**[Supplementary material]**

**Dorstone Hill: a Neolithic timescape**

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## Sample measurement methods

Radiocarbon samples from Dorstone hill were measured by Accelerator Mass Spectrometry (AMS) at the Scottish Universities Environmental Research Centre (SUERC) following methods outlined by Dunbar *et al.* (2016). The results are given in Table S1.

## Sample selection and association

Twelve radiocarbon measurements were produced on samples associated with Early Neolithic material culture, or from features that had stratigraphic associations with contexts containing Neolithic material. Sample selection was hampered because bone preservation on the site was very limited, pockets of osseous material survived in isolated areas on the site because of variation in the underlying geology and subsoil. These areas of good preservation suggest that significant qualities of osseous material that may have been deposited at the site have not been preserved in the archaeological record. In addition, while a programme of bulk sampling and flotation was undertaken limited short-life charred plant macrofossils were recovered. As a result of the limited available ecofacts, it was only possible to produced a relatively limited number of radiocarbon measurements (see discussion below).

## Bayesian analysis

The radiocarbon results from Dorstone hill have been analysed within the framework of Bayesian chronological modelling (Buck *et al.* 1996). Reporting follows Bayliss (2015) and Millard (2014).

Bayesian chronological modelling was undertaken using the program OxCal v4.4 (Bronk Ramsey 2009) and the calibration dataset of Reimer et al. (2020). The chronological models for each site are described and defined exactly in the figures using the OxCal CQL2 keywords. In the text and tables, the Highest Posterior Density intervals of the posterior density estimates are given in italics, followed by a reference to the relevant parameter name and the figure which illustrates how the estimate is calculated. In the diagrams, calibrated radiocarbon dates are shown in outline and the posterior density estimates produced by the chronological modelling are shown in solid black.

## Modelling approaches applied here

Here we present three modelling approaches to the radiocarbon data. These make slightly different interpretations of the temporal relationships between the radiocarbon measurements and the archaeological events of interest. The models are:

1. Model One: Stratigraphic Relationships. In this model we apply the stratigraphic relationships between the parent deposits as prior information. The relationships between the parent contexts are shown in Figure S1. The modelling approaches are shown in Figure S2. In the Western Mound, the context that produced the sample for SUERC-62606 was stratigraphically earlier than the context that produced the sample for SUERC-633307, which in turn was earlier than the context which produced the sample for SUERC-77965. In the Eastern Mound, a group of measurements (SUERC-81186, -81187, -81188 and -80526) represented a premound archaeological phase of activity, which was post-dated by archaeological activity sampled by SUERC-80524. A single measurement (SUERC-62311) was produced from activity prior to the construction of the Central Mound. From the Causewayed Enclosure, a result (SUERC-96876) on an articulating group of red deer bones from a basal fill from the western terminal of the north-west entrance. Subsequent features were cut into the in-filled Causewayed Enclosure. A measurement was produced on a sample (SUERC-81192) from a pit cut into the alluvial material that sealed the Causewayed Enclosure. Later again than this was another feature which cut the Causewayed Enclosure ditch, a measurement (SUERC-80525) was produced on deer antler from this feature.
2. Model Two: Archaeological Phases. In order to test the sensitivity of the output to these interpretations of the prior information, we developed an alternative model. In Model 2 (Figure S3), we revised this stratigraphic model in order to apply an approach that was less informative. In this model we present the results (SUERC-62606 and SUERC-63307) which were produced from contexts prior to the construction of the mound as a phase of archaeological activity rather than a stratigraphic sequence.
3. Model Three: Single Phase Model. We developed Model Three (Figure S4) to take an event more neutral approach to the data. In this we presented the radiocarbon measurements from each of the mounds as representing an archaeological phase of activity, with results related but otherwise not ordered in time.

We compare the results of these different approaches in Table S1 and in Figure S5.

## Results

Table S2 compares the outputs from different modelling approaches. While the posterior density estimate ranges do change depending on the modelling approach employed the differences are relatively minor, as can also be seen from the medians of some of these distributions plotted in Figure S5. The parameters that are appear to be most sensitive to the different modelling choices are those estimating the overall start of activity and those estimating the first early Neolithic activity associated with the Western Mound. We prefer the modelling approach we have employed in Model 2, because we believe the measurements that were produced from the pre-mound activity associated with the Western Mound are better presented using the Phase command rather than relying on the stratigraphic sequence. Both the measurements from this part of the site (SUERC-63306 and SUERC-63307) are from charred plant remains, SUERC-63306 from the Western Mound ‘burnt core’ and SUERC-62606 from the fill of a posthole that was sealed by the Western Mound ‘burnt core’. Taphonomic studies of the formation processes of the fills of posthole (Reynolds 1995) suggest that material that fills postholes may move into voids that are formed as posts settle or rot, and therefore may represent activity associated with the use of a structure. It therefore seems possible that the measurement from the pre-mound posthole may have been produced on material associated with the firing of the mound core. In the rest of this Supplementary Material, and in the main publication we therefore discuss the results from Model 2.

## Preferred model output

From our preferred model (Model 2) we estimate that the start of early Neolithic activity at Dorstone occurred in *3910–3760 cal BC* (*95% probability*; *start Dorstone sensitivity 2*; Figure S3). The early Neolithic activity at Dorstone for which we have evidence ended in *3760–3610 cal BC (95%probable; end Dorstone sensitivity 2*; Figure S3). In addition to the estimates in Table S2 we have been able to estimate the construction of the different mounds. The Western Mound was constructed in *3785–3670 cal BC* (*95% probable*; *construct Western Mound*; Figure S3), most probably in the last three-quarters of the 38th century cal BC, in *3775–3710 cal BC* (*68% probable*. The Eastern Mound was constructed in *3765–3660 cal BC (95% probable*; *construct Eastern Mound*; Figure X.3, or in *3755–3715 cal BC 40% probable* or *3695–3665 cal BC 28% probable*). We estimate that the Central Mound was constructed in *3825–3650 cal BC* (*95% probable*; *construct Central Mound*; Figure S3; or in *3805–3715 cal BC*; *68% probable*).

The premound activity associated with the Central Mound (*SUERC-62311*) could again be slightly earlier than the premound activity associated with the areas that were later the sites of the Western and Eastern mounds; it is *83% probable* that the pre-Central Mound activity (*SUERC-62311*) occurred before our first estimate for the pre-Western Mound activity (*first Western premound)*, and it is *93% probable* that the pre-Central Mound activity (*SUERC-62311*) occurred before our first estimate for the pre-Eastern Mound activity (*first Eastern premound*). However, we only have one radiocarbon measurement associated with the Central Mound so we cannot regarded the chronology of this part of the complex as definitive. It is most probable (*68% probable)* that the pre-mound activity in the area that became the Western Mound (*first Western premound*) occurred before the first activity in the area that became the Eastern Mound (*first Eastern premound*).

These mound construction events occurred over *1–130 years (95% probable*) or *5–75 years (68% probable*; *duration construction;* figure not shown). It is possible that the Central Mound was constructed first; it is *60% probable* that *construct Central Mound* occurred before *construct Western Mound*, and it is *77% probable* that *construct Central Mound* occurred before *construct Eastern Mound.* However, as mentioned above, the chronology of the Central Mound is under-represented. With the better-dated Eastern and Western mounds, it is more probable (*78% probable*) that the Western Mound was constructed before the Eastern Mound.

If we regarded the mounds as part of a single unitary construction—which could be supported by the construction duration estimate above—we can estimate the point in time when this event took place. Figure S6 shows an estimate for this construction event using the Combine function and the posterior density estimates calculated in Figure S3. If the monument was constructed as a single event we estimate that this would have taken place in *3770–3705 cal BC* (*95% probable*) or *3695–3675 cal BC* (*5% probable*; Figure S6). If the monument represents a single construction event therefore, it most probably took place in the 38th century cal BC.

The measurements from the mortuary structure ditch and from the structure appear to represent activity of similar ages. The estimate from the structure (*SUERC-81188*) suggests that this may have been in use in *3805–3705 cal BC* (*95% probable*; *SUERC-81188*; Figure S3). The estimate for the first dated event associated from the mortuary structure ditch suggests this occurred in *3800–3720 cal BC* (*95% probable*; *first mortuary structure ditch*; Figure S3), while the last dated event associated with this features occurred in *3770–3675 cal BC* (*95% probable; last mortuary structure ditch*; Figure S3). The estimate associated with the use of the structure and the first estimate from the ditch could be contemporary.

## Comparison with other sites

We can compare the results (Figure S7) associated with early Neolithic material culture from Dorstone Hill with other enclosure sites south Wales and the Marches, and the estimate for the start of early Neolithic activity in south Wales and the Marches as a whole (Griffiths in Britnell and Whittle 2022). The posterior density estimates from other causewayed enclosure sites in this figure have been recalculated from the estimates in Whittle *et al.* (2011) using the new calibration date of Reimer *et al.* (2020). The occupation activity at Dorstone is as early as any other evidence for early Neolithic practices in south Wales and the Marches, most probably beginning in the 39th century cal BC. As sites in Britain, at Dorstone, causewayed enclosures are not the earliest Neolithic activity.

At Dorstone, the features identified as the causewayed enclosure could be slightly earlier than other examples in south Wales and the Marches. The evidence available for the Dorstone enclosure places the earliest activity here in the 37th or 36th centuries cal BC, most probably in the very late 38th century or the 37th century (*3710–3545 cal BC 68% probable*; *first\_Dorstone\_enclosure*; Figure S7). Given this estimate, Dorstone certainly pre-dates the evidence for causewayed enclosures at Lower Luggy, Wormaston, Hill Croft and Caerau. It is also *74% probable* that the estimate for the first activity associated with the Dorstone enclosure predates the estimate for the first activity associate with the Banc Du enclosure *(start\_Banc\_Du;* Figure S7).

Looking more widely, we can compare the chronology of the Dorstone causewayed enclosure monuments with the history of enclosure making in southern England. For these comparisons, we have used the distributions calculated by Whittle *et al.* (2011) and the dataset of Reimer *et al.* (2013) to provide an initial comparison; it was beyond the capacity of this project to completely recalculate the 2011 Whittle *et al.* dataset. As we can see from Figure S8, the estimate for the Dorston enclosure places it amongst the earliest evidence for these monument types that we have in southern England. In Figure S8, we can compare the Dorstone estimate with selected causewayed enclosure sites from southern England. Here we can see that while the features at Dorstone are early in the sequence of causewayed enclosures, the Dorstone enclosure is not as early as sites in southern England, its is *65% probable* that the parameter associated with south west enclosures occurred before the estimate for the enclosure from Dorstone. It is*76% probable* that the parameter from south east England occurred before the estimate for the enclosure from Dorstone, while the estimate for the first enclosure from central south England is much more similar to the estimate from Dorstone.

Our understanding of the chronology of the Dorstone causewayed enclosure is not as developed as we would like, because of the limited available ecofacts with which to make radiocarbon measurements. However, the key estimate here (SUERC-96876) was on an element from a group of articulating red deer bones in the basal fill of the causewayed enclosure ditch sequence. This result therefore should provide a robust estimate for the infilling of the feature, and therefore the timing of the early use of the monument.

### Table S1. Radiocarbon measurements associated with early Neolithic material culture from Dorstone Hill.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Laboratory code** | **Radiocarbon age (BP)** | **δ13C, δ15N, C/N ratio** | **14C sample** | **Parent context description** | **Calibrated radiocarbon result (cal BC; 95% confidence)** |
| SUERC-62311 | 5113±30 | δ13C −24.8 | Short-life charcoal (*Corylus* sp.) | DH12 (017) Central mound. Burnt core of mound (sample material may represent remains of burnt structure or wood introduced to the structure as fuel before burning). | 3980–3800 |
| SUERC-63307 | 4954±30 | δ13C −26.4 | Short-life charcoal (*Prunus* sp.) | DH14 (513) Western Mound. Primary 'burnt core' | 3795–3645 |
| SUERC-77965 | 4972±28 | δ13C −25.3 | Short-life charcoal (*Alnus/Corylus)* | DH14 (519) Western Mound. Fill of pit [518] on S side of W mound, sealed by earthen mound erosion layer (504) | 3895–3650 |
| SUERC-62606 | 5029±34 | δ13C −25.6 | Short-life charcoal roundwood (*Prunus avium/padus*) | DH15 (788) Western Mound. Fill of posthole [779] sealed by burnt mound core (513). | 3955–3660 |
| SUERC-80524 | 4975±25 | δ13C −21.3 | Burnt (cremated) bone (*Bos*) | DH16 (1054) Eastern Mound. Basal fill of Fill of stone-lined pit [1056] cut into top of Eastern mound. | 3895–3650 |
| SUERC-80526 | 4901±25 | δ13C −25.1 | Cremated bone (Mammalian) | DH16 (1050) (same as 1096) Eastern Mound. Burnt deposit in mortuary enclosure ditch [1066], sealed by mound deposit (1023/1076) | 3710–3635 |
| SUERC-81186 | 4975±21 | δ13C −27.5 | Cremated bone (Mammalian) | DH16 (1050) (same as 1096) Eastern Mound. Burnt deposit in mortuary enclosure ditch [1066], sealed by mound deposit (1023/1076) | 3800–3650 |
| SUERC-81187 | 4973±24 | δ13C −25.3 | Short-life Charcoal (*Corylus* sp.) | DH16 (1096) (same as 1050) Eastern Mound. Burnt deposit in mortuary enclosure ditch [1066], sealed by mound deposit (1023/1076) | 3895–3650 |
| SUERC-81188 | 4997±24 | δ13C −26.2 | Charcoal, sapwood (*Quercus* sp.) | (1091) Eastern Mound. Remnant of burnt in situ post T.011, within posthole [1092], cut into ancient land surface (1003) and sealed by primary 'burnt mound core' (1002) | 3940–3655 |
| SUERC-80525 | 4584±24 | δ13C −21.7  δ15N4.9  C/N 3.2 | Antler (*Cervus* sp.) | (2133) Causewayed Enclosure. Basal fill of intrusive feature cutting Enclosure ditch. | 3490–3340 |
| SUERC-81192 | 4792±24 | δ13C −23.8 | Single-entity charred hazelnut shell (*Corylus* sp.) | (2004) Causewayed Enclosure. Fill of pit cut into alluvial material sealing causewayed enclosure | 3640–3520 |
| SUERC-96876 | 4922±26 | δ13C −23  δ15N3.6  C/N 3.2 | Articulating bone group; *Cervus elaphus* tarsal (articulating with metatarsal) | (2226) Causewayed Enclosure. Basal fill within western terminal of NW entrance | 3770–3640 |

**Table S2. Comparable outputs from different modelling approaches employed here.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Archaeological event of interest** | **Model 1 Output (95% probability; cal BC)** | **Model 2 Output (95% probability; cal BC)** | **Model 3 Output (95% probability; cal BC)** |
| Beginning of early Neolithic activity at the site | *3965–3775*  *start Dorstone mounds* | *3910–3765*  *start Dorstone sensitivity 2* | *3970–3770*  *start Dorstone sensitivity version 3* |
| First early Neolithic activity associated with the Western Mound | *3895–3720*  *first Western Mound* | *3855–3720*  *first Western premound* | *3900–3715*  *first Western Mound* |
| Last early Neolithic activity associated with the Western Mound | *3775–3655*  *last Western Mound* | *3770–3650*  *last Western premound* | *3770–3650*  *last Western Mound* |
| First early Neolithic activity associated with the Eastern Mound | *3890–3720*  *first Eastern Mound* | *3885–3730*  *first Eastern premound* | *3810–3725 (94%)*  *first Eastern Mound* |
| Last early Neolithic activity associated with the Eastern Mound | *3755–3650*  *last Eastern Mound* | *3770–3675*  *last Eastern premound* | *3755–3640*  *last Eastern premound* |
| Date of early Neolithic activity associated with the Central Mound | *3880–3765*  *SUERC-62311* | *3870–3760*  *SUERC-62311* | *3880–3765*  *SUERC-62311* |
| First early Neolithic activity associated with the Causewayed Enclosure | *3770–3640*  *first Dorstone enclosure* | *3770–3640*  *first Dorstone enclosure* | *3770–3640*  *first Dorstone enclosure* |
| Last early Neolithic activity associated with the Causewayed Enclosure | *3495–3125*  *last Dorston enclosure* | *3495–3460 (18%)* or *3380–3330 (66%)* or *3220–3180 (8%)* or *3150–3125 (3%)*  *last Dorston enclosure* | *3495–3455 (18%)* or *3380–3330 (66%)* or *3215–3185 (8%)* or *3155–3120 (3%)*  *last Dorston enclosure* |

## Diagram Description automatically generated

*Figure S1. The stratigraphic relationships between the parent contexts from which radiocarbon samples were recovered (figure by Seren Griffiths and Nick Overton).*

A picture containing diagram

Description automatically generated

*Figure S2. Model One was constructed with the stratigraphic relationships outlined in Figure S1. The OxCal CQL2 keywords and the brackets define the model. Distributions given in outline represent the calibrated radiocarbon results, while the black distributions represent the posterior density estimates (Seren Griffiths and Nick Overton).*

A picture containing text, antenna

Description automatically generated

*Figure S3. Model Two was constructed using an interpretation of the relationships between the radiocarbon measurements based on archaeological phases identified in the Western Mound. The OxCal CQL2 keywords and the brackets define the model. Distributions given in outline represent the calibrated radiocarbon results, while the black distributions represent the posterior density estimates (Seren Griffiths and Nick Overton).*



*Figure S4. Model Three presents the data from each of the mounds as if they represented a single archaeological phase of activity. The OxCal CQL2 keywords and the brackets define the model. Distributions given in outline represent the calibrated radiocarbon results, while the black distributions represent the posterior density estimates (Seren Griffiths and Nick Overton).*

Chart

Description automatically generated

*Figure S5. Comparisons of the different outputs from the models constructed in figures S2–S4 (Seren Griffiths and Nick Overton).*

Chart

Description automatically generated

*Figure S6. The combined estimates for all the mound construction events indicate that, if this represented a single event, the monument was most probably built in the 38th century cal BC (Seren Griffiths and Nick Overton).*

Chart, diagram

Description automatically generated

*Figure S7. Comparisons of the estimate for key parameters from Dorstone with estimate for early Neolithic activity from south Wales and the Marches. These estimates are calculated in Griffiths (in Britnell and Whittle 2022).*

A picture containing text, antenna

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*Figure S8. Comparisons of the estimate for the Dorstone causewayed enclosure with other enclosures from southern England. These comparison data were calculated in Whittle* et al*. (2011) using the dataset of Reimer* et al*. (2013), while these parameters are not directly comparable they give an indication of how the Dorstone enclosure could fit into a wider history of early Neolithic place making in Britain (Seren Griffiths and Nick Overton).*

## Code

//NB the different modelling approaches to the chronometric data from Dorstone should be run separately

//Model 1

Options()

{

Resolution=1;

};

Plot()

{

//please cite as Griffiths, S. 2022. Supplementary material. In K. Ray et al. 2022. Dorstone Hill: A Neolithic Timescape

Sequence()

{

Boundary("start Dorstone mounds");

Phase("Dorstone mounds")

{

Sequence("Western Mound")

{

R\_Date("SUERC-62606", 5029, 34);

R\_Date("SUERC-63307", 4954, 30);

R\_Date("SUERC-77965", 4972, 28);

First("first Western Mound");

Last("last Western Mound");

};

Sequence("Eastern Mound")

{

Phase("pre Eastern Mound")

{

R\_Date("SUERC-81188", 4997, 24);

R\_Date("SUERC-80526", 4901, 25);

R\_Date("SUERC-81186", 4975, 21);

R\_Date("SUERC-81187", 4973, 24);

};

R\_Date("SUERC-80524", 4975, 25);

First("first Eastern Mound");

Last("last Eastern Mound");

};

Phase("Central Mound")

{

R\_Date("SUERC-62311", 5113, 30);

};

Span("Use Dorstone mounds");

};

Boundary("end Dorstone mounds");

};

Sequence("causewayed enclosure")

{

R\_Date("SUERC-96876", 4922, 26);

R\_Date("SUERC-81192", 4792, 24);

R\_Date("SUERC-80525", 4584, 24);

First("first Dorstone enclosure");

Last("last Dorstone enclosure");

};

Order()

{

Date("=first Western Mound");

Date("=first Eastern Mound");

Date("=first Dorstone enclosure");

};

};

//Model 2

Options()

{

Resolution=1;

};

Plot()

{

//please cite as Griffiths, S. 2022. Supplementary material. In K. Ray et al. 2022. Dorstone Hill: A Neolithic Timescape

Sequence()

{

Boundary("start Dorstone sensitivity 2");

Phase("Dorstone")

{

Sequence("Western Mound")

{

Phase("use/firing structure underlying mound")

{

R\_Date("SUERC-62606", 5029, 34);

R\_Date("SUERC-63307", 4954, 30);

};

Date("construct Western Mound");

R\_Date("SUERC-77965", 4972, 28);

};

Sequence("Eastern Mound")

{

Phase("activity predating Eastern Mound")

{

Phase()

{

R\_Date("SUERC-81187", 4973, 24);

R\_Date("SUERC-81186", 4975, 21);

R\_Date("SUERC-80526", 4901, 25);

First("first morturary structure");

Last("last morturary structure");

};

R\_Date("SUERC-81188 structure", 4997, 24);

};

Date("construct Eastern Mound");

R\_Date("SUERC-80524", 4975, 25);

};

Sequence("Central Mound")

{

R\_Date("SUERC-62311", 5113, 30);

Date("construct Central Mound");

};

First("first Dorstone sensitivity 2");

Last("last Dorstone sensitivity 2");

Span("duration Dorstone sensitivity 2");

};

Boundary("end Dorstone sensitivity 2");

};

Sequence("causewayed enclosure")

{

R\_Date("SUERC-96876", 4922, 26);

R\_Date("SUERC-81192", 4792, 24);

R\_Date("SUERC-80525", 4584, 24);

First("first Dorstone enclosure");

Last("last Dorstone enclosure");

};

Order()

{

Date("=first morturary structure");

Date("=last morturary structure");

Date("=SUERC-81188 structure");

};

Phase("calculations")

{

Date("=construct Western Mound");

Date("=construct Eastern Mound");

Date("=construct Central Mound");

Span("duration construction");

};

};

//Model 3

Options()

{

Resolution=1;

};

Plot()

{

//please cite as Griffiths, S. 2022. Supplementary material. In K. Ray et al. 2022. Dorstone Hill: A Neolithic Timescape

Sequence()

{

Boundary("start Dorstone sensitivity version 3");

Phase("Dorstone")

{

Phase("Western Mound")

{

R\_Date("SUERC-62606", 5029, 34);

R\_Date("SUERC-63307", 4954, 30);

R\_Date("SUERC-77965", 4972, 28);

First("First Western Mound");

Last("Last Western Mound");

};

Phase("Eastern Mound")

{

R\_Date("SUERC-81187", 4973, 24);

R\_Date("SUERC-81186", 4975, 21);

R\_Date("SUERC-80526", 4901, 25);

R\_Date("SUERC-81188 structure", 4997, 24);

R\_Date("SUERC-80524", 4975, 25);

First("First Eastern Mound");

Last("Last Eastern Mound");

};

Phase("Central Mound")

{

R\_Date("SUERC-62311", 5113, 30);

};

First("first Dorstone sensitivity version 3");

Last("last Dorstone sensitivity version 3");

Span("duration Dorstone sensitivity version 3");

};

Boundary("end Dorstone sensitivity version 3");

};

Sequence("causewayed enclosure")

{

R\_Date("SUERC-96876", 4922, 26);

R\_Date("SUERC-81192", 4792, 24);

R\_Date("SUERC-80525", 4584, 24);

First("first Dorstone enclosure");

Last("last Dorstone enclosure");

};

};

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