The Antiquaries Journal, **86**, 2006, pp 206–26

CHURCH ALIGNMENT AND PATRONAL SAINT'S DAYS

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The results of this survey of almost 1,500 rural churches do not support the oft-repeated idea that churches are aligned with their patronal saint's sunrise. In fact, they provide evidence that the churches specifically do not face different sunrises and that churches dedicated to saints with summer feast-days are aligned in the same direction as those dedicated to saints with winter feast-days. However, the results of the survey raise significant questions about other aspects of church alignment. A significant variation in alignment has been uncovered east to west across the country, with a difference of 10° in the mean alignment of churches between the west and east of England. Possible reasons for this are explored. In addition, churches built on sloping sites are found to have downhill-facing chancels. If the choice of site were random, churches would face uphill as well as down. The possible implications of this for church and village location are also explored.

INTRODUCTION

This paper continues attempts to take the study of church alignment away from the folklorists and into the realm of more scientific study, and is based on a survey of almost 1,500 medieval rural parish churches. In an earlier article I showed that there was no evidence to support the folkloric idea that churches with naves and chancels on different alignments represented religious imagery of Jesus on the Cross. In fact, while chancels are misaligned left and right equally, three-quarters of all differently aligned churches had their chancel aligned closer to east than the nave.[1] The survey results from that earlier study are used again here to examine the idea that churches were aligned with their patronal saint's sunrise, initially by analysing the results of all the churches in the survey in general terms, then by focusing on a subset of 621 churches for which a more detailed survey was undertaken.

The concept that churches were aligned with sunrise on the feast-day of the churches' patronal saint is often thought to have originated as a Masonic tradition. Lawrie's *History of Freemasonry*, published in 1859,[2] quotes a poem by William Wordsworth, written in 1823,[3] to support this idea, though Wordsworth's reference to a vigil that took place on the night before the dedication of Rydal chapel (Cumbria) and the fixing of the sunrise point the next morning are similar to those used in a seventeenth-century reference quoted by Johnson,[4] referring to a 'vigil' and the subsequent siting of the altar.

The subject has been researched on the ground many times. One survey concluded that there was a definite link between saint's day sunrise and church alignment.[5] Others, including the only large-scale survey,[6] have concluded that there was no such link. A

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more recent survey found that almost a quarter (33 out of 143) of the large monastic churches surveyed aligned with sunrise on the day of their patronal saint.[7] However, the same survey concluded that twenty-eight others aligned with their patronal saint's day sunset, thirty-seven with Easter sunrise, twenty-five were orientated east–west, twelve were aligned with magnetic east, five were aligned for topographical reasons and thirty-one were aligned with Julian calendar sunrises or sunsets, so the issue was not resolved.

There are three specific issues that complicate the analysis of the results of any survey relating to sunrise and patronal saints. The first concerns the height of the eastern horizon relative to the church. An elevated horizon would delay sunrise and make the sun appear later, and therefore further south, with a delay of between 1.5° and 2° along the horizon per one degree of horizon elevation. This would apply to many churches located in valley bottoms or on slopes that rise in an easterly direction. The opposite situation, where the church is higher than its eastern horizon, would have the reverse effect, advancing sunrise relative to a level horizon and making it appear more northerly. In order to allow for either of these situations, a range of 15° either side of the level horizon sunrise position has been used in the general analyses presented in this paper, which will take all but the most extreme differences into account (a separate analysis of the alignment of the churches in Cumbria and Norfolk is presented later).

The second issue concerns calendar drift, which progressively affected the relationship between the calendar date and the solar date in Britain until AD 1752, when the error was corrected by deducting eleven days from the calendar. The error grew steadily after the introduction of the Julian calendar in 45 BC. From the middle of the tenth century to the middle of the fourteenth, the period when most churches were being built, the error varied from six to nine days.[8] So sunrise on a feast-day celebrated on, say, 1 May in the twelfth century, is in the same position as sunrise on 8 May today. This translates to a difference in sunrise position of approximately 5° further north on the horizon around the autumn equinox, when the sunrise position is moving south, 5° further south at the spring equinox, when sunrise is moving north and virtually no difference at the summer and winter solstices, when there is little day-to-day change in sunrise position. If the time of the year when the initial alignment of individual churches was determined were spread throughout the year, then the differences noted above would tend to cancel each other out. Even if some bias does remain, the following general analysis deals with a range of ±15° around the sunrise position on each saint's day to allow for any variation brought about by the calendar change. This is exactly the same tolerance as has been allowed for horizon differences, and is generous enough to make it unnecessary to calculate sunrise positions based on dates (even assuming that we could, given that we don't know in which year the church alignment was first set out and – much more problematically – in which season of that year).

The third issue involves church re-dedications, either in very early times at a change of manorial lordship, or as part of the later religious upheaval in the sixteenth and seventeenth centuries, when many potentially idolatrous dedications were altered to one of the biblical saints or to the Holy Trinity.[9] Richard Clark has shown that 40 per cent of Derbyshire churches changed dedications between the sixteenth century and the present day,[10] and there is no reason to assume that Derbyshire was unusual. Since the majority of the areas examined in this survey have yet to be covered by the work on church dedications pioneered by Graham Jones as part of the Trinity and All Saints College (TASC) database,[11] this leaves as the only complete source the pre-Reformation dedications set out in Arnold-Forster's index of parishes.[12] This would provide

information on changes occurring from the later medieval period, according to the sources that she used, but would not incorporate the unknown number of early re-dedications. In order to avoid these problems, the churches in the survey will firstly be analysed by their current dedication and broad conclusions drawn, then a summary analysis of dedications by their season will be presented and the results compared.

SAMPLE SELECTION AND METHODS

In order to provide a large dataset and one which would allow an area-based analysis, this survey has a structured sample which covers a geographic spread of nine counties across the country (Cumbria, East Yorkshire, Shropshire, north Cambridgeshire, Norfolk, north-east Suffolk, north Somerset, East Sussex, east Kent and west Cornwall). All the rural medieval parish churches in these areas were surveyed except those described in the relevant volume of Pevsner's *Buildings of England* series as having had their naves rebuilt.[13] The exclusion of these churches was to ensure that a post-medieval, especially Victorian, rebuild had not affected the alignment of the nave. Where Pevsner noted that the nave was rebuilt above a particular level (eg the window cills) and the earlier construction could still be seen, measurements were taken from the original structure.

In order to assist in standardizing readings, especially on undulating walls or those built of material such as cobble flint, they were taken with a Silva Type 15 compass fixed to a piece of wood 75cm in length (with brass screws). Where possible, readings were taken inside the church, two on each side of the nave and chancel. If internal readings were not possible, three readings were taken on both the north and south sides of the outside of the nave and the chancel in an attempt to remove anomalies resulting either from local magnetic variations caused by iron in the walls, or inside the church. If there were differences of more than one degree between the readings for either part of the building, they were retaken at different places. A mean was taken of the results to provide single readings for the nave and for the chancel. Finally, the magnetic compass readings were adjusted to true readings by deducting the contemporary magnetic declination in the area (see Appendix). Topographical information was gathered at each of the sites including the slope and size of the churchyard, proximity to boundaries as well as details of the church itself. The angular elevation of horizons of churches in two of the counties in the survey, Cumbria and Norfolk, were taken with the same Silva compass as the church alignments. Placed on its side and held against the south wall of the chancel, the horizon was sighted along the piece of wood on which the compass was mounted and the reading taken from the integral clinometer, in degrees.

ANALYSIS OF THE RESULTS

The 1,444 churches examined in this survey are dedicated to over 150 different saints. Most of the analysis that follows concentrates on the most common dedications and those with a single feast-day. Churches dedicated to St Mary have been excluded in the majority of instances because, without knowing which of the six feast-days was originally celebrated at specific churches, the introduction of additional possible sunrise points for so many churches complicates the issue.

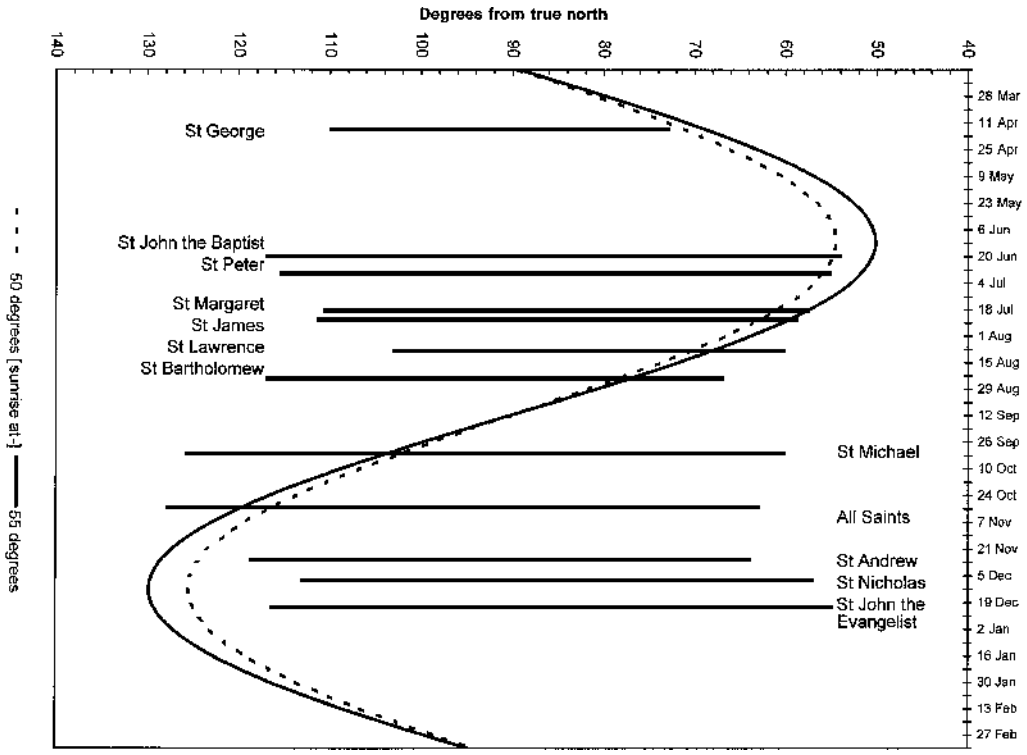

Fig 1. Sunrise azimuth by latitude and church alignment shown on their patron saint's day

General Analysis of Saint's Day Sunrise

Figure 1 shows the position of sunrise at a level horizon throughout the year; the two curves represent the extremes of latitude in England: Cornwall (50°) and Cumbria (55°). They are shown in degrees from true north (the vertical axis), with east at 90° showing sunrises at the spring and autumn equinoxes where the curves cross the 'east' line. Superimposed are columns indicating the range of alignments for all the churches in this survey dedicated to a 'major' saint. These are shown for each individual dedication on the date of the saint's feast-day (the horizontal axis).

The fact that many of the columns in the diagram, describing the range of observed alignments for each dedication, fail to meet the point on the curve that represents the sunrise position on that day demonstrates clearly that almost none of the churches are actually aligned towards sunrise on their patronal saint's day. No church dedicated to a saint with a festival day around midsummer (St John the Baptist and SS Peter and Paul, for example) meets the curve, nor does any church dedicated to a saint whose feast-day occurs in the later part of autumn or winter (St Andrew, St Martin, St Leonard and St Nicholas, for example). For the majority of those where the column does intersect (St James, St Laurence and All Saints), it is only at the extreme end of the alignment range that this occurs, thereby automatically excluding the possibility that the vast majority of churches, clustered around the middle (mean value) of the alignment range, face their sunrise.

Table 1. Alignment of churches by dedication (all dedicated churches in survey with a known feast-day)

	Total	Range of alignments	*Mean alignment*	Standard deviation ±
All Saints	207	63–128	*87.5*	1.4
Holy Trinity	24	61–106	*85.6*	4.2
SS Peter and Paul	45	66–105	*88.8*	3.5
St Andrew	113	61–120	*88.4*	2.1
St Bartholomew	18	66–118	*87.9*	5.7
St Botolph	14	73–118	*85.9*	6.9
St George	17	73–110	*86.9*	5.1
St James	21	58–112	*84.5*	5.6
St John the Baptist	36	55–108	*86.5*	4.2
St Laurence	29	60–103	*84.0*	3.6
St Leonard	16	57–109	*84.0*	6.5
St Margaret	69	57–111	*89.7*	2.9
St Martin	21	65–107	*83.2*	5.1
St Mary	297	56–116	*87.3*	1.2
St Michael	85	60–126	*87.5*	2.7
St Nicholas	43	57–114	*85.6*	3.5
St Peter	111	55–116	*86.6*	2.1
Other saints	231	50–121	*84.6*	1.5
Total	1,397	50–128	*86.7*	0.6

Most of the other saints' dedications have columns of roughly similar length and position, showing that almost all dedications have fairly similar alignment ranges, centred approximately on east, despite the fact that festival day sunrises vary between St John the Baptist and SS Peter and Paul by around 50°, and St Andrew and St Nicholas by around 125°. Even the results for St Michael, with two festival dates close together, and near the middle of the range of possible alignments – 92° and 97° – are inconclusive, in part because the alignments of the eighty-five churches in this survey dedicated to St Michael vary between 60° and 126° (table 1).

The figures in table 2 emphasize this consistent alignment eastwards, irrespective of dedication, rather than towards different sunrises. Four out of every five churches in the survey (80.2 per cent) are aligned within ±15° of east, which includes 64 per cent of churches dedicated to St Botolph and 87 per cent of those dedicated to SS Peter and Paul. By contrast, only one in seven (14.7 per cent) is aligned within ±15° of its sunrise position and half (50.2 per cent) of all the churches in the survey are actually aligned more than 30° away from their saint's day sunrise.

Only churches of two dedications – St Bartholomew and St Michael (whose feast-days are close to the equinox) – have more than 50 per cent of their churches aligned within ±15° of their sunrise position and, even then, almost 80 per cent of churches dedicated to these saints are aligned closer to east than to their own sunrise. In other words, every dedication analysed has a greater proportion of its churches facing east than facing its sunrise. The fact that churches dedicated to five saints (Holy Trinity, St Botolph, St Leonard, St Nicholas and SS Peter and Paul – 143 churches in all) have

Table 2. Church alignment compared with saint's day sunrise and due east, by dedication (all dedicated churches in survey with a known feast-day)

		Degrees from saint's day sunrise					Degrees from due east				
		±15°		16–30°	31 + °		±15°		16–30°	31 + °	
	Total	No.	%		No.	%	No.	%		No.	%
All Saints	207	24	*11.6*	99	84	*40.6*	179	*86.5*	27	1	*0.5*
Holy Trinity	24	1	*4.2*	6	17	*70.8*	19	*79.1*	5	—	—
SS Peter and Paul	45	—	—	9	36	*80.0*	37	*82.2*	8	—	—
St Andrew	113	4	*3.5*	25	84	*74.3*	92	*81.4*	20	1	*0.9*
St Bartholomew	18	10	*55.6*	6	2	*11.1*	15	*83.3*	3	—	—
St Botolph	14	—	—	5	9	*64.3*	9	*64.3*	5	—	—
St George	17	8	*47.1*	6	3	*17.6*	12	*70.6*	5	—	—
St James	21	3	*14.3*	7	11	*52.4*	16	*76.2*	4	1	*4.8*
St John the Baptist	36	3	*8.3*	6	27	*75.0*	27	*75.0*	8	1	*2.8*
St Laurence	29	8	*27.6*	17	4	*13.8*	25	*86.2*	4	—	—
St Leonard	16	1	*6.3*	5	10	*62.5*	11	*68.8*	5	—	—
St Margaret	69	4	*5.8*	20	45	*65.2*	55	*79.7*	13	1	*1.5*
St Martin	21	2	*9.5*	4	15	*71.4*	15	*71.4*	6	—	—
St Michael	85	62	*72.9*	19	4	*4.7*	66	*77.6*	19	—	—
St Nicholas	43	1	*2.3*	3	39	*90.7*	35	*81.4*	6	2	*4.7*
St Peter	111	7	*6.3*	39	65	*58.6*	89	*80.2*	21	1	*0.9*
Other saints	231	63	*27.3*	70	98	*42.4*	182	*78.8*	40	9	*3.9*
Total	*1,100*	*162*	*14.7*	*346*	*552*	*50.2*	*884*	*80.2*	*199*	*17*	*1.5*
St Mary	297						251	*84.5*	46	—	—

either no churches, or just a single church, aligned within ±15° of their sunrise, but 111 (78 per cent) facing within ±15° of east, confirms the consistency with which churches of all dedications face generally eastwards rather than generally towards their patronal saint's sunrise point.

The general results here seem to argue conclusively against the idea of patronal saint's day alignment, at least within this group of rural churches. For statistical purposes, some of the groups are small, but, if churches did indeed face 'their' sunrise, then all the churches of each dedication would tend to align closer to a single direction, so that the size of the sample would not matter. However, churches of each particular dedication patently do not align in different directions. Added to this is the fact that churches in the 'Other' group, consisting of 231 churches dedicated to over 100 different saints, display a similar range of alignments, with a similar mean direction to that of each of the individual saints, and have a similar proportion of churches facing close to east (78.8 per cent).

Elevated Horizons

It was noted earlier that horizons elevated above the horizontal would delay sunrise, therefore making the actual point of sunrise appear further to the south. To take this into account, the horizons of 621 churches in two counties, Cumbria and Norfolk, were

Table 3. Church alignment compared with actual sunrise position and due east, by dedication (churches in Norfolk and Cumbria)

		Degrees from saint's day sunrise					Degrees from due east				
		±15°		16–30°	31 + °		±15°		16–30°	31 + °	
	Total	No.	%		No.	%	No.	%		No.	%
All Saints	108	11	*10.1*	44	53	*49.0*	95	*88.0*	12	1	*1.0*
SS Peter and Paul	22	—	—	5	17	*77.3*	18	*81.8*	4	—	—
St Andrew	62	2	*3.2*	14	46	*74.2*	53	*85.5*	9	—	—
St Botolph	10	—	—	4	6	*60.0*	6	*60.0*	4	—	—
St John the Baptist	13	—	—	1	12	*92.3*	12	*92.3*	1	—	—
St Margaret	37	4	*10.8*	13	20	*54.1*	32	*86.5*	5	—	—
St Michael	37	28	*75.7*	7	2	*5.4*	29	*78.4*	8	—	—
St Nicholas	16	—	—	2	14	*87.5*	14	*87.5*	2	—	—
St Peter	46	3	*6.5*	20	23	*50.0*	37	*80.4*	9	—	—
Other saints	132	30	*22.7*	35	67	*50.8*	109	*82.6*	23	—	—
Total	*483*	*78*	*16.1*	*145*	*270*	*55.9*	*405*	*83.9*	*77*	*1*	*0.2*
St Mary	138						121	87.7	16	1	0.7

measured and calculations of the actual sunrise position made (see Appendix for formulae).

Table 3's results for churches where the horizon was measured and the actual sunrise position was calculated demonstrate the same alignment patterns as the previous table for the whole sample – one in six churches (16.1 per cent) aligned within 15° of their saint's day sunrise, whereas over half (55.9 per cent) are aligned more than 30° away from the sunrise point. However, more than four of every five churches (83.9 per cent) are aligned within 15° of east, with only two churches aligned more than 30° away from east. These figures are confirmed by the graph in figure 2, showing the majority of saint's day sunrises to be at the extreme ends of the church alignment range or outside it completely.

Saints' Season

To demonstrate finally that saints' feast-day sunrises were not the focus for church alignment, a general analysis of the churches in this survey was undertaken by placing churches into three seasons determined by the date of the patron saint's feast-day – summer, winter and equinoctial (see table 4). The year was split into four equal parts of ninety-one days, each centred on a solstice or equinox, resulting in three categories, winter saints between 6 November and 6 February, summer saints between 7 May and 5 August, the remainder, centred on the spring and autumn equinoxes, described as equinoctial. Those saints without a feast-day listed in the *Oxford Dictionary of Saints* are not included,[14] and churches dedicated to St Mary, whose multiple feast-days appear in all three seasons and would complicate the issue, are shown separately.

In all, 1,100 churches were included in the analysis: 282 dedicated to winter saints, 366 to summer saints and 452 to equinoctial saints. The mean alignment of each of these groups is within 1° of the overall mean, whereas sunrises differ by between 50° and

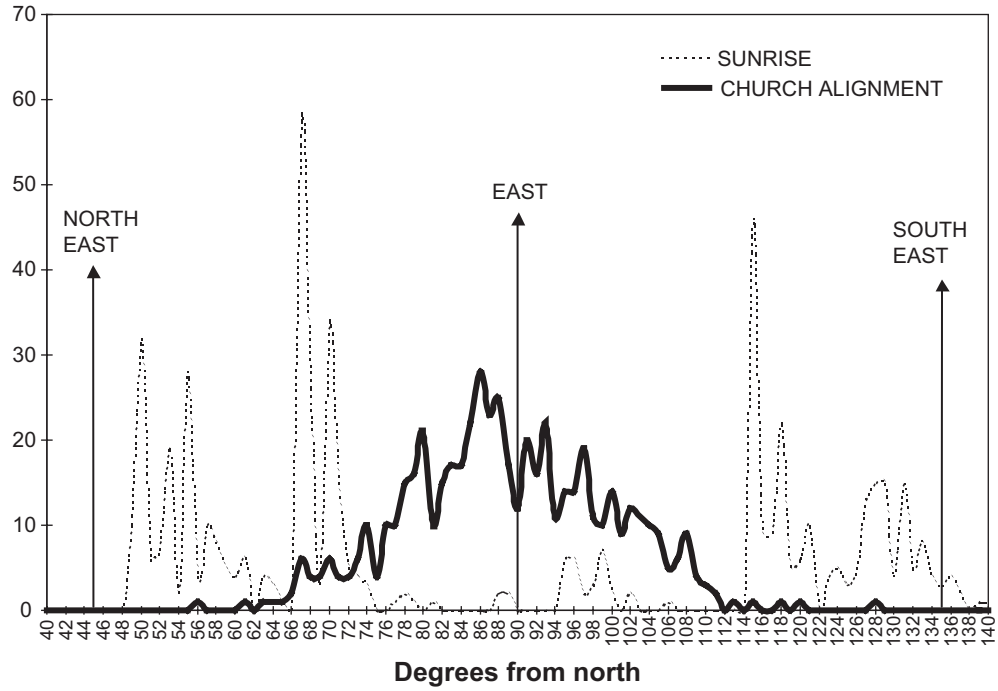

Fig 2. Comparison between actual sunrise position on patronal saint's feast-day and church alignment: Norfolk

Table 4. Mean church alignment by season (all dedicated churches in the survey with a known saint's feast-day)

Churches dedicated to:	No.	*Mean*	Standard deviation ±
Summer saints	366	*85.8*	1.2
Equinoctial saints	452	*86.8*	1.3
Winter saints	282	*86.5*	1.4
Total	1,100	*86.8*	0.6
St Mary	297	*87.3*	1.3

72° for winter and summer. If churches were aligned with saints' feast-day sunrises, the mean alignments would be expected to vary by a similar amount, with sunrise in the summer period varying between 54° and 65° true, and winter sunrises appearing between 115° and 127° true. Elevated horizons would have an effect, but only by a few degrees and would have the effect of delaying winter sunrise even further south, exacerbating, rather than improving the situation.

ALIGNMENT VARIATION ACROSS THE COUNTRY

One interesting result of the survey is the observation that the mean alignment of churches varies significantly in an east–west direction across the country (see table 5).

Table 5. Survey results, county by county

	Number	Range	*Mean*	Standard deviation ±	Alignment range at 1 standard deviation	% north of east
West Cornwall	72	50–111°	*80.4°*	2.8°	77.6–*83.2*	76.4
Cumbria	74	62–104°	*82.3°*	2.2°	80.1–84.5	78.4
Shropshire	104	55–126°	*82.4°*	2.3°	80.1–84.7	71.1
North Somerset	91	54–107°	*82.5°*	2.2°	80.3–84.7	73.6
East Yorkshire	110	51–111°	*83.0°*	2.1°	80.9–85.1	76.4
North Cambridgeshire	123	57–121°	*86.2°*	1.9°	84.3–88.1	67.5
East Sussex	104	54–118°	*86.8°*	2.4°	84.4–89.2	56.7
Norfolk	549	56–128°	*88.9°*	0.9°	88.0–89.8	55.8
North-east Suffolk	125	65–119°	*88.6°*	1.8°	86.8–90.4	55.2
East Kent	92	58–120°	*92.4°*	2.6°	*89.8*–95.0	40.2
Overall	*1,444*	*50°–128°*	*86.9°*	0.6°	*86.3–87.5*	*61.1*

Table 6. Church alignment by longitude in England

	West (2°W+)	Central	East (0.5°E+)	Total
Number	341	372	731	1,444
Range	50–126 (76°)	51–126 (75°)	56–128 (72°)	50–128 (78°)
Median	88°	88.5°	92°	89°
Mean	*82.0°* (±1.1)	*85.6°* (±1.2)	*89.4°* (±0.8)	*86.9°* (±0.6)
% north of east	*74.5%*	*69.0%*	*53.8%*	*61.1%*

Churches in Cornwall have a mean alignment of 80°, whereas churches in east Kent have a mean alignment of 92°. This 12° difference is reduced to 7° (83.2°–89.8°) at the closest ends of one standard deviation, but this still indicates a significant difference.

When these counties are grouped together with other counties in the survey and examined by longitude (see table 6), the churches in the west have a mean alignment of 82° ±1.1°, while churches in the east have a mean alignment of 89.4° ±0.8°. This variation in mean alignment across the country cannot have happened by accident. The trend of these results is continued with the alignment of churches in Denmark. Abrahamsen's survey on the ground of 204 churches in Thistead and Aarhus counties,[15] undertaken as part of a larger map-based survey, found that these churches had a mean alignment of 94.2°, with only 34 per cent of churches aligned north of east (author's calculations from the data presented in Abrahamsen's article).

If the aim was to align churches eastwards, why was there such a difference between churches in the east of the country and churches in the west? Errors in setting out individual churches in the east produced a range of 72°, centred within 2° of East, with an overall mean direction of 89°. In the west, the setting out errors resulted in a similar range of alignments (76°), also centred within 2° of east, whereas the mean alignment was 7° further north at 82°. Churches in the centre of the country fit neatly in the centre of these results, with a mean alignment of 85.6°.

Table 7. Church alignment by longitude in Norfolk

	West of Norfolk < 1.10°E	East of Norfolk > 1.11°E
Number of churches	270	279
Mean alignment	*87.5*	*90.3*
Standard deviation	(±1.3)	(±1.2)
95% range	86.2–88.8	89.1–91.5
% aligned north of east	*62%*	*50%*

The ranges of alignments are very similar, all centred close to east, but the *mean* alignments are significantly different. This is a reflection of the increased skewing of the results from east to west. In the east of the country, the ratio of churches aligned north and south of east was 387 : 332 (53.8 per cent to the north; with twelve churches aligned due east). In the centre of the country, the ratio of churches aligned north and south of east is 245 : 110 (69 per cent north of east), while in the west of the country three-quarters of the churches (74.5 per cent) are aligned north of east, or 254 : 76. It appears that the further west a church is located, the more likely it is to be aligned to the north of east. Did the builders have a different focus for alignment in the west of the country? Their overall accuracy was similar to builders in the east, with 81 per cent of western churches aligned within 15° of east, compared with 84 per cent of churches in the east, so why were so many more churches aligned to the north of east?

The greater density of churches in Norfolk allows closer analysis of alignment in a single county, and the overall relationship between east and west continues here (table 7). Dividing the county so that an equal number of churches appears in each half shows a similar variation in the mean alignment between churches in the west (87.5°) and in the east (90.3°), producing another statistically significant result at 1 standard deviation. Similarly, the proportion of churches aligned north of east follows the same pattern – an increasing proportion of churches aligned to the north of east as the analysis moves westwards.

The fact that this pattern appears to stretch from Cornwall to Denmark, and can even be repeated at sub-county level, makes it seem most unlikely that this difference was brought about by the apparently unconnected acts of a large number of church builders. It is most improbable that this has happened by chance, but what connects them? Is there a physical reason for this variation?

There appear to be no other factors covered in this survey that contribute to this alignment difference. The churches in the east and west of the country, and in the east and west of Norfolk, are similar in terms of construction (eg size and floor plan). They are built on a similar range of sites in terms of such topographical variables as the slope of the site, and their churchyards are similar in terms of their size and the restrictions that might have affected their alignment, such as proximity to boundaries.

We therefore have to look for external reasons for this variation: among possible influences are changes in the earth's magnetic field, seasonal issues and sunrise at specific times of year and chronology (earlier versus later church foundations).

Magnetic Changes

The subject of how churches were set out and whether the compass was known at the

time of much of the church building in England has been discussed before.[16] The idea that churches were set out magnetically towards east, and that the variations in alignment between individual churches built at different dates reflected the changes in magnetic declination (the difference between a magnetic direction and the true direction), seems, on the face of it, to provide a simple explanation for the variation in the alignment of churches. In fact the current consensus appears to be that few, if any, churches were set out magnetically using a compass;[17] the issue here, however, is whether magnetic changes and the use of a compass can explain the difference in observed alignments between the east and west of the country.

As well as varying over time, magnetic declination also varies spatially. In 2002, a compass in south-eastern Britain would have shown magnetic north to be 2° 30′ west of true north, while in Cumbria the difference was 5°, resulting in magnetic directions for true east of 87° 30′ and 85° respectively.[18]

While magnetic declination has been calculated for the centre-point of the country for the medieval period,[19] it is not possible to calculate the variation in declination across the country for the medieval period.[20] It is also not possible to tell whether the spatial variation would have been in the same direction in earlier centuries. But we do know that magnetic north was the other side of true north in the medieval period from where it is now, and it seems probable that spatial differences in declination would also have been reversed, ie *increasing* in an easterly direction. This explanation, therefore can never be used to answer the question of why more churches in the west of the country are aligned to the north of east, as churches here that were aligned with a compass in the medieval period would be more likely to be aligned further south than those in the east of the country – the opposite of the actual case.

Sunrise

Since the east, and its connections with light, good and life has had an influence on humankind since prehistory,[21] consideration has to be given to the issue of sunrise at particular times of the year, particularly at the start of the building of the church – the time at which the alignment of the building is finally fixed – and at Easter – the most important festival of the Church.

At the end of the seventeenth century, antiquarians assumed that churches faced sunrise on the day the foundations were laid. 'One end of every Church doth point to such a place where the sun did rise at the time the foundation thereof was laid ... and by the standing of these churches, it is known at what time of year the foundations of them were laid'.[22] They assumed that churches that were aligned close to north east were laid out near midsummer and those aligned close to south east were laid out near to midwinter sunrise.

It is possible that the ritual setting out of the church foundations could have taken place at any time of year, but this fails to explain the observed differences in mean alignment across the country. If churches were laid out throughout the year, a pattern of alignment that followed sunrise would be expected. Sunrise point moves swiftly along horizon at the equinoxes, but slows to a standstill at the solstices. The result is that sunrise is only within 10° of east on 18 per cent of days throughout the year, whereas it is more than 30° from east on 40 per cent of days. Church alignment is the inverse of this pattern, with 59 per cent of churches aligned within 10° of east and only 2 per cent of churches aligned further than 30° from east (see table 8), indicating again that there was

Table 8. Sunrise position throughout the year compared with church alignment

	Sunrise (days)		Church alignment	
	No	%	No	%
> 30° from east	147	*40*	29	*2*
±21–30° from east	86	*23*	115	*8*
±11–20° from east	68	*18*	448	*31*
±10° from east	64	*18*	852	*59*
Total	365		1,444	

purpose behind the alignment of churches as a whole, and that their general focus was east.

There are certain seasonal 'issues' that need to be examined. The first action in the actual construction of a church would be the digging of the foundation trenches, which would tend to fix fairly closely the alignment of the subsequent structure. Digging foundations for a rural church would have been likely to be more of a winter activity, when less time was taken up with work on the land. Alignments fixed at the time of trench digging during the winter would be aligned well south of east. This does not appear to be the case, since two-thirds of all the churches surveyed here were aligned north of east, which would be towards sunrise during the period after the spring equinox and before the autumn equinox.

Church building – especially where a considerable amount of mortar was used, such as in the flint rubble construction of East Anglia – had to take into account the likelihood of frost, as well as the limitations of the building technique. Building contracts for churches in East Anglia made specific references to start dates for building each year. At St Mary, Helmingham, Suffolk, for example, the contract specified that building could only be undertaken between Whitsun (six weeks after Easter, between 5 May and 5 June) and 8 September,[23] a season of never more than four months, and in some years only a few days over three months. In order to maximize the amount of building in the first year, it would seem reasonable that building would start as soon as feasible, or as soon as the contract allowed. Sunrise at Whitsun in East Anglia is between 62° (5 May) and 54° (5 June). As only two of the 674 churches surveyed in East Anglia are aligned north of 62°, alignments with sunrise at the start of building are not possible, at least in East Anglia.

In areas where soil could be used instead of mortar to bed large non-calcareous cut stones, such as granite and slate in Cornwall and Cumbria, or areas in which the use of large limestone ashlar blocks meant the use of considerably less mortar, late frosts would not be so important, thus allowing earlier building starts each year, and also allowing the continuation of building later on in the year. If church building was started earlier in the year in these areas, and the church aligned with sunrise at that time, it would result in alignments further south on average than in the remainder of the country. The results do not bear this out, as Cornwall and Cumbria exhibit numerically the lowest (most northerly) mean alignments of any of the areas surveyed.

Regional medieval climate patterns are unknown, but modern summary climate records obtained from the Meteorological Office website – especially concerning the number of frost days and the timing of the last frost in the year – do not indicate any regional patterns, either north–south or east–west. In the three decades after 1960, Shropshire had the most frost days and Cornwall had the least, the latest frosts

Table 9. Comparison of Western and Roman Easter dates between AD 400 and 779

	Western Easter earlier by 7 days	Easter on same date	Western Easter later by:			
			7 days	14 days	21 days	28 days
Pre-Whitby synod	81	147	—	—	20	16
Post-Whitby synod	69	7	—	—	25	2
Total	150	154	—	—	45	18

occurring in Kent and the earliest cessation of frost was shared by Cornwall, East Sussex and Suffolk.

Easter is considered to be the most important festival of the Church. Its date falls on the first full moon after the first Sunday after the northern hemisphere's spring equinox. This means that it varies between 22 March and 25 April. Sunrise on these days ranges from 90° to 68° in England, depending on latitude, with a mean of approximately 78°. This is lower, between 2° and 14°, than the mean direction of church alignment in any of the areas surveyed here, so it is not likely that the position of sunrise at Easter was the focus for the alignment of churches across the country, as the mean direction in each area would be similar.

Historically, from the beginning of the fifth century, the dates of Easter celebrated by the Western and Roman Churches were often different. Can this help to explain the variations in alignment across the country? Differences in the methods of calculation of Easter between the Western Church and the Roman Church both before and after the consolidation by the Synod of Whitby of 664 meant that in a period of almost 400 years, the date of Easter only coincided on 154 occasions (table 9).[24] In 150 of those years Western Easter was earlier than Roman Easter and was only later in sixty-three years.

However, in the west of the country, Easter would need to be later in the year in order for the sun to rise further north, to account for the fact that mean church alignments are lower (80°–82°) than in the east of the country (90°–92°). To allow for the mean difference of 10° between churches in the east and west of the country, Western Easter would need to be some sixteen days later than Roman Easter. In fact, Western Easter was only later on sixty-three occasions out of 369 years (17 per cent), and on 150 occasions (40 per cent) it was actually seven days earlier. Thus in 43 per cent of these years, sunrise at Western Celtic Easter was on the same day as Roman Easter, and in 40 per cent of years was seven days earlier, meaning a more southerly sunrise on Western Easter day in the west by approximately 3°, therefore varying the wrong way.

Since the differing dates of Western and Roman Easter cannot explain alignment differences across the country, the issue of whether early wooden church buildings of this period would have influenced the alignment of later stone buildings does not need to be resolved here.

Possible Chronological Effect

It might be suggested that the general pattern of church building across the country may have played a part in the overall difference in church alignment. The majority of the rural churches in East Anglia were built or founded in the late eleventh or early twelfth centuries. The main concentration of church building becomes increasingly later as one

moves westwards. However, this general pattern breaks down in the far west or north west, as increasing numbers of small early British churches are encountered.

In addition, the study of the alignment of the extant parts of Anglo-Saxon churches by Hoare and Sweet produced a mean alignment of 88°.[25] The churches in this study that are located in the same areas as Hoare and Sweet's survey show a similar mean alignment. Comparison of these results implies that, since there was no chronological effect observed in a particular area over a period of several centuries, it is unlikely that such an effect exists between areas. In particular, it cannot explain the differences observed within Norfolk.

SLOPING SITES

One in five of all churches in this survey were built directly on a slope exceeding 1 in 50 (2 per cent), where little or no attempt has been made to alter the slope by artificially levelling a platform (churches built on platformed sites are considered separately). From the summary figures presented in table 10 it appears that the slope of the churchyard has had no measurable effect whatsoever on the alignment of the church. The 289 churches built in yards with a slope greater than 2 per cent exhibit the same overall range of alignments as the remaining sites, and have a mean alignment within 0.7° of the survey mean.

While the slope of the churchyard apparently had no effect on the alignment of churches, the specific siting of the churches does appear to have been influenced by the slope. The specific location of churches has been investigated by others in Norfolk, where it was concluded that 'geographic determinism' was the principal factor in the siting. In other words, churches were located close to the settlement they served, the detailed siting of which was most likely to be controlled by factors such as access to natural resources, land tenure and the layout of the vill.[26] It was noted that no churches were located at the highest points of the parish, although most were located on rising ground. The question here is whether rising ground locations, or slope, affected the siting of these churches. In an attempt to establish this, the alignment of the church was compared with the direction of the slope of the churchyard.

Detailed examination of the results of this survey for churches built on sloping land shows that in many cases it was probable that the lie of the land was more important than other factors in determining the specific siting of a church, although not the alignment (table 11). Taking the eastern horizon viewed from the east end of the chancel as the direction the church is facing, of the 289 churches built on slopes, 95 face directly down the hill and 179 face generally downhill, compared with 29 that face directly uphill and 77 that face generally uphill. This means that, excluding churches aligned across the slope, 70 per cent of churches built on sloping sites face downhill. Facing down the hill would make eminent sense if a view of the distant horizon were required for the purposes of sighting the sun. The elevated, and therefore much closer, horizon of the 77 churches facing up the hill would prevent this. The division between churches facing up and down hill is even more marked when only those facing directly up or down hill are examined: more than three times as many churches face downhill (95 : 29).

In figure 3, the direction of the slope has been normalized to point to the right and the length of each of the radial segments represents the number of churches aligned in that direction relative to the down slope.

Table 10. Church alignments by slope of churchyard

	No.	Range	*Mean*	Standard deviation ±	Alignment range at 1 standard deviation
Sloping sites	289	54–121	*86.2*	1.5	84.7–87.7
Platformed sites	208	50–113	*87.0*	1.6	85.4–88.6
Knoll	80	61–110	*87.8*	2.2	85.6–90.0
Flat/almost flat	867	51–128	*86.7*	0.7	86.0–87.4
Overall	1,444		*86.9*	*0.6*	*86.3–87.5*

Table 11. The direction faced by churches built on slopes

	Total	Down the slope	Up the slope	Across the slope
Total	289	179 (61.9%)	77 (26.6%)	33 (11.4%)
Generally up/downhill (excluding across)	256	179 *(70%)*	77 *(30%)*	
Directly up/downhill	124	95 *(77%)*	29 *(23%)*	

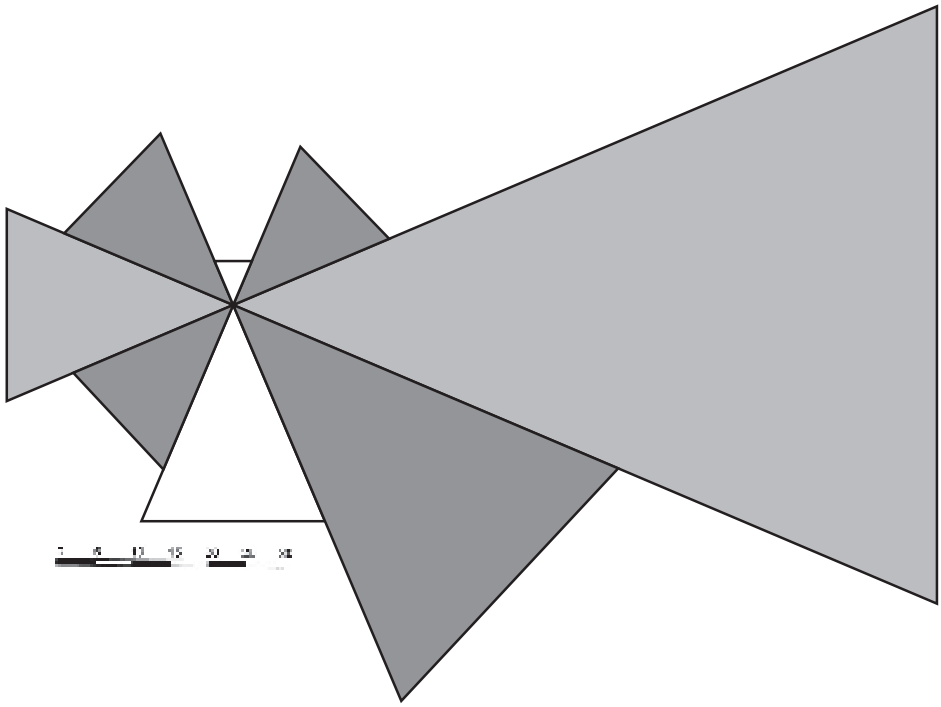

Fig 3. Comparison of church alignment and slope direction: all medieval churches built directly on sloping sites

The requirement for a distant easterly horizon does seem to have played a part in the siting of these churches. If such a view were important, for whatever reason, it would make sense to seek out a site that provided such a vista, if more than one location for the building of the church was available. Since topographical variations are

by their very nature random, churches sited without consideration for the slope and eastern vista would tend to be split roughly equally between those facing generally up and down the hill, rather than the actual 179 : 77 split, excluding those churches in this survey built at right angles to the slope (70 per cent to 30 per cent), or the more emphatic 77 per cent to 23 per cent split of churches facing directly down and up hill. This firmly indicates intent on the part of the person or people who selected the site for the church. The prime questions raised are whether the extended eastern horizon was required by the church as part of its alignment when being set out, whether the extended horizon was considered important at the time for doctrinal reasons, and whether the church was established on a site which had had earlier ritual significance requiring such a view.

Richard Morris describes four possible aspects of church siting in *Churches in the Landscape*,[27] in addition to the frequently observed proximity of church and manor (often described as the 'church/hall focus'). These aspects are 'locally conspicuous sites', 'Christian substitution', 'signs of pre-English activity' and 'indications of more than local status'. In which of these, if any, might an east-facing slope have played a part?

Elements of landscape, such as hillsides, knolls or hilltops, will usually play a part in the creation of conspicuous sites, but these characteristics would be equally effective with any bearing and therefore do not need to contain a specific directional element. Similarly, a specifically directional slope is unlikely to be required by sites of pre-English activity, nor of sites with indications of more than local importance. The remaining aspect of 'Christian substitution' is the only one of the four that could be used to explain the pattern observed here. It was part of Pope Gregory's edict of AD 601 to incorporate, rather than obliterate, previous ritual and religious practices. Was this process implemented more widely than previously realized? Were these churches located on sites that had been used by earlier settlers for ritual reasons?

Where the church was built on a sloping site, but on an artificially created level platform designed to reduce the angle of the slope or to enlarge the space on which to build the church, it might be expected that the builder would have been less restricted in selecting an alignment for the church. Earlier it was shown that platformed sites had little effect on the final alignment of the church, the mean alignment of the 208 churches analysed here being within 0.1° of the whole sample. Were churches built on platforms to allow them to be aligned down the hill? The answer is definitely not. Unlike the obvious emphasis of churches built directly on the slope facing down the hill shown earlier, the relationship of churches built on platforms to the direction of the slope can be split into three, much more equal, groups; with 42 per cent facing down the slope, 34 per cent facing up the slope and 24 per cent facing across the slope (table 12 and fig 4). The opportunity to extend the eastern horizon by using the amended site to align the church differently appears not to have been taken.

What remains to be examined is the age of the churches built on platformed sites. Were these churches built in a later period than those built directly on their sloping site? If this is the case, it is possible that the reason that drove the focus on the eastern horizon for churches built on slopes had become less important, or that the churches built on slopes were built on sites with earlier significance and that platformed sites were new locations with no earlier significance. In either case, the fact that churches on platformed sites face up and down hill equally further emphasizes the significance of the unequal distribution in churches facing up and down hill when built directly on sloping sites.

Table 12. The direction faced by churches built on platforms

	Total	Down the slope	Up the slope	Across the slope
Total	208	87 (42%)	70 (34%)	51 (24%)

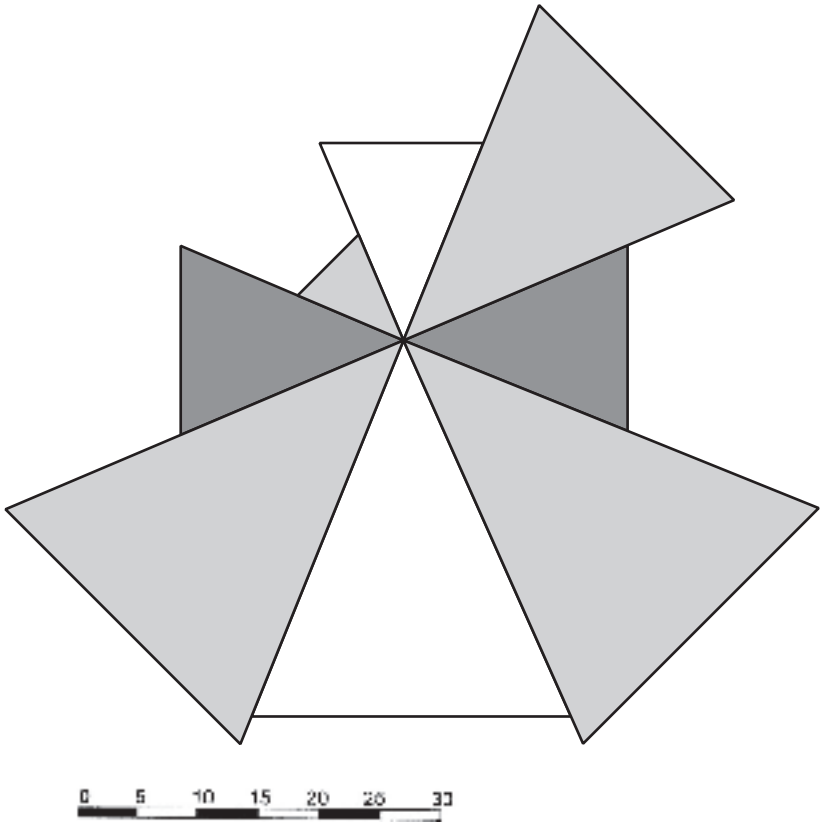

Fig 4. Comparison of church alignment and slope direction: all medieval churches built on platformed sites

CONCLUSIONS

Churches are not aligned with their patronal saint's feast-day sunrises, nor with any other specific sunrises. This conclusion is confirmed by all the analyses here, ranging from the summary statistics of winter and summer saints, which indicate virtually identical alignments compared with sunrise differences of up to one-fifth of the horizon, to a specific analysis of the actual sunrise point of the 550 churches in Norfolk showing no correlation at all. No amount of tinkering with the results to take horizon and calendar change into account can alter the fact that more than half of all churches are aligned further than 30° from their sunrise, whereas less than 2 per cent are aligned more than 30° from east.

The results of this survey confirm that there was an intention on the part of church builders to align their churches roughly with east. Accuracy was not apparently paramount – an approximate direction appears to have been sufficient. However, this does not account for the one particularly significant variation in alignments. A simple desire to face east does not explain the fact that twice as many churches are aligned to the north of east in the west of the country than in the east, resulting in a difference of 12° between the mean alignment of the churches in Cornwall and of those in Kent. This difference is reinforced by the results for the other counties surveyed, which fit neatly, numerically in succession, across the country in between these extremes, confirming the east–west nature of the variation. Abrahamsen's results appear to extend this pattern as far as Denmark.[28]

This pattern cannot be explained by the use of the compass and magnetic alignment. Although currently magnetic declination increases towards the west of the country, the values are not known for medieval times. It must be assumed that, since magnetic north was the other side of true north in medieval times from where it is now, the variation in declination was also reversed, increasing in an easterly direction. This would have resulted in more churches in Kent being aligned to the north of east, with the mean alignment in Kent being numerically lower (further north) than that in Cornwall – the opposite of the results shown here.

Neither can this pattern be explained by variations due to sunrise. Differences in latitude in England affect the sunrise point at the solstices by up to 5° but at the equinoxes the sun rises at the same point on the horizon all over country. Since the mean direction for the churches surveyed here (87°) is towards sunrise just before the autumn equinox or just after the spring equinox, there would be little difference in the position of sunrise at this time of year anywhere in the country. Even the differences in dates between Western and Roman Easter, which might have had an east–west impact on the figures, cannot be considered, because Western Easter was usually earlier than Roman Easter, resulting in more southerly sunrises on Western Easter Day – this would result in western areas having numerically higher mean alignments than the eastern areas – the opposite of that actually observed.

Similarly, delays in building commencement due to climatic variations cannot explain the east–west differences in church alignment. Although the regional details of the medieval climate are unknown, modern climate patterns do not indicate any particular pattern across the country, either north–south or east–west. If the mean church alignment direction in each area was to represent the most popular period of the year for the commencement of church building, it would require that building in Cornwall started later than everywhere else and, in particular, that twice as many churches had later building starts than in Kent, in order that twice as many churches are aligned north of east. In addition, the fact that the mean alignment in Cornwall is even further north of east than in Cumbria, therefore aimed at a more northerly (later) sunrise, meaning later building starts in Cornwall than in Cumbria, appears to confirm that sunrise at the time of building commencement was not a determinant of alignment.

Possible chronological differences in the main building periods of churches in different areas do not seem to explain the pattern either. In addition to the difficulties of establishing a specific chronological pattern of building, the combining of the results from this study and other work shows that there appears to be no chronological

differences in alignment in the same area, implying that there are unlikely to be chronological differences between areas.

There seems to be no room for doubt, from the results here, that a significant pattern of variation in church alignment east–west across the country has been revealed. The sample is large enough, and the results robust enough, to indicate that this is a real pattern rather than an illusory statistical one, but none of the factors measured and analysed here appears to be able to explain it.

It can be equally certain that churches built on sloping sites have been located there to use the extended horizon. The fact that almost two-and-a-half times as many churches face downhill rather than uphill firmly indicates purpose in the selection of the specific site. To discover whether this reflects Christian substitution or the siting of a church on a site whose earlier use required an eastern view will require considerable further work, as does the question of whether the siting and alignment of the church had any influence on the location of the settlements of which they formed a part.

APPENDIX: READINGS OF MAGNETIC DECLINATION FOR 1999–2004

Survey areas' magnetic declination – degrees west of north

	Lat	Long	1999	2000	2001	2002	2003	2004
North Cambridgeshire	52° 55′N	0°		3°20′	3° 12′			
Cumbria	54° 30′N	3° 10′W		5° 5′	4° 55′	4° 46′		
North Somerset	51° 15′N	2° 30′W			3° 58′			
Shropshire	52° 45′N	2° 45′W				4° 14′		
East Sussex	51° 00′N	0°		3° 5′	2° 57′			
North Suffolk	52° 30′N	1° 35′E	2° 48′		2° 33′			
East Yorkshire	53° 55′N	1° 05′W		4° 5′	3° 56′			
East Kent	51° 25′N	1° 20′E				2° 22′		
West Cornwall	50° 15′N	5° 25′W				4° 48′		
Norfolk	52° 45′N	1° 10′E					2° 24′	2° 16′

Calculated by the Canadian Geological Service, April 2000, July 2001, April 2002, December 2003, February 2004, 'Geomagnetism, magnetic declination calculator', <http://gsc.nrcan.gc.ca/geomag/field/mdcalc_e.php> (11 April 2006)

ACKNOWLEDGEMENTS

Thanks are particularly due to my wife, Maggy Chatterley, for her assistance with the fieldwork, for giving up most of her holidays over several years, for her tireless map reading and particularly for her patience. Thanks are due to Tom Williamson and John Blair for their helpful comments and suggestions on earlier drafts, to Larry Newitt of the Canadian Geological Service for his palaeo-magnetic calculations and to John Davies of the British Sundial Society for his assistance with the formulae for calculating sunrise positions over elevated horizons. Lastly, thanks are due to the many churchwardens and key-holders around the country who gave up their time.

NOTES

1. Hinton 2004, 42–54.
2. Lawrie 1859, 441.
3. Jay 1993, np.
4. Johnson 1912, 225.
5. Benson 1956, 205–13.
6. Cave 1950, 47–51; see also Eeles 1913–14, 169; Shore 1886, 95, and Davies 1984, 142–3.
7. Ali and Cunich 2001, 155–93.
8. Duncan 1999, 41–52.
9. Bond 1914, 191.
10. Clark 1992, 49–61.
11. Jones 2004.
12. Arnold-Forster 1899, III.
13. Pevsner 1951; 1958a; 1958b; 1970a; 1970b; 1970c; 1988; 1991; Pevsner and Nairn 1999; Pevsner and Neave 1999; Pevsner and Sherwood 1974.
14. Farmer 1991.
15. Abrahamsen 1992, 292–303.
16. Ibid; Hoare and Sweet 2000, 162–73; Ali and Cunich 2001.
17. Hoare and Sweet 2000, 162–73; Ali and Cunich 2001, 56–7; Hinton 2004, 42–54.
18. Calculations taken from Canadian Geological Service 2004.
19. Clark *et al* 1988, 645–67.
20. L Newitt of Canadian Geological Service, pers comm.
21. See Parker-Pearson and Richards 1994; Lucy 2000; Hoskin 2000 for general discussions.
22. Chauncey 1700, 88.
23. Salzman 1992, 547.
24. Cheney 2000, 147–54.
25. Hoare and Sweet 2000, 162–73.
26. Barnes 1997, 23–36.
27. Morris 1989, 75.
28. Abrahamsen 1992, 7.

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