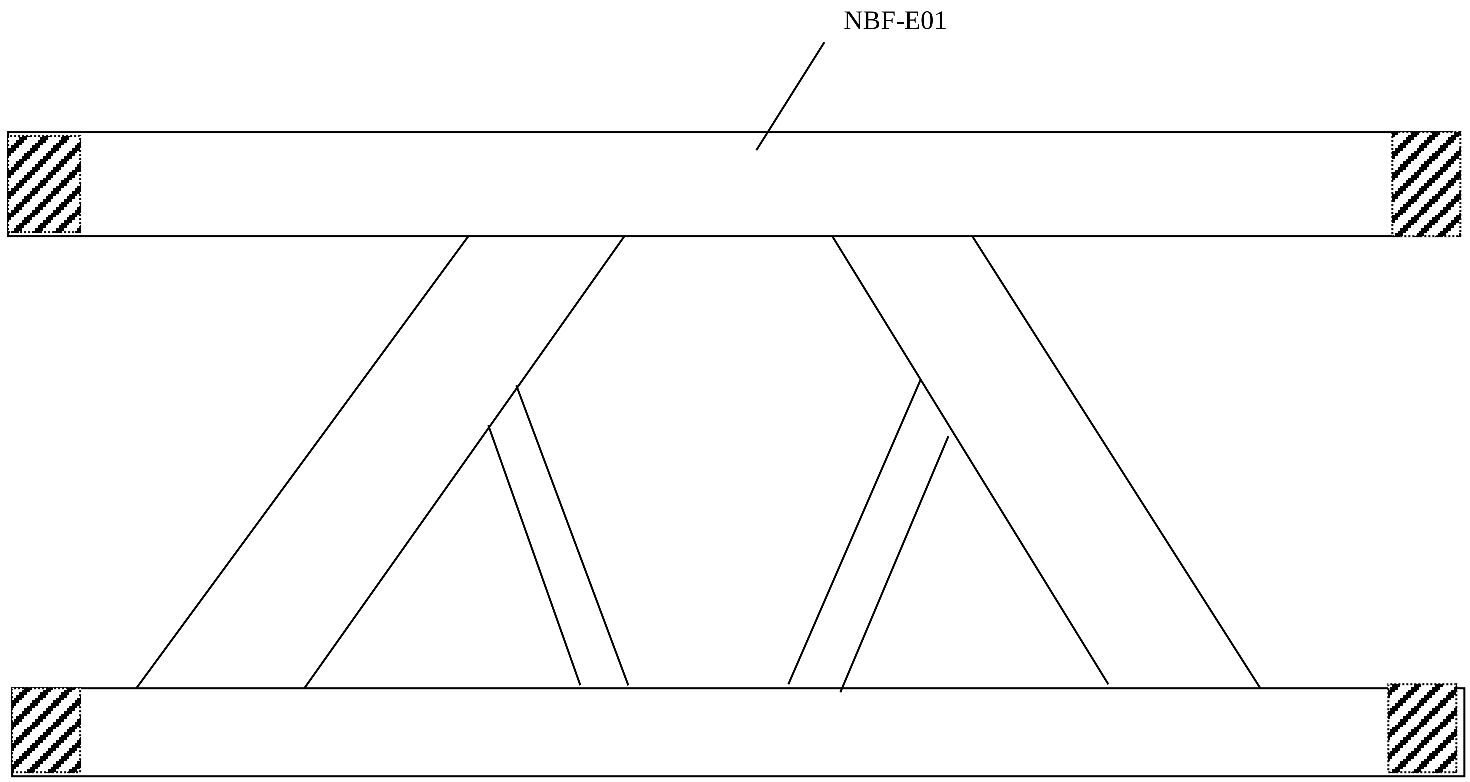

Figure 9: Bar diagram of samples in site sequence NBFESQ01

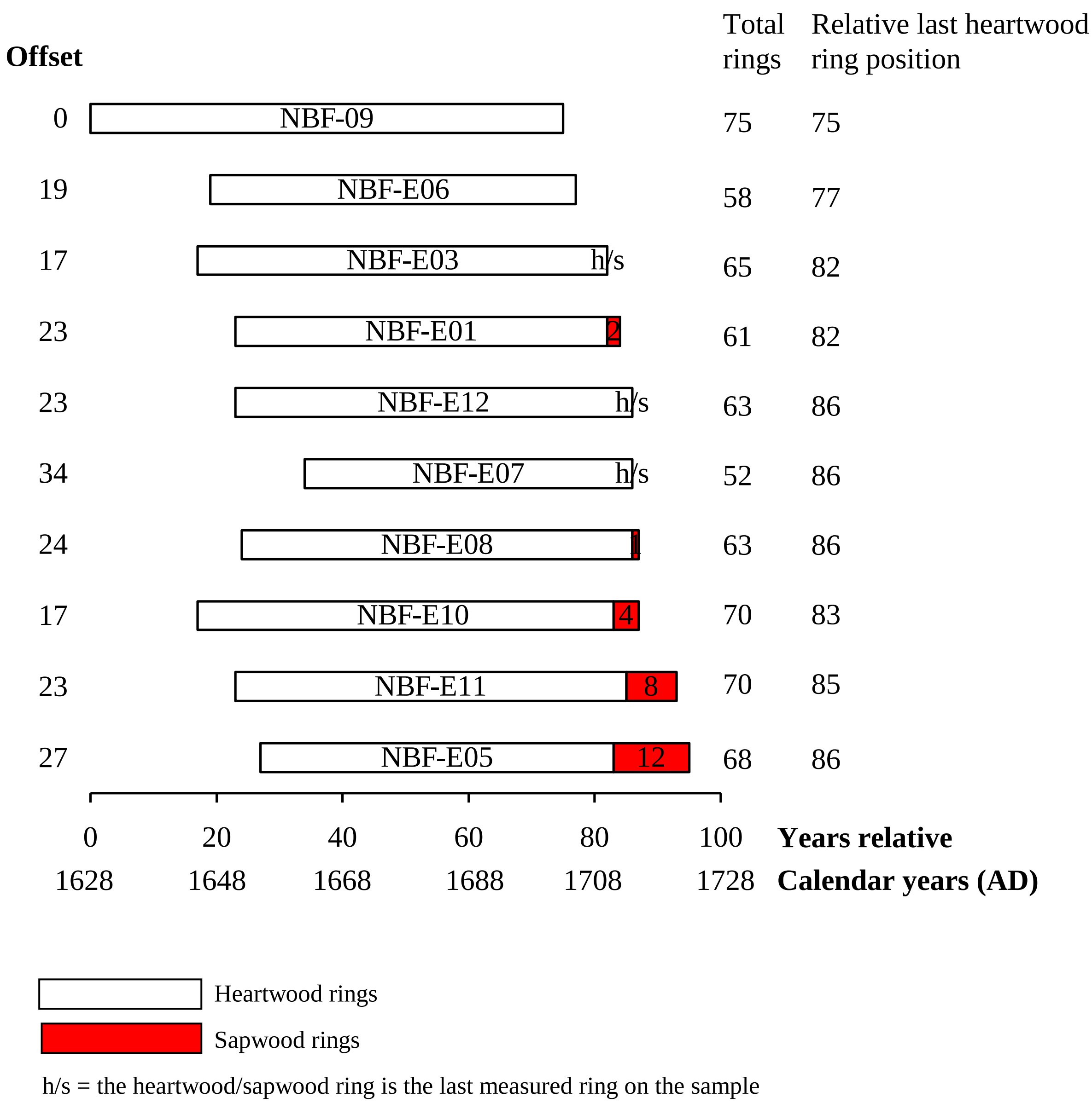

Table 1: Details of samples from St Giles Church, Elkesley, Nottinghamshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last ring date (AD)
NBF-E01	Top cill, truss 3	61	02	1651	1709	1711
NBF-E02	South jack brace, middle truss	NM	--	----	----	----
NBF-E03	Top cill, east end frame	65	h/s	1645	1709	1709
NBF-E04	South brace, east end frame	NM	--	----	----	----
NBF-E05	South brace, middle truss	68	12	1655	1710	1722
NBF-E06	Top cill, truss 1	58	--	1647	----	1704
NBF-E07	North brace, west end frame	52	h/s	1662	1713	1713
NBF-E08	Middle brace, west end frame	63	01	1652	1713	1714
NBF-E09	Top cill, west end frame	75	--	1628	----	1702
NBF-E10	Bottom cill, west end frame	70	04	1645	1710	1714
NBF-E11	South brace, west end frame	70	08	1651	1712	1720
NBF-E12	Middle brace, east end frame	63	h/s	1651	1713	1713
NBF-E13	West brace, truss 1	NM	--	----	----	----
NBF-E14	North brace, middle truss	NM	--	----	----	----

*h/s = the heartwood/sapwood boundary is the last ring on the sample
NM = not measured

Table 2: Results of the cross-matching of site sequence NBFESQ01 with relevant reference chronologies when the first ring date is AD 1628 and last ring date is AD 1722

Reference chronology	Span of chronology	*t*-value
East Midlands	AD 882-1981	8.8
London	AD 413-1728	5.8
England	AD 401-1981	5.2
Worcester Cathedral (Nave roof – inserted timber), Worcs	AD 1597-1730	8.2
Lincoln Cathedral, St Hughs Choir, Lincs	AD 1575-1724	7.4
Old Barn, Stratford on Avon, Warwics	AD 1591-1735	7.3
Wheelwright’s Shop, Chatham, Kent	AD 1615-1780	6.5
Ragnall Barn, Notts	AD 1607-1717	6.4
Ely Cathedral, Cambs	AD 1592-1736	6.0
Rufford Mill Country Park, Notts	AD 1571-1744	5.8