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AN EXTENDED BROAD SPECTRUM OF PAPERS PRESENTED TO LEENDERT LOUWE KOOIJMANS

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3 Timing, tempo and temporalities in the early Neolithic of southern Britain

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3.1 Introduction: cross-Channel perspectives on Neolithisation

The work of Leendert Louwe Kooijmans across four decades of research has made enormous contributions to our understanding of the processes of Neolithisation in Europe. Although working principally in two regions within the Netherlands, his results have major implications for how we can think about sequences of change at the Mesolithic-Neolithic transition everywhere. Diversity and detail are the keys.

On the one hand, Leendert's investigations in the Rhine-Maas estuaries and coastal areas, from early work at Hazendonk through to the complex, large-scale investigations of the Hardinxveld sites and Schipluiden, have strongly suggested the gradual transformation of indigenous communities (for example: Louwe Kooijmans 1974; 1993; 1998; 2001a; 2001b; 2007; Louwe Kooijmans *et al*. 2005; Louwe Kooijmans/Jongste 2006). Beginning *c*. 5000 cal BC, these populations first adopted pottery, then pigs, cows and sheep, and finally, by *c*. 4000 cal BC, cereal cultivation. The occupation of Schipluiden in coastal Delfland, beginning *c*. 3600 cal BC, is taken to represent a small, sedentary and agriculturally based community. It is, however, one placed firmly in a long, slowly developing indigenous tradition by its range of activities, as well as by isotopic signatures of still significant aquatic/marine input into the diet (summarized in Louwe Kooijmans 2007).

On the other hand, and reflecting another strand of Dutch Neolithic research, work on the Linearbandkeramik (LBK) has suggested the intrusion on to the loess of the southern Netherlands of agriculturalists from the outside (Louwe Kooijmans 2007, 295-6). Specifically, Leendert's work at Geleen-Janskamperveld added significant detail to our understanding of western LBK settlements, not least in the number of smaller houses and the unusually well preserved and recorded fence lines around and among the longhouses (Louwe Kooijmans *et al*. 2003).

Such characterizations rely especially on a sense of context and tradition, supported by the fine detail of Dutch fieldwork and the unusual preservation of organic remains down the subsequently covered sides of old dune and sand ridges in the estuarine/coastal area. They serve, among other things, to put current models for the processes of neolithisation in Britain into perspective. Here, as elsewhere, there is a continuing debate between advocates of colonization (*e.g*. Sheridan 2007; Bradley 2007; Rowley-Conwy 2004) and proponents of indigenous change (*e.g*. Thomas 1999; 2007). Rarely are such models applied to different regions within Britain (for an exception see Cummings/Whittle 2004, 1-7, 89-91); rare too are integrationist or fusion models (Zvelebil/Lukes 2008; Whittle 2003; 2007). Supporters of both main models appear to agree on an informal date estimate for the start of the Neolithic across Britain as a whole at *c*. 4000 cal BC, though we must note the more nuanced models of Alison Sheridan (2003; 2004; 2007), albeit also based simply on the visual inspection of calibrated radiocarbon dates. There is, so far, a lack of investigated sites comparable to those of the Dutch estuaries, though some would argue that this apparent absence up and down the eastern side of England and Scotland is support for the model of intrusive colonization (Pailler/Sheridan forthcoming).

What, however, of the timescales of all this? Broadly speaking, the proposed Dutch chronology cannot be doubted. The LBK in the Netherlands cannot belong to the earliest phase of that culture, and must be earlier than wells, for example at Erkelenz-Kückhoven in the Rhineland (Weiner 1998), associated with developed LBK pottery styles and dendrochronologically dated to just before 5050 BC.[1] The appearance of the western LBK beyond the Rhine is often dated to *c*. 5300 cal BC (*e.g*. Lüning 2005). But to what date between 5300 and 5000 cal BC does a site like Geleen-Janskamperveld actually belong, and for how long did it last? There is a hiatus in the visible sequence in the estuarine sites in the second half of the fifth millennium cal BC (Louwe Kooijmans 2007, fig. 2), so at what date does cereal cultivation actually appear in that zone, and what was the pace of change between the use of sites like Hazendonk and that of sites like Schipluiden – a gap informally estimated at up to four centuries? It is clear that in both the Netherlands and Britain, despite our varying success in locating sites directly relevant to processes of neolithisation, only broad chronologies have been produced, principally based on the informal inspection of calibrated radiocarbon dates.

3.2 Modelling chronologies

To fully understand both the flow of life and change in prehistoric societies, we need robust chronologies. From more precise timings come the relationships between events and so the durations of past actions – and from these emerges tempo. Tempo to the level of the single lifetime or even generation opens up the relationship of short-term change to long-term change for examination. So, what has happened that has suddenly placed such resolution within our grasp?

In this paper we present an introduction to the modelling of radiocarbon dates in a Bayesian statistical framework. This approach is fast being adopted as best practice in English archaeology (Bayliss/Bronk Ramsey 2004), and we believe it currently provides the most effective method available for producing explicit, quantifiable estimates of chronology (at least for those regions which lack extensive dendrochronologies). We go on to present two examples of Bayesian models for the chronology of causewayed enclosures from the early Neolithic of southern Britain, to show the potential of the method for establishing different kinds of temporality, at both short and longer timescales. Finally, we offer our first attempts at the formal modelling of the date of the appearance of Neolithic practices in southern England for two contrasting and physically separate regions. These new chronologies raise many implications for our understanding of sequences and processes of change, some of which we discuss briefly below.

3.2.1 Statistics and radiocarbon dates

A generation of archaeologists has grown up with the understanding that radiocarbon measurements have to be calibrated (*e.g*. Pearson 1987). In the Neolithic period, for example, typically this means that a hazelnut shell, which actually fell off its tree on one particular day of one particular year, has a calibrated date range which spans a hundred years or more. Groups of calibrated dates from such samples cover even wider swathes of time, as estimating radiocarbon ages is in itself a probabilistic process and so calibrated dates scatter around the actual ages of the dated samples. Given the uncertainties on most calibrated radiocarbon dates and the relative brevity of much human activity, this statistical scatter on the dates can be substantial in comparison to the actual duration and dates of the archaeological activity in question. Proportionately, the quantity of scatter is greater when the actual period of dated activity is short and/or the number of radiocarbon dates is large.

Take, for example, the assemblage of 21 calibrated radiocarbon dates from a fictitious Neolithic enclosure shown in figure 3.1. At first sight, these appear to span the middle centuries of the fourth millennium cal BC, with the earliest

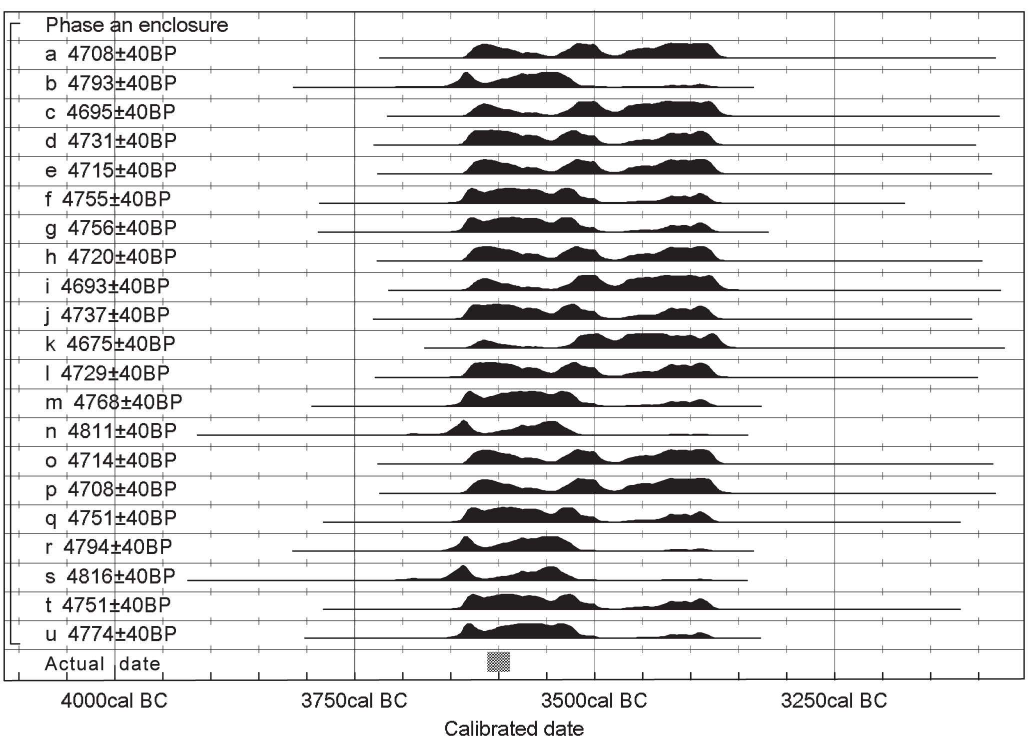

Figure 3.1 Calibrated radiocarbon dates (Stuiver/Reimer 1993; Reimer *et al.* 2004) from a fictitious Neolithic enclosure. The radiocarbon ages have been simulated from samples which actually date to 3615–3585 BC (see table 3.1).

sample dating to 3660-3520 cal BC (95% confidence; n and s; table 3.1), and the latest to 3630-3360 cal BC (95% confidence; k; table 3.1). But in fact, these calibrated dates come from radiocarbon ages which have been simulated (by a process of back-calibration) from samples whose actual ages are known. These samples actually date to between 3615 BC and 3585 BC – a span of 30 years, not 300! Simple visual inspection of groups of calibrated dates such as this runs a very significant risk that past activity will appear to start earlier, end later, and endure for longer than was actually the case. In our view, it is the ability of Bayesian statistics to tackle this issue formally which is one of the major, practical attractions of the approach.

3.2.2 The Bayesian approach

The basic idea behind the Bayesian approach to the interpretation of data is encapsulated in Bayes' theorem (Bayes 1763; fig. 3.2). In archaeological terms this simply means that we analyze the new data we have collected about a problem ('the standardized likelihoods') in the context of our existing experience and knowledge about that problem (our 'prior beliefs'). This enables us to arrive at a new understanding of the problem which incorporates both our existing understanding and our new data (our 'posterior belief'). This is not the end of the matter, however, since today's posterior belief becomes tomorrow's prior belief, informing the collection of new data and their interpretation as the cycle repeats (fig. 3.3).

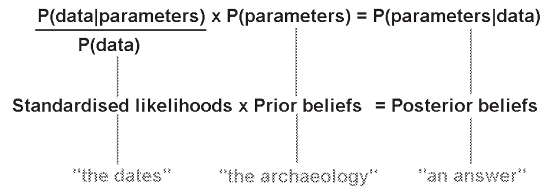

Figure 3.2 Bayes' theorem.

Identifier	Actual Age	Simulated Radiocarbon age	Calibrated date (68% confidence)	Calibrated date (95% confidence)
a	3615 BC	4708±40BP	3630-3375 cal BC	3635-3365 cal BC
b	3615 BC	4793±40BP	3640-3525 cal BC	3655-3385 cal BC
c	3615 BC	4695±40BP	3625-3370 cal BC	3635-3365 cal BC
d	3610 BC	4731±40BP	3635-3380 cal BC	3640-3370 cal BC
e	3610 BC	4715±40BP	3630-3375 cal BC	3635-3370 cal BC
f	3610 BC	4755±40BP	3635-3385 cal BC	3640-3375 cal BC
g	3605 BC	4756±40BP	3635-3385 cal BC	3640-3375 cal BC
h	3605 BC	4720±40BP	3630-3375 cal BC	3640-3370 cal BC
i	3605 BC	4693±40BP	3625-3370 cal BC	3635-3365 cal BC
j	3600 BC	4737±40BP	3635-3380 cal BC	3640-3370 cal BC
k	3600 BC	4675±40BP	3520-3370 cal BC	3630-3360 cal BC
l	3600 BC	4729±40BP	3635-3375 cal BC	3640-3370 cal BC
m	3595 BC	4768±40BP	3640-3520 cal BC	3645-3375 cal BC
n	3595 BC	4811±40BP	3645-3530 cal BC	3660-3520 cal BC
o	3590 BC	4714±40BP	3630-3375 cal BC	3635-3370 cal BC
p	3590 BC	4708±40BP	3630-3375 cal BC	3635-3365 cal BC
q	3590 BC	4751±40BP	3635-3385 cal BC	3640-3375 cal BC
r	3585 BC	4794±40BP	3640-3525 cal BC	3655-3385 cal BC
s	3585 BC	4816±40BP	3645-3535 cal BC	3660-3520 cal BC
t	3585 BC	4751±40BP	3635-3385 cal BC	3640-3375 cal BC
u	3585 BC	4774±40BP	3640-3525 cal BC	3645-3380 cal BC

Table 3.1 Radiocarbon ages simulated by a process of back-calibration from samples whose actual ages are between 3615 and 3585 BC. These measurements are used in figures 3.1-3.3 The calibrated date ranges have been calculated using the maximum intercept method (Stuiver and Reimer 1986) and data from Reimer *et al.* (2004).

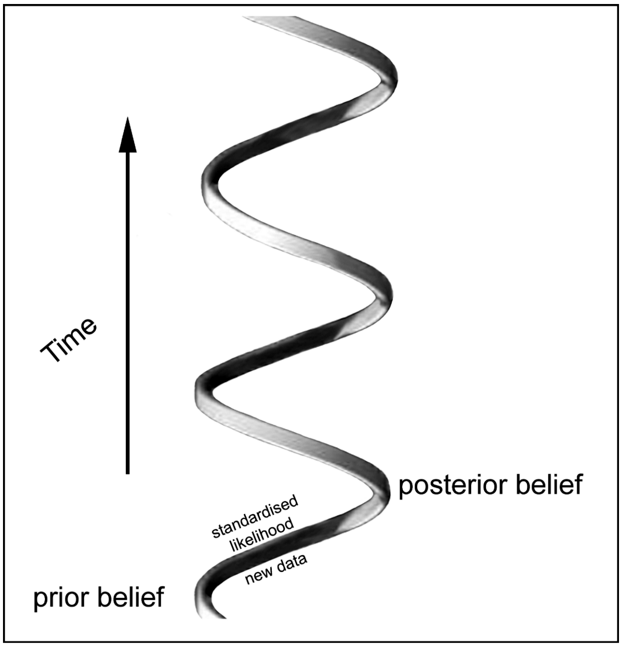

Figure 3.3 Bayes' theorem and the hermeneutic spiral (after Hodder 1992, fig. 22).

In terms of dating a Neolithic site, we may have obtained a series of radiocarbon dates. Perhaps less frequently, we may have a tree-ring date, a luminescence age, or a calibrated archaeomagnetic date. All these dates form the 'standardized likelihoods' component of our chronological model. These dates are interpreted within the framework of our understanding of the site, the taphonomy of the dated samples, and the stratigraphic sequence of the deposits from which they were recovered. This additional information forms the 'prior beliefs' component of our model. Together, these strands of evidence enable us to suggest dates for when the site was in use. These are the 'posterior beliefs' that are the outputs of our model.

None of this is revolutionary. Radiocarbon dates have been interpreted contextually within archaeology since the pioneering days of the 1950s, a practice to which Hans Waterbolk made a signal contribution (1971). What Bayesian statistics do provide, however, is an explicit, quantitative method which can combine our raw scientific dates with the other 'prior information' included in a model to produce formal statistical date estimates which combine both sorts of evidence. Technically these are known as *posterior density estimates*. By convention, these interpretative dates are cited *in italics* to distinguish them clearly from dates based on independent scientific information alone.[2]

3.2.3 A step-by-step guide to a Bayesian model

At this point, a worked-through example may clarify matters. Returning to our fictitious Neolithic enclosure, we have 21 calibrated radiocarbon dates (fig. 3.1; table 3.1), which form the 'standardized likelihoods' component of our Bayesian model. But what 'prior beliefs' do we have about our site?

First, we know that it is a site. At some, unknown, point in time in the past people came and constructed our enclosure. They then used it for some period before they stopped using it. It had a period of use. *Faute de mieux* we assume that this period of activity was relatively constant and relatively continuous, and so we model it as uniformly distributed (Buck *et al*. 1992). The model which incorporates this interpretation is shown in figure 3.4. Here the *posterior density estimates* which are the outputs of our Bayesian model are shown in black, and the calibrated radiocarbon dates (the standardized likelihoods component) are shown in outline. In addition to a posterior distribution for each dated sample, however, we now also have two new parameters. These formally estimate the dates when the enclosure was built (*start*) and when it went out of use (*end*). These estimates do not relate to any particular radiocarbon sample, but rather to all of them and to the distribution of dated events. They allow for the fact that in reality it is extremely improbable that we will have dated the earliest sample to be deposited on the site.

The model shown in figure 3.4 estimates that our fictitious Neolithic enclosure was constructed in *3650-3585 cal BC (95% probability; start)*, probably in *3640-3605 cal BC (68% probability)* and went out of use in *3630-3535 cal BC (82% probability; end)* or *3525-3485 cal BC (13% probability)*, probably in *3610-3550 cal BC (68% probability)*. Furthermore, by calculating the difference between these two distributions, we can estimate that the site was in use for *1-130 years (95% probability; use*; fig. 3.5), probably for *1-65 years (68% probability)*.

In this simulated case the actual dates of use of the enclosure are known, so we can see that the true date for its construction (3615 BC) lies within the posterior density estimate provided by our model at both 95% and 68% probability. Equally the true date for the end of its use (3585 BC) lies within the posterior density estimate for that parameter at both 95% and 68% probability, and the true duration of its use (30 years), also lies within the relevant posterior density estimate at both 95% and 68% probability.

It is perhaps worth examining the prior information that has been used in this example in a little more detail. Technically, the assumption of a uniformly distributed phase is known as an 'uninformative prior belief'. This is not because it necessarily has little effect on the outputs of a model, but because the outputs of the model should be relatively robust against it being untrue. In this example, the samples actually only span a period of 30 years, although each calibrated date

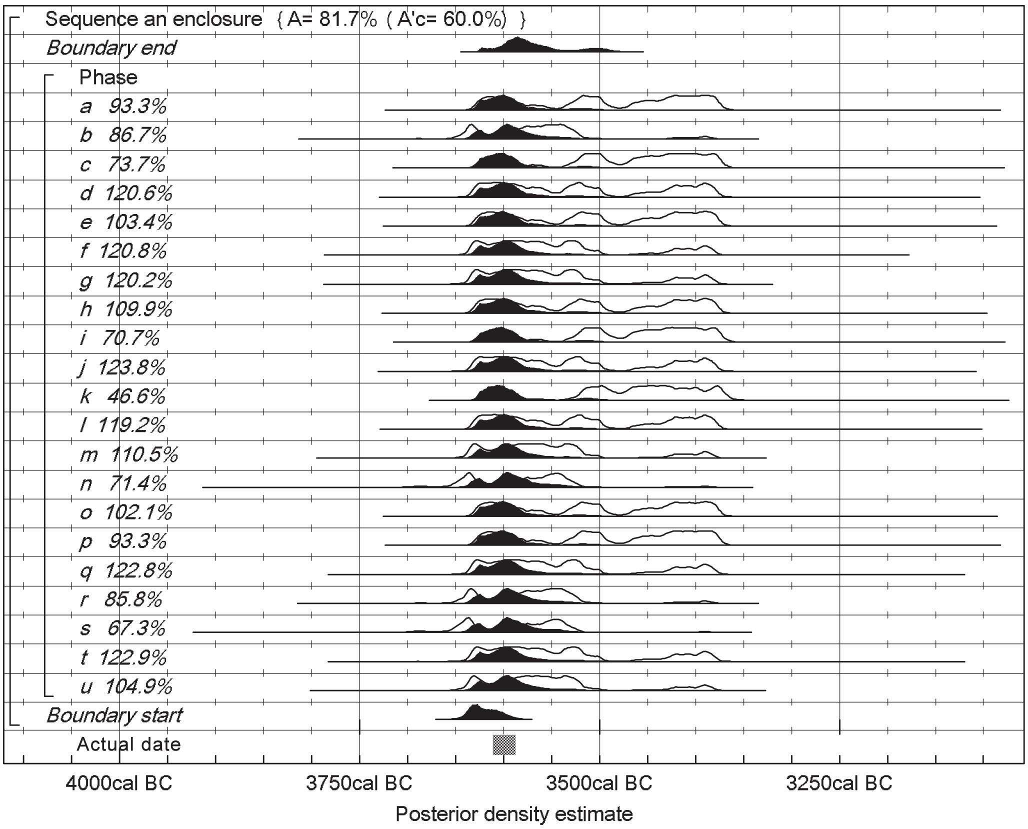

Figure 3.4 Probability distributions of simulated dates from a fictitious Neolithic enclosure. Each distribution represents the relative probability that an event occurs at a particular time. For each of the dates two distributions have been plotted: one in outline, which is the result of simple radiocarbon calibration, and a solid one, based on the chronological model used; the event associated with, for example, 'a', is the growth of the dated sample. Distributions other than those relating to particular samples correspond to aspects of the model. For example, the distribution '*start*' is the estimated date when the enclosure was constructed. The large square brackets down the left-hand side of the diagram, along with the OxCal keywords, define the overall model exactly (http://c14.arch.ox.ac.uk/). The simulated dates are those shown in figure 3.1 and detailed in table 3.1 (3615-3585 BC).

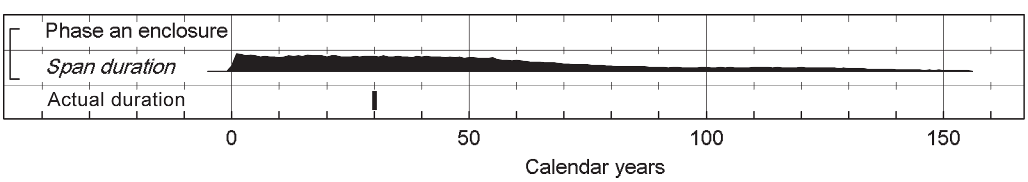

Figure 3.5 Number of years during which the fictitious Neolithic enclosure was in use, derived from the model defined in figure 3.4.

spans around 300 years. As the calibrated dates are so similar, however, the model is able to determine that a large proportion of each calibrated date is a product of statistical scatter rather than variation in actual calendar date. If the period of use of the fictitious enclosure had in reality lasted for three hundred years from *c*. 3600-*c*. 3300 cal BC, then some of the dates would have scattered into the 38th century cal BC and on to the 3300-3000 cal BC plateau in the calibration curve, but proportionately the amount of scatter observed from 21 radiocarbon dates would have been less.

This type of prior information is perhaps more abstract and less intuitive for archaeologists than that derived from, for example, physical stratigraphy. But it is vital. The need for this type of prior belief has been highlighted by Steier and Rom (2000; and see also Bronk Ramsey 2000). In practice, the uniform distribution is very forgiving. Archaeologically 'relatively constant and relatively continuous' could mean 'was inhabited continuously', or 'was used for a week once a year', or 'was used once by each generation'. A quantified illustration of just how wrong this assumption has to be before the outputs of a model are importantly wrong (Box 1976, 792) is provided in Bayliss *et al*. (2007a).[3]

3.2.4 Another model explained

A second model for the chronology of our fictitious Neolithic enclosure is provided in figure 3.6. This uses the same set of simulated radiocarbon dates, but in this case the 'prior beliefs' component of the model has been varied. In addition to treating the site as a coherent period of human activity, we also have stratigraphic information that provides relative dating information about the samples. They are from animal bones in the enclosure ditch, which were articulated and so they cannot be residual, and their relative dating is the same as that of the sequence of deposits. For this reason, we can include the information that samples a-f ('phase 1') are earlier than samples g-n ('phase 2'), which are in turn earlier than samples o-u ('phase 3'). This is a much more 'informative' prior belief and affects the output of the model strongly.

This is why the posterior density estimates output from the model shown in figure 3.6 are rather more precise than those provided by the model shown in figure 3.4. They suggest that the enclosure was constructed in *3645-3590 cal BC*

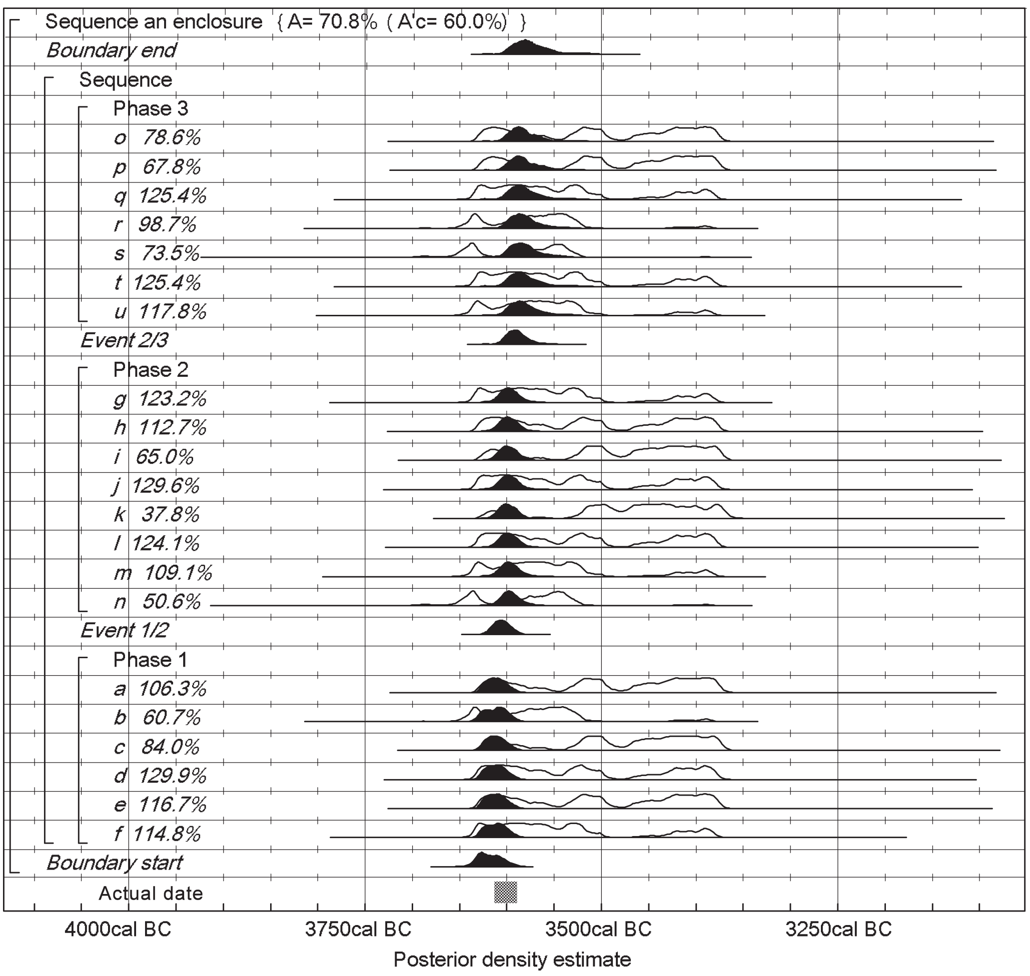

Figure 3.6 Probability distributions of dates from a fictitious Neolithic enclosure, incorporating the information that samples a-f are earlier than samples g-n, which are earlier than samples o-u. The format is identical to that of figure 3.4. The simulated dates are those shown in figure 3.1 and detailed in table 3.1 (3615-3585 BC). The large square brackets down the left-hand side along with the OxCal keywords define the overall model exactly.

(95% probability; start), probably in *3635-3605 cal BC (68% probability)*. The boundary between phases 1 and 2 occurred in *3625-3585 cal BC (95% probability; 1/2)*, probably in *3620-3595 cal BC (68% probability)*, and the boundary between phases 2 and 3 in *3615-3545 cal BC (95% probability; 2/3)*, probably in *3605-3570 cal BC (68% probability)*. The site went out of use in *3610-3510 cal BC (95% probability; end)*, probably in *3605-3570 cal BC (68% probability)*. Again, by taking the difference between the distributions for the start and end of activity on the site, we can estimate that it was in use for *1-105 years (95% probability*; distribution not shown), probably for *1-65 years (68% probability)*.

Again, in this example, in every case the true values for each parameter lie within the relevant posterior density estimate calculated by the model at both 95% and 68% probability. A summary of the actual and estimated dates for the key parameters from the models shown in figures 3.4 and 3.6 is provided in table 3.2. More extensive discussion of the accuracy of Bayesian chronological models in the fourth millennium cal BC, and of their sensitivity to various archaeological and technical factors, is provided in Bayliss *et al*. (2007a). A more extensive introduction to Bayesian chronological modelling for those with a limited background in mathematics is provided in Bayliss (2007).

3.3 Two causewayed enclosures from the Thames estuary

The first Neolithic enclosure we will consider is that at Lodge Farm, St Osyth, Essex. It lies at 15 m OD on a low spur of gravel, 3 km inland from the broad embayment formed by the mouths of the Colne and Blackwater estuaries. Excavations in 2002-3 revealed the remains of a very large causewayed enclosure with three irregular circuits (Germany 2007). Generally the ditches contained few finds, although there were seven concentrations of artefacts, mainly of Mildenhall Ware sherds. Within the ditches, mostly on the western side, were 117 small pits, sometimes arranged in small groups of two or more. The fills of around half of these features were dark with carbonised wood and plant remains, the remainder being similar to the surrounding natural sand; a few had been recut. Artefacts were generally concentrated in charcoal-rich deposits in the pits, and a small number of pits contained large concentrations of material.

The chronological model for the Neolithic enclosure and pits at Lodge Farm is shown in figure 3.7. There are no stratigraphic relationships between samples, and so the model simply incorporates the assumption that the Neolithic activity on the site formed a single, relatively constant and continuous, period of use (see above, example shown in figure 3.4). This model suggests that the start of Neolithic activity on the site, and potentially the initial construction of the causewayed enclosure, dates to *3660-3630 cal BC (70% probability; start St Osyth)* or *3565-3540 cal BC (25% probability)*, probably to *3655-3635 cal BC (61% probability)* or *3555-3545 cal BC (7% probability)*. This period of activity, and the use of the enclosure, ended in *3640-3620 cal BC (69% probability; end St Osyth)* or *3550-3530 cal BC (26% probability)*, probably in *3640-3625 cal BC (61% probability)* or *3545-3540 cal BC (7% probability)*.

The duration of Neolithic activity on the site is estimated to have been *1-35 years* (*95% probability*; figure 3.8), probably *1-20 years (68% probability)* – within the span of a single generation.

Parameter	**Actual Date**	***Posterior density estimate (95% probability)***	***Posterior density estimate (68% probability)***
		Figures 3.4 and 3.5	
start	3615 BC	*3650-3585 cal BC*	*3640-3605 cal BC*
end	3585 BC	*3630-3535 cal BC (82%)* or *3525-3485 cal BC (13%)*	*3610-3550 cal BC*
duration	30 years	*1-130 years*	*1-65 years*
		Figure 3.6	
start	3615 BC	*3645-3590 cal BC*	*3635-3605 cal BC*
1/2	3610 BC / 3505 BC	*3625-3585 cal BC*	*3620-3595 cal BC*
2/3	3595 BC / 3590 BC	*3615-3545 cal BC*	*3605-3570 cal BC*
end	3585 BC	*3610-3510 cal BC*	*3600-3560 cal BC*
distribution not shown	30 years	*1-105 years*	*1-65 years*

Table 3.2 Summary of key parameters from the models described in figures 3.4 and 3.6.

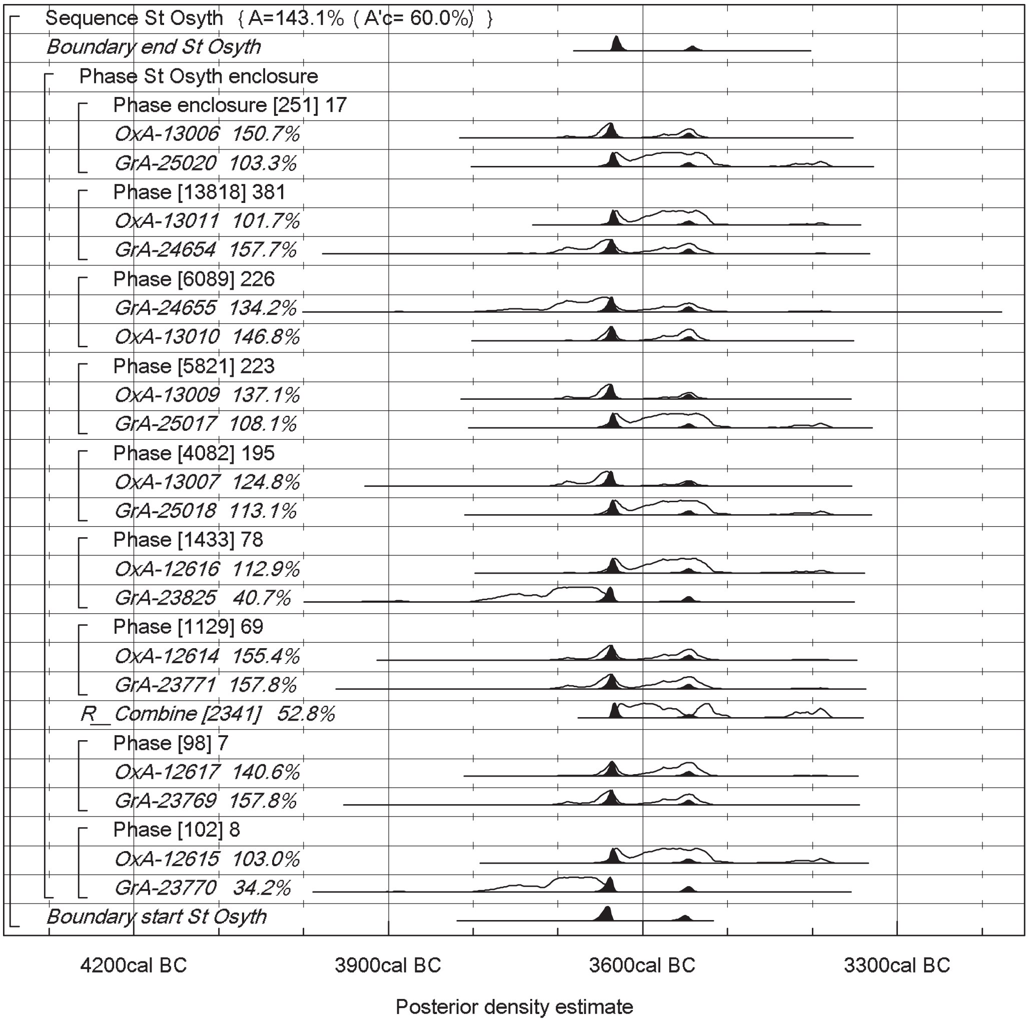

Figure 3.7 Probability distributions of dates from the causewayed enclosure at Lodge Farm, St Osyth. The format is identical to that of figure 3.4. The model is defined exactly by the brackets down the left-hand side of the diagram. The two peaks of probability for each posterior density estimate result from a pronounced wiggle in the calibration curve around the time when the site was used.

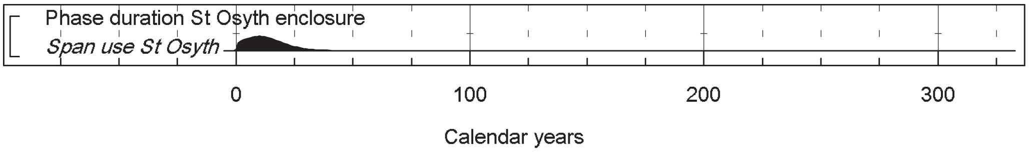

Figure 3.8 Probability distribution of the number of years during which the causewayed enclosure at Lodge Farm was in use, derived from the model shown in figure 3.7.

The second Neolithic enclosure to be considered is at Chalk Hill, Ramsgate, Kent. This lies at 30 m OD on the south side of the Isle of Thanet. Excavations by the Canterbury Archaeological Trust in advance of road building in 1997-8 revealed three interrupted ditch circuits with a maximum dimension of approximately 150 m, internal features, and two closely spaced, parallel interrupted linear ditches cutting the outer and middle circuits and in turn cut by the ditches of a possible cursus monument (Shand 1998; 2001; Dyson *et al.* 2000). The circuits were formed of conjoined pits. Postholes marked possible entrances, especially in the north.

The model for the chronology of the Chalk Hill enclosure is shown in figure 3.9. This includes the relative dating provided by stratigraphy from a series of samples on articulating bones and residues from refitting groups of pottery sherds from the outer ditch, in addition to the assumption that the Neolithic activity on the site formed a single, relatively constant and continuous, period of use (see above, example shown in figure 3.6). On the basis of this model, the first dated circuit of the enclosure was built in *3780-3680 cal BC (95% probability; start Chalk Hill)*, probably in *3740-3690 cal BC (68% probability)*, and the enclosure went out of use in *3635-3560 cal BC (95% probability; end Chalk Hill)*, probably in *3630-3595 cal BC (68% probability)*.

The Chalk Hill enclosure seems to have been in use for *45-165 years* (*95% probability; use Chalk Hill*; figure 3.10), probably for *65-115 years (68% probability)*.

3.4 Some thoughts on causewayed enclosures

These results illustrate some of the more general points that have become apparent following our wider study of the chronology of early Neolithic causewayed enclosures in southern Britain (Whittle *et al.* in prep).

First, although not all enclosures were built at the same time, they do form a concentrated horizon. Chalk Hill is one of earliest examples, perhaps constructed in the latter part of the 38th century cal BC (fig. 3.9), whereas St Osyth was probably constructed in the middle part of the 37th century cal BC (fig. 3.7). Hambledon Hill, Dorset, the modelling of which inspired the wider programme described here, can be formally estimated to have begun in the earlier 37th century cal BC (Healy 2004; Mercer/Healy in press). In contrast, informal modelling of the radiocarbon results available from the 1980s excavations at Maiden Castle, Dorset, suggested construction very early in the fourth millennium cal BC, between 3900 and 3700 cal BC (Sharples 1991, 104-5). Re-assessment of sample longevity and of context in turn proposed that the whole enclosure could have been younger than Sharples had envisaged and that the inner circuit could have pre-dated the outer (Cleal 2004, 169, 188). Our programme has confirmed the essence of this suggestion (Whittle *et al.* in prep., chapter 4).

These are results from just three sites, but it is clear from our programme as a whole, which has dated some 30 out of a probable total of some 90 or more sites and modelled existing results from five others, that these results indicate the recurrent chronological position of southern British causewayed enclosures.

Second, these three examples illustrate very different histories for the use of the monuments. At St Osyth, this use appears to have been brief – a number of episodes, on the evidence of some inter-cutting pits, but spread across a few decades at most. Such brevity has rarely been observed, or suggested, for Neolithic monuments (but see Saville 1990, 265-6, for the Hazleton long barrow; Bayliss *et al.* (2007b) for West Kennet long barrow; and Evans and Hodder (2006, 329) for the Haddenham enclosure). In contrast Chalk Hill was in use for several generations – certainly more than two and perhaps for four or five. This probably takes us beyond the span of the personal memory of any one individual in the community, although probably still within reach of a direct oral tradition passed on by parents or grandparents. For whatever reasons, the people who used St Osyth moved on after a few decades, but those at Chalk Hill persisted in the use of the same space. An even greater contrast is provided by the much larger complex of Neolithic earthworks on Hambledon Hill, where activity persisted for more than 300 years, as it did at Windmill Hill, in Wiltshire (Whittle *et al.* in press). Such longevity, however, now seems the exception rather than the rule.

3.5 The place of enclosures within the early Neolithic of southern Britain

The models already presented for a small sample of long barrows (Bayliss/Whittle 2007; Whittle *et al.* 2007) have now been extended by the much wider programme of modelling of radiocarbon results from causewayed enclosures. With these models it becomes possible to begin to construct a much more precise and robust chronology, based on formal date estimates, for the first centuries of the southern British Neolithic. We will report this in full in due course (Whittle *et al.* in prep.), but we can already begin to add time-depth to, and appreciate change within, this period of transition.

We now have evidence which indicates that causewayed enclosures did not begin in the very first phase of the southern British Neolithic. We appear to be dealing with a sequence within the first centuries of the southern British Neolithic in which long barrows appeared before causewayed enclosures. Probably few long barrows were built before *c.* 3800 cal BC (Whittle *et al.* 2007), though there may be exceptions. Burn Ground, Gloucestershire, may be one (Smith/Brickley 2006; though there are uncertainties about outlying dates and whether dated samples represent deposited

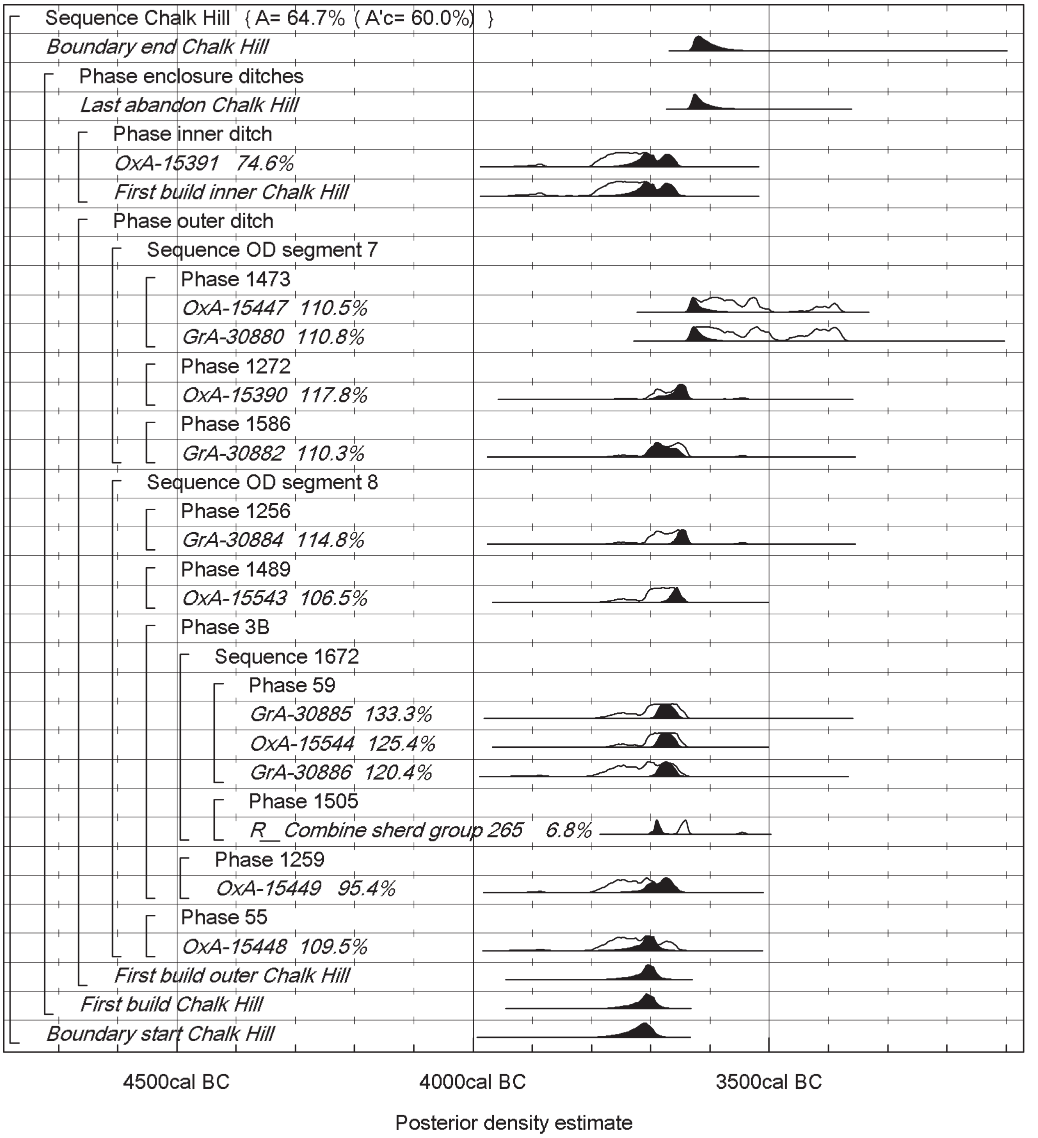

Figure 3.9 Probability distributions of dates from the causewayed enclosure at Chalk Hill. The format is identical to that of figure 3.4. The model is defined exactly by the brackets down the left-hand side of the diagram.

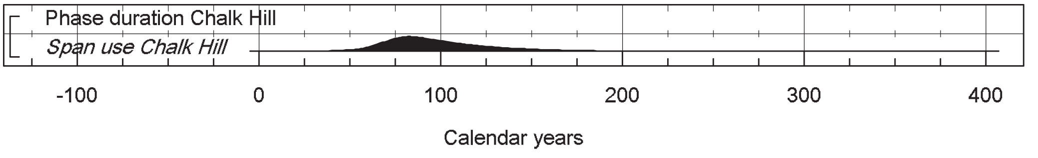

Figure 3.10 Probability distribution of the number of years during which the causewayed enclosure at Chalk Hill was in use, derived from the model shown in figure 3.9.

intact bodies in all cases: Whittle *et al.* in prep., chapter 8). Coldrum, Kent, although the original form of the monument is uncertain, is another (Wysocki *et al.* in prep.). Ascott-under-Wychwood, Oxfordshire, stands currently as a monument probably built in the 38th century cal BC (Benson/Whittle 2007, 221-36; Bayliss *et al.* 2007c). In our wider programme, we have not dated any causewayed enclosure earlier than probably the late 38th century cal BC (Whittle *et al.* in prep., chapter 14).

What then of the start of the southern British Neolithic? Can we refine this date, and indeed is this a question of a single date? How can the sequence from southern Britain be compared now with those across the Channel, including in the Dutch estuaries? Much ink, of course, has been spilt on the Mesolithic-Neolithic transition in Britain as a whole (to say nothing of Ireland). Suffice it to say here that once critical review of samples and association had begun (Kinnes 1985; Kinnes/Thorpe 1986), higher estimates (*e.g.* Case 1969; Whittle 1977) fell out of favour. General opinion, on date though not on process, shifted to a start *c.* 4000 cal BC. This suggested date has been widely repeated (*e.g.* Bradley 2007; Edmonds 1999; Darvill 2004; Pollard/Reynolds 2002; Russell 2002; Schulting 2000).

It is worth noting, however, that variations have also been proposed, for example of a 'Final Mesolithic/?First Neolithic' dating to ?4200-3800 cal BC (Barclay 2007), and of a possible virtually aceramic 'earliest or contact Neolithic', *c.* ?4100-3850 cal BC (Cleal 2004). Alison Sheridan has argued for a number of years for three, if not four, strands of earliest Neolithic activity in Britain and Ireland: the first represented by fifth millennium contacts indicated by the Ferriter's Cove evidence; the second a 'Breton strand' along the Atlantic and Irish sea façade, argued to date to *c.* 4200-3900 cal BC and to be marginally earlier than the Carinated Bowl tradition; the third the Carinated Bowl-associated Neolithic, extending to the eastern side of England and Scotland, claimed to date between *c.* 3950/3900 and 3700 cal BC; and the fourth a northwest French (probably Normandy) – southwest English complex of simple bowl pottery and simple passage tombs in the first quarter of the fourth millennium cal BC (*e.g.* Sheridan 2003; 2004; 2007; Pailler/Sheridan forthcoming).

3.6 The date of the first Neolithic in the Thames Estuary and beyond

In an attempt to address some of these issues, we have gathered existing radiocarbon determinations associated with diagnostically early Neolithic material in the areas where we have dated enclosures. All these dates have been subjected to critical evaluation to determine the association between the radiocarbon date and the Neolithic activity with which it was related (Waterbolk 1971). Some samples, for example unidentified charcoals, simply provide *termini post quos* for their contexts. The dates, or key parameters from sites which have sufficient dates for formal modelling, are then incorporated in the appropriate manner into a model where the early Neolithic is treated as a period of relatively constant and continuous activity. This is critical because, in order to provide a reliable estimate for the start of the Neolithic, it is necessary to impose a statistical distribution on the phase of activity sampled for radiocarbon dating to counteract the statistical scatter on the group of radiocarbon dates. If this is not done, the results can easily be interpreted erroneously as suggesting a start date for the Neolithic which is anomalously early.[4]

The chronological model shown in figure 3.11 includes dates from sites around the Thames estuary which contained diagnostic early Neolithic material (excluding those from causewayed enclosures). It is sobering that measurements from only seven sites are available. Obviously any chronology proposed on such a small sample of data must be highly provisional. Nonetheless, this model suggests that diagnostic Neolithic material first appeared in this region in *4315-3880 cal BC (95% probability; start Estuary Neolithic)*, probably in *4120-3935 cal BC (68% probability)*. On the evidence of two sites – the megalithic monument at Coldrum and the timber longhouse at White Horse Stone – the Neolithic had arrived in Kent by the 40th century cal BC at the latest. Further, by taking the difference between our estimate for the date of construction of the White Horse Stone longhouse and our estimate for the construction of the first circuit at Chalk Hill, we can suggest that the interval between the appearance of Neolithic practices in Kent and the appearance of the first enclosure in that region was probably *95-410 years* (*95% probability*; distribution not shown), probably *195-340 years (68% probability)*.

By way of comparison, a chronological model of similar form shown in figure 3.12 includes dates from sites which contained diagnostic early Neolithic material from the southwest peninsula of England (Cornwall and Devon). This model suggests that the earliest Neolithic activity in this region began in *3900-3690 cal BC (95% probability; start SW Neolithic)*, probably in *3820-3730 cal BC (68% probability)*. This is *55-530 years (95% probability*; distribution not shown), probably *145-360 years (68% probability)* later than the first appearance of Neolithic practices around the Thames estuary.

These results seem to confirm that, around the Thames estuary at least, Neolithic practices had appeared several centuries before the first causewayed enclosure. They may also suggest that the Neolithic did not appear everywhere across southern Britain at the same time – indeed there may

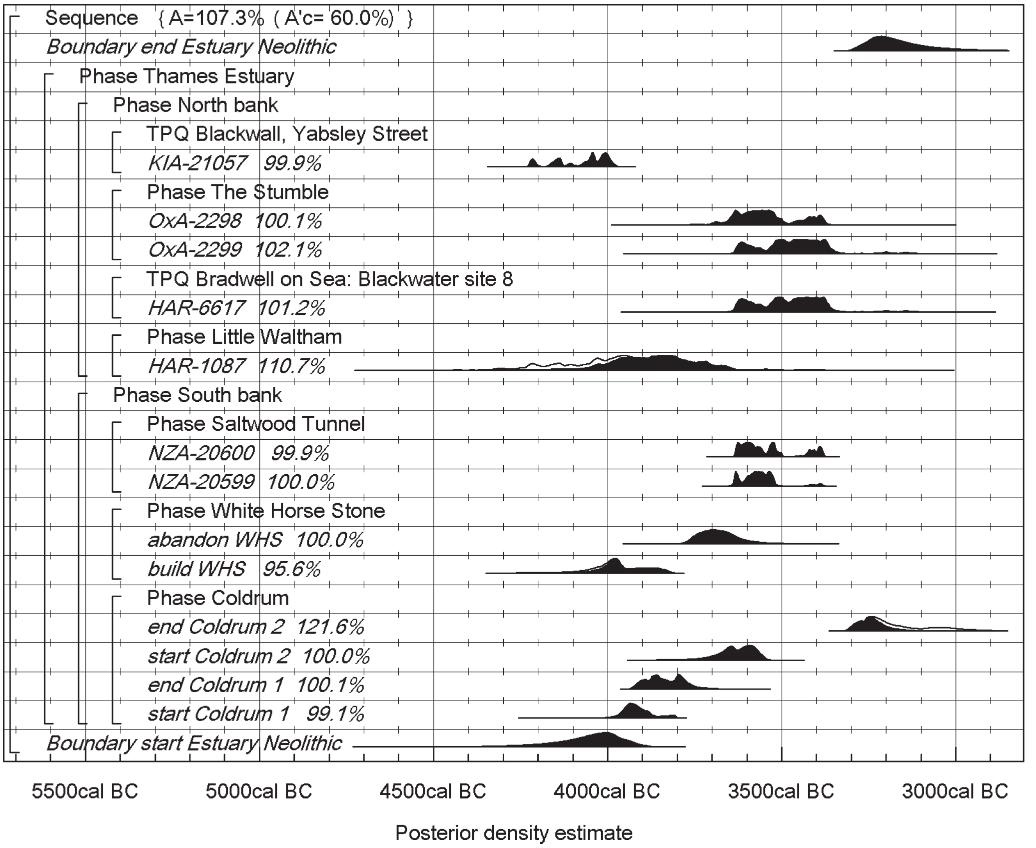

Figure 3.11 Probability distributions of dates for early Neolithic contexts in the Thames estuary (excluding causewayed enclosures). The format is identical to that of figure 3.4. The distributions for White Horse Stone and Coldrum have been taken from the models defined in Whittle *et al.* (in prep., figs 7.26-7). Details of all the radiocarbon dates included in this model are provided in Whittle *et al.* (in prep., tables 7.3 and 7.6-7). The model is defined exactly by the brackets down the left-hand side of the diagram.

have been a transitional period of several centuries whilst these practices spread throughout the island.

At this stage, all this must be tempered with caution. We have dates from seven sites in the Thames estuary (fig. 3.11) and eight in the southwest peninsula (fig. 3.12). This is hardly an adequate sample, and not necessarily representative (what about portal dolmens or entrance graves from the southwest, for example?). As yet the wider early Neolithic has not seen a sustained dating programme to compare with those that we have been able to undertake for some long barrows and for the causewayed enclosures. Nonetheless, formal modelling may be beginning to reveal structure in the existing data which has not previously been apparent.

3.7 The context of enclosures and the start of the southern British Neolithic

These variant and more refined models raise important questions: wider than we have space to go into here (see Whittle *et al.* in prep., chapters 12, 14 and 15). What we have presented here, for southern Britain at least, suggests the importance of both formal modelling and the need for regionally-specific models. The Carinated Bowl-associated Neolithic may indeed start as early as Sheridan has suggested in southeast England, but it is far from clear that this date can be extrapolated to the whole of Britain. The simple bowl pottery of the southwest may start no earlier than the late 39th or 38th century cal BC: in line with the general tenor of Sheridan's model, but more precisely. There is no support yet from formally modelled results for the claimed earlier date of the 'Breton' strand, and indeed discussion of the validity of such a concept must also be reserved for another occasion (Whittle *et al.* in prep.).

Why and how does any of this make a difference to our understanding of neolithisation processes? One of us once argued (as radiocarbon samples began to be re-assessed) that a high start date (*e.g.* earlier-mid fifth millennium cal BC)

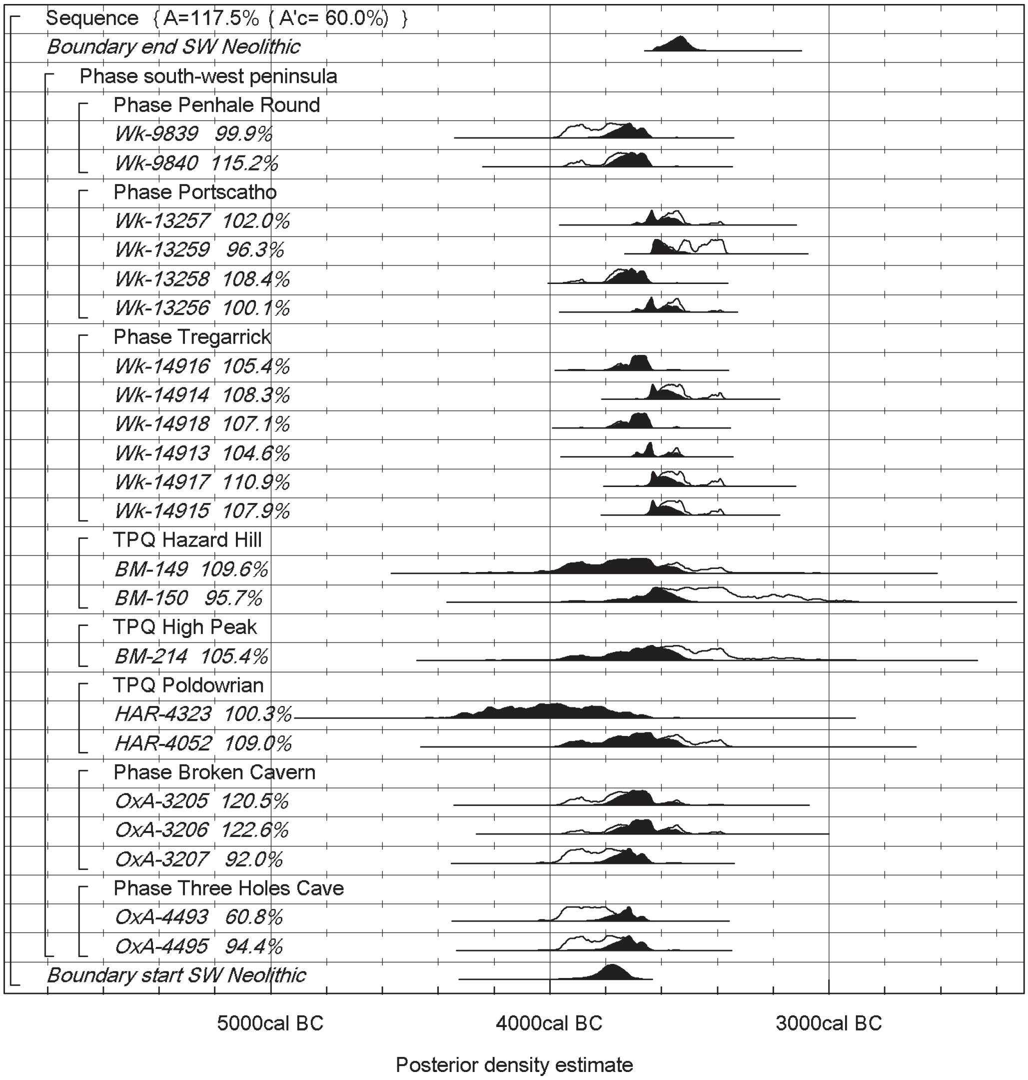

Figure 3.12 Probability distributions of dates for early Neolithic contexts on the south-west peninsula (excluding causewayed enclosures). The format is identical to that of figure 3.4. Details of all the radiocarbon dates included in this model are provided in Whittle *et al.* (in prep., table 10.5). The model is defined exactly by the brackets down the left-hand side of the diagram.

for the southern British Neolithic might indicate colonisation, from the expanding post-LBK settlement system, whereas a low start date (e.g. late fifth millennium or *c.* 4000 cal BC) might suggest acculturation, in a context of cultural convergence represented by the Chasséen, Michelsberg, TRB and insular Carinated Bowl complexes (Whittle 1990). This no longer seems tenable: not least because both the Dutch estuarine/coastal and Danish sequences suggest that acculturation was one major strand in wider processes of change in northwest Europe during the fifth millennium cal BC and again *c.* 4000 cal BC (Louwe Kooijmans 2007; Larsson 2007), but also because formal estimates of regionally varying start dates for Neolithic practices in southern Britain may allow us to specify much more precisely what was in the repertoire of the pre-enclosure horizon before the end of the 38th and the 37th centuries cal BC.

Unlike in the Dutch coastal and estuarine zone, the sites available for characterisation are relatively few and far between. The pre-monument occupation at Ascott-under-Wychwood, Oxfordshire, provides one context with formal date estimates probably of the 40th and 39th centuries cal BC (Bayliss *et al*. 2007d); here are *inter alia* domesticated animals, carinated bowls, a leaf arrowhead and a fragment of a probable polished flint axe, from spreads of occupation and especially a more concentrated midden (Benson/Whittle 2007, 27-54).

If monuments other than enclosures – long barrows and simple forms of chambered tombs, perhaps including portal dolmens – can be shown in the future to have been introduced gradually, then *perhaps* the arguments for colonisation are reduced – since there has been a view that we are dealing with coherent packages, which by their alleged, bounded difference are by definition intrusive (*e.g*. Sheridan 2003; 2004; 2007; Pailler/Sheridan forthcoming), and a view that allegedly abrupt and uniformly dated change requires people from the outside (*e.g*. Schulting 2000). If new practices, and – most importantly – the beliefs which they reflected, were taken up gradually and piecemeal (what Julian Thomas (1999) has called cultural *bricolage*), then it becomes attractive to think of on-going processes involving all manner of contacts between continental and indigenous peoples. Some of the adjacent continental coast at least was occupied by long established indigenous people themselves engaged in a slow process of shifting their practices and identities – as the work of Leendert Louwe Kooijmans has shown.

It is immediately striking that our preliminary date estimates for the start of the Neolithic in southern Britain are earliest in southeast England, the area closest to the continent. Is this an argument for immigration, even though it may have been on a smaller scale and led to less rapid spread within England than usually envisaged by supporters of the colonisation model? There need be no question of choosing between colonisation and indigenous change: both probably occurred.

There is instead the challenge of establishing the extent and nature of their roles in the adoption of beliefs and practices from the mainland. Some of these may have echoed an already distant past, like long barrows whose continental precursors have been seen as commemorating LBK longhouses (*e.g*. Bradley 2007, 86-7). Others may have related directly to contemporary practice on the continent, like causewayed enclosures, which have plausible connections with their counterparts in the Michelsberg and northern Chasséen cultures. More precise chronology is beginning to elucidate the transformation of insular societies in this period.

The preliminary nature of the models presented here should be evident, but it is already apparent that we can begin to think in more subtle ways about the temporality of change. From more precisely modelled timings can be derived more precise estimates of duration, and from duration can come tempo. It has been tempting to suggest an overall accelerating tempo of change (Whittle 2007) over these three centuries but there is much that we still have to investigate before this can be established.

There is probably no single tempo of change across this period of three or more centuries in southern Britain. What we have presented above may suggest both gradual change – as in the regional models for the start of the Neolithic – and rapid change – as probably in the first appearance of causewayed enclosures. But these are not absolute contrasts. The first appearance of Neolithic practices in southeast England might have been as abrupt as the first appearance of causewayed enclosures nearly three centuries later. The uptake of both implies that indigenous beliefs and values were open to or ripe for transformation.

As the sample of properly dated long barrows and related monuments is so far so small, we simply do not know whether there are other explosive horizons of rapid innovation; was there, for example, a sudden burst of barrow construction from the late 39th century cal BC? If we can begin to see the possibility of defining the timing and tempo of change at the scale of lifetimes and even generations, region by region, we can also catch sight of the complexity of the wider explanatory tasks ahead.

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Notes

1 The three oak box-framed wells at Erkelenz were first dated as follows: I: wood felled in 5090, well built in 5089; II: wood felled in 5067; III: wood felled in 5050. Subsequent opinion is that II and III can be re-dated to 5057 ± 5 (Weiner 1998).

2 A user-friendly introduction to the principles of Bayesian statistics is provided by Lindley (1985). Buck *et al*. (1996) introduce the approach from an archaeological viewpoint, and Bayliss *et al*. (2007) more specifically provide an introduction to building Bayesian chronologies in archaeology. Details of the mathematical methods involved can be found in a series of papers by Buck *et al*. (1991; 1992; 1994a; 1994b), Christen (1994), Christen/Litton (1995), Nicholls/Jones (2001), Steier/Rom (2000), and in the papers relating to the program OxCal by Bronk Ramsey (1995; 1998; 2000; 2001; in press). Further details of sampling procedures are provided by Gelfand/Smith (1990) and Gilks *et al*. (1996).

3 Presently the uniform distribution is that most often applied to archaeological problems, simply because it is so uninformative. Research is underway, however, into alternative distributions which may be more appropriate in certain archaeological situations, particularly for producing age-depth models for sediment sequences (Christen *et al*. 1995; Karlsberg 2006; Blaauw *et al*. 2007; Bronk Ramsey in press).

4 The criteria for the inclusion of dates in our models for the early Neolithic will be detailed elsewhere (Whittle *et al*. in prep., chapters 12 and 14). But, as an example, the dates on hazelnut shells pits at the Saltwood Tunnel (NZA-20599-NZA-20600) have been included because they contained "plain and decorated Bowl pottery of Whitehawk affinities", whereas an oak charcoal sample from a posthole of a round structure from Penhale Round, with no associated artefacts or domesticated plants or animals, has not.

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