15. APPENDIX 1: RADIOCARBON DATES

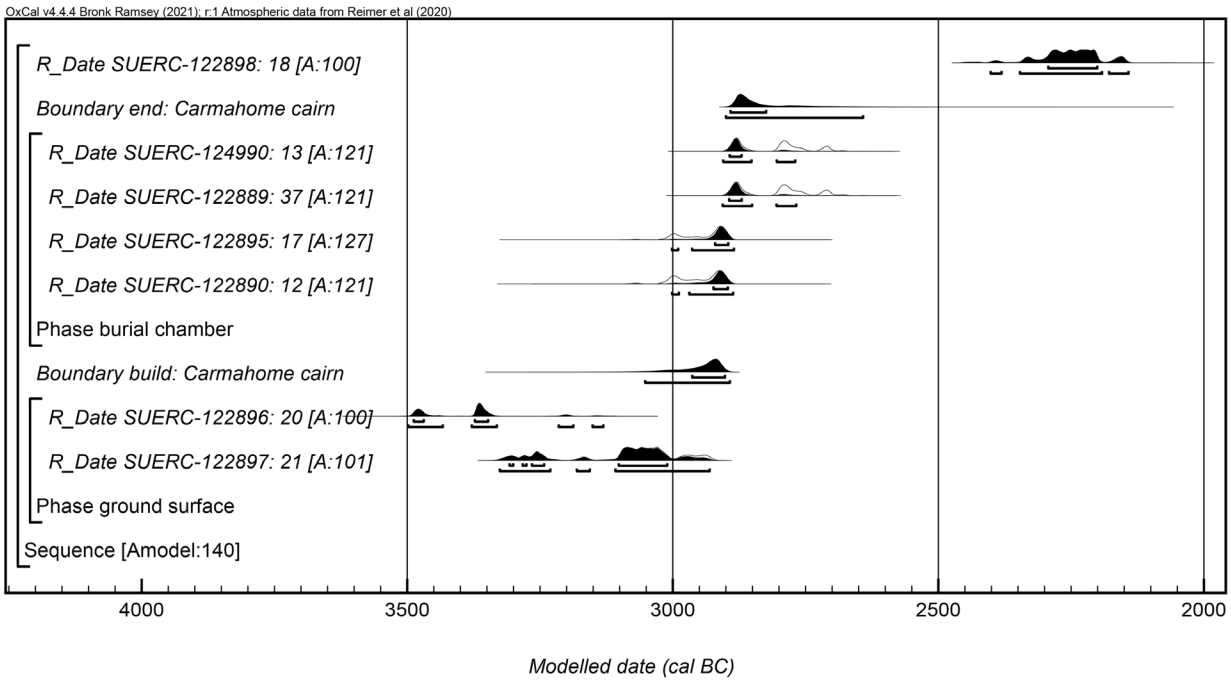
Derek Hamilton

A total of seven samples were processed for radiocarbon dating by accelerator mass spectrometry (AMS). The samples consisted of single entities (Ashmore 1999) of charcoal and cremated human bone. The samples were submitted to the Scottish Universities Environmental Research Centre (SUERC), East Kilbride where they were pretreated and measured as described by Dunbar et al (2016). The SUERC lab maintains rigorous internal quality assurance procedures, and participation in international inter-comparisons (Scott 2003; Scott et al 2010) indicate no laboratory offsets; thus, validating the measurement precision quoted for the radiocarbon ages.

The results are presented (Table 1) as conventional radiocarbon ages (Stuiver & Polach 1977). They have been calibrated using the internationally agreed terrestrial calibration curve (IntCal20) of Reimer et al (2020) and the OxCal v4.4 computer program (Bronk Ramsey 2009). Simple calibrated results are presented at 95% confidence intervals (unless otherwise noted) in plain text and rounded outward to 10 years. The *italicised* dates presented in the text below are posterior density estimates derived from mathematical modelling of archaeological problems and have been rounded outward to five years. These dates can change with the addition of new data or when the modelling choices are varied.

15.1 Methodological approach

A Bayesian approach (Buck et al 1996) has been applied to the interpretation of the chronology of the archaeological activity at Carmahome. Although simple calibrated dates are accurate estimates of the radiocarbon age of samples, this is not, usually, what archaeologists really wish to know. It is the dates of the archaeological events represented by those



Illus 15 Chronological model for activity at Carmahome. Each distribution represents the relative probability that an event occurred at some particular time. For each of the radiocarbon measurements two distributions have been plotted, one in outline, which is the result of simple radiocarbon calibration, and a solid one, which is based on the chronological model use. The other distributions correspond to aspects if the model. For example, 'build: Carmahome cairn' is the estimated date that the cairn was constructed, based on the radiocarbon dating results. The large square 'brackets' along with the OxCal keywords define the overall model exactly. (image: Forestry and Land Scotland)

samples that are of interest. For example, the start and end of the activity associated with the cairn is of interest. The chronology of this activity can be estimated not only by using the absolute dating derived from the radiocarbon measurements, but also by using stratigraphic relationships between samples and the relative dating information provided by the archaeological phasing.

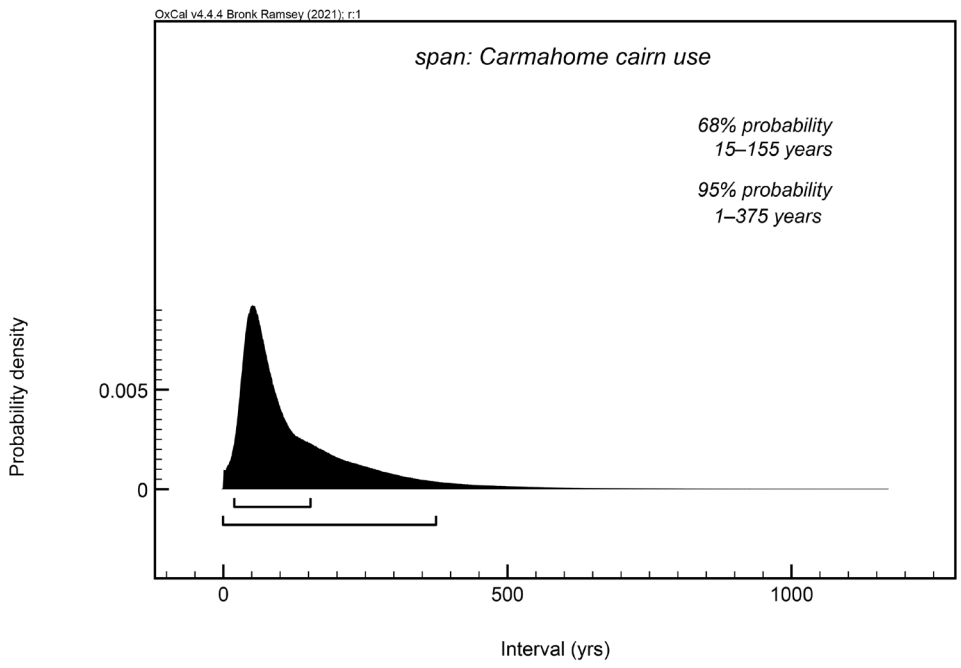
The methodology used allows the combination of these different types of information explicitly to produce realistic estimates of the dates of archaeological interest. The posterior density estimates produced by this modelling are not absolute, rather they are interpretative estimates, which can and will 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 v4.4 (http://c14.arch.ox.ac.uk/). Details of the algorithms employed by this program are available in Bronk Ramsey (1995; 1998; 2001; 2009) or from the online manual. The algorithm used in the models can be derived from the OxCal keywords and bracket structure (Illus 15).

15.2 Samples and models

The submitted samples come from contexts associated with layers and specific deposits associated with the period surrounding and including the activity in the cairn. While the results cover nearly 1500 years, the cairn activity was restricted to the first half of the 3rd millennium cal BC. The modelling investigated the chronology of this activity using the simple bounded phase model in OxCal as presented in Hamilton and Kenney (2015) but including dates from pre- and post-cairn elements into a bracketing sequence.

15.3 Results

The chronological model has good agreement (Amodel=140) between the radiocarbon dates and the modelled archaeological relationships. The model estimates the Carmahome cairn was constructed by *3055–2890 cal BC* (*95% probability* (Illus 15); *build: Carmahome cairn*) or *2965–2900 cal BC* (*68% probability*). The monument was in use for up to *375 years* (*95% probability* (Illus 16); *span: Carmahome cairn use*) or probably *15–155 years* (*68% probability*). The cairn stopped being used by *2900–2640 cal BC* (*95% probability* (Illus 15); *end: Carmahome cairn*) or *2895–2825 cal BC* (*68% probability*).



Illus 16 Span of the activity modelled at Carmahome. The span is derived from the modelling shown in Illus 15. (image: Forestry and Land Scotland)

Table 1 The radiocarbon dates from Carmahome

Lab ID	Context	Context Description	Material dated	δ13C (‰)	Radiocarbon age (BP)	Radiocarbon date (95% probability)
SUERC-122889	037	small patch of cremated bone with rare charcoal below (036)	charcoal: *Corylus avellana*	–27.2	4216 ±28	2900–2690 cal BC
SUERC-122890	012	small deposit of cremated bone under floor (005)	cremated human bone; skull	–22.9	4332 ±28	3030–2890 cal BC
SUERC-122895	017	concentration of burnt bone with no charcoal	cremated human bone; skull	–24.5	4324 ±28	3020–2890 cal BC
SUERC-122896	020	trampled, mixed and disturbed buried soil beneath cairn	charcoal: *Corylus avellana*	–24.0	4593 ±28	3500–3140 cal BC
SUERC-122897	021	soil beneath cairn	charcoal: *Corylus avellana*	–25.7	4427 ±28	3320–2930 cal BC
SUERC-122898	018	turf within the cairn makeup	charcoal: *Corylus avellana*	–27.6	3814 ±28	2400–2150 cal BC
SUERC-122490	013	sediment overlying (005) and containing cremated bone	cremated human bone	–23.4	4216 ±26	2900–2690 cal BC