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Cat’s Brain, Vale of Pewsey, Wiltshire

Radiocarbon Dating and Chronological Modelling

Peter Marshall, Jim Leary, Michael Dee and Irka Hajdas

Scientific Dating

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Summary

Radiocarbon dating and chronological modelling of samples from Cat's Brain was undertaken as part of the University of Reading and Historic England *Vale of Pewsey Project*. The results suggest that the sub-rectangular timber building was constructed in the first or second half of the 38th century cal BC and extended in the decades around 3700 cal BC. A chalk barrow was then raised 'wrapping' the disused timber buildings in an act of containment in the first half of the 37th century cal BC.

Contributors

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Acknowledgements

We would like to thank Dana Challinor and Fay Worley for identifying the charcoal, antler and animal bone samples submitted for radiocarbon dating.

Front cover photo

Front cover image: Excavation of Cat's Brain, 25 July 2017. [photograph taken by Damian Grady, Aerial Photo - 33389_007, © Historic England Archive]

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Introduction

The Vale of Pewsey project

The National Mapping Programme (NMP) has provided almost continuous data for the area between Stonehenge and Avebury in Wiltshire (Carpenter and Winton 2011; https://historicengland.org.uk/research/results/aerial-archaeology-mapping-explorer/), demonstrating that there are extensive and previously unrecognised archaeological landscapes in the Vale of Pewsey. The Vale is in a key position between the two geographically separated parts of the Stonehenge and Avebury World Heritage site. These newly identified sites and monuments, particularly the spatially cohesive group along the headwaters of the River Avon, formed the basis for a staged, collaborative excavation project to understand the evolution of this landscape. This will go some way towards linking the Stonehenge landscape to the south with the Avebury landscape to the north.

The fieldwork took place over three seasons (2015–17) and comprised targeted excavation and analysis of poorly understood monuments, Cat’s Brain long barrow, Wilsford henge (Gaydarska et al. 2024) and, as well as further excavation of Marden henge. The collaborative project undertaken by the University of Reading and Historic England was supported by a major research grant from the Arts and Humanities Research Council, awarded to Jim Leary and Martin Bell of the University, with Historic England also providing financial support and specialist resources.

This document is a technical archive report on the radiocarbon dating and chronological modelling of samples from Cat’s Brain, Wiltshire (Figs 1 and 2). Elements of this report may be combined with additional research (Leary et al. 2020) at some point in the future to form a comprehensive publication on the chronology of Cat’s Brain, and its timescape within the Stonehenge and Avebury World Heritage Site.

Cat’s Brain

Cat’s Brain long barrow (Monument Number: 1483725, NMR Number: SU 15 NW 143) was first recognized in 1972 as a cropmark on an aerial photograph. This image also revealed the cropmarks of three probable Bronze Age ring ditches arranged in a line running southeast (Carpenter and Winton 2011). The photograph showed a U-shaped ditch enclosing an area approximately 26 x 20m, aligned east–west with the open-end facing east. Within the ditch, the faint remains of a trapezoidal structure were visible, though more recent photographs suggest this feature has been ploughed away. Based on the ditch's form, the site was believed to resemble the 'Cranborne Chase type' long barrow identified by Ashbee, like those found at Thickthorn Down, Cranborne Chase, Dorset (Ashbee 1970; 1984; Barrett et al. 1991, 36–7). However, the internal structure appeared more consistent with trapezoidal long barrows such as Fussell's Lodge (Ashbee 1966), with parallels in the Thames Valley, e.g., Radley (Bradley 1992).

Targeted excavation in the summer of 2017 at Cat's Brain had expected to reveal the U-shaped ditch seen in the aerial photographs and little else, however in the event, the investigations exposed the footprint of the Early Neolithic trapezoidal structure, which comprised postholes and beam slots that looked strikingly like a longhouse in plan, along with two large, flanking ditches. The building is aligned east–west, parallel to the Vale itself, and measured 19.2m in length and at the front (to the east) was 10.2m in width tapering to 6m at the back. It is exceedingly robust in places with deeply cut foundation trenches and large postholes (the largest measuring up to 1.3 m in diameter) that would have once held colossal timbers. While traditional interpretation suggests that this represents a mortuary chamber or enclosure, there is little to back this up, no burials for example, and the detail recorded on site suggests that it could equally represent a house for the living.

Despite being plough-razed, the remains of a floor plan are discernible, which implies that it was tripartite; divided into three roughly equal sections, with a very clear internal partition marking the most narrow, back section, while the slight remains of a central posthole indicates the division between the first and second sections (note this tripartite arrangement occurs in some much earlier houses). This arrangement is also reflected in the sides of the building. An earlier ditch was clearly visible under the back of the building (a feature that, combined with the flanking ditches, gave the appearance of a U-shaped ditch on the aerial photographs), and therefore this back section may represent an extension (or annexe) to the structure. The beam slots along the front of the building are substantially deeper than the rest, suggesting that the fabric of the building's frontage was more substantial than elsewhere, perhaps monumentally so. A break halfway along this front beam slot indicates the threshold, 1.1m wide, through which people would have entered the building. Two large postholes either side of the building's façade further monumentalised this area, although there was no indication that they formed part of a forecourt.

Either side of the building are large crescent-shaped flanking ditches; the curving nature of which juxtapose with the straight lines of the building. A deeper, wider pit marks the easternmost terminal of these ditches. Both ditches conform to the same general plan and mirror each other, perhaps implying a deliberate design.

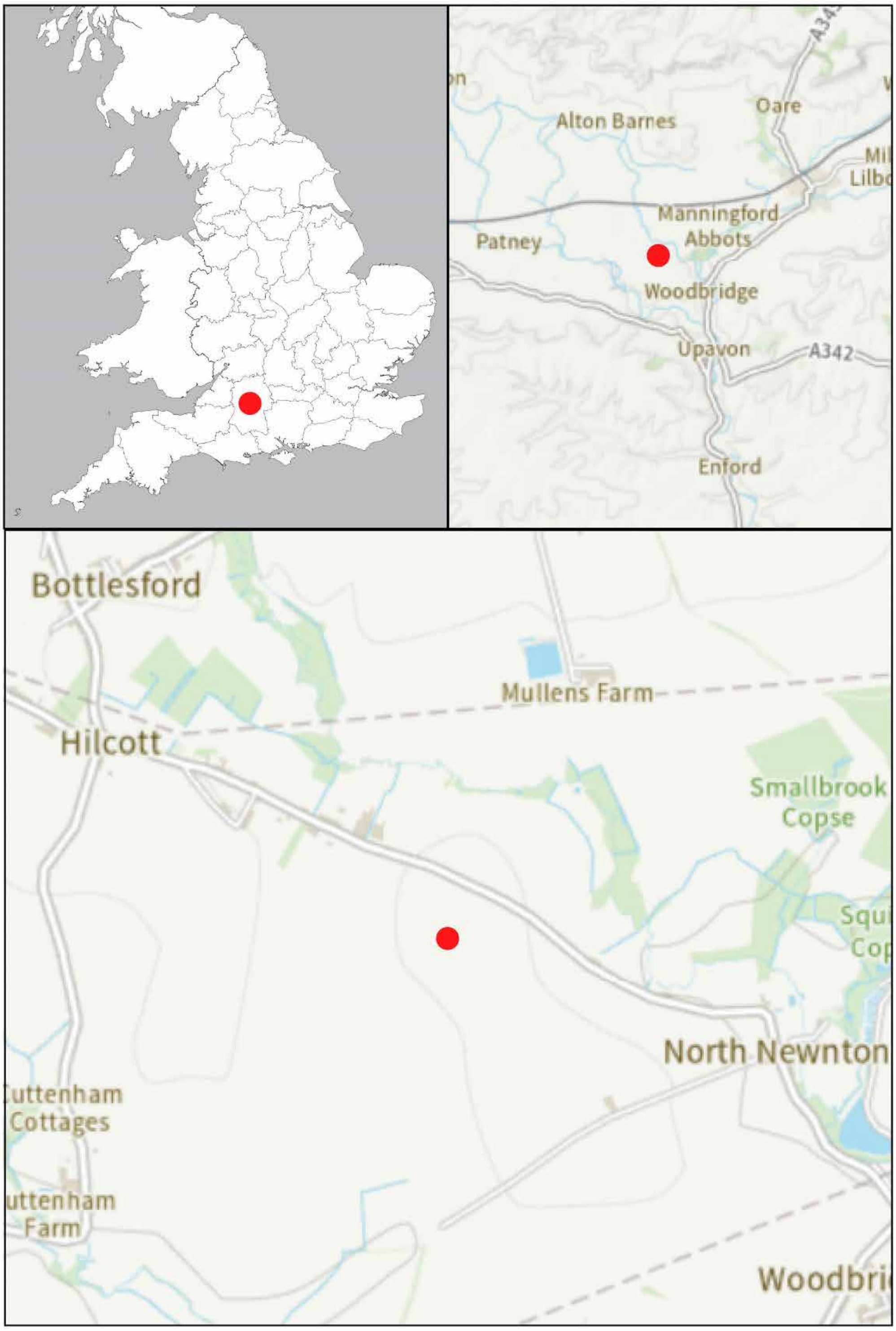

Figure 1: Maps to show the location of Cat's Brain long barrow, in red. Scale: top right 1:200,000; bottom 1:20,000. [© Crown Copyright and database right 2025. All rights reserved. Ordnance Survey Licence number 100024900.]

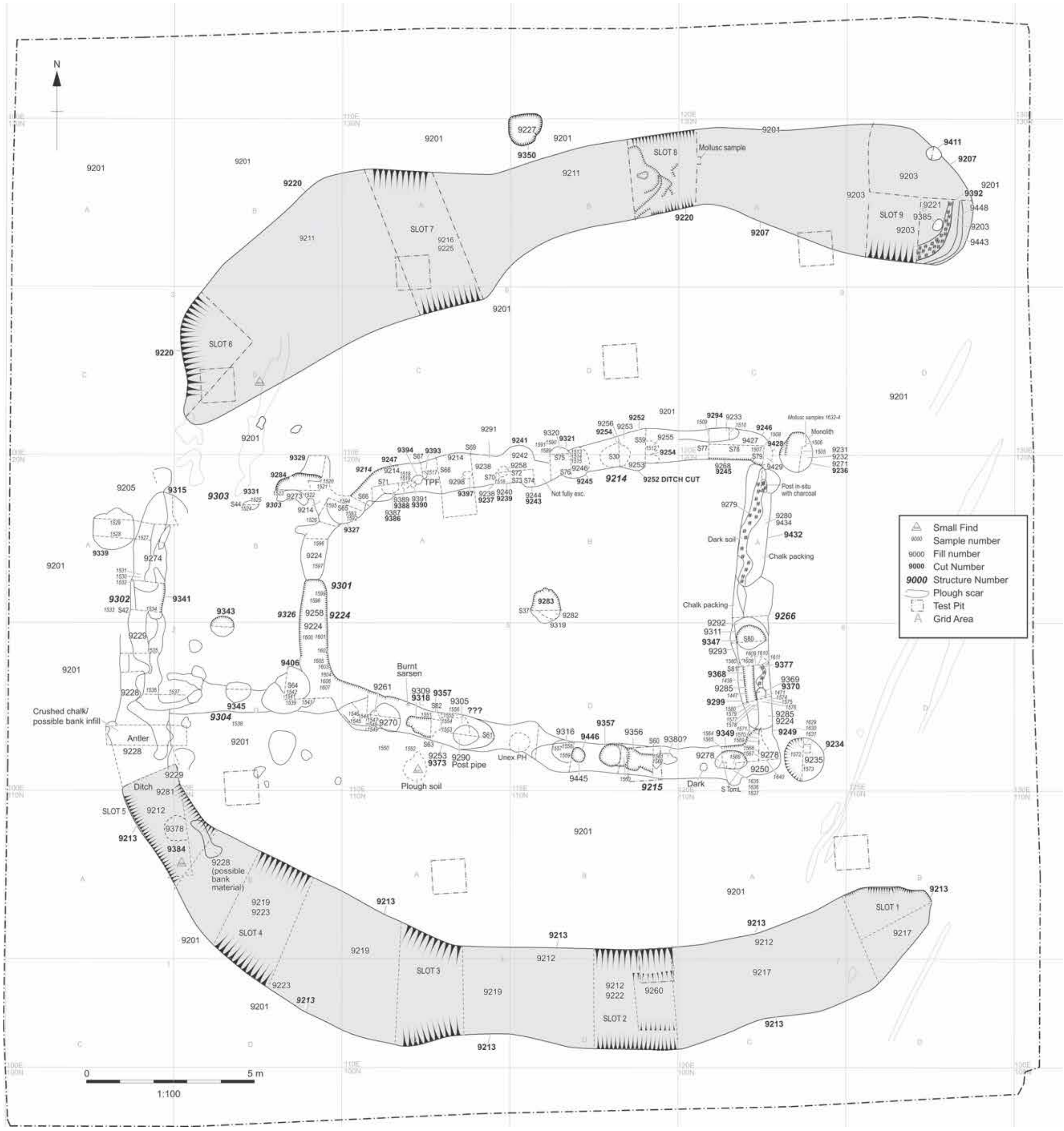

Figure 2: Cat’s Brain excavation plan. [© University of York]

The general sequence can thus be summarised as follows:

Construction of Neolithic timber building

Construction of a sub-rectangular, timber building (longhouse), evidenced by a series of beam slots and postholes, that would have supported foundation timber beams and timber posts. The shape of the beam slots suggests that at least two long beams had been placed at the base of each ‘wall’. Each corner of the building was interspersed by at least one posthole, as was the centre of the northern, eastern and southern beams. Additional postholes and possible stakeholes were identified along the lengths of these beams. The cutting of a ditch to the west, southwest of the sub-rectangular, timber building may be contemporaneous with its construction. This feature was only partially exposed but had clearly been backfilled prior to the construction of an 'annex', added to the building (see below).

Construction of an annex to the Neolithic timber building

Enlargement of the timber building, with the construction of an 'annex' at its western end, following backfilling of the ditch that was cut by its beam slots.

Construction of Neolithic barrow

Cutting of two, substantial, curvilinear ditches with the chalk from these used to raise a barrow above the disassembled Neolithic timber building and annex. Although, as the barrow had been removed by modern ploughing, this is an archaeological interpretation.

Infilling the curvilinear ditches

Following the accumulation of the chalk-rich primary fills the curvilinear ditches were infilled by a series of 'dumps' with large quantities of charcoal and material culture.

Radiocarbon dating and chronological modelling

Objectives

The programme of radiocarbon dating, and chronological modelling was designed to address the following objectives:

- to establish the date of construction and length of use of the timber building;
- to establish the date of construction of the annex to the timber building;
- to determine when the barrow mound was raised over the timber building and its annex;
- to clarify the temporal interval between the two structures;
- to elucidate where the barrow appears in the sequence of long barrows, long cairns and associated structures that appeared in southern England from the 38th century cal BC (Roberts et al. 2018);
- to contribute to our understanding of the currency of timber halls in Great Britain and Ireland (Gibson et al. 2017).

Sampling

Sample selection was undertaken using the iterative process for implementing Bayesian chronological modelling on archaeological sites as outlined in Bayliss and Marshall (2022). At Cat’s Brain we aimed to maximise the number of stratigraphic relationships between dated deposits included in the modelling where possible as stratigraphy provides a relative sequence of excavated deposits, and radiocarbon dating provides dates for samples. Accordingly, for it to be effective to use a sequence derived from stratigraphy to constrain the calibration of radiocarbon dates in a Bayesian model, it is essential to ensure that the carbon in the sampled material was in equilibrium with the atmosphere at the time the deposit was formed.

The fundamental basis of the sampling strategy was the Harris matrix of excavated deposits. Short-lived plant material from targeted deposits was identified by Dana Challinor, with selected material chosen based on context description (i.e. oak sapwood in postholes was interpreted as deriving from the outside of burnt structural posts). Potential articulating or rearticulating animal bones that were probably deposited shortly after the death of the animal concerned were identified during assessment of the faunal assemblage for material suitable for radiocarbon dating undertaken by Fay Worley along with antler tools discarded on the base of ditches and other negative features thought to be functionally related to the digging of the features. This inference is more secure when use-wear such as battering on the posterior side of the beam/burr/coronet is identifiable (Bayliss and Marshall 2022: §3.2.2).

Radiocarbon dating

Twelve radiocarbon measurements (antler n=3, animal bone n=1, and charcoal n=8) are now available relating to activity at Cat's Brain. Details of the dated samples, radiocarbon ages, and associated stable isotopic measurements are provided in Table 1. The radiocarbon results are conventional radiocarbon ages (Stuiver and Polach 1977), corrected for fractionation using $\delta^{13}C$ values measured by Accelerator Mass Spectrometry (AMS; in Groningen and Zürich). For some samples, $\delta^{13}C$ values were also measured by Isotope Ratio Mass Spectrometry (IRMS). These values more accurately reflect the natural isotopic composition of the sampled material.

Six samples were dated at the Laboratory of Ion Beam Physics, ETH Zürich, Switzerland in 2022. The four antler samples were gelatinised and ultrafiltered as described by Hajdas et al. (2007; 2009) and the two charcoal samples were pretreated using the acid-base-acid protocol described by Hajdas (2008). They were then combusted in an elemental analyser and graphitised using the fully automated system described by Wacker et al. (2010a). Graphite targets were dated using a 200kV, MICADAS Accelerator Mass Spectrometer as described by Wacker et al. (2010b). Stable isotopic ratios were obtained on sub-samples of the pretreated material using a ThermoFischer Flash-EA 1112 elemental analyzer coupled through a Conflo IV interface to a ThermoFisher Delta V Isotope Ratio Mass Spectrometer.

Three antler samples and three fragments of charcoal were dated at the Centre for Isotope Research, University of Groningen in 2022. The samples were pretreated as described by Dee et al. (2020). They were then combusted in an elemental analyser (IsotopeCube NCS), coupled to an Isotope Ratio Mass Spectrometer (Isoprime 100) for measurement of %C, %N, C/N, $\delta^{13}C$ and $\delta^{15}N$ (Wijma et al. 1996; Aerts-Bijma et al. 1997). The resultant CO_2 was graphitised by hydrogen reduction in the presence of an iron catalyst. The graphite was then pressed into aluminium cathodes and dated by AMS (Synal et al. 2007; Salehpour et al. 2016).

Data reduction at ETH Zürich and the University of Groningen was undertaken as described by Wacker et al. (2010c). Both facilities maintain continual programmes of quality assurance procedures, in addition to participation in international inter-comparison exercises (Scott et al. 2017). Details of quality assurance data and error calculation at Groningen are provided by Aerts-Bijma et al. (2021), and similar details for ETH are provided in Sookdeo et al. (2020).

Replicate radiocarbon measurements on a single charcoal fragment that was split and processed at both Groningen and ETH are statistically consistent at the 5% significance level (Table 1).

Table 1: Cat's Brain – radiocarbon and stable isotope results. Replicate measurements have been tested for statistical consistency and combined by taking a weighted mean before calibration as described by Ward and Wilson (1978).

Laboratory code	**Sample ID, material & context**	**$\delta^{13}C_{IRMS}$ (‰)**	**$\delta^{13}C_{AMS}$ (‰)**	**$\delta^{15}N_{IRMS}$ (‰)**	**C:N**	**Radiocarbon age (BP)**
ETH-122537	9305.1. Charcoal, *Alnus/Corylus* sp. (D Challinor) from [9305] <1450> the fill of beam slot [9310] cutting natural chalk [9201] forming part of a sub-rectangular footprint (Structure 9287), measuring 14m (E-W) by 10.20m (N–S)		−28.4			3865±24
GrM-29669	9305.2. Charcoal, *Quercus* sp. cf. sapwood (D Challinor) from [9305] <1450> the fill of beam slot [9310] cutting natural chalk [9201] forming part of a sub-rectangular footprint (Structure 9287), measuring 14m (E–W) by 10.20m (N–S)	−23.7±0.15				3861±24
GrM-29738	9285.1. Charcoal, *Quercus* sp. cf. sapwood (D Challinor) from [9285] <1438> the fill of beam slot [9368]	−26.3±0.15				5030±27
ETH-122543	9395.1. Antler, red deer (F Worley) from the fill [9395] of ditch (southern) [9213]	−21.9±0.1	–26.2	4.7±0.1	3.3	4919±25
GrM-29739	9282.1. Charcoal, *Quercus* sp. cf. sapwood (D Challinor) from [9282] <1442> the secondary fill of posthole/pit [9283] at the centre of Structure 9287	−23.2±0.15				5029±27
ETH-122540	9319.1. Charcoal, *Quercus* sp. cf. sapwood (D Challinor) from [9219] <1456> the primary fill of posthole/pit [9283] at the centre of Structure 9287	-	−27.2			5056±18
GrM-29740	9319.2. Replicate of ETH-122540	−24.6±0.15				5098±27
9319	^{14}C: 5069±15 BP; T'=0.1, T'(5%)=3.8, v=1					
GrM-29397	9263.1 Animal bone, pig, articulating foot (F Worley) from [9263] the fill of ditch (southern) [9213]	−21.4±0.15		5.4±0.3	3.2	4928±24
ETH-122542	9356.1. Antler. Red deer pick SF 1519 (F Worley) from the fill [9356] of posthole [9357]	−20.8±0.1	−27.1	6.0±0.1	3.3	4879±25
GrM-29398	9447.1. Antler, red deer crown with three tines, SF 807 (F Worley) from [9447] the fill of ditch [9399]	−21.8±0.15		4.1±0.3	3.2	4891±24

Laboratory code	Sample ID, material & context	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{15}N_{IRMS}$ (‰)	C:N	Radiocarbon age (BP)
ETH-122538	9290.1. Charcoal, *Alnus/Corylus* sp. (D Challinor) from the fill [9290] <1446> of posthole [?9453]		−26.4			7299±26
ETH-122539	9376.1, Charcoal, *Quercus* sp. cf. sapwood (D Challinor) from the fill [9376] <1478> of posthole [9377]		−26.1			5001±18

Chronological modelling

The chronological modelling presented here has been undertaken using OxCal 4.4 (Bronk Ramsey 2009), and the internationally agreed calibration curve for the northern hemisphere (IntCal20; Reimer et al. 2020). The model is defined by the OxCal CQL2 keywords and by the brackets on the left-hand side of Figure 2. The CQL2 code for the model is provided in Appendix 1. In the figures, calibrated radiocarbon dates are shown in outline, and the posterior density estimates produced by the chronological modelling are shown in solid black. The other distributions correspond to aspects of the model. For example, the distribution *BuildStructure9287* (Fig. 3) is the posterior density estimate for when the timber hall at Cat's Brain was built. In the text and tables highest posterior density intervals, which describe the posterior distributions, are given in italics.

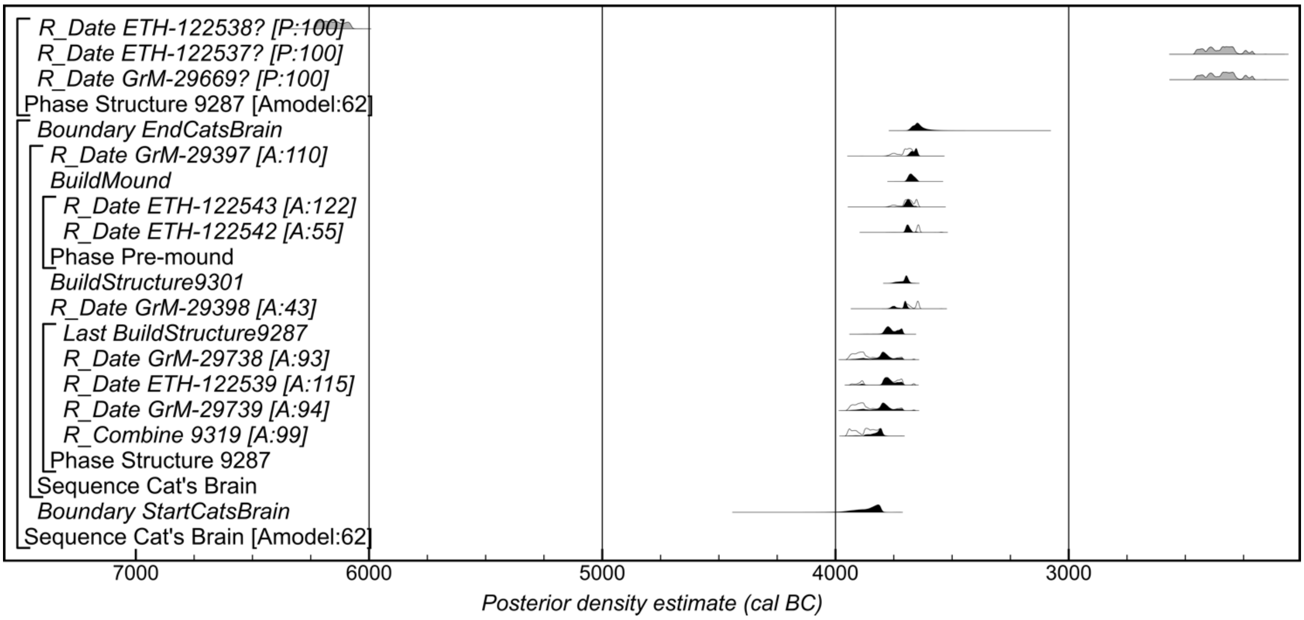

Figure 3: Probability distributions of dates from Cat's Brain. Each distribution represents the relative probability that an event occurs at a particular time. For each of the dates two distributions have been plotted: one in outline, which is the result of simple radiocarbon calibration, and a solid one, based on the chronological model used. Distributions other than those relating to particular samples correspond to aspects of the model. For example, the distribution '*BuildStructure9287*' is the estimated date when the sub-rectangular timber building was built. The large square brackets down the left-hand side along with the OxCal keywords define the overall model exactly.

Seven samples were dated from the fills of the beam slots and postholes of Structure 9287 (ETH-122537–40, GrM-29738–9 and GrM-29669). ETH-122538 is much earlier than the other samples and is therefore interpreted as deriving from earlier activity, while GrM-29669 and ETH-122537 are both significantly later than the other samples and are almost certainly intrusive. Given these two statistically consistent measurements (T'=0.0, T'(5%)=3.8, v=1; Ward and Wilson 1978) come from the fill [9305] of beam slot [9310] this suggests previously unrecognised late Neolithic activity on the site. The four other determinations, all on oak charcoal sapwood, are not statistically consistent at the 5% significance level (T′=8.7; T′(5%)=7.8; v=3) but are statistically consistent at the 1% significance level (T′=8.7; T′(5%)=11.3; v=3), nonetheless it should be taken into account that the amount of sapwood on prehistoric English oaks varies between 10 and 55 years (Hillam et al. 1987).

Prior to the addition of the almost square 'annex' (Structure 9301), ditch [9399] to the south and southwest of Structure 9287 was backfilled with antler SF 807 (GrM-29398) from its fill [9447] plausible deriving from this activity. To provide enough material (chalk) for the creation of a mound over the footprint of dismantled Structure 9287/9301, two substantial curvilinear ditches were cut ([9213] and [9220]). Red deer antler (ETH-122543) from fill [9395] is interpreted as deriving from the digging of ditch [9213] and SF 1519 (an antler pick) from the base of posthole [9357] from its post's removal and the dismantling of structure [9287/9301]. The articulated pig foot (GrM-29397) from fill [9263] of ditch [9213] provides a *terminus ante quem* for the construction of the barrow.

A summary of the archaeological information included in the model is shown in Figure 4. Replicate radiocarbon measurements were combined by taking a weighted mean (Ward and Wilson 1978) before calibration and inclusion in the model, and the measurements on residual Mesolithic and intrusive material of late-Neolithic date are excluded.

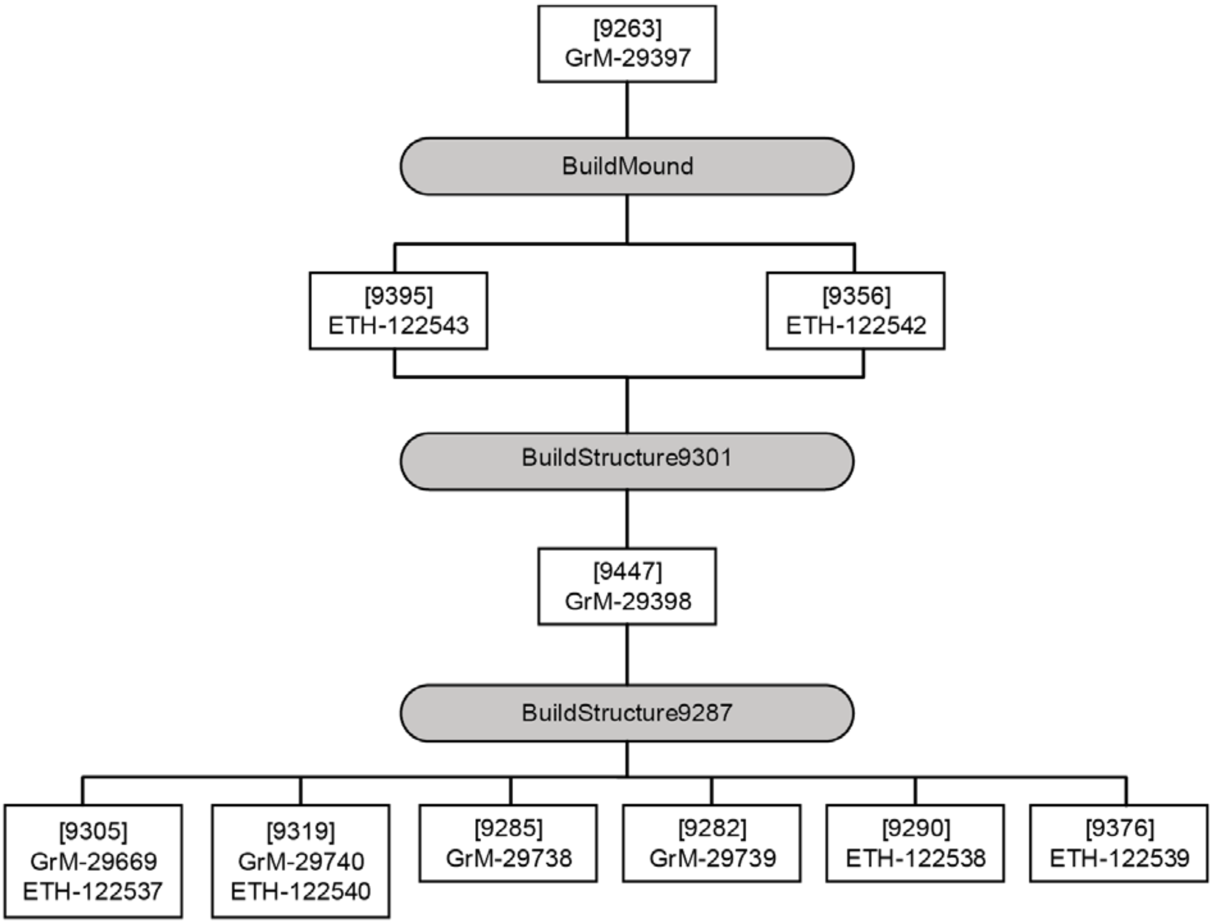

Figure 4: Summary of the prior information incorporated in the chronological model shown in Figure 3.

The model shown in Figure 3 includes all the dated features in a single, continuous uniform phase of activity (Buck et al. 1992). It has good overall agreement (Amodel: 62; Bronk Ramsey 2009: 356–57) and suggest that the construction of trapezoidal structure [9287] occurred in *3800–3705 cal BC* (*95% probability; BuildStructure9287*; Fig. 5), probably in *3795–3755 cal BC* (*47% probability*) or *3735–3710 cal BC* (*21% probability*)*.* It should be noted that the posterior date estimate for the construction of the structure [9287] is bi-modal and thus it is uncertain whether it is built in the first or second half of the 38th century cal BC. Enlargement of structure [9287] with the addition at its west end of structure [9301] took place in *3755–3675 cal BC* (*95% probability; BuildStructure9301*; Fig. 5), probably in *3720–3680 cal BC* (*68% probability*). The final act of entombing the footprint of structures [9287/9301] beneath a chalk barrow is estimated to have taken place in *3700–3645 cal BC* (*95% probability; BuildMound*; Fig. 5), probably in *3690–3660cal BC* (*68% probability*).

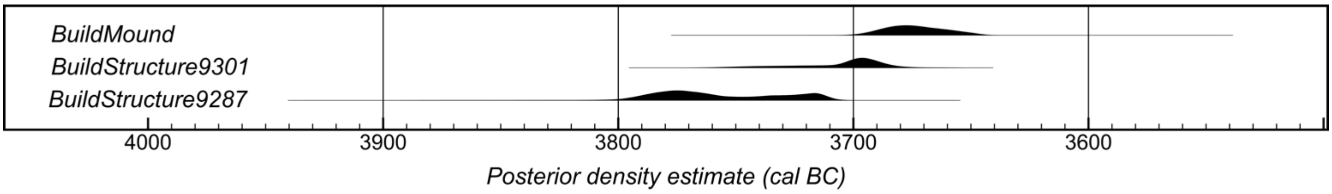

Figure 5: Posterior density estimates for the date of constructional events at Cat's Brain, derived from the model described in Figure 3.

Structure [9287] was in use for *5–105 years* (*95% probability*; *use Structure9287*; Fig. 6), probably for *15–75 years* (*68% probability),* and structures [9287/9301] were used for 2*5–135 years* (*95% probability*; *use Structures9287/9301*; Fig. 5), probably for *50–115 years* (*68% probability).*

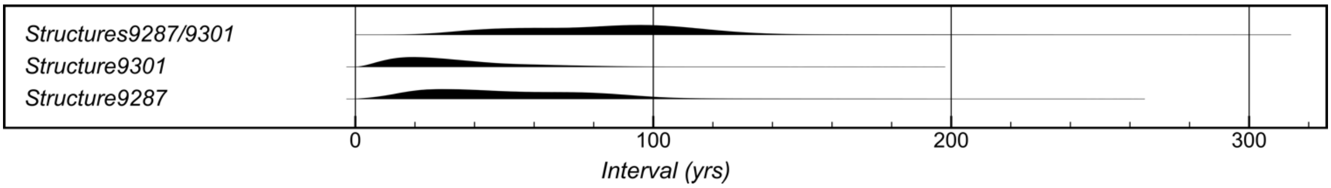

Figure 6: Probability distributions of the number of years during which trapezoidal structure [9287], and annex [9301] were in use, derived from the model described in Figure 3.

Discussion

The sequence at Cat's Brain has striking similarities to Dorstone Hill, Herefordshire where three long barrows were constructed on the footprints of three timber buildings that had been deliberately burned (Ray et al. 2023). Although not as chronologically distinct as the Irish early Neolithic 'house horizon' (Whitehouse et al. 2014), the construction of the sub-rectangular timber building at Cat's Brain, in the first or second half of the 38th century cal BC, adds to the growing corpus of such structures that have been identified in the last 15 years that have a currency from the 39th–37th centuries cal BC (Gibson et al. 2017). Superficially Cat's Brain appears comparable to the structures at Lismore Fields (Garton 1991) and White Horse Stone (Garwood 2011) as they are all composed of two attached buildings. The 'annex' at Cat's Brain is estimated to have been added to the sub-rectangular timber building in the decades around 3700 cal BC.

The plausible creation of a chalk barrow over the abandoned timber buildings took place in the first half of the 37th century cal BC. Both long and oval barrows overlap with a parallel tradition of non-mounded long (mortuary) enclosures, and other related categories including cursus monuments and bank barrows, which could be seen as extremely extended long enclosures and long barrows respectively (Roberts et al. 2018). With all these uncertainties in mind, here we compare the period of use of non-megalithic earthen long barrows with chambered tombs, oval barrows and other forms of linear monument across central southern England, as well as with causewayed enclosures in the more local area of Wessex. Figure 7 is a schematic diagram summarising the currency of these different types of monument in use in fourth millennium south-central England. The horizontal bars represent the probability that a particular monument-type was in use in a particular 50-year period (light shading is less probable, darker shading more probable). Given the difficulties in estimating when linear monuments and oval barrows went out of use an arrow has been used to denote when they would probably have remained a visible feature in the landscape. For Cat's Brain we have just used the estimate for when the mound was constructed.

Megalithic long barrows and chambered long cairns were clearly the first monuments to be built in south-central England (*80.6% probable*) from the late 39th/early 38th centuries cal BC. Causewayed related enclosures and non-megalithic earthen long barrows were in use by the late 38th or early 37th centuries cal BC when the mound at Cat's Brain was constructed.

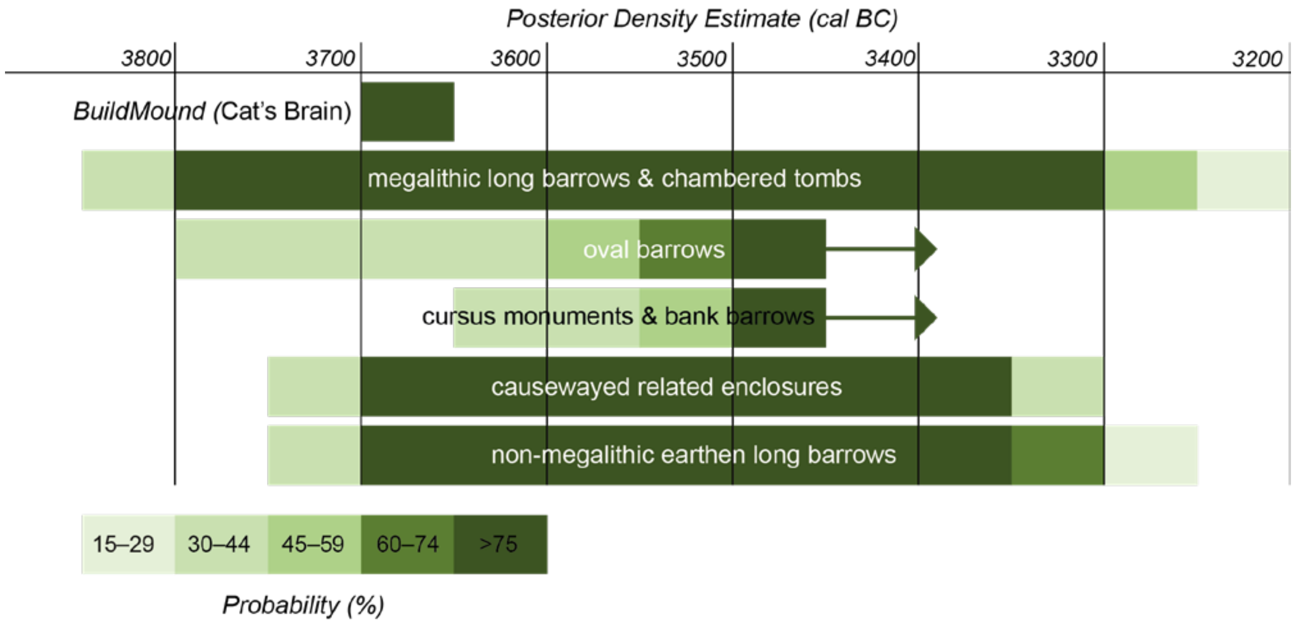

Figure 7: Schematic diagram showing the periods of use of dated monuments in south-central England of the 4th millennium cal BC together with the estimated date for the construction of the mound at Cat's Brain. Given the difficulties in estimating when linear monuments went out of use an arrow has been used to denote when they would probably still have remained a visible feature in the landscape. Distributions have been taken from rerunning the models defined in the Roberts et al. (2018; appendix 5) with IntCal20 (Reimer et al. 2020): earthen long barrows (Roberts et al. 2018, fig. 15), chambered long barrows, cairns and oval barrows (Roberts et al. 2018, fig. 16–19), linear monuments (Roberts et al. 2018, fig. 20) and causewayed related enclosures (Roberts et al. 2018, fig. 21).

References

Aerts-Bijma, A. T., Meijer, H. A. J., and Van Der Plicht, J. 1997 'AMS sample handling in Groningen', *Nuclear Instruments and Methods in Physics Research B,* 123, 221–5 https://doi.org/10.1016/S0168-583X(96)00672-6

Aerts-Bijma, A. T., Paul, D., Dee, M. W., Palstra, S. W. L., and Meijer, H. A. J. 2021 'An independent assessment of uncertainty for radiocarbon analysis with the new generation high-yield accelerator mass spectrometers', *Radiocarbon*, 63(1), 1–22: https://doi.org/10.1017/RDC.2020.101

Ashbee, P. 1966 'The Fussell's Lodge long barrow excavations, 1957', *Archaeologia*, 100, 1–80: https://doi.org/10.1017/S0261340900013709

Ashbee, P. 1970 *The Earthen Long Barrow in Britain: an introduction to the study of the funerary practice and culture of the Neolithic people of the third millennium BC* (London).

Ashbee, P. 1984 *The Earthen Long Barrow in Britain* (Norwich).

Barrett, J., Bradley, R., and Green, M. 1991 *Landscapes, Monuments and Society: the prehistory of Cranborne Chase* (Cambridge).

Bayliss, A. and Marshall, P. 2022 *Radiocarbon Dating and Chronological Modelling: Guidelines and Best Practice* (Liverpool).

Bradley, R. 1992 'The excavation of an oval barrow beside the Abingdon causewayed enclosure, Oxfordshire', *Proceedings of the Prehistoric Society*, 58, 127–42: https://doi.org/10.1017/S0079497X00004138

Bronk Ramsey, C. 2009 'Bayesian analysis of radiocarbon dates', *Radiocarbon,* 51, 37–60: https://doi.org/10.1017/S0033822200033865

Buck, C.E., Litton, C. D., and Smith, A. F. M. 1992 'Calibration of radiocarbon results pertaining to related archaeological events', *Journal of Archaeological Science,* 19, 497–512: https://doi.org/10.1016/0305-4403(92)90025-X

Carpenter, E., and Winton, H. 2011 'Marden Henge and Environs, Vale of Pewsey, Wiltshire: A Report for the National Mapping Programme', English Heritage Research Department Report, 76–2011: https://historicengland.org.uk/research/results/reports/76-2011

Dee, M. W., Palstra, S. W. L., Aerts-Bijma, A. T., Bleeker, M. O., de Bruijn, S., Ghebru, F., Jansen, H. G., Kuitems, M., Paul, D., Richie, R. R., Spriensma, J. J., Scifo, A., van Zonneveld, D., Verstappen-Dumoulin, B. M. A. A., Wietzes-Land, P., and Meijer, H. A. J. 2020 'Radiocarbon dating at Groningen: new and updated chemical pretreatment procedures', *Radiocarbon* 62, 63–74: https://doi.org/10.1017/RDC.2019.101

Garwood, P. 2011 'Early prehistory', in Garwood, P., Booth, P., Champion, T., Foreman, S., Glass, H., Munby, J., and Reynolds, A. eds. *On Track: The Archaeology of High Speed 1 Section 1 in Kent*, Oxford Wessex Archaeology Monographs 4 (Oxford), 37–150.

Garton, D. 1991 'Neolithic settlement in the Peak District: perspective and prospects', in Hodges R., and Smith K. eds, *Recent developments in the archaeology of the Peak District* (Sheffield) 3–22.

Gaydarska, B., Bayliss, A., Marshall, P., Bronk Ramsey, C., Dee, M., Dunbar, E., Hajdas, I., and Leary, J. 2024 'Wilsford Henge, Wilsford, Wiltshire Radiocarbon Dating and Chronological Modelling', Historic England Research Report Series, 91/2024: https://historicengland.org.uk/research/results/reports/91-2024

Gibson, A., Neubauer, W., Flöry, S., Filzwieser, R., Nau, E., Schneidhofer, P., Strapazzon, G., Batt, C., Greenwood, D., Bradley., and Challinor, D. 2017 'Excavation of a Neolithic house at Yarnbury, near Grassington, North Yorkshire', *Proceedings of the Prehistoric Society*, 83, 189–212: https://doi.org/10.1017/ppr.2016.15

Hajdas, I. 2008 'The radiocarbon dating method and its applications in Quaternary studies', *Eiszeitalter und Gengenwart: Quaternary Science Journal*, 57, 2–24: https://doi.org/10.3285/eg.57.1-2.1

Hajdas, I., Bonani, G., Furrer, H., Mader, A., and Schoch, W. 2007 'Radiocarbon chronology of the mammoth site at Niederweningen, Switzerland: results from dating bones, teeth, wood, and peat', *Quaternary International,* 164–65, 98–105: https://doi.org/10.1016/j.quaint.2006.10.007

Hajdas, I., Michczynski, A., Bonani, G., Wacker, L., and Furrer, H. 2009 'Dating bones near the limit of the radiocarbon dating method: study case mammoth from Niederweningen ZH, Switzerland' *Radiocarbon*, 51, 675–80: https://doi.org/10.1017/S0033822200056010

Hillam, J., Morgan, R. A., and Tyers, I. 1987 'Sapwood estimates and the dating of short ring sequences' in Ward, R. G. W. ed, *Applications of Tree-ring Studies: Current Research* *in Dendrochronology and Related Areas*, British Archaeological Reports International Series 333, (Oxford) 165–85.

Leary, J., Field, D., and Barclay, A. 2020 'Schrödinger's Cat: Houses for the living and the dead', in Barclay, A., Field, D., and Leary, J. eds, *Houses of the Dead*?, Neolithic Studies Group Seminar Papers 17 (Oxford) 1–14.

Ray, K., Thomas, J., Overton, N., Griffiths. S., Hoverd T., Allen, M. J., Barclay, A., Birchenall, J., Challinor, D., French, C., Healey, E., Ixer, R., Roseveare, A., Martin Roseveare, M., Garcia Rovira, I., Adam Stanford, A., and Wiltshire, I. 2023 'Dorstone Hill: a Neolithic timescape', *Antiquity*, 97(394), 869–86: https://doi.org/10.15184/aqy.2023.93

Reimer, P. J., Austin, W. E. N., Bard, E., Bayliss, A., Blackwell, P., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Hajdas, I., Heaton, T. J., Hogg, A. G., Hughen, K. A., Kromer, B., Manning, S. W., Muscheler, R., Palmer, J. G., Pearson, C., van der Plicht, J., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Turney, C. S. M., Wacker, L., Adolphi, F., Büntgen, U., Capano, M., Fahrni, S., Fogtmann-Schultz, A., Friedrich, R., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A., and Talamo, S. 2020 'The IntCal20 Northern Hemispheric radiocarbon calibration curve (0–55 kcal BP)', *Radiocarbon,* 62, 725–57: https://doi.org/10.1017/RDC.2020.41

Roberts, D., Valdez-Tullett, A., Marshall, P., Last, J., Barclay, A., Bishop, B., Dunbar, E., Forward, A., Law, M., López-Dóriga, I. L., Manning, A., Pelling, R., Powell, A., Reimer, P., Russell, M., Soutar, S., Vallender, J., and Worley, F. 2018 'Recent investigations at two long barrows and reflections on their context in the Stonehenge World Heritage Site and environs', *Internet Archaeology*, 47: http://intarch.ac.uk/journal/issue47/7/

Salehpour, M., Håkansson, K., Possnert, G., Wacker, L., and Synal, H-A. 2016 'Performance report for the low energy compact accelerator mass spectrometer at Uppsala University', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* 371, 360−4: https://doi.org/10.1016/j.nimb.2015.10.034

Scott, E. M., Naysmith, P. and Cook, G. T. 2017 'Should archaeologists care about ^{14}C intercomparisons? Why? A summary report on SIRI', *Radiocarbon,* 59, 1589–96: https://doi.org/10.1017/RDC.2017.12

Sookdeo, A., Kromer, B., Büntgen, U., Friedrich, M., Friedrich, R., Helle, G., Pauly, M., Nievergelt, D., Reinig, F., Treydte, K., Synal, H-A., and Wacker, L. 2020 'Quality dating: a well-defined protocol implemented at ETH for high-precision ^{14}C-dates tested on late glacial wood', *Radiocarbon*, 62, 891–9: https://doi.org/10.1017/RDC.2019.132

Stuiver, M., and Polach, H. A. 1977 'Reporting of ^{14}C data', *Radiocarbon,* 19, 355–63: https://doi.org/10.1017/S0033822200003672

Synal, H-A., Stocker, M., and Suter, M. 2007 'MICADAS: a new compact radiocarbon AMS system', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* 259, 7–13: https://doi.org/10.1016/j.nimb.2007.01.138

Wacker, L., Němec, M., and Bourquin, J. 2010a 'A revolutionary graphitisation system: fully automated, compact and simple', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* 268, 931–4: https://doi.org/10.1016/j.nimb.2009.10.067

Wacker, L., Bonani, G., Friedrich, M., Hajdas, I., Kromer, B., Němec, M., Ruff, M., Suter, M., Synal, H-A. and Vockenhuber, C. 2010b 'MICADAS: routine and high-precision radiocarbon dating' *Radiocarbon,* 52, 252–62: https://doi.org/10.1017/s0033822200045288

Wacker, L., Christl, M., and Synal, H-A. 2010c. 'Bats: A new tool for AMS data reduction' *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 268, 976-9. https://doi.org/10.1016/j.nimb.2009.10.078

Ward, G. K., and Wilson, S. R. 1978 'Procedures for comparing and combining radiocarbon age determinations: a critique', *Archaeometry,* 20, 19–31: https://doi.org/10.1111/j.1475-4754.1978.tb00208.x

Whitehouse, N., Schulting, R., McClatchie, M., Barratt, P., McLaughlin, T., Bogaard, A., Colledge, S., Marchant, R., Gaffrey, J., and Bunting, M. 2014 'Neolithic agriculture on the European western frontier: the boom and bust of early farming in Ireland', *Journal of Archaeological Science,* 51, 181–205: https://doi.org/10.1016/j.jas.2013.08.009

Wijma, S., Aerts, A. T., van der Plicht, J., and Zondervan, A. 1996 'The Groningen AMS facility', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, 113, 465–9: https://doi.org/10.1016/0168-583X(95)01420-9

Appendix 1

CQL2 code for the chronological model shown in Figure 3.

```
Options()
 {
  Resolution=1;
  kIterations=20000;
 };
 Plot()
 {
  Sequence("Cat's Brain")
  {
   Boundary("StartCatsBrain");
   Sequence("Cat's Brain")
   {
    Phase("Structure 9287")
    {
     R_Combine("9319")
     {
      R_Date("GrM-29740", 5098, 27);
      R_Date("ETH-122540", 5056, 18);
     };
     R_Date("GrM-29739", 5029, 27);
     R_Date("ETH-122539", 5001, 18);
     R_Date("GrM-29738", 5030, 27);
     Last("BuildStructure9287");
    };
    R_Date("GrM-29398", 4891, 24);
    Date("BuildStructure9301");
    Phase("Pre-mound")
    {
     R_Date("ETH-122542", 4879, 25);
     R_Date("ETH-122543", 4919, 25);
    };
    Date("BuildMound");
    R_Date("GrM-29397", 4928, 24);
   };
   Boundary("EndCatsBrain");
  };
  Phase("Structure 9287")
  {
```

```
   R_Date("GrM-29669", 3861, 24)
   {
    Outlier();
   };
   R_Date("ETH-122537", 3865, 24)
   {
    Outlier();
   };
   R_Date("ETH-122538", 7299, 26)
   {
    Outlier();
   };
  };
};
```

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