The Traprain Law Environs Project

Fieldwork and Excavations 2000-2004

Colin Haselgrove

ISBN: 978-0-903903-46-2 (hardback) • 978-1-908332-30-1 (PDF)

Chapter 9

Absolute Dating

DEREK HAMILTON and COLIN HASELGROVE

INTRODUCTION

As at other prehistoric settlements in East Lothian, it was anticipated that relatively little material culture would be recovered in the TLEP excavations, so that establishing chronologies for each site would depend on obtaining an adequate number of radiocarbon dates from suitable contexts. This of course is no easy undertaking, since the survival rate of dateable material such as animal bone, let alone *in situ* structural remains, was unlikely to be any better – as proved to be the case. In order as far as possible to offset this and to maximize the recovery of carbonised material which could ultimately be used for radiocarbon dating, bulk soil samples were taken routinely from all contexts and subsequently screened in the laboratory, at the same time fulfilling another key objective, that of reconstructing the agricultural economy (Chapter 8). This strategy had proved successful at Fishers Road, Port Seton, enabling developments at the adjacent enclosures to be related chronologically (Haselgrove and McCullagh 2000). Whilst relying heavily on cereal seeds and other items from bulk samples is certainly not without difficulties – their taphonomy can never be as certain as single-entity samples from an *in situ* deposit – it does also have some advantages, notably the relative ubiquity of such material and the enhanced possibilities for economic reconstruction opened up by directly dating individual cultigens.

Dating strategy

Following completion of the fieldwork and post-excavation phasing of the individual sites, a detailed radiocarbon dating strategy was developed and submitted to Historic Scotland for approval. For the three main excavations, at Whittingehame Tower, Standingstone and Knowes, the radiocarbon programme was designed as far as possible to provide an overall chronological framework for each site within which estimates of the start, end, and duration of activity at the sites, and for specific horizons or features, could be made. In the case of the three evaluations, at East Bearford, Foster Law, and East Linton, the objectives were limited to dating when the major enclosure features within the limited areas explored were open.

In line with the principles set out by Ashmore (1999), short-lived, single entity samples were employed for dating. Ideally, only samples with a clear relationship to their context would have been selected, but this was rarely possible for the TLEP sites. There were hardly any cases of organic waste that had been put fresh into their context or even of probable structural charcoal in the fill of post-holes, let alone identifiable charcoal from a short-lived species such as hazel. The presumed primary deposits were not without their problems either: the grain cache from Standingstone was recovered by flotation, whilst the human bone fragments from the Knowes cist turned out to be much older than the other contents!

The taphonomic relationship between a sample and its context is the most hazardous step in the whole dating process, since the mechanisms by which a sample came to be in its context are always a matter of interpretative decision rather than certain knowledge. With the TLEP sites, this was compounded by most of the dated material having derived from bulk soil samples, rather than being found *in situ*, although both the environmental sampling and dating strategy were constructed to mitigate the twin risks of contamination and residuality as far as possible. Samples were routinely taken from the base of deposits, any which contained modern cultivars or uncarbonised plant remains were rejected, and contexts directly beneath the ploughsoil avoided unless no alternative existed. To reduce the risk of residuality, cereal grains and crop-processing waste were privileged for dating, since such fragile items are less likely to survive long periods of exposure or repeated episodes of transport and/or redeposition than robust materials such as twigs. The environmental analysis detected no obvious indicators of grain spread from a cache or other single act of deposition, as seems to have occurred in an Early Bronze Age context at

Eweford (Lelong and McGregor 2008, 90–1). Dates were as far as possible spread spatially and by species.

With any dating programme, demonstration of consistency in the results is important. Second dates were therefore sought from deposits mixing two cereals or other species to test whether they were of the same actual age, providing a check on the 'security' of the context and also answering archaeobotanical questions about whether the crops might have been cultivated together (Chapter 8). To test for consistency, a chi-square test is run on the results following the method of Ward and Wilson (1978). Where two or more radiocarbon measurements from a single context or archaeological phase are consistent at 95%, it is possible that the material dated is the same actual age or derived from a relatively short period of activity. If the measurements are not consistent, this is frequently the result of residual or intrusive material.

In the event, the intended dating strategy had to be significantly modified. A substantial number of environmental samples proved barren of carbonized plant remains of any kind and those cereal seeds that were recovered were often in appalling condition. This had an impact both on sample selection and subsequent processing. At both Whittingehame Tower (19) and Knowes (26), the number of samples submitted was less than originally intended and at all the main sites, the dating of some key contexts could not be addressed. This was compounded by the very poor condition of the botanical material. As many as one third (33.7%) of the 86 samples initially submitted either broke up during pre-treatment or proved too small for dating. Most of these were replaced by other samples from the same context, but nine dates were lost altogether. The final failure rate was worst at Standingstone (5), where the material was in particularly wretched condition – for example, not only the original sample, but all the replacement hulled barley from the cache [46] dissolved in pre-treatment, although happily the emmer seed did yield a date.

These difficulties had a differential effect on the main sites. At Standingstone – which had the largest number of samples originally (31) – and Knowes, there are still enough dates from key contexts to generate a reasonable overall framework and permit probabilistic modelling, but only 15 dates are available at Whittingehame and these are nearly all from late contexts. An indication of just how far it proved necessary to depart from the intended dating strategy is the relatively low proportion of determinations on cereals: 75% at Knowes – a reflection of the lighter sandier soils here – but falling to 40% at Whittingehame, 39% at Standingstone and a mere 14% for the three evaluations. The other samples consisted mainly of birch charcoal and charred hazel nutshells, along with small quantities of waterlogged alder and hazel, charred seaweed, human bone, and a cattle tooth.

Results and calibration

All the samples were submitted to the Scottish Universities Environmental Research Centre, East Kilbride (SUERC). The samples were pre-treated following standard methods, with the exception of three samples of cremated human bone, which were processed as outlined by Lanting *et al.* (2001). They were then graphitised using the methods outlined in Slota *et al.* (1987) and measured by Accelerator Mass Spectrometry (AMS), as described by Xu *et al.* (2004). SUERC maintains continual programmes of quality assurance procedures, in addition to participation in international inter-comparisons (Scott 2003). These tests indicate no laboratory offsets and demonstrate the validity of the measurements quoted.

In total, 77 radiocarbon age determinations were obtained from the TLEP sites, all but seven from the three main excavations. The results are given in Tables 9.1–9.4 and are quoted in accordance with the Trondheim convention (Stuiver and Kra 1986) as conventional radiocarbon ages (Stuiver and Polach 1977). Calibrated date ranges were calculated using the calibration curve of Reimer *et al.* (2004) and OxCal v4.0.5 (Bronk Ramsey 1995; 1998; 2001) and are cited in the text (here and in other chapters) at 95% confidence. They are quoted in the form recommended by Mook (1986), with the end points rounded outwards to 10 years if the error term is greater than or equal to 25 radiocarbon years, or to five years if it is less. The ranges quoted in italics in Tables 9.1–9.3 and in the text are posterior density estimates derived from mathematical modelling of archaeological problems (see below). The ranges in plain type in Tables 9.1–9.4 have been calculated according to the maximum intercept method (Stuiver and Reimer 1986). All other ranges are derived from the probability method (Stuiver and Reimer 1993).

Methodological approach

A Bayesian approach to the interpretation of the chronology has been applied to all three main sites (Buck *et al.* 1996).

Although simple calibrated dates are accurate estimates of the age of samples, this is not usually what archaeologists really wish to know. It is the dates of the archaeological events represented by those samples that are of interest. At Standingstone, for example, it is the chronology of the enclosure and of the start and end of the use of the site in general that is under consideration, not the dates of individual samples. The dates of this activity can be estimated not only by using the absolute dating from the radiocarbon measurements, but also by using the stratigraphic relationships between samples and the relative dating information provided by the archaeological phasing.

Fortunately, methodology is now available which allows the combination of these different types of information explicitly, to produce realistic estimates of the dates of archaeological interest. It should be emphasized that the posterior density estimates

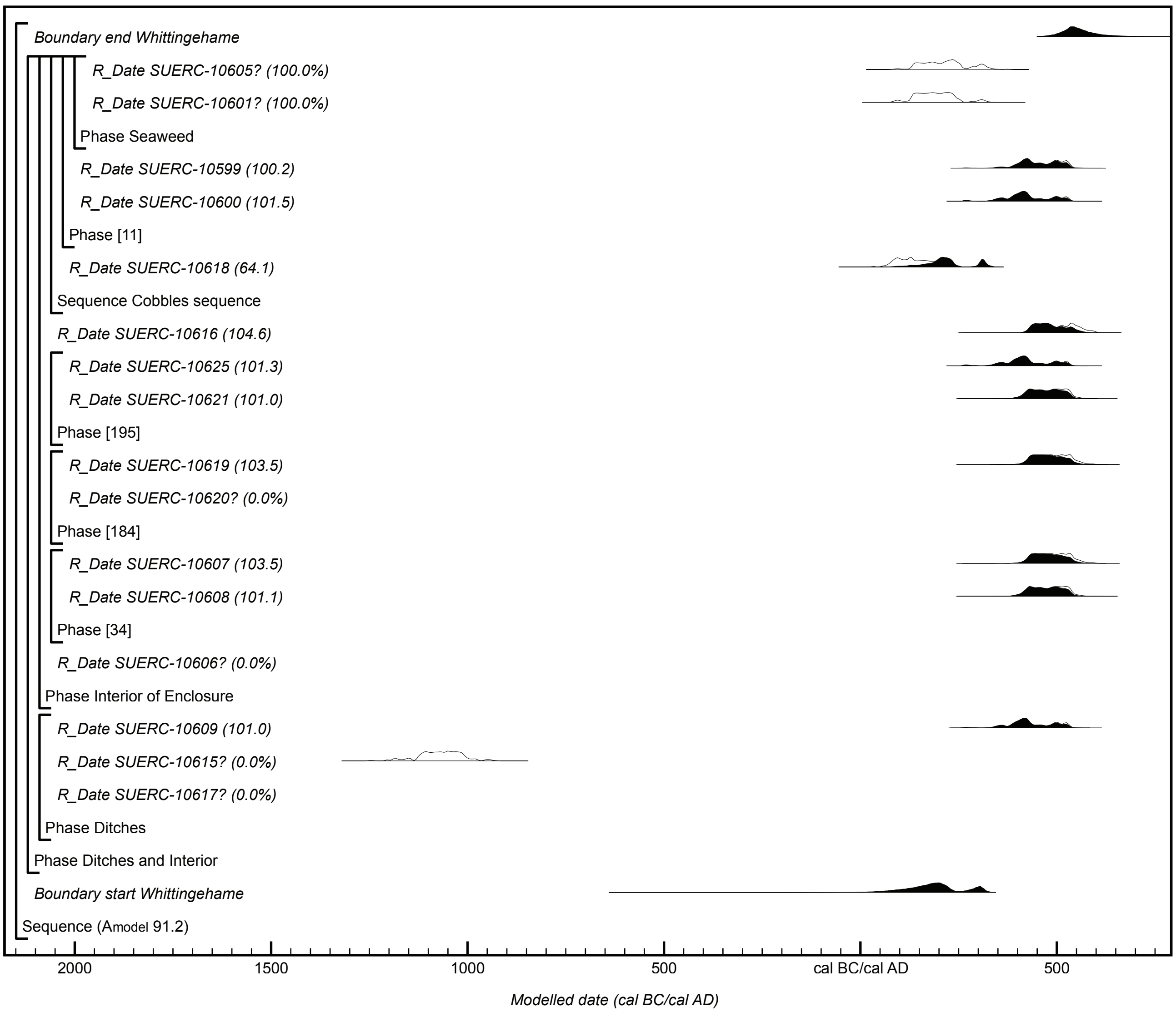

Figure 9.1

Probability distributions of dates from Whittingehame Tower. For each of the radiocarbon measurements two distributions have been plotted, one in outline, which is the result of simple calibration, and a solid one, which is based on the chronological model used. The other distributions correspond to aspects of the model. For example, the distribution '*Boundary end*' is the estimated date for the end of activity, based upon the radiocarbon results. The large square 'brackets' along with the OxCal keywords define the overall model exactly. The model structure is described in the text

Table 9.1
Radiocarbon results from Whittingehame Tower

Lab ID	*Sample ID*	*Context interpretation*	*Material type*	*Radiocarbon age (BP)*	*$\delta^{13}C$ (‰)*	*Calibrated date (95% confidence)*	*Posterior density estimate (95% probability)*
SUERC-10599	TWT02 11a	Over later cobbled surface	Charred grain, hulled barley	1615 ± 35	−21.4	cal AD 350–550	*cal AD 350–370 (2%)* or *cal AD 380–540 (93%)*
SUERC-10600	TWT02 11b	Over later cobbled surface	Charred hazel nutshell	1635 ± 35	−24.2	cal AD 330–540	*cal AD 330–540*
SUERC-10601	TWT02 11c	Over later cobbled surface	Charred seaweed	1820 ± 35	−16.4	cal AD 80–330	*cal AD 80–260 (91%)* or *cal AD 290–330 (4%)*
SUERC-10605	TWT02 11d	Over later cobbled surface	Charred seaweed	1800 ± 35	−15.3	cal AD 120–340	*cal AD 120–340*
SUERC-10606	TWT02 20	Post-hole F19	Charred grain, barley	235 ± 35	−22.8	cal AD 1520–1960	–
SUERC-10607	TWT02 34a	Post-hole F33 beside pit F85	Charred grain, hulled barley	1570 ± 35	−23.1	cal AD 410–570	*cal AD 410–550*
SUERC-10608	TWT02 34b	Post-hole F33 beside pit F85	Charred grain, emmer type	1590 ± 35	−21.9	cal AD 400–560	*cal AD 400–550*
SUERC-10609	TWT02 38	Main ditch recut F258, upper fill	Charcoal, birch	1630 ± 35	−25.0	cal AD 340–540	*cal AD 340–540*
SUERC-10610	TWT02 55	Hollow F54	Charcoal, hazel	1660 ± 30	−26.6	cal AD 250–530	*cal AD 260–290 (4%)* or *cal AD 320–440 (89%)* or *cal AD 480–530 (2%)*
SUERC-10611	TWT02 63	Outer ditch recut F255; overdug?	Charcoal, parenchyma	52,900 ± 1400	−23.3	Beyond calibration	–
SUERC-10615	TWT02 103	Main ditch, lowest fill of recut F258	Charcoal, birch	2885 ± 30	−25.7	1200–940 cal BC	*1200–970 cal BC (94%)* or *960–940 cal BC (1%)*
SUERC-10616	TWT02 106	Pit complex F85, lower fill	Charred grain, cereal	1550 ± 35	−20.7	cal AD 420–590	*cal AD 420–570*
SUERC-10617	TWT02 111	Outer ditch recut F255, lowest fill	Charcoal, birch	4490 ± 35	−25.2	3350–3030 cal BC	*3350–3080 cal BC (93%)* or *3060–3030 cal BC (2%)*
SUERC-10618	TWT02 118	Repair to first cobbled surface	Charred grain, hulled barley	1870 ± 35	−21.8	cal AD 60–240	*cal AD 90–260 (76%)* or *cal AD 290–340 (19%)*
SUERC-10619	TWT02 184a	Post-pit F182	Charred grain, oat	1570 ± 35	−24.0	cal AD 410–570	*cal AD 410–550*
SUERC-10620	TWT02 184b	Post-pit F182	Charred pea	160 ± 35	−28.1	cal AD 1660–1960	–
SUERC-10621	TWT02 195a	Post-pit F193	Charred grain, hulled barley	1590 ± 35	−23.1	cal AD 400–560	*cal AD 400–550*
SUERC-10625	TWT02 195b	Post-pit F193	Charred grain, emmer type	1635 ± 35	−22.8	cal AD 330–540	*cal AD 330–540*

produced by this modelling are not absolute. They are interpretative estimates, which can and will change as further data become available and as other researchers choose to model the existing data from different perspectives. The technique used is a form of Markov Chain Monte Carlo sampling, and has been applied using the program OxCal v4.0.5 (http://c14.arch.ox.ac.uk/). Details of the algorithms employed by this program are available in Bronk Ramsey (1995; 1998; 2001) or from the on-line manual. The algorithm used in the models described below can be derived from the structures shown in Figures 9.1, 9.3, and 9.6.

SITES, SAMPLES AND MODELS

As elsewhere in the volume, the results from the three main sites are considered first in the order of excavation, followed by the results for the three evaluations.

Whittingehame Tower

A total of 18 dates were obtained and are shown graphically in Figure 9.1, excluding SUERC-10611, which most likely represents contamination through over-digging into natural (ironically, the parenchyma sample was preferred to a piece of oak heartwood charcoal from the sample fill, owing to the longevity of the latter species). The Bayesian approach has been adopted with some caution at Whittingehame, as not enough dates were obtained from the earlier stages of occupation in the interior to provide a reliable estimate for the start of activity. While the model presented is likely to provide poor estimates for the start of all activity at Whittingehame, most of the dated deposits appear to be part of the same phase of activity, which is characterized by an abundance of charred cereals and other burnt remains. The model ought therefore to estimate the start of this phase of activity and when the site went out of use fairly accurately.

Only three samples were available from the main enclosure ditches. Birch charcoal from the base [111] of the recut outer ditch yielded a Neolithic date (SUERC-10617); a second piece from the base [103] of the recut main ditch gave a Late Bronze Age date (SUERC-10615). At face value, there is no reason not to accept these dates, but the possibility of residuality cannot be ruled out, especially as there are no comparable dates elsewhere on the site. They are therefore excluded from the model in Figure 9.1, as denoted by the ? next to the laboratory number. A third piece of birch charcoal from higher in the fill of the main ditch [38] appears, however, to be contemporary with dated activity in the interior and is therefore retained (SUERC-10609).

No dates were obtained from the small inner ditch or other internal features underlying the first cobbled surface. Stratigraphically, the earliest dated sample from the interior was a barley seed from secondary cobbling [118] (SUERC-10618). This deposit may be a repair to the earliest cobbles, or part of the second surface. On either view, this date gives a *terminus post quem* for a series of deposits rich in charred remains that subsequently accumulated over the later surface, and, what is more, one consistent with the abraded piece of later second century AD samian, found on the later surface.

Four samples came from the deposits over the second surface [11]: a charred hazelnut shell (SUERC-10600), one barley grain (SUERC-10599) and two of charred seaweed (SUERC-10601, SUERC-10605). The latter samples were submitted to investigate whether any marine reservoir effect could be observed. This does seem to be the case, since the four dates are not statistically consistent ($T' = 8.3$; $\nu = 3$; $T'(5\%) = 7.8$), whereas the pair of measurements on the seaweed ($T' = 0.2$; $\nu = 1$; $T'(5\%) = 3.8$) is consistent, as are the barley and hazelnut ($T' = 0.2$; $\nu = 1$; $T'(5\%) = 3.8$). The laboratory expected an even older date (G Cook pers. comm.), but *fucus* is an inter-tidal variety and would obtain carbon from both the ocean and the atmosphere, thus reducing the influence of the former (Chapter 8). Given these uncertainties, no attempt has been made to correct the radiocarbon ages of the seaweed, and they have been excluded from the model. The measurements on the barley and hazelnut are inconsistent with the barley from the underlying cobbles, suggesting that this derives from a different phase of occupation ($T' = 33.1$; $\nu = 2$; $T'(5\%) = 6.0$).

The remaining dates derive from features surrounding the surfaces, many of which were again rich in charred remains. They include three from the pit complex (F85): a single charred cereal grain from the lower fill [106] (SUERC-10616) and two from post-hole F33, which may be part of a screen (SUERC-10607, SUERC-10608). All three measurements are statistically consistent ($T' = 0.7$; $\nu = 2$; $T'(5\%) = 6.0$) so these samples could be of the same actual age. The pit was infilled after the later paved surface was laid, but could have been in use at the same time. Also of note is a pair of dates from pit F193 – one on emmer, the other on barley (SUERC-10621, SUERC-10625)

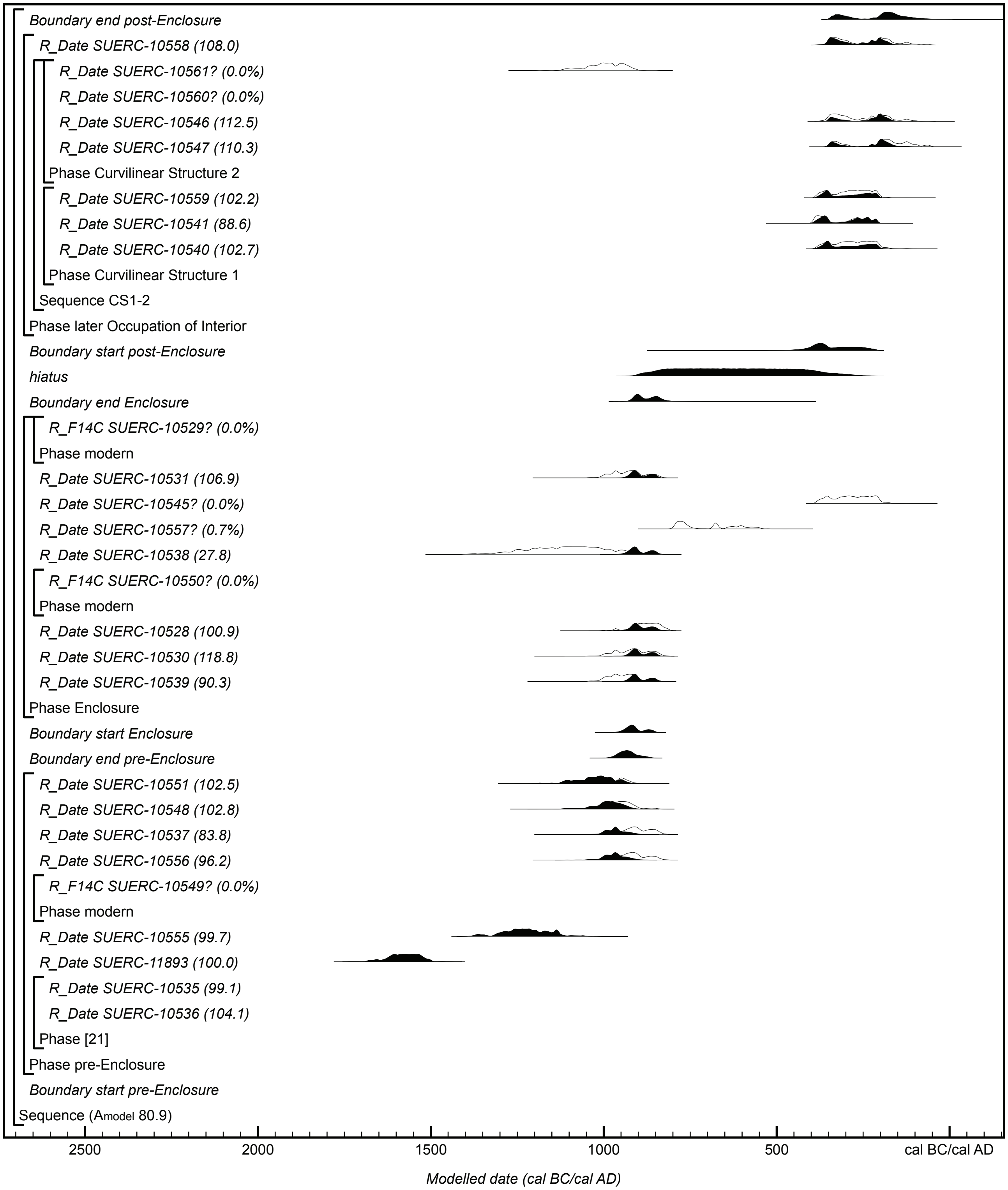

Figure 9.2
Probability distributions of dates from Standingstone. The model structure is as described in Figure 9.1

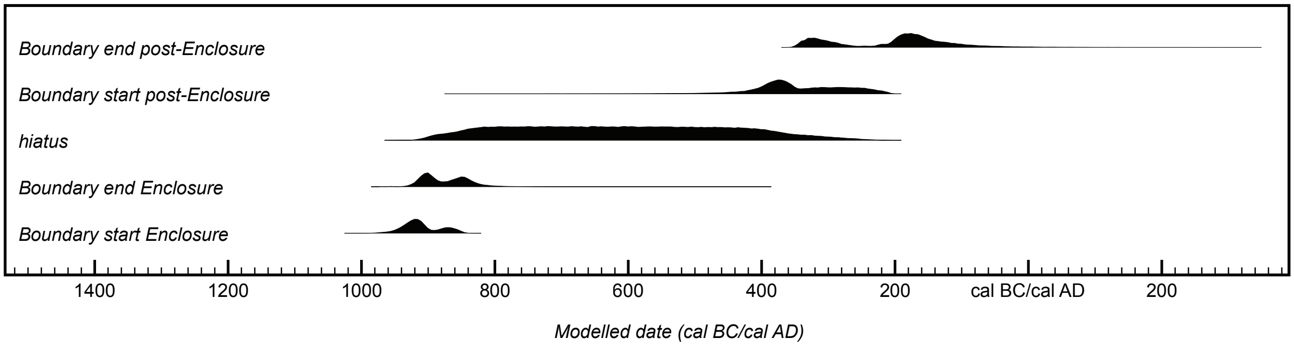

Figure 9.3
Probabilities for the start and end of two identified phases of activity along with the date for the hiatus in activity between use of the enclosure ditch and the post-enclosure interior features at Standingstone, as derived from the model shown in Figure 9.2

– since emmer is not normally thought to be have been cultivated at such a late date. The two measurements are statistically consistent (T' = 0.8; ν = 1; T'(5%) = 3.8). A barley grain from post-hole F19 is either intrusive or the feature is post-medieval (SUERC-10606). A charred pea from post-pit F182 also yielded a post-medieval date (SUERC-10620), but as this feature is beneath the later trackway and yielded an oat of much earlier date (SUERC-10619), the pea is likely to be intrusive. These post-medieval dates are excluded from the model.

The model places the radiocarbon dates into a phase of activity with the only stratigraphy being that SUERC-10618 can be placed at an earlier stage of the stratigraphic sequence in the interior than [11]. The model has good agreement (A_{model} = 91.2%) and estimates that the phase of activity which gave rise to the richer archaeobotanical samples began by *cal* AD *30–330* (*95% probability*; *start Whittingehame Tower*; Figure 9.1), but perhaps in *cal* AD *120–230* (*59%*) or *cal* AD *290–320* (*9%*). Dated activity at the site ended in *cal* AD *470–670* (*95% probability*; *end Whittingehame Tower*), but probably in *cal* AD *510–590* (*68%*).

Standingstone

A total of 26 results were obtained and are shown graphically in the model in Figure 9.2. Due to the very poor condition of botanical material from the site, this is significantly fewer than had originally been hoped for, but they nevertheless provide a good overall framework for the site. Despite all the precautions, three samples proved to be modern (SUERC-10529, SUERC-10549, SUERC-10550) and are excluded from the model.

Eight results are available from seven unrelated pre-enclosure contexts. The two from pit F56 (SUERC-10535, SUERC-10536) are statistically consistent (T' = 0.5; ν = 1; T'(5%) = 3.8), with SUERC-10536 providing the best estimate for the date of the feature. A further seven measurements come from contexts that were not stratigraphically related, but are assigned to the construction and occupation of the enclosure, including fills and features associated with the palisade and ditch. The seven measurements are not consistent (T' = 213.0; ν = 6; T'(5%) = 12.6). Two of the results (SUERC-10545 and SUERC-10557) are too young when compared to the other results and presumably represent later material incorporated in these deposits when the site was reoccupied. After excluding these, the remaining results are consistent (T = 4.3; ν = 4; T'(5%) = 9.5). Finally, eight samples are available from an equivalent number of contexts associated with the three curvilinear structures. Again the results are not consistent (T' = 2188.1; ν = 7; T'(5%) = 19.1), but after excluding SUERC-10560 and SUERC-10561 as residual material incorporated in the fills of later features, the remaining measurements are statistically consistent (T' = 8.9; ν = 5; T'(5%) = 11.1).

The model places the radiocarbon results into three groups based on archaeological phasing (e.g. the various pre-enclosure features; the enclosure phase; and the later curvilinear structures) and has good overall agreement (A_{model} = 80.9%) with the stratigraphic relationships of the various samples. Figure 9.3 estimates that the construction of the enclosure began in *960–850 cal*

Table 9.2
Radiocarbon results from Standingstone

Lab ID	*Sample ID*	*Context interpretation*	*Material type*	*Radiocarbon age (BP or FM)*	*δ¹³C (‰)*	*Calibrated date (95% confidence)*	*Posterior density estimate (95% probability)*
SUERC-10528	TST03 8	Post-hole F7 cut into outer palisade F555	Charred grain, hulled barley	2735 ± 35	–23.5	980–810 cal BC	*940–830 cal BC*
SUERC-10529	TST03 10	Palisade F13	Charred grain, hulled barley	1.2383 ± 0.0052	–27.0	cal AD 1950–1990	Intrusive modern grain
SUERC-10530	TST03 12	Post-hole F11, palisade F13	Charred grain, *Triticum*	2770 ± 35	–22.9	1010–830 cal BC	*940–840 cal BC*
SUERC-10531	TST03 14	Palisade F13, upper fill	Charcoal, birch	2780 ± 35	–25.5	1010–830 cal BC	*940–840 cal BC*
SUERC-10535	TST03 21a	Pit F56	Charred grain, naked barley	4120 ± 35	–25.4	2880–2570 cal BC	*2860–2800 cal BC (10%)* or *2780–2570 cal BC (85%)*
SUERC-10536	TST03 21b	Pit F56	Charred grain, hulled barley	4085 ± 35	–24.8	2870–2490 cal BC	*2860–2810 cal BC (7%)* or *2760–2560 cal BC (78%)* or *2540–2490 cal BC (10%)*
SUERC-10537	TST03 46b	Grain cache in scoop F45, foundation deposit?	Charred grain, emmer type	2770 ± 35	–21.6	1010–830 cal BC	*1030–890 cal BC*
SUERC-10538	TST03 49	Middle fill of ditch terminal F3	Charred tooth, cattle	2900 ± 75	–20.0*	1370–900 cal BC	*950–840 cal BC*
SUERC-10539	TST03 60	Post-hole F61, next to palisade	Charred hazel nutshell	2790 ± 35	–26.4	1020–830 cal BC	*950–840 cal BC*
SUERC-10540	TST03 82	CS1, sunken floor feature F79	Charcoal, birch	2215 ± 35	–24.9	390–200 cal BC	*380–200 cal BC*
SUERC-10541	TST03 94	CS1, gully F106	Charcoal, hazel	2270 ± 35	–27.8	400–200 cal BC	*400–340 cal BC (36%)* or *320–200 cal BC (59%)*
SUERC-10545	TST03 104	Palisade F103	Charred hazel nutshell	2215 ± 35	–23.6	390–200 cal BC	Intrusive in earlier context
SUERC-10546	TST03 110	Second cut of CS2 gully (F360)	Charcoal, hazel	2170 ± 35	–25.5	370–110 cal BC	*360–280 cal BC (32%)* or *270–150 cal BC (63%)*
SUERC-10547	TST03 130	CS2, sunken floor feature F451	Charred grain, emmer type	2145 ± 35	–23.0	360–50 cal BC	*360–280 cal BC (31%)* or *260–110 cal BC (64%)*
SUERC-10548	TST03 132	Post-hole F131, inside palisade	Charcoal, birch	2815 ± 35	–25.6	1110–840 cal BC	*1080–900 cal BC*
SUERC-10549	TST03 140	Post-hole F139	Charred grain, hulled barley	1.4418 ± 0.0061	–26.5	cal AD 1960–1980	Intrusive modern grain
SUERC-10550	TST03 146	Post-hole F145	Charred grain, hulled barley	1.4420 ± 0.0057	–26.2	cal AD 1960–1980	Intrusive modern grain

Table 9.2 (continued)

Lab ID	*Sample ID*	*Context interpretation*	*Material type*	*Radiocarbon age (BP or FM)*	*$\delta^{13}C$ (‰)*	*Calibrated date (95% confidence)*	*Posterior density estimate (95% probability)*
SUERC-10551	TST03 197	Post-hole F196, outside enclosure, pair to F200	Charcoal, hazel	2850 ± 35	–25.6	1130–910 cal BC	*1130–930 cal BC*
SUERC-10555	TST03 228	Pit F227, cut by enclosure ditch	Charcoal, birch	2985 ± 35	–25.3	1380–1090 cal BC	*1380–1110 cal BC*
SUERC-10556	TST03 231	Pit F230, near palisade end	Charcoal, hazel	2780 ± 35	–25.2	1010–830 cal BC	*1030–900 cal BC*
SUERC-10557	TST03 253	Enclosure ditch F273, upper fill	Charred hazel nutshell	2555 ± 35	–22.3	810–540 cal BC	
SUERC-10558	TST03 298a	CS3, sunken floor feature F297	Charred grain, emmer type	2165 ± 35	–24.4	370–100 cal BC	*370–160 cal BC*
SUERC-10559	TST03 329	CS1, post-hole F328 at end of gully F106	Charcoal, birch	2225 ± 35	–24.9	390–200 cal BC	*390–200 cal BC*
SUERC-10560	TST03 345	CS2, first cut of gully F359	Charred hazel nutshell	3815 ± 35	–24.5	2560–2140 cal BC	Residual in later context?
SUERC-10561	TST03 462	CS2, second cut of gully F360	Charred hazel nutshell	2835 ± 35	–23.6	1120–900 cal BC	Residual in later context?
SUERC-11893	TST03 233b	Cinerary urn F232	Cremated bone, human	3300 ± 35	–24.4	1680–1490 cal BC	*1680–1500 cal BC*

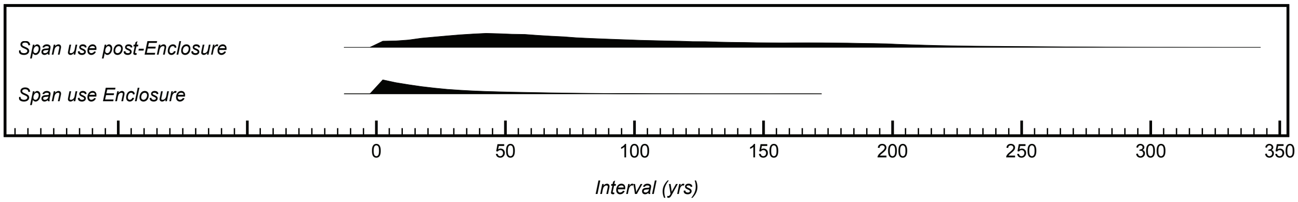

Figure 9.4
Probabilities for the spans of use for the enclosure ditch, post-enclosure interior features, and estimated length of hiatus at Standingstone, as derived from the model shown in Figure 9.2

BC (*95% probability*; *start Enclosure*), and probably in *950–900 cal* BC (*60% probability*) or *880–860 cal* BC (*8% probability*). Its use finished in *940–800 cal* BC (*95% probability*; *end Enclosure*), and probably in *920–880 cal* BC (*38% probability*) or *870–830 cal* BC (*30% probability*). The overall span of enclosure activity was *1–80 years* (*95% probability*; *use Enclosure*; Figure 9.4) and probably *1–30 years* (*68%*). There was then a hiatus between the use of the enclosure and the later re-occupation represented by the curvilinear structures, which lasted between *380–690 years* (*95% probability*) and probably between *450–620 years* (*68%*). The building of the curvilinear structures began in *470–200 cal* BC (*95% probability*; *start post-Enclosure*; Figure 9.3), and probably in *410–340 cal* BC (*38% probability*) or *330–250 cal* BC (*30% probability*). This activity ended in *360–50 cal* BC (*95% probability*; *end post-Enclosure*), and probably in *350–290 cal* BC (*22% probability*) or *210–120 cal* BC (*46% probability*). The overall span of activity associated with these structures was *1–220 years* (*95% probability*; *use post-Enclosure*; Figure 9.4) and probably *1–120 years* (*68%*).

Even if further samples had been available from post-enclosure contexts, it is unlikely they would have overcome the bi-modality seen in the posterior distributions. Simulations with up to two-dozen additional dates were run and suggested that very little extra precision would be gained without the addition of stratigraphic constraints.

Knowes

A total of 25 measurements are available from the enclosure ditch and scooped settlement at Knowes. The results are shown graphically in Figure 9.5. One date is modern (SUERC-10581) and has been excluded from further modelling. The occupation may be separated into two phases. The enclosure ditch was certainly dug first, but was almost certainly not completely infilled when the scooped settlement was occupied. As such, the model allows for the possibility of overlap between the start of the scooped settlement and the final use of the ditch circuit.

Dates were obtained from sections through the western ditch and the northern terminal of the eastern ditch. Taking the western ditch first, three dates are from the basal fill [162, 189] of the first recut (SUERC-10575, SUERC -10576, SUERC -10580); a fourth is from the primary fill [146] of the second recut (SUERC-10569); whilst the last derives from one of its higher fills [132] (SUERC-10567). While these samples form a vertical sequence, all five measurements are statistically consistent (T' = 2.6; ν = 4; T'(5%) = 9.5) and could be the same age, suggesting that deposition was fairly rapid. The samples from the northern terminal consist of four from the recut ditch, two of them from the lowest fill [271], one of them barley, one waterlogged hazel (SUERC-10587, SUERC-10588), and two from an overlying deposit of sand [272], both charred barley (SUERC-10589, SUERC-10590). As with the western ditch, all four measurements are statistically consistent (T' = 4.4; ν = 3; T'(5%) = 7.8), implying that, here too, deposition was fairly rapid.

All the results from the ditch fills were subjected to a chi-square test, but were found not to be statistically consistent (T' = 19.4; ν = 8; T'(5%) = 15.5). Results from a preliminary run of the model suggested that SUERC-10590 was not in the correct position. Given the archaeological evidence and the fact that the measurement passes tests of consistency within its smaller group, it seems likely to be an outlier. After excluding the date, the model shows that there is only a *0.5% probability* of the measurement being correct, or in the correct position.

A total of 14 radiocarbon results was obtained from the features associated with the scooped settlement.

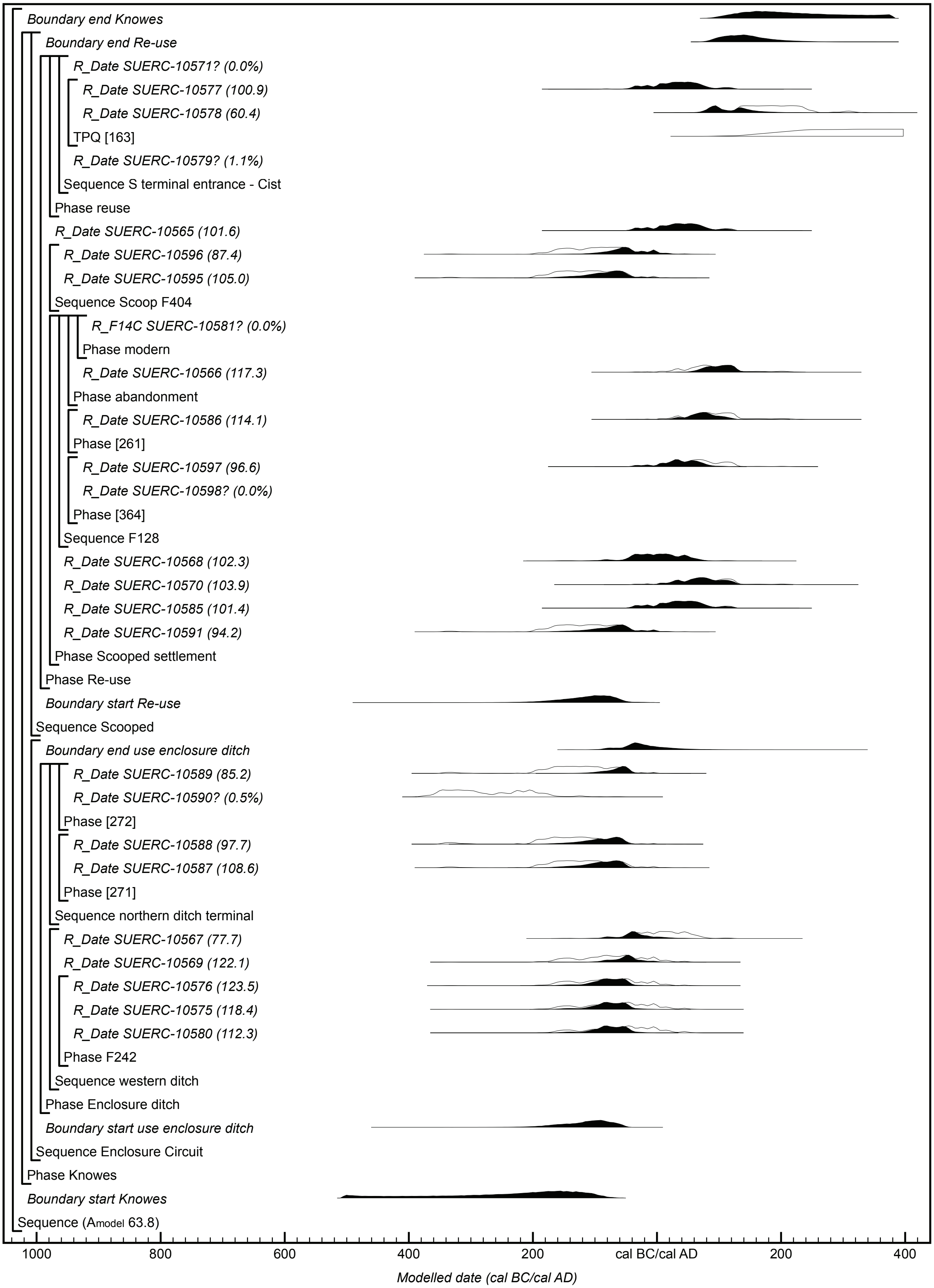

Figure 9.5
Probability distributions of dates from Knowes: the model structure is as described in Figure 9.1

Table 9.3
Radiocarbon results from Knowes

Lab ID	*Sample ID*	*Context interpretation*	*Material type*	*Radiocarbon age (BP or FM)*	*$\delta^{13}C$ (‰)*	*Calibrated date (95% confidence)*	*Posterior density estimate (95% probability)*
SUERC-10565	TKN03 7	External pit complex NNW of enclosure	Charred grain, wheat	1960 ± 35	–22.8	50 cal BC–cal AD 130	*40 cal BC–cal AD 90 (91%)* or *cal AD 100–120 (4%)*
SUERC-10566	TKN04 124	Silt within CS2	Charred hazel nutshell	1915 ± 35	–25.0	cal AD 1–220	*cal AD 50–160*
SUERC-10567	TKN04 132	Western ditch, higher fill of 2nd recut F243	Charred grain, wheat	1990 ± 35	–22.8	90 cal BC–cal AD 90	*100 cal BC–cal AD 30*
SUERC-10568	TKN04 135	Scoop F129, fill	Charred grain, barley	2000 ± 35	–21.0	100 cal BC–cal AD 80	*60 cal BC–cal AD 80*
SUERC-10569	TKN04 146	Western ditch, primary fill of 2nd recut F243	Charred grain, wheat	2055 ± 35	–22.6	170 cal BC–cal AD 30	*100 cal BC–cal AD 10*
SUERC-10570	TKN04 147	Main scoop F232, behind revetment wall	Charred grain, barley	1925 ± 35	–22.4	40 cal BC–cal AD 210	*cal AD 1–120*
SUERC-10571	TKN04 149	Cist, upper fill	Cremated bone, human	2405 ± 35	-17.9	750–390 cal BC	–
SUERC-10575	TKN04 162A	Western ditch, primary fill of 1st recut F242	Charred grain, barley	2050 ± 35	–23.7	170 cal BC–cal AD 30	*160–30 cal BC*
SUERC-10576	TKN04 162B	Western ditch, primary fill of 1st recut F242	Charred grain, wheat	2060 ± 35	–23.1	180 cal BC–cal AD 20	*160–30 cal BC*
SUERC-10577	TKN04 163A	Cist, middle fill	Charred grain, barley	1965 ± 35	–22.1	50 cal BC–cal AD 130	*50 cal BC–cal AD 90 (92%)* or *cal AD 100–120 (3%)*
SUERC-10578	TKN04 163B	Cist, middle fill	Charcoal, birch	1825 ± 35	–25.9	cal AD 80–320	*cal AD 60–200*
SUERC-10579	TKN04 187	Cist, lower fill	Cremated bone, human	2305 ± 35	–21.8	420–210 cal BC	–
SUERC-10580	TKN04 189	Western ditch, primary fill of 1st recut F242	Charred grain, wheat	2045 ± 35	–22.6	170 cal BC–cal AD 30	*160– 20 cal BC*
SUERC-10581	TKN04 197	CS2, deposit over floor	Charred grain, barley	1.3140 ± 0.0055	–24.8	cal AD 1950–1990	Intrusive modern grain
SUERC-10585	TKN04 229	Scoop F284, fill	Charred grain, barley	1960 ± 35	–22.6	50 cal BC–cal AD 130	*50 cal BC–cal AD 120*
SUERC-10586	TKN04 261	CS2, fill of oven	Charred grain, barley	1915 ± 35	–23.5	cal AD 1–220	*cal AD 20–130*
SUERC-10587	TKN04 271A	Northern ditch terminal, lowest fill of recut F405	Charred grain, barley	2095 ± 35	–22.8	340–1 cal BC	*160–40 cal BC*

Table 9.3 (continued)

Lab ID	*Sample ID*	*Context interpretation*	*Material type*	*Radiocarbon age (BP or FM)*	*$\delta^{13}C$ (‰)*	*Calibrated date (95% confidence)*	*Posterior density estimate (95% probability)*
SUERC-10588	TKN04 271B	Northern ditch terminal, lowest fill of recut F405	Waterlogged wood, hazel	2110 ± 35	–27.1	350–40 cal BC	*160–40 cal BC*
SUERC-10589	TKN04 272A	Northern ditch terminal, sand over 271	Charred grain, barley	2100 ± 35	–23.0	350–40 cal BC	*120–20 cal BC*
SUERC-10590	TKN04 272B	Northern ditch terminal, sand over 271	Charred grain, barley	2185 ± 35	–23.8	380–160 cal BC	–
SUERC-10591	TKN04 296	Scoop F232, sand below paving F274	Charred grain, barley	2090 ± 35	–23.0	210–1 cal BC	–
SUERC-10595	TKN04 330	Scoop F404, levelling for 3rd cobbles 248	Charred grain, barley	2090 ± 35	–24.1	210–1 cal BC	*160 cal BC–cal AD 10*
SUERC-10596	TKN04 331	Scoop F404, levelling for 3rd cobbles 248	Charred grain, barley	2075 ± 35	–22.3	200 cal BC–cal AD 10	*120 cal BC–cal AD 30 (94%)* or *cal AD 40–50 (1%)*
SUERC-10597	TKN04 364a	Scoop F238, hollow F378	Charred grain, barley	1935 ± 35	–21.3	40 cal BC–cal AD 140	*40 cal BC–cal AD 90*
SUERC-10598	TKN04 364b	Scoop F238, hollow F378	Charcoal, onion couch	2860 ± 35	–27.2	1130–910 cal BC	Residual in this context

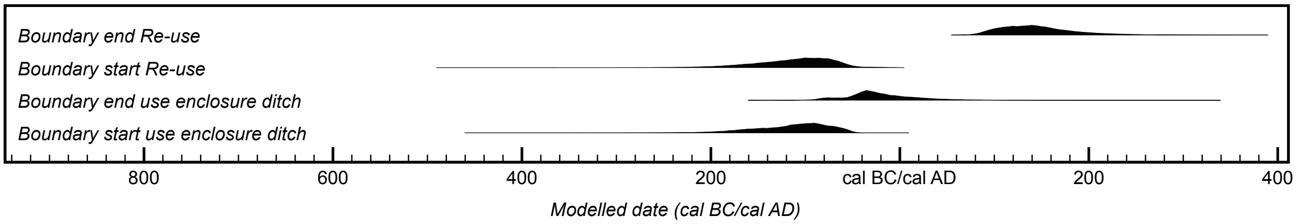

Figure 9.6
Probabilities for the start and end of the two spatially identified phases of activity at Knowes, as well as the beginning and end of the overall use of the site as derived from the model shown in Figure 9.5

Two came from sand [330, 331] used as bedding for the third of four surfaces [248] in scoop F404 near the entrance (SUERC-10595, SUERC-10596). Three more came from elsewhere within the central scooped area: one from beneath the tumbled revetment along the northern edge of scoop F284 (SUERC-10585), a second from behind the revetment of scoop F232 (SUERC-10570), and a third from sand [296] below paving in the northern part of the same scoop (SUERC-10591).

Another group of four dates came from contexts within the western scoop F238 and CS2. Two were obtained from the fill [364] of a shallow depression F378 in the base of the scoop (SUERC-10597, SUERC-10598), but SUERC-10598 has been excluded from the modelling as it is 1000 years too early and is clearly reworked material. A third came from deposits [261] within the CS2 oven (SUERC-10586), providing a date for the use of the structure, whilst a fourth came from silt [124] that accumulated after the structure went out of use (SUERC-10566). Another date came from the smaller adjacent scoop F129, to the west (SUERC-10568).

Four dates were obtained from the contents of the stone cist inserted in the top of the southern terminal of the enclosure ditch after this had almost completely filled up. Two of the measurements are on fragments of cremated human bone from the lower [187] and upper [149] fills (SUERC-10579, SUERC-10571), whilst the other two were on charred barley and birch charcoal from the middle [163] fills of the cist (SUERC-10577, SUERC-10578). The cremated bone turned out to be not only much older than the charcoal in the middle fill, but also older than the dated material found in other ditch sections, suggesting that it is curated or redeposited. The two dates on the human bone have therefore been excluded from the model, whilst those from middle fill have been retained, providing a *terminus post quem* for the filling of the cist.

Finally, a single date was obtained from charred wheat found in the pit complex F5, 30m north of the enclosure (SUERC-10565), suggesting that it is contemporary with the settlement.

The model shown in Figure 9.5 has good agreement (A_{model} = 63.8%) with the stratigraphic relationships of the samples. Based upon this, it estimates that the enclosure was constructed by *200–50 cal* BC (*95% probability*; *start use enclosure ditch*; Figure 9.6) and probably by *140–60 cal* BC (*68%*). The ditch was open for *1–230 years* (*95% probability*; *span enclosure ditch*;

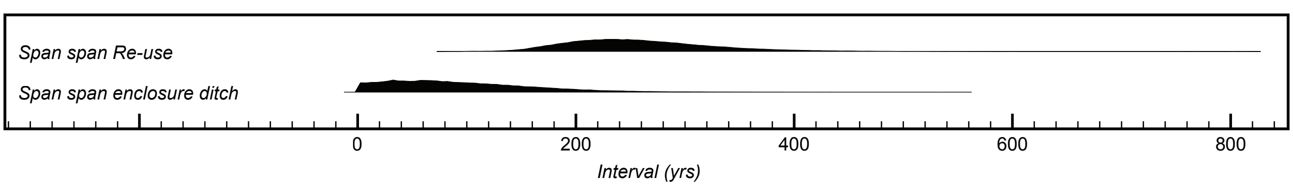

Figure 9.7
Probabilities for the spans of use for the enclosure ditch, post-enclosure interior features, and the site as a whole for Knowes, as derived from the model shown in Figure 9.5

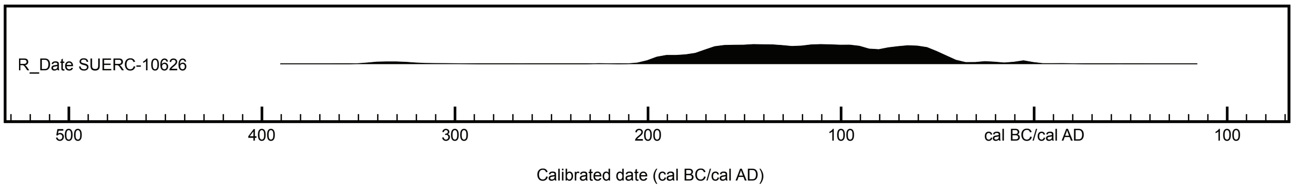

Figure 9.8
Calibrated radiocarbon date for East Bearford

Figure 9.7) and probably *1–120 years* (*68%*). It was largely infilled by *100 cal* BC*–cal* AD *70* (*95% probability*; *end use enclosure ditch*; Figure 9.6), probably in the period *60 cal* BC*–cal* AD *20* (*68%*).

The use of the interior represented by the scooped settlement and associated features began in *220–40 cal* BC (*95% probability*; *start Re-use*; Figure 9.6) and probably in *150–60 cal* BC (*68%*). The scooped settlement persisted for *140–410 years* (*95% probability*; *span Re-use*; Figure 9.7), ending in *cal* AD *80–230* (*95% probability*; *end Re-use*; Figure 9.6) and probably in *cal* AD *90–170* (*68%*). The model estimates that there is a *97% probability* that the scooped settlement was constructed while the enclosure ditch was still open.

The evaluations

Dates were also obtained from the enclosure ditches of the three evaluated sites, although the programme was limited by a lack of suitable samples from relevant contexts. A single date from a waterlogged alder twig in the basal fill [23] of the enclosure ditch at East Bearford (SUERC-10626) is consistent (Figure 9.8) with the dates from the very similar rectilinear enclosure at Knowes. At Foster Law (Figure 9.9), samples from the primary fill in different sections of the inner ditch [27, 53] both yielded Earlier Iron Age dates (SUERC-10631, SUERC-10636), whilst a third from the fill of the possible recut [51] higher up the ditch produced one in the Later Iron Age (SUERC-10635). Unfortunately, a barley grain submitted from the basal fill [13] of the earlier, outer ditch had a modern result and must have fallen in (SUERC-10630).

Three dates were obtained for the multivallate enclosure at East Linton (Figure 9.10). Charred wheat from the primary fill [21] of the inner ditch and birch charcoal from the fill [24] of the palisade trench both produced Late Bronze Age dates (SUERC-10627;

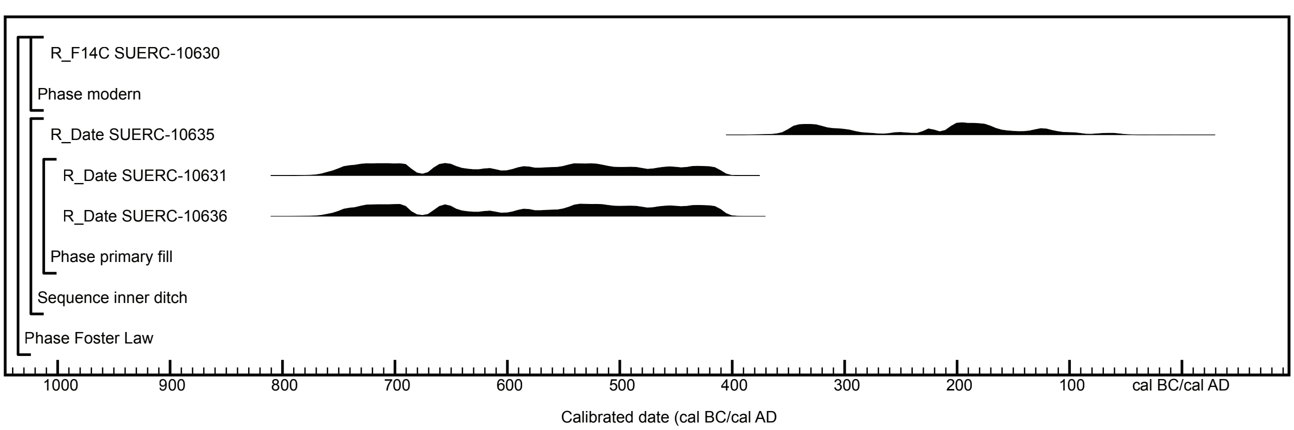

Figure 9.9
Calibrated radiocarbon dates for Foster Law

Table 9.4
Radiocarbon results from the evaluations

Lab ID	*Sample ID*	*Context Interpretation*	*Material Type*	*Radiocarbon Age (BP or FM)*	$\delta^{13}C$ *(‰)*	*Calibrated date (95% confidence)*
EAST BEAR-FORD						
SUERC-10626	TEB02 23	Enclosure ditch F22, basal fill	Waterlogged alder twig	2095 ± 35	–26.6	340–1 cal BC
FOSTER LAW						
SUERC-10630	TFL03 13	Outer ditch F14, basal fill	Charred grain, hulled barley	1.9323 ± 0.0081	–22.2	cal AD 1960–1970, evidently intrusive
SUERC-10631	TFL03 27	Inner ditch terminal F30 (=F21), primary fill	Charcoal, ?hazel twig	2455 ± 35	–25.0	760–410 cal BC
SUERC-10635	TFL03 51	Inner ditch F21, fill of recut F18	Charcoal, twig	2155 ± 35	–28.4	360–60 cal BC
SUERC-10636	TFL03 53	Inner ditch F21, primary fill	Charred hazel nutshell	2445 ± 35	–23.5	760–400 cal BC
EAST LINTON						
SUERC-10627	TEL04 21	Inner ditch F5, primary fill	Charred grain, wheat	2975 ± 35	–24.0	1370–1050 cal BC
SUERC-10628	TEL04 24	Palisade F25	Charcoal, birch	2910 ± 35	–24.5	1260–1000 cal BC
SUERC-10629	TEL04 30	Middle ditch F26, basal fill of recut F29	Charcoal, birch	2235 ± 35	–25.4	390–200 cal BC

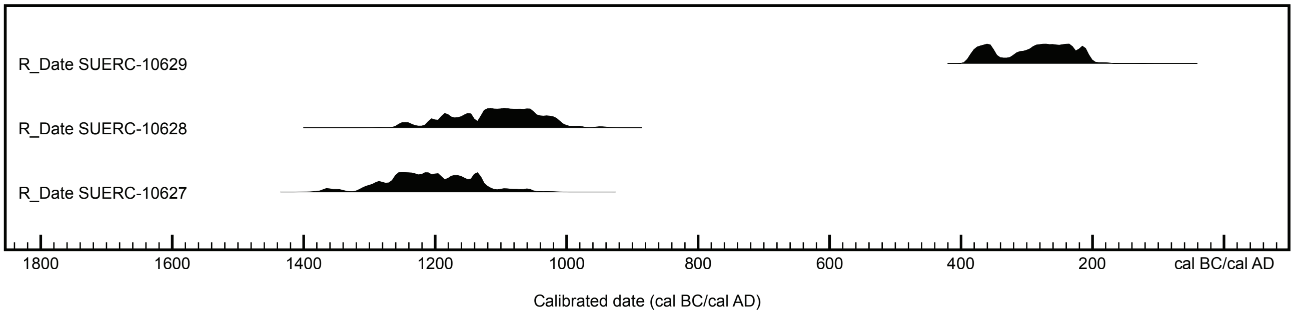

Figure 9.10
Calibrated radiocarbon dates for East Linton

SUERC-10628), whilst birch charcoal from the base [30] of the recut middle ditch yielded a Later Iron Age date (SUERC-10629), comparable to that from the recut ditch at Foster Law.

DISCUSSION

Despite fewer determinations being obtained than we would have liked, the scientific dating programme has proved extremely valuable both for individual sites and by highlighting some consistent patterns across a number of TLEP sites. At site level, the most important outcomes are undoubtedly, first, the tight dating of the Standingstone enclosure to the ninth century cal BC; second, the dating of the secondary occupation to the Later Iron Age, and third, the identification at Whittingehame of a late phase of re-use in the fifth and sixth centuries cal AD. None of these would have been inferred on either morphological or material grounds. Without scientific dating, the abandonment of Whittingehame would probably have been put in the second to third century cal AD on the basis of the worn samian platter from what is stratigraphically one of the latest contexts on the site. At the same time, the dates obtained directly on cereals from the site have made a significant contribution to our knowledge of crop husbandry in the coastal plain, on the one hand furnishing persuasive evidence for the continued cultivation of emmer at an unexpectedly late date in this part of Scotland, on the other indicating that oats were introduced here by the mid-first millennium cal AD.

Standing back from the individual sites, certain broader patterns are apparent. At least three of the TLEP enclosures apparently originated in the Late Bronze Age rather than the Iron Age, since there are Late Bronze Age dates from East Linton and Whittingehame as well as Standingstone. The first enclosure at Foster Law might well date to this period too, since the primary fill of the later enclosure yielded Early Iron Age dates, but this is not certain. The Later Iron Age was another period of enhanced enclosure, with the ditch circuits at two TLEP sites showing evidence of refurbishment at this period (East Linton, Foster Law), whilst other sites seem to be new foundations, including the two rectilinear enclosures investigated in the TLEP (East Bearford, Knowes); the ditched enclosure at Eweford Cottages and the small palisaded homestead at Biel Water on the A1 (Lelong and McGregor 2007); and both enclosures at Fishers Road (Haselgrove and McCullagh 2000).[1] As in many parts of Britain (Haselgrove *et al.* 2001; Haselgrove and Pope 2007), the Earlier Iron Age is notable for its low profile, with only the second enclosure at Foster Law and midden material from a scoop at South Belton on the A1 (Lelong and McGregor 2007) having produced determinations of this date.

At several TLEP sites, the construction and refurbishment of the enclosures were merely episodes in a much longer history of human activity at the particular locations. At Standingstone and Whittingehame, frequentation of the locale goes back at least to the Neolithic, and all three extensively-excavated enclosures were used on some scale after their ditch circuits ceased to be maintained. At Knowes, intensive occupation continued for up to two centuries after the ditch had largely filled up, a pattern we also find at Eweford Cottages on the A1 (Lelong and McGregor 2008) and probably – from the finds in the top of ditches – at Foster Law. In contrast, there was a hiatus of anything from four to six centuries at Standingstone between the short-lived enclosure and the establishment in the later Iron Age of a new settlement inside the silted up ditch circuit. Finally at Whittingehame, intensive activity involving cereals is attested within the remains of the enclosure as late as the mid-first millennium cal AD, although owing to the lack of dates from earlier contexts, it is unclear quite how this relates to the earlier occupation or whether or not there was a hiatus between the enclosure and the later phases of occupation in the interior.

At Whittingehame, the dates from the ditches unfortunately raised more questions than they answered. Once again, this highlights the risks in relying on a handful of radiocarbon dates to establish the chronology of any site, as too many excavators still do (Haselgrove *et al*. 2001), rather than obtaining enough determinations to construct a rigorous model. The problem is compounded if, as at Whittingehame and some other TLEP sites, the dates are obtained on a substance like birch charcoal that could easily have been disturbed from a much earlier context and redeposited, rather than on a sample with a more certain taphonomy. The waterlogged alder twig from the base of the ditch at East Bearford, for example, seems less likely to have been disturbed from a context centuries or even millennia earlier than the ditch, so that the single date that it yielded – or more strictly, the *terminus post quem* it provides for the silty clay above the waterlogged horizon – is not only consistent with the plentiful evidence from Knowes, but can probably be relied upon as reasonably secure.

NOTE

1. The first two enclosure phases at Fishers Road West are undated and might be earlier, whilst Fishers Road East appears to have originated as an open settlement.